

I N T R O D U C T O R Y

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INTRODUCTORY

BUSINESS

FORECASTING

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PREFACE

Forecasting is not simply an important aspect of business management—it is an unavoidable task. No rational decision can be made without, at least implicitly, taking some view of the future. Often in the past, the forecasting activity in many organizations was quite informal. However, over the last several years it has become increasingly well recognized that more formal methods could contribute to increased forecast accuracy, and hence to enhanced quality in decision making. Some knowledge and understanding of these methods is therefore a considerable asset for the well-trained manager.

Our aim in writing this book has been to provide a widely accessible introduction to business forecasting methods. Some of the methods in current use are technically quite complex. However, we have written this text with the intention that it be readily comprehensible to readers who have followed the typical introductory (non-calculus) business statistics course. The level of mathematical and technical sophistication demanded will be no higher than that for such a course. However, subject to this constraint, we attempt to explain not only how the various techniques work, but as far as possible *why* they work. We have tried to write a textbook, not a cookbook. This book should be suitable as a text for both undergraduate and M.B.A. students who have taken an introductory business statistics course. (Chapter 2 of the book provides a brief review of some of the relevant material from such a course.)

We have concentrated heavily on *quantitative* approaches to forecasting. In particular, we have emphasized three approaches: regression analysis, exponential smoothing, and ARIMA (autoregressive integrated moving average) models. All are widely used in business, and we feel that all should be understood by the modern business forecaster. Regression methods are introduced in Chapters 3 and 4 of the book. Following an introduction to time series in Chapter 5, Chapters 6 and 7 cover, respectively, exponential smoothing and ARIMA models. In Chapter 8 we return to regression methods, discussing there the simultaneous equations models often employed in econometric forecasting. Chapter 9 attempts to bring together the regression, exponential smoothing, and ARIMA approaches to forecasting, discussing relationships among them and possibilities for amalgamation. These seven chapters constitute the central core of the text.

Because of their widespread use, we believe it appropriate that an introduction to quantitative business forecasting methods concentrate most heavily on regression, exponential smoothing, and ARIMA models. However, a good many forecasting methods that do not fit into any of these categories have also been proposed and implemented. In Chapter 10 we introduce some of these, though not at the detailed level of coverage provided by the earlier chapters. Our major goal in this book is to introduce formal quantitative approaches to business forecasting, but we would not wish to give the impression that we do not value sound human judgment in the area. Indeed, we believe that in practice best results will most often be achieved through an alliance between formal methodology and judgment, the latter being most useful for incorporating into the forecast those factors which cannot be accommodated easily within a formal framework. On occasions, purely judgmental approaches to forecasting are employed, and some of these are briefly discussed in Chapter 11.

Chapters 12 and 13 cover two topics that we regard as extremely important. Often forecasts of the same quantity are available, or can be generated, from different sources. It is possible to combine these competing forecasts to achieve an overall composite prediction. The methods most often used in the combination of forecasts are remarkably simple; in practice, they have proved to be remarkably successful. Forecasts, once made, are often forgotten. Sometimes, when the eventual outcome has been realized, the forecaster may look back rather casually with pain or pleasure, depending on the relative accuracy of his or her prediction. We feel strongly that this is inadequate. Rather, it is important that forecasts that have been made be systematically evaluated. Only in this way is the analyst likely to learn from experience, and perhaps be in a position to improve future forecast quality. The topic of evaluation is sufficiently important that we are somewhat embarrassed that it appears so late in the text. It does so for technical reasons. One important approach to evaluation requires the combination of forecasts, a topic that is most sensibly covered only after the introduction of individual forecasting methods.

The first and last chapters of the book provide an introduction to, and summary of, business forecasting methods. Both are somewhat opinionated. Not all of our colleagues in the field will share all of our opinions. It is hoped that some of them at least will prove stimulating.

Although various theoretical aspects of forecasting methodology need to be understood, forecasting is essentially a practical activity. We have therefore provided throughout the book many illustrative examples involving the analysis of real data sets. It is hoped that these will facilitate understanding of the techniques, and also illustrate the circumstances in which various methods are useful. Of course, in forecasting, as in many other fields, data analysis is becoming progressively less painful as a result of the proliferation of computer program packages. Our text is liberally sprinkled with sample output from such packages. It is not, however, our aim here to teach the use of any particular packages. In fact, a large number of different programs are available for the analysis of data through some or all of the methods discussed in this book. There are some differences in output style among the programs, but they are sufficiently similar that familiarity with one should be sufficient for an understanding of the output of another.

