4 Business Analysis

Every business decision must start from an in-depth analysis of the potential investment opportunities. In order to understand the right choice for project undertaking, all possible choices must be analyzed.

Capital budgeting goes through the application of well-known rules that allow the analyst to understand the potential of every investment opportunity, by setting criteria to be used in order to make the best possible choice in terms of profitability.

Project valuation is then an important part of the corporate finance literature, in that financial managers can use probabilistic approaches in order to value a project, given possible future states of the world.

The definition of scenarios and simulations in fact allows to implement efficient valuation practices and to obtain a fair valuation of the profitability of each investment opportunity through careful identification of the most likely outcomes.

Once good projects are identified, then it is very important to properly calculate the cost of capital associated with financing a profitable investment opportunity, so as to minimize the funding cost.

Cost of capital valuation can be done for both equity capital and debt capital and involves applying a fairly simple mathematical tool to the valuation of financial assets, so to realize what is the cost involved in fund raising.

After studying this chapter, you will be able to answer the following questions, among others:

- What are the rules of capital budgeting, and how can they be implemented for project selection?
- How is it possible to decide which rule is best to apply for any specific case?
- How can probabilistic approaches be used for project valuation?
- What are the models and procedures for debt and equity capital valuation?
- What is the difference between levered and unlevered capital?

A. Corelli, *Analytical Corporate Finance*, Springer Texts in Business and Economics, https://doi.org/10.1007/978-3-319-95762-3_4

The first section of the chapter is about the rules of capital budgeting, how they can be defined, and the differences between them in terms of application and final output. The second section deals with the probabilistic approaches to project valuations. The third section focuses on the cost of capital and how it can be calculated for both debt capital and equity capital, with insight on the concept of levered and unlevered capital, and how it impacts on valuation.

4.1 Capital Budgeting Decision Rules

Learning Outcomes

- Learn how to apply the net present value rule for capital budgeting.
- Learn how to apply the internal rate of return rule for capital budgeting.
- Learn how to apply other rules for capital budgeting.

4.1.1 The Net Present Value Rule

Capital budgeting is the process, also named investment appraisal, for determining the feasibility (in terms of economic and financial convenience) of some long-term investment and their worthiness to fund them through the firm's capitalization structure.

Capital can be input in the form of equity, such as retained earnings, or debt, and the capital budgeting definition extends to the process of allocating resources for major capital, or investment, expenditures.

As per theory of corporate finance, the capital budgeting of investments has the primary goal to increase the value of the firm to the shareholders, and maximize it, given the financial constraints (McNeil et al. 2005).

Long-term projects are expected to generate cash flows over several years, making the choice of the right projects a crucial task. The decision to accept or reject a capital budgeting project depends on an analysis of the cash flows generated by the project and its cost.

In the financial theory of capital budgeting, two main rules apply for the decision of acceptance or rejection of a project, namely:

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

A capital budgeting decision rule should satisfy the following criteria:

- Consider all of the project's cash flows.
- Consider the time value of money.
- Always lead to the correct decision when choosing among mutually exclusive projects.

In theory a firm should pursue all investment opportunities that enhance shareholders' value. The problem is that resources are not infinite; therefore, there are constraints related to the amount of capital available for new projects, at any point in time.

Before examining the various capital budgeting rules available to financial analysts, it is important to have a look at the assumptions governing capital budgeting in general, which are as follows:

- Decisions are based on cash flows, not income.
- Timing of cash flows is important.
- Cash flows are based on opportunity cost: cash flows that occur with an investment compared to what they would have been without the investment.
- Cash flows are analyzed on an after-tax basis.
- Financing costs are ignored because they are incorporated in the cost of capital.

There are some concepts in capital budgeting that are very common among managers, who find them useful. Sunk costs, for example, are costs already incurred by the firm, so that they do not affect the actual costs.

Opportunity costs are those related to the value of a resource that is used in some way but could have been used for another purpose. Those costs should be considered at the current market value of the asset in use.

The concept of incremental cash flow is also very important, and it focuses on the cash flow that is generating by making some decision about the project and net of the cash flow that could be realized without making the decision (Scott et al. 1999).

Externality is the effect of an investment on other things apart from the investment. Those effects hit the society or other external agents that are somehow connected to the firm, and they can be positive or negative. Both should be considered.

An example of externality is cannibalization, defined as the situation where an investment takes customers and sales from another part of the company. They should be considered in the analysis because they are incremental cash flows.

Decision criteria can be evaluated according to three main issues. First of all, one must assess whether the decision rule adjusts for the time value of money. Secondarily, it is important to understand whether the decision rule adjusts for risk. The final issue is the informative power of the decision rule about whether value is being created for the firm.

Recall that the NPV of a project indicates whether the impact of investing in it on the value of the firm will be positive or negative. Specifically, projects with a positive NPV are expected to increase the value of the firm.

Based on the above concepts, the NPV decision rule states that the company should undertake the independent projects having a positive NPV. When projects are mutually exclusive, the project with the largest NPV should be chosen.

Consider two different projects, A and B, available to the company. They can be any investment opportunity involving some capital expense and producing an outcome of some type and value.

Financial constraints do not allow the company to invest in both projects, so an analysis is needed to understand which project to undertake, if any. Two investments that are alternative to each other but cannot be both undertaken are called mutually exclusive.

Project A cash flows can be indicated as $\{C_{A,\ 0}, C_{A,\ 1}, \ldots, C_{A,\ N}\}$, while for project B the cash flows are shown by the series $\{C_{B,\ 0}, C_{B,\ 1}, \ldots, C_{B,\ N}\}$.

Formally, the NPV rule states that project A is preferred to project B if

$$\mathrm{NPV}_{\mathrm{A}} > \mathrm{NPV}_{\mathrm{B}}$$

where:

$\mathrm{NPV}_{\mathrm{A}}$ is the net present value of project A.
$\mathrm{NPV}_{\mathrm{B}}$ is the net present value of project B.

The present value of projects' cash flows corresponds to the economic actual value of the project, as

$$\mathrm{NPV}_{\mathrm{A}} = C_{\mathrm{A},0} + \frac{C_{\mathrm{A},1}}{(1+r)} + \frac{C_{\mathrm{A},1}}{(1+r)^2} + \ldots + \frac{C_{\mathrm{A},N}}{(1+r)^N} = \sum_{t=1}^{N} \frac{C_{\mathrm{A},t}}{(1+r)^t}$$

Given the right choice for r, the value is the price at what the project could be sold at present in the market. The associated NPV represents the wealth increment brought by the project, and then if NPV > 0 the project is augmenting the wealth.

