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Application of Models in Financial Management

Abstract. *The basic purpose of using any model is to construct a representation of the real world for purposes of experimentation. Financial models are key tools for decision makers. Financial models can help the user of a model to examine problems and evaluate the impact of changing the model's assumptions. The model allows the modeller to understand and learn relevant financial concepts. In order to be used correctly, a financial model must be adequately designed and consist of three components: data, logic and output. The use of models in practice requires a proper understanding of economic and financial aspects of a given business and its environment. It also requires some discipline in structuring the model.*

Keywords: *financial management, financial models*

1. Basic definitions

A model is a small copy of something to show what will it look like when finished [*English Business Dictionary* 1990: 186]. It is a representation, generally in miniature, which shows the structure or serves as a copy of something [*Webster's Encyclopedic Unabridged* 1989: 920]. It is a small representation or copy of something [*Longman Dictionary of Contemporary English* 1990: 668]. A model is a simplified representation of a real object or situation that facilitates the understanding and manipulation of the real thing [Diacogiannis 1994: 1].

A model of the situation being analysed is a basic tool of management science [*The Software Toolworks* 1992]. A model is a representation – usually simplified

– of reality intended to explain the behaviour of one of its aspects. Often a model is an abstract mathematical formulation of the problem. For example, one may construct a mathematical model that can be used to determine how to blend petroleum crudes to yield different amounts of various fuels so as to maximise the profit derived from the sale of these fuels. This type of model making is known as linear programming or, more generally, mathematical programming. Other well-known techniques include inventory models used to recommend optimum purchase or production quantities under varying conditions of consumer demand; Queueing Theory models that describe waiting-line conditions for randomly arriving people requesting service from a facility (stochastic process); and simulation models that can be used to test the performances of complex interactive systems (e.g., an air-traffic control simulation model) under different operating policies.

2. Types of models

Models can be classified into three categories:

– an iconic model is a physical replica of the real thing; a scale model for a shopping centre or an airport, or an aircraft simulator are examples of iconic models;

– an analogue model is a physical representation of objects or situations but does not look like the real thing; for example, a diagram showing the relationship between the financing decisions and objectives of a firm, profitability charts, and so on are analogue models;

– a mathematical model is a set of symbols and mathematical relationships that represent a real situation; for example, break-even analysis, maximising the earnings per share of a firm, optimising the use of financial resources, and so on can all be represented as mathematical models [Diacogiannis 1994: 1].

A more detailed method of classifying models can be based on their type. There are many different types of models:

– iconic – looks like,
– analogue – behaves like,
– symbolic – representative of,
– mathematical – mathematical representative of,
– descriptive – descriptive of behaviour, relationships, physical characteristics,
– deterministic – behaves in prescribed patterns,
– probabilistic – behaviour only predicts probabilities,
– static – static representation,
– dynamic – changing representation,
– algorithmic – optimised and structured,
– heuristic – trial and error [Asch & Kaye 1990: 12].

N. Hogg identifies four main types of models:

– option evaluation using relative criteria – this sort of model rates previously identified options against each other, for example, if a number of projects have been put forward for central approval by divisional management, a model may be used to rank the proposals and, thus, make a selection;

– option evaluation against absolute criteria – in practice, purely relative evaluation is unlikely as there must also be some absolute measure of "goodness", for example, if all of the projects submitted by divisions have a negative net present value (NPV), it would be undesirable to authorise any of them (an example of a common absolute criterion is a hurdle rate for the internal rate of return);

– option identification – in some cases, the business options may not have been fully identified before modelling begins, in which case, one of the main reasons for using a financial model is to provoke thought about what the options are;

– optimisation – the last type of model is used to analyse one option in greater detail, for example a human resource planning model may be concerned with identifying the minimum staff cost for a given work forecast [Hogg 1994: 3].

Financial modelling is the process by which a firm constructs a financial representation of some, or all, aspects of the firm or given security. The model is usually characterized by performing calculations and makes recommendations based on that information.[1]

The term financial modelling is widely used to describe a spectrum of analytical methods. The common theme of these is the representation of business processes in numerical terms on a computer. Applications of financial modelling vary from the complicated and business-critical, such as corporate planning and acquisition analysis, to the straightforward and routine, such as monthly cash monitoring. Some of the most common applications of financial modelling include:

– assessment of strategic/business options,

– evaluation of financing structures, including merger and acquisition opportunities,

– capital project appraisal,

– forecasting of cash flow, profit or asset base,

– bid evaluation,

– cost reduction planning,

– market planning,

– human resource planning.[2]

G.R. Kaye maintains that a generic structure for the modelling process consists of seven stages:

1. Problem definition.

2. Problem analysis.

[1] www.investopedia.com/terms/f/financialmodeling.asp [access: 9.11.2017].