A number of people have read and commented on various chapters of this book. In particular, we would like to thank J. Scott Armstrong, University of Pennsylvania; Richard T. Baillie, Michigan State University; David A. Bessler, Texas A & M University; Lawrence D. Brown, State University of New York at Buffalo; John L. Kling, Washington State University; Anne B. Koehler, Miami University; and David J. Pack, Miami University. Our understanding of the subject has also been immeasurably enhanced through discussions with many of our current and former teachers, colleagues, and students. We wish we could apportion part of the responsibility for the many shortcomings of this book to some of these people, but are unable to do so.

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Theodore Bos

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1 BUSINESS FORECASTING: BEYOND THE CRYSTAL BALL



1.1

THE IMPORTANCE OF FORECASTING

What will be the state of your career and your personal life in five years? Faced with such questions, most of us have two reactions. We cannot possibly know with certainty what the future will bring, and we would wish that the future were a little less obscure. All of us have learned to live with the reality of uncertainty, but most of us would feel more comfortable if that uncertainty were diminished somewhat. To a certain extent this reflects natural human curiosity. Throughout the ages such curiosity has provided a market for the services of those who claimed to see the future. Ancient history is replete with stories of consultations of oracles and soothsayers. Fortune tellers, equipped with such aids as tarot cards, crystal balls, and tea leaves, were an integral part of traveling fairs through much of the twentieth century. Today, more people than care to admit it subscribe to astrology to the point of regular reading of horoscopes. There *is* a human instinct to know more of the future. Of course, this is all a matter of degree. Our lives would be very much poorer if we knew with complete certainty everything that the future would bring. For example, the interest in watching a football game would be far lower if we were certain about the eventual outcome. Fortunately, there is no danger that we will ever be able to see the future with such certainty. However, to

say that certain knowledge of the future is impossible is not to say that the future must remain totally obscure. The forecaster's aim is to shed a little light, while acknowledging that some element of uncertainty will inevitably remain. It is the demand for more enlightenment about the future that accounts for forecasting being one of the oldest professions.

We have stressed the element of human curiosity in the market for forecasts. However, this is not the only, and certainly not the most important, factor motivating the demand for predictions, even in our day-to-day lives. Indeed, forecasting is inevitable. Whether we want to or not, we all make forecasts quite regularly. This is so because we are all *decision makers*, being required to choose among alternative actions in an uncertain world, where the consequences of these actions cannot be perfectly anticipated. Should we start off on a long journey by car, when there is some prospect of snow? Should we take an apparently attractive job, when we cannot know for sure what will be the status of the prospective employer, or what would be our status with that employer, in a few years' time? Should we invest much of our savings in a speculative project or stock, when the possible gains may be substantial, but the chance of serious loss nonnegligible? We are all faced with the need to make such decisions, and hence at least implicitly with the need to forecast. Presumably, before making decisions whose consequences will have some impact on our lives, we give these matters some thought, gathering whatever relevant information is available, seeking informal advice, and processing that information and advice to the best of our abilities. Of course, the amount of effort spent on these activities will depend on the importance of the decision that is to be made. In making our decisions, we will necessarily attempt to form some picture of the future: the clearer that picture, the greater the faith in the correctness of the decisions made. This discussion of forecasting in everyday life has brought out two important points:

1. Forecasting is an unavoidable activity.
2. Forecasting is an essential input to decision making. The better our forecasts, the better, all else equal, will be the decisions we make.

These same points remain pertinent when we turn our attention to the activities of organizations, whether government or business. Indeed, here the position is even more clear. Businesses cannot avoid planning for the future, in either the short or long term. Manufacturers must necessarily hold inventories of finished products to meet anticipated demand. Failure to meet demand leads to foregone profits, as well as goodwill losses. On the other hand, excessive inventory holdings will result in unnecessary holding costs. Thus, in planning production and inventory holding, manufacturers require regular short-term forecasts of product demand, typically on a month-to-month basis. In planning further ahead, new product developments must be considered, new markets may be investigated, and possibilities for expansion—either at home or abroad—will be studied. Decisions on these questions will have to be taken in the face of an uncertain longer-term future, about which it is obviously

desirable to learn as much as possible. Forecasting is an equally important element in the activities of financial institutions. Business now is essentially an international activity, and currency transactions are routinely required. The exchange markets have become so volatile in recent years that the gains from their correct anticipation, and the losses from poor forecasts, can be very substantial. Again, if a bank is to be heavily committed in loans to a particular business sector, such as agriculture or oil, or to particular countries, some view must be taken about relevant future trends in those sectors in assessing capacity to repay. The theme that runs through all of these examples is not simply that forecasts are a vital input to business decision making, but also that the stakes can be very high indeed. High-quality forecasting then should be seen as having a very direct, and possibly quite large, impact on the "bottom line." A little improvement in forecast accuracy can easily translate into substantial gains in profits. Thus, while in our every day lives we typically make forecasts quite casually and informally, in the business world forecasting is an activity on which it is worth spending a good deal of effort. Klein (1984) provides an excellent discussion and illustration of the value and importance of forecasts to government and business organizations.