The relationship can be then formalized as

$$C_{\mathrm{A},0} + \sum_{t=1}^{N} \frac{C_{\mathrm{A},t}}{(1+r)^t} > C_{\mathrm{B},0} + \sum_{t=1}^{N} \frac{C_{\mathrm{B},t}}{(1+r)^t}$$

According to the NPV decision rule, a project should be accepted only if it has a positive or null NPV. Projects with negative NPV should be rejected. In case resources allow for only one project to be undertaken, when comparing two or more exclusive projects having positive NPVs, accept the one with the highest NPV (Khan 1993).

When cash flows are uneven, so not constant over time, the calculation is different and can be summarized in the following example:

Example 4.1 Assume an initial investment on fixed assets of 832,000 €. It is expected to generate cash inflows of 341,100 €, 407,000 €, 582,400 €, and 206,500 € at the end of the first, second, third, and fourth year, respectively. At the end of the fourth year, the residual value of assets is 90,000 €. To calculate the present value of the investment for a discount rate of 18%, it is necessary to first calculate the PV factors associated with the 4 years. The rest of the problem can be solved more efficiently in table format as shown below:

Year	0	1	2	3	4
Net cash inflow		341,100	400,700	582,400	206,500
Salvage value					90,000
Total cash inflow		341,100	400,700	582,400	296,500
PV of cash flows		289,068	287,776	354,467	152,931
Total PV of cash inflows	1,084,242				
Initial investment	(−)832,000				
Net present value	252,242				

4.1.2 The Internal Rate of Return Rule

Another popular capital budgeting rule is based on the internal rate of return of the project, therefore named the IRR rule. Recall that the IRR is defined as the discount rate for which the NPV equals zero. It is the compound rate of return that you get from a series of cash flows.

Suppose there is a project that generates cash flows $\{C_0, C_1, \ldots, C_N\}$. Consider discounting the series of cash flows by the IRR of the project, so to get a null NPV, as described by

$$C_0 + \frac{C_1}{(1+\mathrm{IRR})} + \frac{C_2}{(1+\mathrm{IRR})^2} + \ldots + \frac{C_N}{(1+\mathrm{IRR})^N} = C_0 + \sum_{t=1}^{N} \frac{C_t}{(1+\mathrm{IRR})^t} = 0$$

Assume now discounting the same series of cash flows by the appropriate discount rate r for the project, given by the nature of the project itself and the market conditions. The IRR rule states that the project should be accepted if its IRR $> r$ and rejected it if its IRR $< r$.

The logic behind that is that when r is lower than IRR, the project cash flows give a positive NPV, therefore making the investment worthwhile. The IRR is the compound return you get from the project. Since r is the project's required rate of return, it follows that if the IRR $> r$, the project gives more than required.

As for the NPV rule, the IRR rule also can be extended to set the criteria for the choice between two or more projects. Consider trying to decide between two mutual exclusive projects.

The IRR rule states that project A is preferred to project B if $\mathrm{IRR}_A > \mathrm{IRR}_B$. The logic is clear if one thinks that the IRR is the project compound rate of return. When choosing between two projects using the IRR rule, it is logic to prefer the higher compound rate of return.

Both budgeting rules are logical and sound reasonable when applied to projects. In most cases both NPV and IRR rule will give the same answer on whether it is worth it to invest in a specific project or not.

There are some cases, however, where NPV and IRR give different answers. In such cases, one should always use the NPV to decide between projects. The logic is that if individuals are interested in maximizing their wealth, they should use NPV, which measures the incremental wealth from undertaking a project.

4.1.3 The Payback Rule

The length of time required to recover the initial amount invested in a project is called payback period. The payback period (P_P) capital budgeting rule takes its name from that concept.

In order to apply the rule, first of all the financial manager must establish the maximum acceptable payback period length, indicated with $\tilde{P}_P$. The practice suggests that common average payback period is around 3 years.

In determining whether to accept or reject a particular project, the payback period decision rule is

Accept if $P_P < \tilde{P}_P$.
Reject if $P_P > \tilde{P}_P$.
Indifferent where $P_P = \tilde{P}_P$.

For mutually exclusive alternatives, accept the project with the lowest P_P if $P_P < \tilde{P}_P$.

Example 4.2 Consider a firm that is offered two mutually exclusive projects, A and B, where the firm's required rate of return is 10% and the project cash flows are given in the below table:

Time	Project A cash flows (€)	Project B cash flows (€)
Year 0	−10,000	10,000
Year 1	2000	6000
Year 2	8000	3000
Year 3	250	10,000
P_P	2.0	2.1
NPV	−1380	5480

The payback rule suggests that project A should be accepted; however, the NPV indicates that if A is accepted, the share price will fall. It appears that the payback method is not consistent with the goal of shareholder wealth maximization.

Compared to other rules, the PP rule shows some major drawbacks. For example, it ignores the time value of money and also does not account for the cash flows occurring after the payback period. Moreover, it ignores the scale of the investment.

The rule is appealing in that it provides a measure of the actual money at risk for the project. However, uncertainty increases for cash flows coming further in the future, making the rule not the best tool to account for risk (Levy and Sarnat 1994).

The advantage of implementing a measure like the payback rule is that it gives some measure of the money at risk in the investment. At the beginning of the investment, in fact there is a lot of uncertainty about future cash flows.

The economic environment and the cash flows from the project may be less favorable than initially forecasted. The uncertainty would increase for those cash flows in the more distant future.

But analyzing risk can be done more efficiently by using different methods than the payback criterion. If the measure of risk is what one is interested in, more than other pieces of information, there are two tools for analyzing the risk associated with more distant cash flows.

Recall that the discount rate associated to a series of cash flows can be decomposed in the risk-free part plus a risk premium on top, calculated as the reward demanded by investors for taking the risk of the investment. The discount rate can be therefore defined as

$$r_{\mathrm{DSC}} = r_{\mathrm{f}} + \lambda$$

where:

r_{f} is the risk-free rate.
λ is the risk premium.

It is interesting to analyze what the impact is of a higher discount factor on the present value factor (discounted unit value). The discount rates relate to the time horizon accordingly as can be indicated in the following table, containing a numerical example:

Discount factor	Year 1	Year 2	Year 3	Year 4
10%	0.91	0.83	0.75	0.68
15%	0.87	0.76	0.66	0.57
Difference	3.95%	7.03%	9.38%	11.13%

The risk premium clearly reduces the value of one dollar in the future, to a lower present value at current time. The reduction gets more substantial for longer periods, and it increases for periods 2–4.

4.1.4 The Profitability Index Rule

Another capital budgeting technique that can be employed when the company has limited supply of capital with which to invest in positive NPV projects is the profitability ratio or profitability index (PI).

Capital rationing problem is the lack of funds that forces a company to target the limited capital on just few projects, the ones that result in being the very best among the range of possible investment choices.

Given that the objective is to maximize shareholder wealth, the objective in the capital rationing problem is to identify that subset of projects that collectively have the highest aggregate net present value. In order to compute each project's PI, the formula to be implemented is

$$\mathrm{PI} = \frac{\mathrm{NPV}}{I}$$

where:

I is the amount invested in the project.

