Building Financial Models

A Simulation Approach

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Title	*Description*	*Computer Programming Language*	*Chapter*
TABOL and FORTRAN	example of FOR-TRAN within a TABOL model	TABOL	Appen. 1 in Manual*
Demand model 2	modifications of first model	AS	Appen. 2 in Manual*
Consolida-tion	more consolidation examples	TOTAL	Appen. 11 in Manual*
Demand model 3	further examples in loops	AS	Appen. 12 in Manual*
Consolida-tion	using cycles	AS	Appen. 13 in Manual*
Further examples	demonstrating range of modelling	ORACLE	Appen. 14 in Manual*

* *Manual to Building Financial Models – A Simulation Approach* by Krish Bhaskar, available from the publishers or through booksellers.

Preface

My interest in simulation techniques was first stimulated by my long–standing friend and mentor, Professor John Flower. Since then, my interest and keenness have continued to blossom. Academics normally favour studying and writing about the more esoteric and theoretically elegant concepts. I have always placed a high value on the practicality of techniques. To this end, I have committed the academic sin of 'getting my hands dirty' by building practical simulation models for real–life situations. This has led me to concentrate the research efforts embodied in the task of the more mundane and less academically respectable work. Hence this book concentrates on simple financial models of companies. The technical description (which is explained in Chapter 1) is: deterministic simulation models – with a financial bias. For short, I have often referred to them as financial simulation models.

The book is geared towards those who have some experience of financial simulation models. The inexperienced and newcomer will, however, find much that is useful. Some of the more difficult sections may have to be left by the newcomer until he gains experience.

During the course of the book, I have attempted to set out a number of standard examples of financial models tailored to specific uses and applications. In addition a number of standard subroutines have been provided. This software can either be used to form the basis of a model or will provide ideas from which an entirely distinct model can be built. Either way, the examples should prove useful. This software has been extensively tested and has been used in many real–life models. However, as with all software, no guarantee, explicit or implicit, can be given as to the value, performance or documentation of the software in this text and in the Manual to this text (explained below).

As well as the above software which is written in FORTRAN IV, a large amount of commercial software is included in the book. The grateful assistance of four computer bureaux must be acknowledged. The alternative to a general purpose language is to use a modelling system usually provided by a commercial time—sharing service (although the ICL PROSPER modelling system is normally run on in—house machines). The four computer bureaux were: Comshare, Honeywell Timesharing Mark III Service, IBM Remote Computing Services, and ADP Network Services Ltd, which provided respectively the following modelling systems: FCS, TABOL, AS (formerly STRATPLAN), and ORACLE. In particular, grateful thanks to: Ian Spacie, Roger Lancaster and Janet Hawke from IBM; Jeremy Ashton from ADP Network Services Ltd; and Pat Power from EPS Consultants (which has ownership of FCS). In addition I have had enormous help from many other firms.

This brings me to the question of highlighting four particular systems. Undoubtedly this will be unfair to the many excellent systems not included in the book. My intention was purely to provide four representative examples of modern and easy-to-use modelling systems.

Available as supplementary material to this book is a Manual* which includes full details of all the software not given fully in the main text, a lucid discussion by Geoff Wells of the Imperial Group about his experiences with ICL's PROSPER package (or at least a DATASKIL variant), and two brief commentaries from two practising accountants: Peter Juul (Price Waterhouse and Co.) and Nick Mearing-Smith (Thomson McClintock). A brief analysis of local authority models is also made. Unfortunately it was not possible to include this material in the published book, but it is to be hoped that many readers will want to take up the opportunity to discover the further detailed information that the manual provides.

My grateful thanks also goes to Fenella McCann, Mike Lowcock, Chris Slater, Peter Juul and Jonathan Fenn for help in the preparation of simulation models.

