1.1 Why Forecast?

Why do we check the weather forecast? Partly, we may do so out of idle curiosity, but the information also serves to guide our planning for the days ahead. The planning activity may include such decisions as what to wear, whether to carry (and maybe lose) an umbrella, or whether to go ahead with a scheduled outdoor activity or travel plan. The forecast helps us plan, and planning, in turn, may improve our quality of life, compared with just rushing out the door. If we examine the elements of this simple vignette, we arrive at the following motivation for forecasting:

FORECASTING AND PLANNING

The purpose of forecasting is to inform the process of planning future actions.

The purpose of planning is to develop a course of action so that current activities don't "just continue" based on a no-change forecast.

Before embarking on a forecasting exercise, we should always consider the "Why?". That is, we need to specify the reasons for generating the forecast, how it fits with possible plans over the planning horizon, and the kind of forecast we need. Once the specifications are settled we must resolve the "How?" by careful analysis of the available information, its potential value in improving the planning decisions and the development of a forecasting system to implement the resulting forecasts. Indeed, "How?" is the question that we seek to answer throughout most of this book. Finally, last but by no means least, we must check whether the forecast system is doing the job for which it was designed – a question that is all too often ignored. Using the mnemonic PIVASE, we may identify these components as follows:

- **P**urpose
- **I**nformation
- **V**alue
- **A**nalysis
- **S**ystem
- **E**valuation.

1.1.1 Purpose

What do we hope to achieve by generating the forecast? What plans depend on the results of the forecasting exercise? The meteorologist provides information to a broad range of individuals and organizations, and they are all interested for their own reasons. For the weather service, it suffices to know that there is a demand for forecasting services. We tailor the level of detail in the forecast to satisfy our planning needs. If the weather forecast was for downtown Washington, but we were planning an outing to the nearby coast, the city forecast would give us only limited help. Similarly, the overall forecast demand for a company's cars is not sufficiently detailed to plan the production line. An integral part of this question is how far ahead do we wish to forecast? We refer to this period as the *forecasting horizon*. In turn, the horizon depends on our purpose in forecasting and will drive the choice of method. The methods we employ for short-term forecasting will consider only the factors that change rapidly, whereas longer term forecasts need to take into account a larger number of factors that may change during the time frame of interest. We also refer to the

forecast origin, the point in time from which the forecasts start. The horizon often affects the accuracy and usefulness of a forecast. As we know, weather forecasts are quite accurate up to 7–10 days ahead, but they tend to be more like long-term seasonal averages beyond that time frame.

1.1.2 Information

What do we know that may help us in forecasting, and when will we know it? Detailed information is useful only if it is available in a timely fashion. Tomorrow's financial reports may provide an excellent explanation of today's events, but they are of no use in forecasting stock prices today. Likewise, information is of value only if it has an impact on the forecasting procedure we seek to implement. Population changes may have a major effect upon sales ten years from now, but such changes take place at a relatively slow rate and would be irrelevant to forecasting sales in the next three months.

What do we know and when will we know it? A large-scale forecasting model may take into account a broad range of key factors, but if we have to wait several months for the data to become available, the forecasts may be too dated to be useful. Thus, a forecaster often relies upon leading indicators, such as closing levels of a major stock index or a survey of consumer sentiment, to signal changes in short-term economic conditions. These factors do not provide a cause-and-effect description of what is happening, but they may well yield a timely assessment of potential changes.

An often critical factor in producing an accurate forecast is knowledge of plans made in other parts of the organization that will affect the variable to be forecast. Producing a forecast of incoming calls to a call center without information on the corporate marketing plans over the horizon will usually lead to poor forecasts. Thus, identifying potentially important drivers that will affect future outcomes is an important step in developing a forecasting system.

The distinction between forecasting and explanation is often somewhat blurred. On the one hand, we may consider so-called pure forecasts that use only currently available information. On the other hand, a detailed description of a process (e.g., a macroeconomic model of the economy or a model of the world's climate) may enable us to answer what-if questions based upon the understanding that the detailed description provides. Such models typically require more information than pure forecasting exercises. When seeking to answer what-if questions, it is entirely reasonable to use data that are available only after the fact, because they provide an indication of the likely effects of certain policy decisions. They may also provide an explanation of the forecast errors we have made. In this book, we focus primarily upon pure forecasts, although the methods discussed in later chapters are useful in both contexts.

1.1.3 Value

How valuable is the forecast? What would you pay to have perfect knowledge of a future event? For example, a weather forecast is useful to an individual in that she is better able to decide on appropriate clothing. However, most of us would not pay very much for such information, and we do not need to know exactly how much rain will fall.