Once all the PIs for the projects in analysis are calculated, they must be ranked from the highest to the lowest, in order to select the appropriate investments from the top to the last until the capital budget is exhausted.

The method is based on the underlying idea that the index can provide the subset of projects that maximize the aggregate NPV. This is not always the case and in some cases this information can be inaccurate.

In case the company has limited resources to spread over several projects, then the profitability index cannot give complete information about the profitability of combinations of project, since it focuses on the single projects and their comparison.

If it is already known that there is a limited available budget, then it is possible to analyze the project(s) from the point of view of independent projects or combinations (portfolios) of them, against the available budget. This is done by calculating the weighted average profitability index (WAPI).

The formula for calculating the WAPI of a group of n projects is

$$\mathrm{WAPI} = \sum_{i=1}^{n} \frac{\mathrm{PI}_i A_i}{\mathrm{L}}$$

where:

PI_i is the profitability index of project i.
A_i is the amount invested in project i.
L is the total budget to invest, available to the company.

Example 4.3 Consider a company that has the following projects on the table, and decide in what project(s) to invest in, given a maximum total budget of 600,000 €.

Project	NPV (€)	Investment (€)	PI
A	460,000	400,000	1.15
B	282,500	250,000	1.13
C	388,500	350,000	1.11
D	324,000	300,000	1.08

It is clear that with the available budget, the company can only invest in either project B and D together, project B and C together, or project A only. So to choose which one is the right portfolio of projects, among the above three, one must calculate the WAPI associated to each of them:

$$\text{WAPI}_{\text{B,D}} = \frac{1.13 \times 250}{600} + \frac{1.08 \times 300}{600} + \frac{0.00 \times 50}{600} = 1.01$$

$$\text{WAPI}_{\text{B,C}} = \frac{1.13 \times 250}{600} + \frac{1.11 \times 350}{600} = 1.12$$

$$\text{WAPI}_{\text{A}} = \frac{1.15 \times 400}{600} + \frac{0.00 \times 200}{600} = 0.77$$

It is clear that given the assigned budget, the best way to invest the money is to invest in the combination of projects B and C, which has the highest WAPI.

The choice of the right capital budgeting rule to apply for investment decisions primarily relies on the nature and sequence of the cash flows generated by a project. These can be in fact conventional or nonconventional.

Conventional cash flows are such that there are one of many outflows followed by a series of inflows, and the change in sign occurs therefore only once. In general, every series of cash flows can be considered conventional as long as it involves only one change in sign in the whole series, either from plus to minus or from minus to plus.

Nonconventional cash flows involve initial outflow(s) followed by a series of both inflows and outflows, with more than one change in sign during the length of the timeline.

Another important distinction for choosing the right rule to apply is between independent versus mutually exclusive projects. Two projects are defined as independent when cash flows from one project are independent from those of another project.

It implies that there is no connection or overlap between projects, and all of them are being evaluated and could potentially all be selected as long as their projected cash flows will produce a positive NPV or generate an IRR greater than the firm's hurdle rate.

On the other hand, two projects are defined as mutually exclusive when they directly compete with each other. This happens, for example, in the case when some machinery or equipment in a factory must be changed.

Usually it happens that more than one supplier can make an offer on a brand new piece of equipment to replace the old one, and only one of the many offers will be accepted so that they are all in competition.

With regard to capital available, a distinction can be made between unlimited funds and capital rationing. Recall that capital rationing exists when a company has fixed amounts of funds to invest.

The existence of capital constraints will lead to the existence of the capital rationing issue, therefore not allowing the company to invest in more than just a few selected projects.

Another important concept is project sequencing, a concept related to the situation where many projects are evaluated through time. It happens when investing in one project gives the option to invest for other projects in the future. For example, an investor can decide to open a restaurant this year and if the financial results are positive after some years, a hotel could then be built next to the restaurant.

The conclusion is that the NPV criterion, with appropriately set discount rates, already accounts for the fact that risk increases with the time horizon.

Moreover, there is much less information about the more distant future than the immediate future, and if circumstances change in the future, the design of the project would also change accordingly (Emery et al. 1998).

4.2 Project Valuation

Learning Outcomes

- Learn how to use scenario analysis for project valuation.
- Learn how to design decision trees for project valuation.
- Learn how to run simulations for project valuation.

4.2.1 Scenario Analysis

Standard rules for capital budgeting are based on assumptions about the knowledge of the right amount of cash flows associated to a project and their valuation according to some criteria.

In real life, most cases show that there is uncertainty in the future, and it is not easy to predict future cash flows without using some specific tools. This section is devoted to the definition and explanation of some of the probabilistic tools that can be used for project valuation.

The first valuation tool that helps take into account the uncertainty under different possible states of the world is the scenario analysis, evaluating the impact of simultaneous changes in a number of sensitive variables (Dutta and Babbel 2013).

The simplest implementation of scenario analysis is called back testing, which involves developing a specific asset in case history should repeat itself. It consists in creating just one scenario of how the situation could evolve.

The actual real scenario analysis moves further in the analysis, by considering more factors than the back testing, with a deeper view of the historical scenarios to replicate. It takes a more in-depth look at the future while taking into account historical data and economic knowledge.

There are four basic steps involved in general preparation of a scenario analysis. They can be listed as follows:

- Identification of the relevant factors to build the scenario around
- Choice of the number of scenarios to be analyzed for each selected factor
- Estimation of the outcomes for each possible scenario
- Determination of the probabilities to assign to each scenario

The usual representation of results of the analysis is through outcomes generated, but if probabilities are assigned to each scenario, it is also possible to express the outcomes as weighted averages (expected value) assuming probabilities for each scenario can be estimated, in order to weigh the average accordingly.

Each factor gets assigned a value in order to depict a specific scenario. It is common practice, for example, to simulate a best-case and worst-case scenario in order to bound the range of possible outcomes from some possible investment decision.

The analysis usually starts from historical analysis, by taking into account past returns as a basis for the modeling of the scenario. In fact, on returns many variables can be calculated as volatility and correlation.

After the scenario is completed and all the above points are fulfilled, the last step is the use of the scenario result to plan strategies.

Example 4.4 Consider the following table summarizing three possible states of the world:

Economy	Probability	Stock A return	Stock B return
Boom	20%	15%	10%
Normal	60%	5%	−5%
Recession	20%	−10%	20%

It is possible to calculate expected returns as

$$\mu = \sum_{i=1}^{n} p_i x_i \rightarrow \mu_{\mathrm{A}} = 4.0\%, \mu_{\mathrm{B}} = 3.0\%$$

and the standard deviations

$$\sigma = \sqrt{E(x^2) - (E(x))^2} \rightarrow \sigma_{\mathrm{A}} = 8.0\%, \sigma_{\mathrm{B}} = 10.3\%$$

Once the first scenario is created, it is then possible to change the values assigned to the probabilities in different states of the world, in order to generate new scenarios. It is also possible to change the returns assigned to each state. The ultimate goal is to generate extreme scenarios.