[2] www.investopedia.com/terms/f/financialmodeling.asp [access: 9.11.2017].

3. Parameter estimation.
4. Specification of the model.
5. Encoding the model.
6. Testing the model.
7. Implementation [Kaye 1994: 96].

G.P. Diacogiannis emphasises the following benefits of the financial model:

– the model allows the modeller to understand and learn the relevant financial concepts;

– the model can help the modeller to examine more problems and evaluate the impact of changing the model's assumptions;

– creating graphs using a spreadsheet offers an impressive way to communicate the results of data and information processing;

– the financial model allows the modeller to quantify, model, understand and evaluate complex financial situations – a task which is impossible to perform without the use of the spreadsheet;

– the financial model allows the modeller to provide an effective and more accurate solution to the problem;

– the financial model can have multiple uses, which allows the modeller to save considerable time in the future when the same model has to be used again;

– building financial models with a spreadsheet helps the modeller to develop skills that are immediately transferable in everyday business situations;

– the financial model helps owners and managers of small businesses to utilise their resources more effectively;

– application of the financial model does not always require expert knowledge of computer science or finance [Diacogiannis 1994: 16-17].

The basic purpose of using any model is to try and construct a representation of the real world for purposes of experimentation. Models, such as financial models that we are concerned with, are known generically as mathematical models because they represent the world through a series of equations. Mathematical models are widely used outside business. For example, in aircraft design, as an alternative to wind tunnel testing, use is increasingly made of hugely complicated models of aerodynamics that are run on super-computers. In a field such as aircraft design, the model means that the effects of changes in designs can be more quickly, effectively and cheaply examined than by other methods [Hogg 1994: 13].

Financial models are used for many different reasons. The most common ones include business valuation, scenario preparation for strategic planning, cost of capital calculations for corporate finance projects, capital budgeting decisions and the allocation of corporate resources. Financial models are also used in the creation of projections and trends for forecasts and in many other applications related to industry comparisons, ratio analysis and common size financial statements.[3]

[3] www.investopedia.co/terms/f/financialmodeling.asp#xzz4wAnf1OwW [access: 9.11.2017].

Most authors treat financial modelling as an important tool of financial analysis (or financial planning) [Brealey & Myers 1991: 707; Pluta 1999: 25-29] that provides important benefits: 1) a model combines financial and non-financial information in a common (that is, financial) format; 2) allows the impact of a change in one variable to be seen on the bottom line and, thus, facilitates the development of multiple scenarios; 3) is thought-provoking – the focus of most business is financial and, as such, seeing a situation represented in financial terms often enables managers to gain a better "feel" than being presented with the same picture in qualitative terms; 4) allowing the financing requirement to be sized, depending on assumptions, such as the timing of capital payments, the rate of revenue build-up and the funding instruments available to the project [Hogg 1994: 13-14].

3. Spreadsheet-based financial modelling process

A spreadsheet is frequently referred to as a personal "modelling" tool because it enables the user to build a "personal" model and carry out the modelling on their own. The user decides on the logic and data during the construction phase of the model. Additionally, the user validates the model by using it and expanding it if necessary. The creation of a spreadsheet-based financial model consists of the following stages:

Initial view of the problem. This stage does not require a clear and concise definition of the problem, because a spreadsheet provides the tools to revise and restructure the model at any time. In some cases, the recommended strategy is to plan the model on a piece of paper.

Constructing an initial model. At this stage, an initial model is built by planning the logical steps in the model and using the necessary numerical data. Here you are developing a process for converting input data to output. The presentation style of the model is tailored to the individual. For example, when developing a model that calculates the net present value of an investment project, one can choose to display all the input data before the solution of the problem. It is a good idea to separate the input data from the main calculation section of your model, where the data is employed for processing.

Testing the initial model. Once the initial construction of the model is completed, the model is tested. Testing involves using the model with different sets of data to determine whether it always produces correct results. If there is an error (or errors), it should be located and then corrected using the spreadsheet tools. Typical errors include misreferenced cells, errors in a formula or function, a missed bracket in a lengthy formula or function. If the model needs restructuring, the worksheet can be altered as necessary. Before moving on to the next stage review the learning achieved up to this point.