In contrast, the agricultural sector is very interested in using weather forecasts to plan irrigation and the planting of crops, and it is willing to pay for more accurate location-specific forecasts. In a different context, consider a company with thousands of product lines. Although the value of forecasts for any single line may be modest, an effective

forecasting system for the complete range of products is very valuable in making production and inventory decisions.

1.1.4 Analysis

Once the purpose is clear and the information has been assembled, we turn to the analysis of the data. This process includes the development of a forecasting model, which will involve the consideration of several different approaches and the final selection from within these alternatives. Once the model has been selected, we estimate any unknown model parameters and then test the model's performance using a *hold-out sample* (that is, data that are held in reserve and are separate from the information used to fit the model). For example, we might have six years of monthly sales figures and use the first four years to fit the model and keep the last two years as the hold-out sample to test performance.

1.1.5 System

Most of the examples in this book refer to a single time series or forecasting issue. However, practical applications may involve the simultaneous forecasting of thousands of items (products, stock prices, etc.). Further, an organization may generate forecasts at several different levels (e.g., individual products, distinct sales regions, weekly or monthly sales) with many people involved and these forecasts must be integrated into a consistent description of total sales as the basis for budgeting, marketing, and production planning. Thus, we must develop a forecasting system and process that is capable of meeting these needs. Such systems are usually computer based. Chapters 12 and 13 focus on these issues.

1.1.6 Evaluation

How do we know whether a particular forecasting exercise was effective? The obvious answer is that we should compare past results with the forecasts that were made, possibly comparing several different forecasting methods as we proceed. We examine several such criteria in Chapter 2, all of which are based upon the differences between forecasts and actual values. A statement about checking forecast performance might seem almost too obvious to be worth making, yet the evidence suggests that some companies never go back to check their forecasting performance. For example, an informal survey conducted by the software company Business Forecasting Systems produced the results shown in Table 1.1. Respondents *who used statistical forecasts* were asked how they did so:

> *Baseline:* Use the statistical forecast as a baseline and then make judgmental adjustments
>
> or
>
> *Reference:* Use the statistical forecast as a reference, or "sanity check," on some other primary forecast.

Respondents were then asked whether they regularly checked the performance of the forecasts. The *percentages* in each category who said yes are given in Table 1.1. The survey was small and relied upon self-reporting, but the figures are striking nevertheless. The baseline group is making adjustments to the statistical forecasts, yet nearly half of them are not checking to see whether those adjustments improve forecast performance. Nearly one-third of the reference group do not even check their principal forecasts, and more than two-thirds fail to check the statistical forecasts.

Table 1.1 Percentages of Respondents Who Regularly Monitor Forecasting Performance

	Percentages of Respondents Who Checked	
Use Made of Statistical Forecast	**Adjusted/Principal Forecast**	**Statistical Forecast**
As a baseline	91	57
As a reference	71	29

Source: Trends Business Forecasting Systems Newsletter.

If you don't check from time to time, how do you know whether your approach is any good? Making effective forecasts is as much an art as it is a science, but asking about PIVASE before you start the exercise will help avoid expensive mistakes.

MONITORING FORECAST ERRORS

Always check on forecast performance. Checking helps you avoid repeating mistakes and leads to improved results.

■ Example 1.1: PIVASE in action

Some years ago, a US state agency asked one of the authors (KO) to develop a short-term forecasting system for state tax revenues. The author used simple extrapolative models (the details don't matter at this stage) to accomplish the job. The *purpose* was to provide the state legislators with a revenue-forecasting model that they could use to compare with the forecasts generated by the executive branch (the governor's office). Because all state representatives are up for reelection every two years, the forecast horizon was set at two years. The monthly state revenues, for each of a half dozen tax categories, were published typically within a month of the end of the collection period; because these figures are a matter of public record, the necessary *information* was freely available. Some additional information, such as upcoming changes in tax rates, was also provided. The *value* of the study lay in the provision of an independent forecasting system for the legislature to serve as a check on the executive's budgetary proposals.

The *analysis* followed the general approach laid out in Chapter 6 and the overall *system* involved monthly updates to the half-dozen series and the generation of new forecasts. As happens all too often with forecasting systems, no follow-up study was performed to *evaluate* performance. However, several years later, it was a pleasant surprise to learn that the system was still in use and that the outputs compared quite favorably with the forecasts from the state's model sponsored by the governor's office. A firm of consultants provided the state's economic statistical (econometric) model for around $100,000 per year (compared with a one-time payment of $10,000 for the short-term model). Doubtless, the econometric model is also used for other purposes, and the fees are probably well spent. ■

DISCUSSION QUESTION: *There was a two-year cycle in the tax revenues data, with a surplus in year one and a deficit in year two. Why might this be?*