In terms of regulation, scenario analysis is included in the framework of the Basel banking supervision accords issued by the Basel Committee on Banking Supervision (BCBS).

According to the regulatory framework, the financial institutions subject to regulation should use internal and external loss data in order to create scenarios, together with some additional microeconomic factors.

Criteria are loose in terms of the process of scenario formation, given the information processed. Regulated inputs have to be used for regulatory capital calculation in the Basel framework.

Once results are obtained, they can be used for internal purposes, for guiding the business planning, as well as indicators of market functioning, chasing what might happen to financial market returns, such as bonds, stocks, or cash, in each of those economic scenarios.

4.2.2 Decision Trees

Decision trees are a popular tool for financial applications, and their use extends to many activities in social science. The general main use of trees is to help with making good choices, especially the ones involving high levels of risk.

Decision trees allow to compare many different alternatives in a visually efficient graphical format, and compared to other methodologies, decision trees offer some remarkable advantages:

- The graphical approach allows to visualize at a glance the various alternatives and possible outcomes.
- The method allows for a high flexibility, depicting complex alternatives and being easy to modify according to new information.
- A tree can be always split into sub-trees, allowing for almost infinite levels of complexity in the analysis.
- They are not in contrast with other forms of decision methods but arise as a useful complementary tool.

The decomposition of trees into multiple sub-trees allows for a deeper analysis of some specific actions and outcomes. However, it is never too good to put too much information on it, to not lose the intuition effect (Werner 2010).

The starting point for building a tree is the bottom of it, with backward analysis over the branches, through stepping back. This is because sometimes the further development of the tree discloses the need for changing the information in the previous steps.

The tree is developed in nodes from which new branches depart, at any step. There are two types of nodes. Chance nodes are indicated by a circle and are followed by an event that is not under the control of the agent. Decision nodes (squares) are the nodes followed by some decision (Fig. 4.1).

The purpose of decision tree analysis is to forecast future outcomes, assigning probabilities to possible events. Bayesian probability models help to analyze the problem when the analysis involves complex decisions.

Example 4.5 The expansion of a factory has a cost of 1,500,000 €. If the management decides to not do anything, and the state of the economy is good, the expected revenues are 3,000,000 €. If the economy is bad, revenues will only be 1,000,000 €.

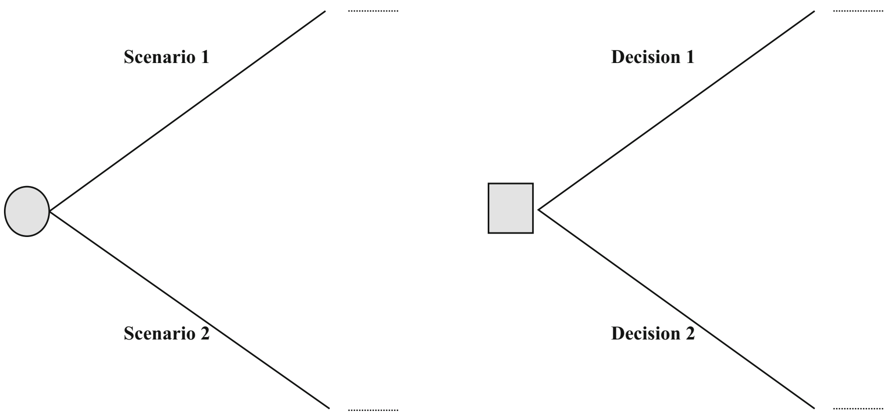

Fig. 4.1 Chance nodes (left) are defined as the nodes where some new information is expected afterward. Decision nodes (right) are the nodes when it is requested to make a decision between the following alternatives

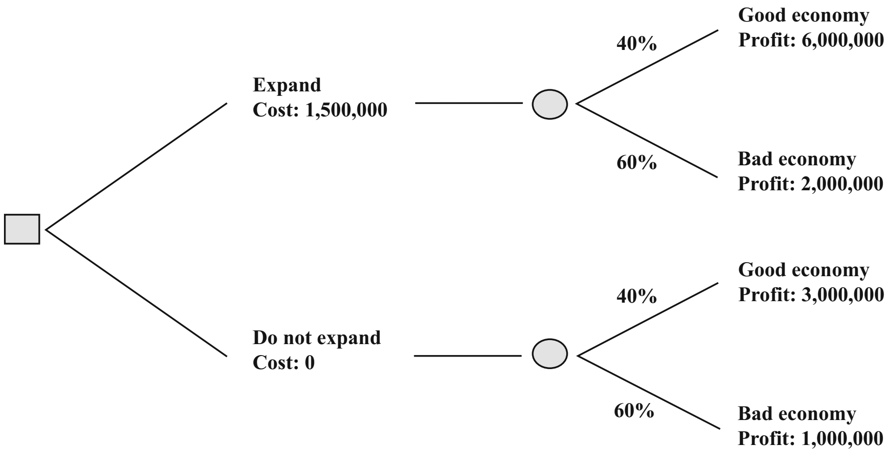

Fig. 4.2 An example of a decision tree where decision nodes are alternate with information nodes, whose output is subject to branching probabilities

If the expansion is approved, the firm will register revenues of 6,000,000 € and 2,000,000 € if the economy is bad. Assume there is a 40% probability of a good economy and a 60% chance of a bad economy.

It is possible to represent the problem on a decision tree as in Fig. 4.2.

The net present values from expansion and no expansion are

$$NPV_{EX} = 0.4 \times 6,000,000 + 0.6 \times 2,000,000 - 1,500,000 = 2,100,000 \ \text{€}$$

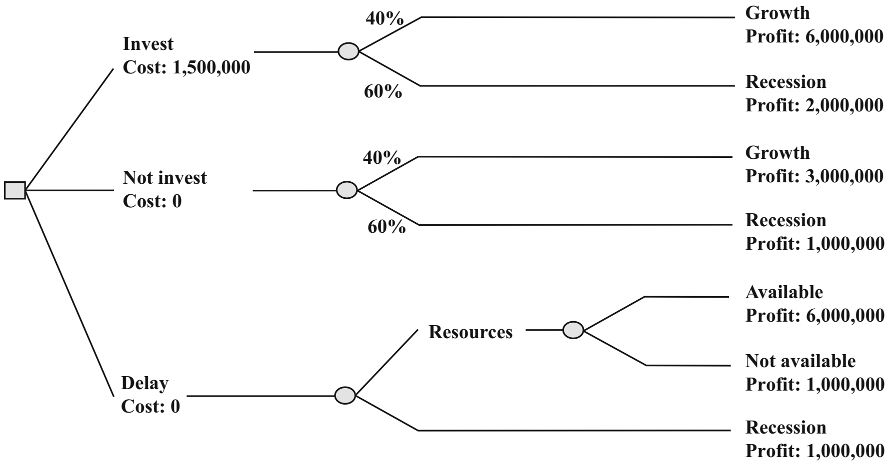

Fig. 4.3 Decision trees can be as complicated as the problem they represent. Also the availability of resources can be an input to the tree

$$\mathrm{NPV_{NE}} = 0.4 \times 3{,}000{,}000 + 0.6 \times 1{,}000{,}000 = 1{,}800{,}000\ €$$

The NPV from expanding is higher; therefore, the factory should expand.