Expanding the model. This stage is devoted to the expansion of the model by using more data, modifying one or more of its initial assumptions, or providing a further development. The presentation style of the model is tailored to the needs of the model creator.

Table 1. Advantages and disadvantages of computer models

Advantages of computer models	Disadvantages of computer models
They provide a framework for examining problems. Though they may not always lead to solutions, they could highlight gaps in information.	There is a danger of over-simplification. The model builder may leave out crucial factors for expediency.
The process of building the model contributes significantly to a better understanding of the problem.	Symbolic language, though valuable, has its limitations, and not every relationship can be expressed mathematically.
They allow manipulation of both the rules and the data to test a wide variety of possible outcomes.	Model builders can become so enamoured of their models that they begin to believe that they are better than reality, and the model may become rigid.
They are easier and less expensive than carrying out a full-scale exercise, saving both time and money.	Models produce only predictions of outcome. These might be a simple figure (as in a budget) or a range of results with an indication of the one most likely to occur. Models are never (or extremely rarely) absolutely right, which leads some people to perceive them as inherently inaccurate.

Source: Asch & Kaye 1990: 16-17.

Testing the expanded model. At this stage the expanded model is put to the test. If it needs to be restructured or simplified, the worksheet is adapted as necessary. If there are no errors and the model needs further expansion, the creator reviews the learning achieved up to this point and goes back to Stage 4. If no further modifications are necessary, you have constructed you final version of the model. Review the learning achieved from using the modelling approach [Hogg 1994: 10-11]. In Table 1 there are some advantages and disadvantages of computer models.

4. Approaches to financial modelling

Neil Hogg identifies two basic approaches to financial modelling: Pragmatist's Approach and Theorist's Approach. The characteristics of the so-called Pragmatist's Approach to financial modelling are:

– PC spreadsheet-based – the increased availability of cheap, powerful and easy to operate spreadsheet packages for PCs in the 1980s opened up the possibil-

ity of non-computer people developing and running complicated financial models, and accountants were a key group in taking advantage of this;

– financial statement-driven – financial models are viewed as a tool for producing standard statements of balance sheet, profit and loss and cash flow, possibly together with a number of key performance indicators;

– non-optimising – with this approach, models are not designed to produce one optimal result because of the complexity involved in modelling the necessary relationships;

– deterministic – it is uncommon to find models that explicitly incorporate a range of probabilities for variables such as sales – typically, multiple sensitivity analyses will be conducted to examine the behaviour of the output in different scenarios;

– tautological and not algorithmic assumptions – assumptions entered into this type of model tend to be primarily simple accounting relationships, such as profit = sales – cost, so the model is primarily arithmetic [Hogg 1994: 7-8].

The Pragmatist's Approach keeps the model computationally simple and focuses on carrying out the arithmetic that might previously have taken place on large sheets of analysis paper. The model is, therefore, a means of presenting a body of input data in a commonly understandable format and allowing straightforward manipulation of these results. However, this is not to say that these models cannot be both large and complicated.

This approach is viewed by many as the most suitable role for a financial model. It avoids the necessity to model complicated economic variables and to model uncertainty directly. The process of building the model is seen as a prompt for thought and discussion about the issues facing the business. Less deterministic aspects of the problem will probably be tackled via less analytical means.

The so-called Theorist's Approach brings together the economist's approach to analysis and the simulation approach to financial modelling. The Theorist's financial model may be characterised as follows:

– not confined to PC environments – the analysis traditionally used by economists has often made use of powerful midrange machines using specialist statistical and analytical software and this heritage still has an influence: people following this approach will often use a specialist modelling package, such as FCS, in place of, or in addition to, spreadsheets;

– goal driven – whereas the Pragmatist's Approach focuses on producing traditional financial statements, the Theorist's Approach is directed more at examining the impact of assumptions on a few key variables, which might be profit measures, but might equally be variables such as market share or the height of barriers to entry;

– complicated assumptions – with this approach, more of an attempt is made to achieve optimal solutions, such as the profit maximising price and to ascribe

probability functions to variables in order to take account of chance factors, so the relationships in the model will also be more complicated, resulting from the need to model economic relationships.

The Theorist's Approach, therefore, makes greater use of relationships built into the model itself to give explanatory power to the modelling process, as opposed to using the model more as a prompt, as in the Pragmatist's Approach.