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Contents

List of FORTRAN subroutines

Name	*Description/purpose*	*Chapter in which subroutine explained*	*Page*
CREDOR	*Calculates amount of debitors or creditors*	*8*	*222*
DEPRB	*Calculates reducing balance depreciation*	*8*	*223*
DEPSTR	*Calculates straight line depreciation*	*8*	*225*
DEBTCA	*Updates debt details and calculates interest charge*	*8*	*228*
WACCAL	*Calculates weighted average cost of capital*	*8*	*228*
DCHECK	*Calculates and performs checks concerned with dividend policy*	*8*	*231*
CTAX	*Corporation tax routine*	*8*	*233*
SHARDI	*A more sophisticated and flexible subroutine for dealing with dividend policy*	*8*	*260*
IRR	*Calculates the internal rate of return (DCF return) of a series of cash flows*	*Appendix 1*	*325*
NPV	*Calculates net present value*	*Appendix 1*	*325*

List of programs

1 The choices open to the modeller

Introduction

A manager involved in decision–making often finds the concept of model building mysterious. There is no reason why he should. A model is little more than a formal representation of notions which the decision–maker has about a problem. The construction of a model involves building a set of relationships which represent a simplification of the more complex real world situation. When the decision–maker builds a model, he must endeavour to draw these complex strands of his problem into a coherent, logical framework. This framework may then be used subsequently to provide greater information on the problem in hand.[1]

The purpose of the book is to help the person in business who has little knowledge about financial models, to build such a model. A secondary aim is to suggest some new ideas to the trained modeller. These ideas are firmly based upon experience and research-orientated towards practicality. This book is a sequel to an earlier book[2] which was written specifically for the person with no knowledge of computer models. The reader who wishes to know what other companies have done to date, is referred to an excellent survey of computer models contained in *Corporate Models Today*,[3] published by the Institute of Chartered Accountants in England and Wales. Rather than describe what other companies have done, this book is geared to the modeller who wishes to be given some pointers and guidelines about the development of his model.

Throughout the book a number of examples and 'standard' types of models will be given. It is hoped that these models will form a framework which can be used by a newcomer as a base from which to work. The more experienced modeller may find some of the examples too simplistic but may gain valuable insight into ways of improving his own company's model from other examples. This book assumes that the reader has a rudimentary knowledge of FORTRAN. (If not, some references are provided at the end of Chapter 2.)

Many of the examples provided here are not given in full. For the modeller who is building or extending his model, this book should be used in conjunction with the Manual,[4] which has been produced separately. The Manual contains the complete examples encompassing input data, output listings and model logic/computer program.

Simulation approach

The type of model dealt with in detail is broadly described as a financial simulation model. The purpose of a simulation model is to simulate the activity of a company over a given time span or model horizon (e.g. five years). During this time it will use a set of assumptions embodied in the input data and, applying certain formulae, will produce a set of results for each year which forms the output of the model. Figure 1.1 shows how some input may be required initially (such as the bank opening balance) whilst other information (sales forecasts) will be required for each time period.

Some definitions

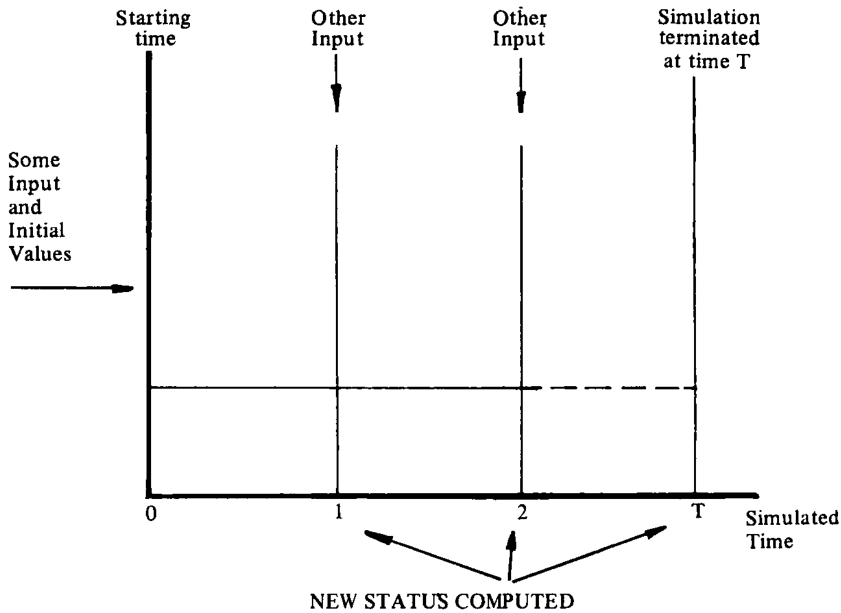
The technical term which is used for describing various financial and physical terms is a variable. A variable in terms of a mathematical model is an item which is uniquely represented. The simplest example of a model is:

$$R = P \times Q$$

(revenue = price multiplied by quantity)

The variables of this mathematical model are R, P and Q. In order to determine the output (R), input data is required for P and Q. The technical term for variables whose values are taken from input data is *exogenous* – that is, determined *out*side the model. Those variables whose values are calculated within a model are termed *endogenous* variables. The relationships which transform the exogenous variables (inputs) into providing values for endogenous

Figure 1.1 A schematic representation of the simulation approach over time



(Adapted from MEIER [4])

variables (output) are termed functional relationships. An example of a functional relationship linking price and quantity to revenue is given above.

Types of models

There are many types and varieties of models. This book cannot hope to deal with all of them. Broadly speaking, models may be defined as representations of all or part of a company's current or prospective operations or of its economic environment.[6] There are many classifications of models and a classification is given below using the correct technical names, although where other names are commonly used these are given in brackets.

Report generators

A report generator is a computer program operating on historical or actual information stored in a file usually held in a computer's memory. (If the amount of data is large and comprehensive the file is sometimes described as a data base.) The report generator, performing a minimal amount of computation (perhaps totalling rows or columns, etc.) produces a neat report in full or in summary. No attempt is made to incorporate assumptions or relationships pertaining to the firm which together can produce forecasts of the endogenous variables – this is the province of the next category of model. Financial simulation models are often used to produce neat reports for presentation to the boardroom. Much emphasis is given to the speedy generation of reports in modelling systems (special packages for financial simulation models). Such facilities are useful for the financial planner or modeller but in the final analysis he must weigh the costs of his own time and any computer charges against the cost of employing a secretary to do the same task.

Deterministic simulation (financial model, corporate model or planning model)

A deterministic model is a model which uses a single valued or point estimate as input data. A simulation model is one which imitates a more complex reality. Combined and applied to management, a deterministic simulation model is a representation of all or part of a company's current or prospective operations. The representation requires certain assumptions which are single valued or point estimates. However, these representations do permit the model builder to vary (1) the conditions under the control of management and (2) the assumptions relating to the environment or conditions outside the control of management. Taken together these two factors should allow the modeller to test the implications of various plans for the future. This book primarily concerns itself with this type of model.

Probabilistic Simulation

Probabilistic models use multiple estimates as input data usually with a relative frequency reflecting the probability of the occurrence of specific values. Such probability distributions of variables yield implications of various proposed future plans reflecting the range of likely performances of a company and the probability of a specific performance being achieved. The book does not deal with probabilistic simulation models.

Optimising Models (LP Models)

The model in this instance derives an 'optimum' solution of some specified objective using mathematical techniques and analysis. By adjusting the controllable variables, a model builder may be able to search for optimal or best plans. Some models automatically search for such an optimal plan in which case they are said to be *optimising* models. However, all models, to a certain extent, allow the model builder to search for better alternatives. The distinction between optimising and non–optimising models is that an optimising model, within the confines of a given set of objectives searches for an optimum automatically. The model builder may, however, only wish to know what is the likely outcome of differing variables given a range of alternatives.