The final payoffs are determined by the expected outcome, given some forecasted probabilities determined according to each possible future state of the world. Sometimes the probabilities are linked to dependent uncertainties among steps, which increases the degree of complication in the analysis.

Example 4.6 Now consider an additional alternative to wait and see how the economy goes, bearing the risk that there will not be enough resources available if waiting. The tree becomes as in Fig. 4.3.

Backward induction on the tree gives a new NPV for the choice of waiting, as

$$\mathrm{NPV_{Wait}} = 0.4(0.5 \times 6 + 0.5 \times 1) + 0.6 \times 1 = 2{,}000{,}000\ €$$

The new NPV from waiting is higher than not expanding but still lower than in the case of immediate expansion. This is an example of dependent uncertainties, where the dependency is between the uncertainty about the state of the economy and the one about the availability of resources.

4.2.3 Simulations

Simulations are a very useful tool in case distributional assumptions are available. The method involves drawing one outcome from a distribution to generate a set of cash flows and values. The process is then repeated several times in order to derive a distribution for the value.

The degree of accuracy of simulations is very high because, as opposed to other probabilistic approaches, the number of variables to be changed and the potential outcomes are not constrained to some limited number.

When past data are not available for a historical analysis, it is necessary to pick some appropriate statistical distribution to capture the shape of the input variables and estimate the parameters (Lea and Cohen 2004).

Correlation plays a major role in simulations, given the fact that most statistical distributions carry statistical features that are hardly approximated by the actual variables in the real world.

When simulation inputs are strongly correlated, the analyst must choose between letting only one input vary, or embed the correlation in the simulation algorithm, which makes the computation more cumbersome.

The number of inputs and iterations determines how many simulations are required in every case. Other criteria include the type of distribution involved in the analysis and the range of possible outcomes.

The simulation can be run using several methods. One of the most popular is the Monte Carlo method, which can be used when there is limited knowledge about data population and sampling is complicated.

In the case of an exploratory approach, exogenous variables are changed in order to generate specific courses of action, defined by models that are usually built from historical data (Jackel 2002).

Sometimes the best solution is a hybrid approach with human and artificial intelligence mixed in a real-time simulation.

Example 4.7 Assume the estimation of some quantity $\theta = E[h(\mathbf{x})]$, where $\mathbf{x} = \{x_1, x_2, \ldots, x_n\}$ is a random vector in $\mathbb{R}^n$, $h(.)$ is a function from $\mathbb{R}^n$ to$\mathbb{R}$, and $E[|h(\mathbf{x})|] < \infty$ must be carried on.

The following Monte Carlo algorithm can be used:

1. For $i = 2$ to n.
2. Generate $\mathbf{x}_i$.
3. Set $h_i = h(\mathbf{x}_i)$.
4. Set $\widehat{\theta}_n = \dfrac{h_1 + h_2 + \ldots + h_n}{n}$.

That gives a good estimator for the parameter.

When choosing a random number generator, the choice is between speed and reliability. It is therefore recommended to keep this trade-off in mind and go for a balanced solution.

Uniform number generators are characterized by a generally good overall performance in terms of both speed and reliability, with an average score in both aspects without excelling in any of the two.

A faster generator is not necessarily a better one, but a good random generator is usually fast. Also, a good equi-distribution is necessary but not sufficient condition for the quality of a generator.

In finance a very useful class of simulations, the explanatory simulation, is widely used. Based on historical data for modeling real world realistically, it spares from the computational burden of standard simulation.

Computing power is used to carry on the simulation, including the risk-adjusted NPV, which is simulated by using inputs that are not always fixed, besides being well defined by the user.

The aim of the simulation is to replicate the performance of the target project, with the outcome of a distribution of possible NPVs over a range of discount rates and other variables.

Monte Carlo integration is a useful computational math tool which is able to solve computationally common problems in financial mathematics. It achieves good results by approximating complicated integrals.

Consider the problem of estimating an analytically tricky integral of a function f over some domain D, given by

$$F = \int_D f(\mathbf{x}) d\mu(\mathbf{x})$$

where

$\mu(\mathbf{x})$ is the mean of the variable $\mathbf{x}$.

The function f can have many dimensions, and the solution to the integral is such that it is not possible to get it analytically. Assuming there is a pdf p defined over the same domain, the equation can then be written as

$$F = \int_D \frac{f(\mathbf{x})}{p(\mathbf{x})} p(\mathbf{x}) d\mu(\mathbf{x})$$

That is equal to

$$E\left(\frac{f(\mathbf{x})}{p(\mathbf{x})}\right)$$

which is the expected value of $\frac{f(\mathbf{x})}{p(\mathbf{x})}$ with respect to a random variable distributed according to $p(\mathbf{x})$. Whenever $f(\mathbf{x}) \neq 0$, this is true for all $p(\mathbf{x}) \neq 0$.

The expectation $E\left(\frac{f(\mathbf{x})}{p(\mathbf{x})}\right)$ can be also calculated as an average. First of all random samples must be generated according to p. Then the ratio $\frac{f}{p}$ is calculated for each sample, and the average is proxy for the value for the expectation.

The convergence to the expected value is higher for the sample size increasing. The expected value is the actual solution to the integral. That is the process of Monte Carlo integration.

4.3 Sub-disciplines of Business Analysis

Learning Outcomes

- Understand the use of enterprise analysis.
- Learn how to perform business requirements analysis.
- Explain other common analysis techniques.

4.3.1 Enterprise Analysis

Understanding the needs of a business, the strategy, and identifying actions to put in place for the business to meet its goals is called enterprise analysis, or strategic enterprise analysis.

The span of the analysis goes from the identification of the business problem or need, the proposed solution to it (when existing), and also the assessment of whether the proposed solution is the best available. The analysis also involves developing detailed analysis of what the solution entails, its risks, and its feasibility in the existing organizational climate (Grinblatt and Titman 2002).

Enterprise analysis involves a consistent amount of research and examination. This is the reason why the overall process is usually run at project's inception, or when the project is small, throughout it.

