CHAPTER 1

Models of Models

INTRODUCTION

This chapter provides an overview of financial modelling, including its objectives, stages and processes. The discussion sets the context and frameworks that are used in much of the subsequent text.

CONTEXT AND OBJECTIVES

A model is a numerical or mathematical representation of a real-life situation. A financial model is one which relates to business and finance contexts. The typical objectives of financial modelling include to support decisions relating to business plans and forecasts, to the design, evaluation and selection of projects, to resource allocation and portfolio optimisation, to value corporations, assets, contracts and financial instruments, and to support financing decisions.

In fact, there is no generally accepted (standardised) definition of financial modelling. For some, it is a highly pragmatic set of activities, essentially consisting of the building of Excel worksheets. For others, it is a mainly conceptual activity, whose focus is on the use of mathematical equations to express the relationships between the variables in a system, and for which the platform (e.g. Excel) that is used to solve such equations is not of relevance. In this text, we aim to integrate theory and practice as much as possible.

THE STAGES OF MODELLING

The modelling process can be considered as consisting of several stages, as shown in Figure 1.1.

The key characteristics of each stage include:

- Specification: This involves describing the real-life situation, either qualitatively or as a set of equations. In any case, at this stage one should also consider the overall objectives and decision-making needs, and capture the core elements of

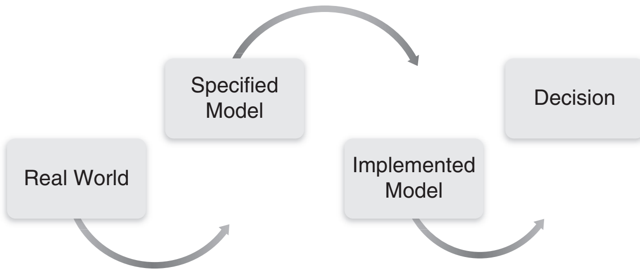

FIGURE 1.1 A Generic Framework for Stages of the Modelling Process

the behaviour of the real-world situation. One should also address issues relating to the desired scope of model validity, the level of accuracy required and the trade-offs that are acceptable to avoid excessive complexity whilst providing an adequate basis for decision support.

- Implementation: This is the process to translate the specification into numerical values, by conducting calculations based on assumed input values. For the purposes of this text, the calculations are assumed to be in Excel, perhaps also using additional compatible functionality (such as VBA macros, Excel add-ins, optimisation algorithms, links to external databases and so on).
- Decision support: A model should appropriately support the decision. However, as a simplification of the real-life situation, a model by itself is almost never sufficient. A key challenge in building and using models to greatest effect is to ensure that the process and outputs provide a value-added decision-support guide (not least by providing insight, reducing biases or correcting invalid assumptions that may be inherent in less-rigorous decision processes), whilst recognising the limitations of the model and the modelling process.

Note that in many practical cases, no explicit specification step is conducted; rather, knowledge of a situation is used to build an Excel workbook directly. Since Excel does not calculate incorrectly, such a model can never truly be "(externally) validated": the model specification is the model itself (i.e. as captured within the formulae used in Excel). Although such "self-validation" is in principle a significant weakness of these pragmatic approaches, the use of a highly formalised specification stage is often not practical (especially if one is working under tight deadlines, or one believes that the situation is generally well-understood). Some of the techniques discussed in this text (such as sensitivity-driven model design and the following of other best practices) are particularly important to support robust modelling processes, even where little or no documented specification has taken place or is practically possible.

BACKWARD THINKING AND FORWARD CALCULATION PROCESSES

The modelling process is essentially two-directional (see Figure 1.2):

- A "backward thought process", in which one considers a variable of interest (the model output) and defines its underlying, or causal, factors. This is a qualitative process, corresponding to reading Figure 1.2 from left to right. For example, cash flow may be represented as being determined from revenue and cost, each of which may be determined by their own causal factors (e.g. revenue is determined by price and volume). As a qualitative process, at this stage, the precise the nature of the relationships may not yet be made clear: only that the relationships exist.

- A "forward-calculation process", in which one which starts with the assumed values of the final set of causal factors (the "model inputs") and builds the required calculations to determine the values of the intermediate variables and final outputs. This is a numerical process corresponding to reading Figure 1.2 from right to left. It involves defining the nature of the relationships sufficiently precisely that they can be implemented in quantitative formulae. That is, inputs are used to calculate the intermediate variables, which are used to calculate the outputs. For example, revenue would be calculated (from an assumed price and volume), and cost (based on fixed and variable costs and volume), with the cash flow as the final output.

Note that the process is likely to contain several iterations: items that may initially be numerical inputs may be chosen to be replaced by calculations (which are determined from new numerical inputs), thus creating a model with more input variables and detail. For example, rather than being a single figure, volume could be split by product group. In principle, one may continue the process indefinitely (i.e. repeatedly replacing hard-coded numerical inputs with intermediate calculations). Of course, the potential process of creating more and more detail must stop at some point:

- For the simple reason of practicality.
- To ensure accuracy. Although the creation of more detail would lead one to expect to have a more accurate model, this is not always the case: a detailed model will require more information to calibrate correctly (for example, to estimate the values of all the inputs). Further, the capturing of the relationships between these inputs will become progressively more complex as more detail is added.

The "optimal" level of detail at which a model should be built is not a trivial question, but is discussed further in Chapter 4.

It may be of interest to note that this framework is slightly simplified (albeit covering the large majority of cases in typical Excel contexts):

- In some applications (notably sequential optimisation of a time series, and decision trees), the calculations are required to be conducted both forward and backward,

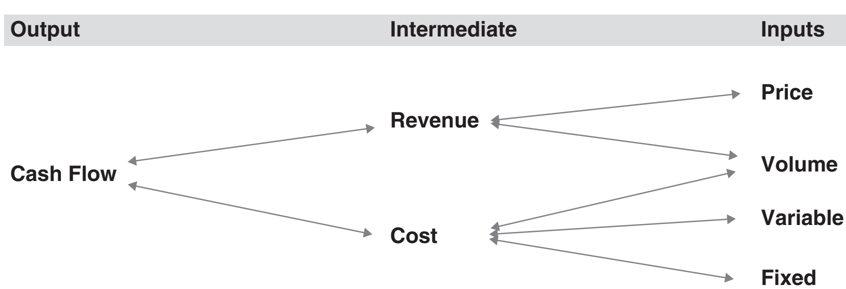

FIGURE 1.2 Modelling as a Combination of a Backward Thought Process and a Forward Calculation Process

as the optimal behaviour at an earlier time depends on considering all the future consequences of each potential decision.

- In econometrics, some equations may be of an equilibrium nature, i.e. they contain the same variable(s) on both sides of an equation(s). In such cases, the logic flow is not directional, and will potentially give rise to circular references in the implemented models.