Forecasting has been viewed for many years as an important activity in any number of enterprises. However, in the last few years there has been increasing momentum, so that this activity is becoming more widely recognized as having crucial value. In part, the increased attention that has been paid to forecasting may stem from the relatively recent development of new methodological approaches, some of which will be discussed in subsequent chapters of this book. Certainly the rapid development of computing power in the last two decades has also greatly expanded the scope of what can be done at a reasonable cost. However, it appears that the demand for reliable forecasts has increased in part because the need for them is more acute. This is a result of the rapidly changing environment in which we now live. Business must now operate in a world of rapidly evolving technology, of changing national and international market structures, and of critical political developments. In short, stability seems to be a thing of the past, and the future appears more uncertain than ever. Naturally, the anticipation of change has become increasingly important.

We have stressed the point that business forecasting should not be an isolated activity, but rather an integral part of the decision-making process. Indeed, it is difficult to see how rational plans can be developed without forecasts. We have heard it said that a particular corporation does not produce, even internally, forecasts of the sales of its products in various markets. Rather, it operates with a "marketing plan." This seems to misunderstand the nature of the forecast. We would not think of forecasting and planning as separate activities, but rather as two sides of the same coin. After all, what in isolation is a plan? Either it is realistic, in which case it embodies an element of prediction, or it is unrealistic, in which case it is of doubtful value, and indeed could be counterproductive.

1.2

FORECASTING AS ART AND SCIENCE

It is interesting to ask whether there exists, as a coherent intellectual discipline, a subject called "forecasting." On the one hand, the 1980s saw the birth of two journals, aimed at scholars and practitioners, in this area. The *Journal of Forecasting* and the *International Journal of Forecasting* each run to about 500 pages of articles per year. On the other hand, it is easy to have doubts on this question. After all, one presumably consults a meteorologist for weather forecasts, a demographer for population predictions, and an expert on the politics of the Middle East for an assessment of prospective developments in that area. An optimist might even consult an economist if forecasts of macroeconomic trends are wanted! Even if, as is our intention in this book, we restrict attention to the areas of business and economics, it is not difficult to visualize the value of a diversity of expert opinions in these fields. Readers will have encountered, for example, introductions to corporate earnings per share, daily currency exchange rates, national unemployment, and the marketing of new products in different courses, taught by instructors possessing different specialist knowledge. Can it then be useful to lump together the prediction of these quantities in a single course or text? Obviously, if we didn't believe that there is some value in this, we would not have written this book. The point is that certain methodological developments are valuable for considering a range of forecasting problems in business and economics, and indeed in a great many other fields. We have, for example, used essentially the same methodological approach for the prediction of unemployment in the United States and the volume of river flow in Iceland. The appropriate parallel is with a business statistics course, in which are studied techniques that have applications in accounting, finance, economics, marketing, and organizational behavior. These same techniques are also widely applied in many other fields. Since prediction of the future necessarily entails uncertainty, the reader will not be surprised to learn that many of the approaches to forecasting that we will be discussing are grounded in statistical methodology. We hasten to add that it is not our intent to minimize the value of specialist subject matter expertise. Indeed, this necessarily is equally valuable in looking into the future and understanding the past and present. The latter activity is a very desirable prerequisite for the former. We do, however, claim that a valuable set of methodological tools is available to the putative forecaster, and the main objective of this book is to introduce the reader to these tools, rather than concentrating on specific forecasting problems. In practice, for any particular job, it will be necessary to select the appropriate tools, and to use them in an appropriate way. We will try to clarify, at least in broad outline, what types of problems might sensibly be attacked through the various procedures that are introduced in subsequent chapters.