A thorough enterprise analysis endeavor will include points like:

- Proper evaluation of the viability and effectiveness of the proposed business initiatives.
- Identifying the needs of the business, despite the proposals on the table.
- The ideal solution to address the problem or need must be described.
- Evaluating the risk and return associated to the proposed strategy is also important.
- Some important questions are: What is the scope of the proposed solution? What tools and processes are involved in getting the solution?
- The environment for the problem-solving must be created with aids like visuals and business cases

In many companies the senior analysts take care of the enterprise analysis process, given the high level of specialization of such a task. It is however useful for many other employees to get knowledgeable about the analysis.

There are a number of roles in the business world, with an interest in pre-project research and solution justification. These roles include but are not limited to business analysts, project managers, stakeholders, business owners, and software engineers.

The enterprise analysis introduces the analyst to the overall requirement process. It identifies the needs of the business, and it confirms the appropriate solutions. It is the foundational research that undergirds any successful set of requirements.

Many steps of business analysis in a company are usually performed in coordination with the IT department. This is not the case of the enterprise analysis, which is usually carried on irrespectively (Pinches 1996).

The focus of the analysis is on the business, and the contribution of the IT sector is welcome, but it is not the focus. Solutions are focused on business, including changes in business processes, models, and strategies.

A *Guide to the Business Analysis Body of Knowledge®* (*BABOK® Guide*) is the globally recognized standard for the practice of business analysis. It is a collection of the most widely accepted analysis standards, as established by the business analysis community worldwide.

The guide was published in 2005, as a consulting tool for analysis and standardization of the standardized and generally accepted at that time. The first formal release was version 1.6 in June 2006.

The guide defines the knowledge underlying the performance of correct business analysis, taking into account the evolution of the approach, and determining the skills that a practitioner should demonstrate to work in the field.

BABOK standards relate to the framework of business analysis and indicate the various steps to be performed to deliver a solution that will provide value to the sponsoring organization.

The overall analysis goal is influenced by how each single task is performed, with either a direct or an indirect effect. The elements of the tasks like the performing order and the form of execution can vary, as well as their relative importance.

The *BABOK® Guide* identifies five main steps involved in enterprise analysis. The process combines the following elements:

The first step entails the definition of the business needs. This is a task that can be done even before project inception, but the risk is that the analysis will be inaccurate, and the identified need may not be the true one that the business needs to address in order to achieve its goals.

The identification of the need is a crucial step, in that an incorrect identification of the need will hinder the achievement of a viable solution and all efforts toward that end will be wasted.

Many types of event, like market opportunity, decrease in revenues, or other factors, may generate a business need and lead to analysis as a consequence. It is common in this case for most firms to try to resolve the issue without investigating the underlying business need.

In order to improve such a behavior, the business analyst has the duty of investigating the underlying causes of the need. This helps identify the possible solutions and collect them in order to be presented to the stakeholders.

In order for the task to produce the best outcome, it is very important that group thinking is avoided, as well as preconceived ideas and wrong assumptions. The view on the problem should be as objective as possible and effective as well.

As outlined in the BABOK standards, the accurate definition of the business need requires the analyst to identify:

- The signals of problem in the organization that can be quantified, like losses in profits, etc.
- The outcome expected after applying the selected solution, like higher revenues, cost reduction, etc.
- The potential speed of implementation of the chosen solution to the problem and the consequences of doing nothing
- The underlying real source of the problem to be addressed

The second step is the capability analysis, which defines whether the organization can meet the identified need. As from BABOK, if an organization does not have sufficient capabilities to meet a business need, the analyst must indicate the missing capabilities that must be added.

Once the business need is identified, and the capabilities have been sorted out, the third step involves choosing the right approach to the problem, as the most viable solution to the business need.

At this stage a careful description of what is needed to implement in the business must be given. Changes in items like software, website, and business processes must be clearly indicated, if that is the case, as well as the combinations of those.

More than one solution, or multiple parts to a solution, may be proposed. If capability gaps prohibit a smooth implementation of the ideal solution, solution alternatives must be anticipated.

A good analyst makes a list of possible viable solutions, each defined by feasibility, accurate risk analysis, and constraints, as well as accompanying assumptions underlying its adoption.

The fourth step is about defining the solution scope, meaning the analyst must identify new capabilities to be generated as a consequence of the implementation of a new project.

The stakeholders focus on this step because it helps them to understand the path to the solution's arrival and the tools that will be required to implement it. Items involved in the scope include warehouses, databases, and processes.

It is mentioned in BABOK that "The solution scope will change throughout a project, based on changes in the business environment or as the project scope is changed to meet budget, time, quality, or other constraints."

The final step involves defining the business case, as a tool to represent the practical benefits of the solution proposed, and the true benefits to the organization from a business point of view.

The case is about quantifying the benefits of the solution, so to complete the work initiated with the expected payback analysis in step one. The outcome is a specific amount of revenue, dollars saved, and other quantifiable benefits, including the description of the metrics that helped the analysis.

The key factor in the success of the overall analysis, after completing the five steps, is the involvement and agreement of the stakeholders, together with the help of communication as an efficient tool for implementation.

Performing the enterprise analysis requires specific core competencies that an analyst must possess in order to effectively lead enterprise analysis projects. The competencies required can be listed as follows:

- Ability in creating and maintaining a business structure. This competency requires the analyst to understand the architecture of the business, defined as the company's present and future state, in terms of strategy, goal, and objectives.
- Attention to the feasibility of the options that are on the table, to be exerted by looking at them, assessing whether they are technically possible and whether they will meet the organization's goals.
- Identification and analysis of opportunity, done by identifying new investment opportunities, in collaboration with experts in the field of operation of the target business.
- The business case must be prepared and maintained afterward. The proposed solution comes at a cost in terms of resources, and the costs must be weighed against the tangible benefits that the solution will offer.
- Management of the several types of risk (financial, operational, economic, etc.) to be faced when implementing the selected solution. Comparison with the risk of not implementing the solution is a logic consequence.

Enterprise analysis is commonly offered, as outsourced service, by individuals and companies. They offer the service to companies that are less experienced in the analysis process, thus unable to provide it internally.

The several types of services offered by professionals in the field include the organizational research, aimed at ensuring that all the possible potential solutions are explored.

4.3.2 Business Requirements Analysis

The main reason for developing a new product or services in the various industries is to address a specific need of the consumers. Sometimes, companies find themselves in situations where, despite spending tremendous time and resources, there's a mismatch between what has been designed and what is actually needed.

Sometimes the discrepancy is even between some order of the client and the final product. In other cases, there is a change of mind halfway through a project. Finally, it is even possible that new requirements come at the conclusion of product creation.

All of these problems can be easily avoided by developing a careful and detailed business requirements analysis, which is the process of identification, analysis, and recording of the requirements related to a specific business goal.

By such analysis it is possible to give a clear definition of the scope of the project, in order to provide a careful assessment of important factors such as the timescale and the amount and type of resources needed to complete it (Robertson 2006).

The first step in obtaining the desired outcome, product, or service is the accurate definition of it. Requirements analysis allows to break the business need into specific requirements on which there is common consensus, for a better understanding of it.

