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Probabilistic valuation: a brief overview

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1 Introduction

A probabilistic valuation analysis provides a way to assess and aggregate the impact of project risks and uncertainties on the decision metrics like Net Present Value or capital efficiency indicators. Such an analysis does not need to be complex. It yields improved insights for investment decision making and promotes a much better understanding of the risks and uncertainties through the rigour of quantification.

This approach differs fundamentally from the practice of incorporating opportunity risk in the discount rate. In the probabilistic approach, the discount rate is kept fixed to the long run cost of capital of the enterprise. By quantifying uncertainty and risk by means of probability distributions, more clarity on the nature of the risks and their impact is obtained and mitigation strategies can be developed. Where uncertainties cannot be meaningfully quantified, a scenario approach is recommended.

The probabilistic valuation method is also different from evaluating a base case along with some sensitivities.

2 Purpose

The fundamental characteristic of a probabilistic economic analysis is that probabilities are assigned to the input data (costs, sales volumes, prices, etc.) which are subsequently aggregated, taking into account the valuation model. The classical deterministic approach is to develop a base case and show several sensitivities around that, as examples of other outcomes using different sets of assumptions. However, the numbers that represent the base case are often biased. Although efforts will be made to include contingencies and make the base case a balanced representation, experience suggests that choices made are often optimistic.

A key benefit of more rigorously assigning probabilities is that we consolidate the judgement of experts and maximize the utilization of knowledge available. The decision maker is often presented with a myriad of possible outcomes and 'what ifs' on the basis of which a decision is expected. A probabilistic economic analysis aggregates these uncertainty perpectives in a holistic view that allows better interpretation. It provides more nuance to the value proposition than only the base case.

Considering probabilities for the purpose of incorporating them in the economics also promotes that teams think hard about the uncertainties affecting their project. The requirement to quantify uncertainties can result in rich discussions.

3 Definitions

With *uncertainty* we mean a variable or phenomenon with a range of possible outcomes. With risk we mean the *exposure to an undesirable outcome*. The term project *risk* must thus refer to the possibility that the project will have an undesirable outcome, which in economics terms must be understood to, for example, imply a negative NPV. To assess this project risk, we must therefore have a handle on the uncertainty range of the NPV. If there is a serious possibility that the NPV turns negative, we would obviously like to know the chance that this might happen.

4 Uncertainties

A project will have many uncertainties that affect the economics. There will be some parameters for which the numeric values are certain, for example the equity share. Most parameters, however, will have an uncertainty range. The first step is to identify the uncertainties that really matter. This is best done within the context of a framing process. The resulting list of issues is subsequently subdivided into facts, decisions (choices) and uncertainties. Uncertainty identification should be a multidisciplinary activity. It is also appropriate to examine the risks and uncertainties that have been identified in the risk register, if this is available. Sensitivity analysis can help to assess whether the uncertainty in a variable could have a material impact on decision metrics and thus should be considered for further quantification.

5 Probabilities and probability distributions

Often a variable can take on a continuous range of values. Such a continuous uncertainty can be characterized by a probability distribution, defined by range and shape. In NavIncerta we use the convention of so called descending (or decreasing) cumulative distributions. Percentile numbers are used to characterize such a distribution: the Pxx value of a variable is the value that has a chance of xx% of being exceeded. P90 thus means, for example, that there is a 90% chance that the variable of interest is larger than this number. Under this convention, the P90 is therefore the 'low number' and P10 is the 'high number'.

The shape or type of the distribution should be chosen such that it best reflects the structure and behaviour of the variable. For example, costs are often skewed to the right because it is more likely that costs will turn out to be higher than lower.

Another type of uncertainty is a question for which the outcome can only be yes or no. A typical example in oil exploration is the question whether the well will find hydrocarbons or not. In essence this is a discrete distribution with two possible outcomes. Each outcome has a chance factor. There can also be a question with more than two outcomes, for example several cases. Each case can be given a weight. These weights need to add up to 1.

6 Uncertainty assessment

The crucial step in a probabilistic analysis is the uncertainty assessment. Typically two inputs are needed: historical data analysis (to the extent available) and expert judgement. For some parameters, it will be possible to use data from previous projects, for example comparisons of estimated and actual costs. Also then, an element of judgement is needed as the project at hand may have specific circumstances. If there are no meaningful historical data, an uncertain range variable may still be characterized by a P90, P50 and P10 value through the so called expert interview approach: a structured process by which one or more domain experts are guided to arrive at a best estimate of the bounds within which the variable might range. For assessing chance factors and scenario weights, similarly rigorous procedures have been designed to arrive at well considered probabilities. These processes can be applied to technical uncertainties (costs, production), but equally to non-technical risks.

It is absolutely crucial that probability assessments are done with care and that poorly challenged, quick assumptions are avoided. If probabilities cannot be established in a credible way, it will be necessary to forego the probabilistic analysis and revert to a 'sensitivity analysis only' approach.

Another critical success factor for uncertainty assessment, and for credible valuation analysis in general for that matter, is the regular execution of lookbacks or post investment reviews for calibration purposes.

7 Translation to decision metrics

Once the uncertainties in the input variables have been established, they need to be translated to the domain of the decision metrics, in most cases NPV and a capital efficiency indicator. There are various ways in which this can be accomplished, ranging from a simple weighted average of two or more scenario NPVs to more complex combinations of decision trees and Monte Carlo simulations. The latter may involve embedding Monte Carlo functions inside the valuation model, but such processes can also be applied to derived approximated relationships between target decision metrics and input uncertainties.

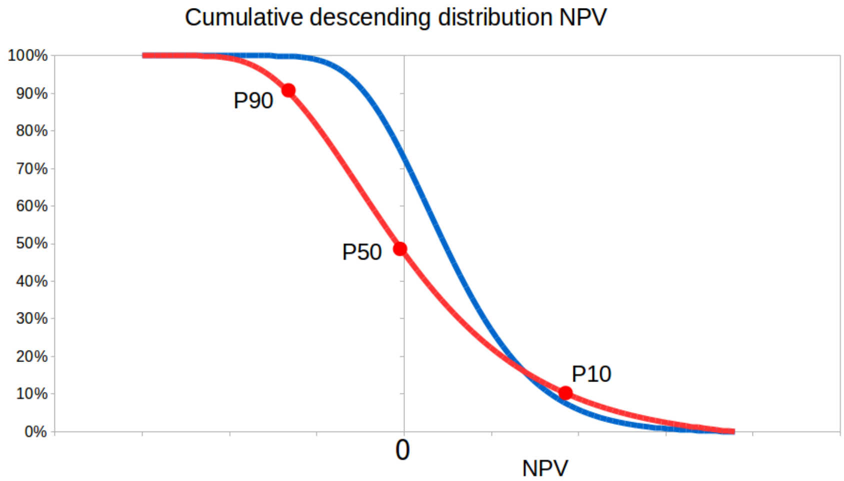

Figure 1: NPV distributions

The most efficient way, however, is to use an analytical approach. A recommended method is *DeltaLogN*. For most investment evaluations the generation of the uncertainty ranges in the decision metrics from the inputs can be done this way and does not involve a major effort. The output will consist of probability distributions of NPV and if desired other decision metrics as well. From these, the P90 (lower) and P10 (upper) values of the metrics can be inferred. It is also possible to assess the chance that the NPV will be greater than zero or establish probability thresholds for other metrics.

Such insights provide a better basis for decision making than a base case with more or less arbitrary sensitivities or risk adjusted NPVs following from manipulating the discount rate.