Stochastic modelling

There are two basic modelling techniques employed to develop financial and other models: the stochastic approach and the deterministic approach. The latter technique has historically been used when models are developed on spreadsheets but new, modern tools available to us have initiated a strong trend towards stochastic modelling.

Deterministic modelling

With the deterministic modelling technique the approach is to try and eliminate uncertainties. Elimination is usually achieved by breaking every factor or variable of the model into smaller and smaller parts in order to 'isolate' key uncertainties from those factors or variables that are not (deemed) uncertain. These uncertainties are then modelled through assuming (or attributing) specific values for them for every model run. This modelling technique often leads to very large and detailed models. While there is nothing wrong with that, my personal view is that one of the most under-estimated risks in any project is 'modelling risk' – the risk that somewhere a '+' sign was erroneously replaced with a '–' sign or something similar. The larger the model becomes, the more difficult it is to pick up such errors, and the consequences can be dramatic. Thus in trying to mitigate the risk of some uncertainties a new risk is often created. My view is that 'modelling risk' is positively correlated with the size of the model!

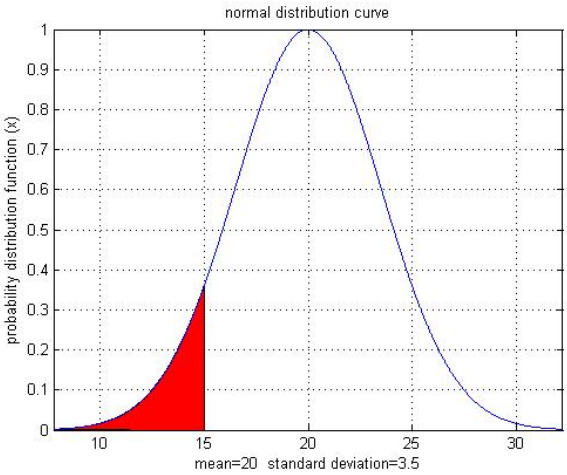
The impact of the assumed values attributed to the uncertain variables are typically analysed through sensitivity – or scenario analysis. As models become larger and the number of uncertain variables increase, the effectiveness of this type of analyses decrease rapidly, often leaving one with a sense of uncertainty around the validity and impact of the assumed values.

Stochastic modelling

With the stochastic modelling technique the approach is to focus in much more detail on those variables or factors that are uncertain. In fact, the approach is to model that very uncertainty. Due to the fact that one is not really concerned about the variables or factors that are certain (or well known) there is no need to break-up those factors into more detail – doing so seldom adds additional value (read accuracy) but increases 'modelling risk'. A simple example of this may be the cost of manufacturing a widget – there may be many factors contributing to this cost but they are all well known and not uncertain. For that reason it does not add any value to break this cost into sub-factors in the model. The same does not apply to the number of widgets that

will be sold in the market over a period of time – this variable is uncertain and it is that uncertainty that one would like to model explicitly! Not breaking certain variables down into smaller components means simpler and smaller models that are easier to understand and audit.

In the stochastic modelling technique, an uncertain variable is not modelled as a single point value, but the variable is defined through a probability distribution of its potential range of values. Through statistical sampling techniques, a different value for the variable is attributed in every model run. This process is often referred to as Monte Carlo simulation. Monte Carlo simulations are characterised by running thousands of simulations in order to ensure that every uncertain variable is adequately sampled according to its probability distribution. When we look at the 'output' variables of the model, they will by definition also not be represented by single point values but also by probability distributions. The probability distribution of each such 'output' variable will reflect the combined impact of all the uncertain 'input' variables or factors.



Which model would you prefer to analyse your latest project?

A deterministic project model calculating the project NPV under set input conditions. Sensitivity and/or scenario analysis is used to give some insight into certain risk factors and their impact on the project NPV.

OR

A stochastic model calculating the probability distribution of the project NPV given the uncertainties defined for various input parameters. This model can be used to identify those scenarios (combinations of input variables) under which the project NPV will exceed certain targets (such as 0).

Benefits of stochastic modelling

What is the benefit of this modelling approach? The presence of uncertainty in the input variables implies that there must be uncertainty in the output variables. Remember: uncertainty = risk.

The probability distribution of an output variable thus gives a direct measure or indication of the risk (in that output). This type of risk measurement is invaluable when evaluating projects especially at an early stage in the project life cycle.

Implementing stochastic modelling techniques

To implement stochastic modelling techniques on a spreadsheet can be quite cumbersome. Luckily there are 3rd party software vendors who have developed the necessary routines to automate and considerably ease this process. Since around 1995, I have been using the @Risk add-in for Excel for this purpose. Over the years @Risk has been refined and extended many times and the functionality and analysis it offers is staggering. Visit the developer of @Risk at www.palisade.com for more details.

Stochastic modelling is a powerful and indispensable tool to be utilised in the analysis, preparation and development of every infrastructure project.