What's more, it's usually much quicker and cheaper to fix a problem or misunderstanding at the analysis stage than it is when the "finished product" is delivered.

Modern corporate sector is characterized by a general tendency to establish internal procedures and methodologies to conduct the analysis. The procedures are then specific for different industries and different companies.

As for the enterprise analysis in previous sections, the business requirements analysis is based on five steps. The first one is the identification of the key stakeholders in the organization, who will be affected by the project.

The first thing to do at this stage is to exactly identify the sponsor of the project, who could be either an internal or an external client. In both cases, it is essential to know who has the final say on what will be included in the project's scope and what won't.

It is then important to identify the final users of the proposed solution, product, or service. The needs of the end users are the foundation of the analysis, and their input should be carefully considered.

The end users of the product may belong to several departments in the organization, or they may be all concentrated in one division. The stakeholders' requirements about the product have to be collected and recorded.

When recording preferences, the individual perspectives should be taken into account. The understanding that different perspectives correspond to different requirements allows to build a complete picture of what the project should achieve.

The stakeholders should be interviewed in a format that clarifies the basic scope of the project, without deviating from the main idea. This should discourage the end users from describing functionalities never supposed to be embedded in the project. If users have articulated these desires in detail, they may be disappointed when they are not included in the final specification.

Interviews with stakeholders can be held either individually or in groups. In the first case, there will be a better understanding of the individual positions, while in the second case, the way how information between departments flows can be understood.

Another technique available to the analyst is the use of scenario-based cases, in order to walk through the system or process as a user. The simulated environment gives the idea of how the system or service would work. It is a good technique for gathering functional requirements, but you may need multiple "use cases" to understand the functionality of the whole system.

When implementing the technique, it is useful to check for previous cases about similar services and build a mock model for the system or product to give the idea of the final look of the product.

Using this, users can address feasibility issues, and they can help identify any inconsistencies and problems. You can use one or more of the above techniques to gather all of the requirements.

A third step is the categorization of the requirements, in order to simplify the analysis by grouping the requirements into four main categories. This step simplifies a lot of the analysis.

Functional requirements define what the functioning of the product should be from the point of view of the end user. They describe the features and functions with which the end user will interact directly.

The set of actions to implement in order to keep the product functioning over time defines the operational requirements. Technical requirements refer to the technical issues to consider when trying to successfully implement the process. Finally, transitional requirements define what steps are needed for a smooth implementation of the product creation (Larson 2009).

After all the requirements have been collected, recorded, and categorized, they must be interpreted, in what constitutes the fourth step of the analysis. Once all requirements are gathered, it must be decided which ones are achievable and how the system or product can deliver them.

The interpretation of requirements follows several sub-steps including the following:

- Precise definition of the requirements, that have to be clearly specified and sufficiently detailed, in order to avoid problems coming from non-identified unknowns.
- Establishment of the prioritization of requirements by giving priority to those that are more relevant and more critical.
- Analysis of the impact of change, to make sure that all the consequences related to the impact of project implementation (especially on existing processes and people) are clear and fully understood.
- Resolution of conflicting issues by interacting with stakeholders in order to identify potential conflicts. Scenario analysis can be helpful to solve the task, in that it allows all those involved to explore how the proposed project would work in different possible states of the world.
- Feasibility analysis is also important for determining the reliability and ease of use of the new product or system and identifying the major problems that may be encountered.

The outcome of the analysis is a detailed report to be circulated among the involved stakeholders, end users, and development teams. The feedback received can resolve remaining conflicts and constitute a sort of contract between the analyst and the stakeholders.

The final step is the collection of signed agreement of the key stakeholders, stating that the presented requirements are effective in addressing the specific needs. This formal commitment will play an important part in ensuring that the project does not suffer from scope creep.

4.3.3 Analysis Techniques

Several analysis techniques are available to the analyst, to facilitate the business change. One of them is called PESTLE, and it is used to perform an external environmental analysis by examining the many different external factors affecting an organization.

The "P" of PESTLE stands for political and represents the influences that may come from political pressures. The "E" means economic, mainly the impact of national and world economy.

After that there is the "S" for sociological, which is related to how the society can affect the many aspects of an organization. The "T" stands for technological and refers to the effect of new technology.

The letter "L" is for legal and describes the effects of domestic and global legislation, while the last "E" is for environmental and focuses on the local, national, and world environmental issues.

Another method of analysis is called heptalysis, and it is performed as an in-depth analysis of seven core factors, for early-stage businesses. The factors are market opportunity, product/solution, execution plan, financial engine, human capital, potential return, margin of safety (Sharp et al. 2001).

The MOST analysis is used for internal environmental analysis and defines four different attributes. The purpose of the analysis is to ensure that the project currently under development is aligned to each of the four attributes.

The first MOST attribute is mission, meaning the overall direction of the business. Then there are objectives, identified as the key goals to complete the mission. After that there are strategies, which are the options available to move forward. Finally, the tactics state how the strategies can be implemented.

SWOT analysis is another popular tool for business analysis, with a focus on the areas of strength and of major opportunities. Another side of the analysis concentrates on the weaknesses of the business as well as on the internal and external threats.

The analysis of the strengths relies on understanding what are the advantages of running the business and what are the strong areas of current operations and the best-performing activities of the firm.

Weaknesses include the aspects of the firm that could be improved, aspects of the business that are not run properly, and key areas where the overall performance is quite poor (Jacka and Keller 2009).

Another point is about the opportunities available to the organization, namely, what are the business areas where competition is weaker. Threats are the last issue, and they focus on the obstacles the business has to face, including key areas where competitors are much stronger than the firm.

The CATWOE analysis relies on the prompt thinking about the aimed achievements of the business. The perspectives of the firm over some time interval help analysts to quantify the impact of possible solutions on the agents involved.

The first component of CATWOE are customers that aims at identifying who are the beneficiaries of the business project outcome and how the issue under investigation affects them.

The second component is actors, meaning those who are involved in the process, and will be also involved in the solution implementation, and what factors will affect their success in the process.

Transformation process is another important component, addressing the issue of what processes or systems are affected by the issue. The world view factors identify what is the big picture and the generalized impact of the issue.

The owner component identifies who is the owner of the process under investigation and what is their role in the achievement of a solution. Finally, the environmental constraints define what are the constraints and limitations that will impact the solution and its success.

The Six Thinking Hats (STH) analysis method is a brainstorming approach to business analysis, meant to generate ideas and analyze options. It is useful for fostering thinking and it can have a high motivation power. It basically involves restricting the group to only thinking in specific ways—giving ideas and analysis in the "mood" of the time.

The color combinations are as follows:

- White: Pure facts, logical
- Green: Creative
- Yellow: Bright, optimistic, positive
- Black: Negative, devil's advocate
- Red: Emotional
- Blue: Cold, control

The MoSCoW analysis technique is used for requirement prioritization, by matching tasks with the appropriate level of priority, gauging it against the validity of the requirement itself and its priority against other requirements.