In between the Pragmatists and the Theorists there is clearly a fairly broad spectrum of other possible approaches. Indeed, it is even too sweeping a stereotype to say that accountants are Pragmatists and economists are Theorists – these are merely handy labels for the approaches that are evident in business. In addition to those mentioned already, a third important group of people also becomes involved in financial modelling in business. These are the technical people, such as operational researchers, engineers and scientists. As might be expected, their approach is, in many ways, quite close to the view of the Theorist, as it places greater emphasis on the model and less on the process than that of the Pragmatists. The distinguishing factor between these two approaches lies more in their focus: the theorists focus on economic relationships, the technicians perhaps more on physical relationships, such as machine efficiency and resource usage [Hogg 1994: 8-10].

5. Financial planning and inflation

A financial plan must always be preceded by a decision on how to express future cash flow. There are two possible approaches:

– cash flow expressed in nominal values;
– cash flow expressed in fixed prices (real terms).

In practice, the first approach is preferred. If a prognosis is completely accurate and the financial plan is consistent with its execution, figures shown in profit and loss accounts, balance sheets and cash flow statements will correspond to the actual values. Therefore, prognoses and plans based on nominal values are potentially clearer and more consistent with the reality. This approach also enables automatic adjustment of mutual price relationships and structural movements of costs, according to a projected scenario of inflation in various areas of the economy. Nominal values should also be used in short range planning for utilitarian reasons.

In the case of a high inflation rate and long-term plans, the approach mentioned above has several significant disadvantages (e.g. unavailability of nominal sales figures, costs, profits). Therefore, in particular circumstances, the latter method of expressing cash flow and financial resources becomes more and more popular. It is a simpler approach, enabling a better generalisation of assumptions.

It should be used whenever it is certain that a projected cash flow expressed in nominal values will not increase the effectiveness of the planning process and that fixed prices will not make it difficult to communicate the content and objectives included in a company's financial plan.

Irrespective of the kind of financial planning, i.e. based on nominal or real prices, the effect of inflation should always be taken into account. The opinion that the use of fixed prices prevents calculation problems connected with inflation is completely false. Determining fixed prices (i.e. real, but not unchangeable, used for example to calculate quantitative changes) means calculating real future prices, that is after eliminating the influence of the general inflation. These prices do not have to be and are usually not the same as those at the moment of making a financial plan. Mutual price relationships depend on inflation dynamics, particularly with respect to categories of costs, goods and services. If, for example, labour costs are projected to grow faster than the general inflation rate, the real price of labour will be higher, which should be taken into account while making a financial plan using fixed prices. Prices of other production factors and the company's product prices may grow more slowly than the general inflation rate, which means they will actually fall [Zarzecki 1994: 29-30; Pluta 1996: 149-151].

6. The model's structure

It is very important to consider the actual content of the model itself. All financial models can be thought of as comprising three basic sections:

– data section: various types of input information,

– logic section: relationships within the model that transform input data into the desired output, for example the statement "variable costs = 40 per cent of sales" is a piece of logic,

– output section: the desired end result of the model, such as a cash flow or statement of key performance indicators [Hogg 1994: 8-10, 61-63].

Within each of these sections, there will be one or more subsections, or modules as they are called in Figure 1. For example, the data section can include modules of operating cost, capital cost, sales, price and depreciation data, as well as one or more modules of assumptions covering finance, tax, economic variables and so on. The logic section will contain modules to calculate revenue for financial statements and for key performance ratios.

Typically, emphasis is placed on producing working logic. From the perspective of model building, this is entirely natural as the model is largely determined by its logic. However, from the standpoint of financial analysis, the logic on its own is of little use without sound input data. To use an analogy, if the logic is the engine of the model, the data is the fuel. According to Asch and Kaye, one of the

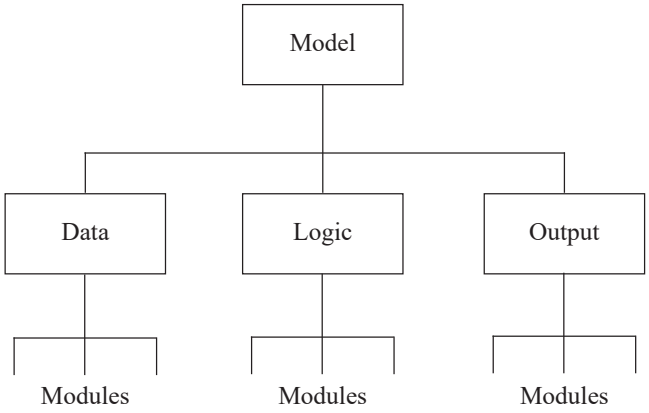

Figure 1. Outline of the model's structure

Source: Hogg 1994: 61.

shortcomings of the modelling process is that it is prone to the "garbage in, garbage out" syndrome [Asch & Kaye 1994: 17].