We have asserted that there exists a methodological apparatus for approaching a diversity of forecasting problems. However, that diversity is such that it is unreasonable to expect that there would be a single method that is best, or even suitable, for attacking all prediction questions. Although the methodol-

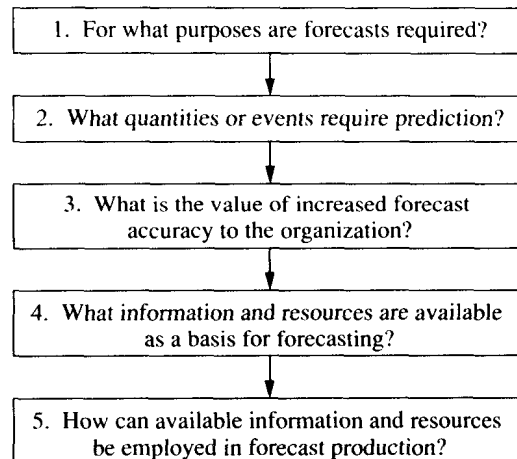
ogy of business forecasting does have some coherence, the range of important problems met in practice calls for a range of solution approaches. A corporation may produce a large number of mature products for which sales forecasts up to a year ahead are routinely required on a monthly basis for production and inventory planning purposes. This same corporation may be contemplating a substantial new development in the Middle East, and would like an assessment of political and economic prospects in that region over the next decade or two. One would not reasonably expect to approach these two forecasting problems through the same methods. It is easy to imagine, for example, that the latter would call for considerably more specialist subject matter expertise than would the former. We will have far less to say about those problems for which such specialist knowledge forms the major part of the solution than about those that allow the application of more formal and generally applicable methods.

That there is no single right way to approach all forecasting problems is pretty clear. Indeed, we would be reluctant to claim that there is a single right way to approach any forecasting problem. For one thing, every problem met in practice will have its unique features, and the careful analyst will want to study these before proceeding. Further, even after such careful study, it will often be the case that two or three more or less equally attractive avenues are open. This is not a retreat from our earlier claim to a degree of coherence in the subject matter of forecasting methodology. A number of approaches to forecasting problems have been developed that are soundly and sensibly based, and that have been found to enjoy practical success over a broad range of applications. It is this methodology on which we concentrate in the bulk of this book. Many of these methods are based on the familiar scientific principle of *model building*. A model to represent what is known of past behavior is constructed. That model is then projected to predict the future. The art in forecasting arises through the need to tailor this scientific method to the specific characteristics of individual forecasting problems.

As we will see in later chapters, a number of interesting technical methods for attacking forecasting problems have been developed. It is easy to become so impressed by this technical sophistication that the analyst develops an attachment to a particular methodology and an urge to implement it without giving due consideration to the individual characteristics of the forecasting problem at hand. However, all problems have their unique features, and it is important to pay attention to the problem context before embarking on a complex technical analysis. The questions set out in Figure 1.1 will often provide a useful basis for thinking about the individual ingredients of a forecasting exercise.

In one sense, it seems obvious that such questions should be asked. Their goal, however, is the important one of establishing a working relationship between the forecaster and the client organization. A two-way communication must be established in the interests of both. A manager should not simply commission forecasts of a particular quantity without considerable further elaboration. It is important that the forecaster fully understands the underlying objectives of the exercise. Predictions are generally required to do more than satisfy idle curiosity. As we have stressed, forecasts are an important ingredi-

FIGURE 1.1
Questions in a
forecasting exercise.



ent of the management decision-making process. The forecaster, who should acquire a good understanding of the reliability and limitations of the predictions that will be employed, ought to be thoroughly integrated into decision making. Once the purpose of forecasting has become established, it should become clear precisely what must be predicted. Naturally it is important that this be as specific as possible. Certainly, a broad question on potential developments in the automobile industry is worth asking, and may lead to some interesting conjectures that could influence manufacturers' decision making. However, for many more pressing decisions, there will be far more specific requirements. Not only is it important to know what must be predicted, but it is also necessary to be clear about the relevant forecasting horizon. Again, this depends on the decision maker's objectives. In some applications—for example, the management of corporate cash flow—daily forecasts are needed. On the other hand, even if resources were available to provide them, forecasts of tomorrow's unemployment rate would be of no value to the macroeconomic policy maker. In some applications, where for example a corporation is considering a large investment with a long life, the relevant horizon for forecasts can extend over several years.

Having established what must be predicted and why, the analyst now has some basis for assessing what might be a reasonable methodological approach. Two factors are important in making this choice. First, some thought needs to be given to the amount of effort it is worthwhile to make. In establishing the purpose of the forecasts, it should be possible to assess the potential payoffs from increased forecast accuracy. In some circumstances these payoffs will be very substantial indeed; in some others they will not. There is little point in expending vast resources of time, effort, and money in the production of superior forecasts when a crude, simple approach can yield predictions of adequate quality for the purposes at hand. Second, what can be attempted depends on