Optimising models usually use a technique known as mathematical programming in order to make the search for the optimum more efficient. The most common mathematical programming technique in use today is one called Linear Programming (LP) which permits the use of only linear relationships. This technique involves the specification of a linear objective function (e.g. contribution per product) and a number of constraints (e.g. total machine hours and total labour hours available to the firm). The solution to the LP model will then yield an optimal plan (e.g. an optimal product mix) which maximises the objective function (e.g. the contribution to profit). More recently a technique known as goal programming[7] can be used within the LP framework to provide a much more flexible approach by allowing multiple and conflicting objectives. A priority structure is specified for these objectives which then permits an optimal solution to be found. Apart from the optimal product mix, another use of LP models is in the area of optimal capital project selection in capital rationing situations where money is sufficiently scarce to prohibit the adoption of all worthwhile projects.

By and large, LP models have not been very successful because early models tended to be too complicated and users misunderstood the nature of the models. Although an optimal solution is produced by the model, this solution cannot be regarded as optimal for the firm, but only optimal in so far as the input data is correct (a rare occurrence). Alternatively, the model must be run several times, each run yielding more information towards the best plan of action for the firm as a whole.

This book does not deal with optimising models.

Statistical forecasting models

Statistical techniques can be used to provide forecasts by operating on historical data. This type of model is often used in conjunction with a deterministic model. Chapter 13 deals briefly with this type of model.

Other analytical models

Analytical models are models in which some type of algorythm is used to produce a solution or output. The LP type of model mentioned above is an example of an analytical model. Other analytical models such as DCF (Discounted Cash Flow) techniques and optimal inventory holding models (such as the simple economic reorder point model) may be used within a deterministic simulation model.

The current trend in the use of models is towards simple deterministic simulation models with a financial application bias. Neither optimising nor probabilistic models have found the general acceptance of the former simpler type of model. The growing use of the simpler type of model will lead some modellers (after the learning process concerned with these financial models has been completed) to experiment with optimising models (e.g. LP models) in order to search for optimum solutions. Similarly some modellers will want to incorporate probabilistic elements[8] into their deterministic models in order to have a better understanding of the riskiness of their business. However, it is probable that deterministic models will always have a wider appeal. Hence this book concentrates on this type of model. Statistical forecasting models will probably be used increasingly as a vertical extension of deterministic models in order to aid the derivation of assumptions such as future sales. This point is further discussed in Chapter 13.

The particular models discussed in this book are referred to as 'financial simulation models', to differentiate them from the wide range of models given above.

Applications

Changes in model design are also reflected in changed applications. Earlier models were often designed for a wide range of applications – often intended to aid both long– and short–run financial planning, to assist production and marketing decisions, and designed for use by line or middle management. Although models of this type are still being developed, there has been an increasing growth in the simpler model geared to the needs of top management with a much greater emphasis on specific financial considerations. In order to illustrate the range of applications a somewhat arbitrary classification is given below. It should be realised that in practice many models span several of the classifications given below.[9]

1. Strategic – to evaluate alternative courses of action (e.g. diversification into different fields, new plants, etc.), usually built by corporate strategists or Operation Research (OR) departments.
2. Impact – to provide a rapid calculation of the impact of changes in the environment (including inflation) on the firm, usually built by accountants or OR departments.
3. Budgeting – to computerise the short–run budgeting process of a firm and to facilitate the recalculation of those budgets (typically, short–run models vary from six to twenty four months with the most common models being twelve monthly ones); heavily accounting oriented.
4. Planning – an extension of the budgeting models but usually simpler and less detailed with a longer time horizon (5-10 years), less well equipped to deal with major alternative courses of action, such as diversification (although new products could be analysed in this model): – financial management/business finance oriented.
5. Cash flow forecasting – a relatively shorter run model (daily, weekly, monthly) to aid in cash flow management. (To decide how much finance was needed for a major long–term investment programme, the planning or strategic model should be used.)