So basically the levels of prioritization start from the highest, namely, the Must have, which means the requirement is needed for the delivery to not be a failure. After that, the Should have level means that in absence of the requirement, the business will have to adopt a workaround.

The Could have level is the level where the possession of the requirement will increase the delivery satisfaction. Finally, at the Would like level, the requirement is maybe needed in the future but not immediately.

4.4 Summary

Business analysis is important to assess the potential contribution of an investment to the overall value of the firm. Capital budgeting and project valuation help in the analysis process.

There are three main rules of capital budgeting that help in identifying the profitable investment opportunities, discarding the unprofitable ones, and concentrating the choice of investment on the best solutions.

The net present value rule states that only projects having a positive NPV should be taken into consideration, and among many possible opportunities, the project with the highest NPV should be selected.

The valuation of projects can be done in several ways, relying on probabilistic approaches. The most common type of approach is the scenario analysis, which relies on the simulation of several states of the world and assesses the potential outcomes.

Decision trees are another tool that helps in the analysis of an investment by drawing on the branches of a tree the many possible outcomes of actions, as represented by the three nodes.

Simulations are a computational tool and involve the use of algorithms and computer power to estimate the parameters of a model that represents the possible future outcomes based on the analysis of historical data.

Business analysis is composed of sub-disciplines that approach the issue from different points of view. Enterprise analysis, for example, relates to the needs of a business, the strategy, and identifications of the actions to put in place to meet the goals of the firm.

The business requirements analysis relates to the development of a careful and detailed process of identification, analysis, and recording of the requirements related to a specific business goal.

The several types of analysis techniques available include methods that challenge the analysis issue from different sides and process the available information to produce outcomes about issues and options.

Problems

1. A project has even cash inflows and requires an up-front investment of 350,000 €. It will generate positive cash flows of 56,000 € per month, for 1 year. The target discount rate is 12% on a yearly basis. There is no salvage value. Calculate the NPV.
2. Assume an initial investment on fixed assets of 1,022,000 €. It is expected to generate cash inflows of 271,100 €, 385,000 €, 442,400 €, and 266,500 € at the end of first, second, third, and fourth year, respectively. At the end of the fourth year, the residual value of assets is 90,000 €. Calculate the NPV.
3. Given the three possible states of the world in the below table, calculate the expected return and standard deviations.

Economy	Probability	Stock A return	Stock B return
Boom	5%	21%	25%
Normal	70%	2%	−1%
Recession	25%	−15%	−20%

4. The expansion of a factory has a cost of 16,000,000 €. If the management decides to not do anything, and the economy state is good, the expected revenues are 24,750,000 €. If the economy is bad, revenues will only be 2,000,000 €. If the expansion is approved, the firm will register revenues of 18,500,000 € and 1,800,000 € if the economy is bad. Assume there is a 53% probability of a good economy and a 47% chance of a bad economy. Should the company expand or not?
5. Following exercise 4, consider an additional alternative to wait and see how the economy goes, bearing the risk that there will not be enough resources available if waiting. What is the right decision in this case?
6. What are the advantages of probabilistic approaches to risk, compared to analytical methods? What about the disadvantages?
7. Describe the steps needed in the implementation of simulations for project and business analysis.
8. Daniele is offered a choice where you can take a certain amount of 15,000 € or take part in a gamble, where he can win 50,000 € with probability 50% and 1000 € with probability 50%. Draw a decision tree to represent the choice.

Case Study: Net Present Value

Voltoncamp Ltd

The Case

Voltoncamp Ltd is a company active in tourism and hospitality, which offices in Europe and operating worldwide. They offer tourism packages around the world and own estate in the form of touristic villages worldwide.

Willing to expand its business operations, the company is willing to invest fresh capital into new ventures. In particular the company wants to build a new village in order to face the high postcrisis demand for tourism.

The company is considering a new investment proposal by a partner in Hong Kong, for building a new village, and to operate it starting early 2018. But there is also an investment opportunity in Europe, which requires to refurbish and renovate an existing village, therefore at a lower cost.

There are catches with both investment opportunities. For instance, Hong Kong charges no taxes on corporate income, while in Europe profits from any investment are charged at an average 30% rate.

On the other hand, the European investment requires a much lower investment of $10,000,000, compared to the $20,000,000 required to build a village from scratch in Hong Kong. Both amounts are available as up-front cash payment.

Cristina, a freelance financial analyst, is hired by the company to analyze the two investment opportunities and recommend the best investment, given the financial environment, the maturity of the investment, and the macroeconomic variables involved.

Tourism in Hong Kong is targeted to various types of tourist. Voltoncamp would offer medium-high level tourist facilities and services, with an expected gross profit of $2,000,000 for the first year, increasing of an average 5% per year for the following years.

A village in Europe would make the company gross a pretax income of $2,000,000 as well. The revenue growth in Europe is supposed to be milder than in Hong Kong, due to the postcrisis economy still to be fixed, at a rate of 3% per year.

Other factors to be taken into consideration are the expected reinvestment rate for average low-risk financial investments in Europe, estimated at a constant 3% per year. The same level of risk grants a return of 5% in Hong Kong.

Building a new village in Hong Kong means the company will have no refurbishing costs for the first 15 years of the investment life. After that, an investment of further $5,000,000 will be required in order to keep running the business for further 15 years.

About the village in Europe, it will have to be demolished and rebuilt in 15 years from now. Rebuilding a new village will cost $15,000,000 and will guarantee further 15 years of operations without refurbishing needs.

Consider that profits are also subject to inflation, which in Hong Kong is currently set at 2%, and supposed to increase by 0.1% per year on average, for the next 30 years. In Europe the inflation is much lower, at 1%, set to increase by 0.05% per year on average, for the next 30 years.

Last but not least, the average cost of capital for similar investments in Europe is 13% per year, while in Hong Kong is 15% per year. As a company, Voltoncamp normally conforms to the competitors in terms of cost of capital, so the above figures are assumed to be good proxies for the company's cost of capital.

Questions

1. Assuming a maturity of 15 years, if you were Cristina, which course of action would you recommend to the company, invest in Hong Kong or in Europe?
2. How would your answer to point 1 change if one considers a 30-year maturity of the investment?
3. What factor could influence the calculation of the amounts involved and therefore change the answers to both points 1 and 2, if taken into consideration?
4. Assume profits can be reinvested at a rate of 1% in Europe and 3% in Hong Kong. Would the answer to points 1 and 2 change? How? Explain.
5. Assume the company decides to borrow the money to invest instead of paying it up front in cash. What factors would then influence the decision of the company?
6. How does the answer to point 1 change if the company can borrow the full amounts needed over the maturity of the investment, at a fixed constant rate of 3% per year in Europe and 5% per year in Hong Kong?

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