# Chapter 1 Introduction



*There are three types of SFM worksheets: data analysis, seasonal adjustment, and forecasting. The data analysis worksheets help you identify seasonality and trends. Seasonal adjustment removes seasonal patterns before forecasting. The forecasting models themselves are based on exponential smoothing, growth models, and regression. Exponential smoothing and growth models extrapolate historical data patterns into the future. In smoothing, we assume changing data patterns, while in growth models we assume stable data patterns. Regression requires the use of causal variables to explain changes in the data.*

## 1.1 How to choose a forecasting model

First, use the data analysis worksheets in Chapter 2 to gain an understanding of patterns in your data. The Forecast Manager uses data in time-series format, which is simply a list of data in time order, such as monthly or quarterly. All three data analysis worksheets require time series of at least two years' duration. CYCLES detects changes in the rate of growth from month to month, and identifies turning points in business cycles longer than one year. IDENTIFY determines whether seasonality, defined as a sequence of regular data fluctuations due to the period of the year, is present. Another important function in IDENTIFY is classification of the type of trend, if any. The identification process is reliable but not perfect. Thus the ANOVA model provides another check on the presence of trend and seasonality. ANOVA also computes the proportion of noise, defined as unpredictable randomness, in the data. Trend extrapolation is extremely risky with a large proportion of noise.

If seasonality is present, you must perform seasonal adjustment using one of the worksheets in Chapter 3, MULTIMON and ADDITMON. These models remove the seasonal pattern and produce a new time series called deseasonalized or seasonally adjusted data for input to the forecasting models. MULTIMON assumes that seasonal fluctuations are proportional to the value of the data. Therefore, as a trend grows, the range of seasonal fluctuation from peak to trough increases. This type of seasonality is called multiplicative. In contrast, the ADDITMON model assumes additive seasonality, in which seasonal fluctuations are constant in value, regardless of trend.

The simple exponential smoothing (SIMPLE) model in Chapter 4 is ubiquitous in short-range forecasting, usually one period in advance, for inventory demands and line-item expenses in budgets. SIMPLE is the best choice when there is no consistent trend. The objective of the forecasting model is straightforward: to track the level or average value of the data. If a trend is apparent, use another smoothing model (TREND), which can project three alternative types of trend: linear, exponential or damped. Linear trends call for a constant amount of growth per period in the future. Exponential trends call for increasing growth, while damped trends call for decreasing growth. The damped trend is usually the best choice for product sales data and is widely used in practice. SIMPLE and TREND can be used with nonseasonal data or data that has been seasonally-adjusted. Chapter 4 also includes models that combine seasonal adjustment with exponential smoothing in a single worksheet.

For new products or markets, there may not be enough historical data to use an exponential smoothing model. Thus Chapter 5 includes four alternative growth models that can be extrapolated with very little data. If fact they can be used with no data at all if one is willing to make assumptions about the future. The models are based on ordinary-least-squares regression although the independent variables are not considered to be causal variables. Instead, the variables are functions of time that describe certain trends. As in exponential smoothing, two models, linear and exponential, allow growth without bound. The latter is common early in the life cycle of many products. Two models, modified-exponential and logistic, forecast growth up to a saturation level or a limit on growth, similar to damped-trend smoothing. In the modified-exponential, growth is steep at first, followed by a gradual decline in growth until the saturation level is reached. In the logistic, growth follows an S-curve; growth is slow at first, followed by a period of steep growth, and finally by a gradual decline in growth to the saturation level. Both the modified-exponential and the logistic models are widely used to forecast the development of aggregate markets for consumer goods.

It may be that causal or independent variables are available to explain the variable you wish to forecast, called the dependent variable. If so, the regression models in Chapter 6 should be considered. DISCREG operates with one causal variable and can fit (1) a linear regression in which the data are equally-weighted or (2) a discounted regression in which recent data receive more weight. More variables can be included in DISCREG but I have never seen a practical business forecasting problem in which more than one useful causal variable was available. Chapter 6 also includes an autoregression model (AUTOREG) in which the causal variables are prior values, one or two periods ago, of the dependent variable (the one being forecasted).

In general, exponential smoothing and discounted regression assume that trends are unstable and change over time, while growth models assume that trends are stable. The basic idea in exponential smoothing is to give more weight to recent data to keep up with changes. Growth models usually work best with highly aggregated data such as market or industry sales, while exponential smoothing is more suitable for company or product-level data. Exponential smoothing and discounted regression are also more resistant to noise than the growth models.

It is not unusual to find that several alternative forecasting models appear to be reasonable choices for a particular time series. If so, you should test the alternatives. This is done by dividing the series into two parts. The first part is used to "fit" the forecasting model. Fitting consists of running the model through the first part of the data to get "warmed up." We call the fitting data the warm-up sample. The second part of the data is used to test the model and is called the forecasting sample. Accuracy in the warm-up sample is really irrelevant. Accuracy in the forecasting sample is more important because the pattern of the data often changes over time. Thus the forecasting sample helps evaluate how well the model tracks such changes.

## 1.2 References

The exponential smoothing models in SFM are enhanced versions of models that originally appeared in:

R. I. Levin, D. S. Rubin, J. P. Stinson, and E. S. Gardner, Jr. *Quantitative Approaches to Management* (8th ed.). New York: McGraw-Hill, 1995.

References for other models are:

S. Makridakis, S. C. Wheelwright, and R. J. Hindman, *Forecasting: Methods and Applications* (3rd edition), New York: McGraw-Hill, 1998.

J. E. Hanke and A. G. Reitsch, *Business Forecasting*, Upper Saddle River, New Jersey, Prentice-Hall, 1998.

Some SFM worksheets contain numeric approximations to probability distributions. All numeric approximations are based on:

Milton Abramowitz and Irene A. Stegun, *Handbook of Mathematical Functions.* New York: Dover Publications, 1972.