7. Concluding comments

Most business financial models are simulation models designed to project and analyse consequences of alternative strategies under specified assumptions about the future. Models range from general-purpose ones to models containing a large number of equations and interrelated variables.

Most large businesses have a financial model. Sometimes they use more than one, e.g. a detailed model integrating capital budgeting and operational planning, a simpler model focusing on aggregate impacts of a financing strategy, or a special model for evaluating mergers. Such models are popular for a simple and practical reason. They support the financial planning process by making it easier and cheaper to construct pro forma financial statements. Models automate an important part of planning that used to be boring, time-consuming, and labour-intensive [Brealey & Myers 1991: 707]

On the other hand, it should be emphasised that, as Brealey and Myers put it, "there is no finance in corporate financial models". The first reason is that most such models are based on an accountant's view of the world. They are designed to forecast accounting statements, and their equations naturally embody accounting conventions employed by the firm. Consequently, models do not emphasise the tools of financial analysis: incremental cash flow, present value, market risk, and so on. Second, as Brealey and Myers argue, financial models produce no signposts

pointing toward optimal financial decisions. They do not even tell which alternatives are worth examining. All this is left to their users. Brealey and Myers [1991: 712] maintain that no model can find the best of all financial strategies.

References

Asch D., Kaye G.R., 1990, *Financial Planning. Modelling Methods and Techniques*, London: Kogan Page.

Brealey R.A., Myers S.C., 1991, *Principles of Corporate Finance*, New York: McGraw-Hill.

Diacogiannis G.P., 1994, *Financial Management*. *A Modelling Approach Using Spreadsheets*, Maidenhead: McGraw-Hill.

English Business Dictionary, 1990, Teddington: Peter Collin Publishing.

Hogg N., 1994, *Business Forecasting Using Financial Models*, London: Financial Times/Pitman Publishing.

Kaye G.R., 1994, *Financial Planning Models. Construction and Use*, London: Chartered Institute of Management Accountants/Academic Press.

Longman Dictionary of Contemporary English, 1990, London: Longman, Warszawa: WN PWN.

Pluta W., 1996, *Strategiczne zarządzanie finansami*, Wrocław: Ekspert.

Pluta W., 1999, *Planowanie finansowe w przedsiębiorstwie*, Warszawa: PWE.

The Software Toolworks Multimedia Encyclopedia, 1992 Edition.

Webster's Encyclopedic Unabridged Dictionary of the English Language, 1989, New York: Portland House.

www.investopedia.co/terms/f/financialmodeling.asp#xzz4wAnf1OwW [access: 9.11.2017].

www.investopedia.com/terms/f/financialmodeling.asp [access: 9.11.2017].

Zarzecki D., 1994, Planowanie finansowe w organizacjach gospodarczych, *Rachunkowość*, 1, 26-28.

Zastosowanie modeli w zarządzaniu finansami

Streszczenie. *Głównym celem, jaki stawiany jest wszelkim modelom, jest odwzorowanie realnego świata na potrzeby prowadzenia określonych doświadczeń. Modele finansowe są kluczowymi narzędziami wykorzystywanymi przez decydentów. Mogą one pomóc użytkownikowi modelu przetestować różne problemy i ocenić wpływ zmian w założeniach. Modele umożliwiają identyfikację i zrozumienie rozpatrywanych zagadnień ekonomicznych i finansowych. Poprawne zastosowanie modeli finansowych opiera się na właściwie zaprojektowanej strukturze konkretnego modelu, w którym powinny być wyraźnie wydzielone trzy części: dane wejściowe, formuły oraz wyniki. Wykorzystanie modeli w praktyce wymaga dogłębnej wiedzy na temat ekonomicznych i finansowych aspektów danego przedsiębiorstwa, sektora i szerszego otoczenia biznesu, a także dyscypliny w zakresie ustrukturyzowania modelu.*

Słowa kluczowe: *zarządzanie finansami, modele finansowe*