FORECASTING METHODS

ARMAAN SALIK J
Assistant Professor
Jamal Institute of Management
Jamal Mohamed College

THREE GENERAL TYPES

- *Qualitative techniques*
  - uses qualitative data (expert opinion, for example) and information about special events of the kind already mentioned, and may or may not take the past into consideration.
- *Time series analysis*
  - focuses entirely on patterns and pattern changes, and thus relies entirely on historical data.
- *Projection*, and *causal mode*
  - uses highly refined and specific information about relationships between system elements, and is powerful enough to take special events formally into account.

QUALITATIVE TECHNIQUES

- Primarily, these are used when data are scarce.
- For example, when a product is first introduced into a market. They use human judgment and rating schemes to turn qualitative information into quantitative estimates.

- The objective here is to bring together in a logical, unbiased, and systematic way all information and judgments which relate to the factors being estimated.
- Such techniques are frequently used in new-technology areas, where development of a product idea may require several "inventions," so that R&D demands are difficult to estimate, and where market acceptance and penetration rates are highly uncertain.

TIME SERIES ANALYSIS

- These are statistical techniques used when several years' data for a product or product line are available and when relationships and trends are both clear and relatively stable.

- Now, a *time series* is a set of chronologically ordered points of raw data—for example, a division's sales of a given product, by month, for several years.

- Time series *analysis* helps to identify and explain:

1. Any regularity or systematic variation in the series of data which is due to seasonality—the "seasonals."
2. Cyclical patterns that repeat any two or three years or more.
3. Trends in the data.
4. Growth rates of these trends.

CAUSAL MODELS

- When historical data are available and enough analysis has been performed to spell out explicitly the relationships between the factor to be forecast and other factors (such as related businesses, economic forces, and socioeconomic factors), the forecaster often constructs a *causal model*.

- A causal model is the most sophisticated kind of forecasting tool.
- It expresses mathematically the relevant causal relationships, and may include pipeline considerations (i.e., inventories) and market survey information.
- It may also directly incorporate the results of a time series analysis.

- The causal model takes into account everything known of the dynamics of the flow system and utilizes predictions of related events such as competitive actions, strikes, and promotions.

- If the data are available, the model generally includes factors for each location in the flow chart (as illustrated in Exhibit II) and connects these by equations to describe overall product flow.

- If certain kinds of data are lacking, initially it may be necessary to make assumptions about some of the relationships and then track what is happening to determine if the assumptions are true.

- Typically, a causal model is continually revised as more knowledge about the system becomes available.

BASIC FORECASTING TECHNIQUES

Technique	A. Qualitative Methods		
	1. Delphi Method	2. Market Research	3. Panel Consensus
Description	A panel of experts is interrogated by a sequence of questionnaires in which the responses to one questionnaire are used to produce the next questionnaire. Any set of information available to some experts and not others is thus passed on to the others, enabling all the experts to have access to all the information for forecasting. This technique eliminates the bandwagon effect of majority opinion.	The systematic, formal, and conscious procedure for evolving and testing hypotheses about real markets.	This technique is based on the assumption that several experts can arrive at a better forecast than one person. There is no secrecy, and communication is encouraged. The forecasts are sometimes influenced by social factors, and may not reflect a true consensus.
Accuracy Short term (0–3 months) Medium term (3 months–2 years) Long term (2 years & up)	 Fair to very good Fair to very good Fair to very good	 Excellent Good Fair to good	 Poor to fair Poor to fair Poor
Identification of turning points	Fair to good	Fair to very good	Poor to fair
Typical applications	Forecasts of long-range and new-product sales, forecasts of margins.	Forecasts of long-range and new-product sales, forecasts of margins.	Forecasts of long-range and new-product sales, forecasts of margins.
Data required	A coordinator issues the sequence of questionnaires, editing and consolidating the responses.	As a minimum, two set of reports over time. One needs a considerable collection of market data from questionnaires, surveys, and time series analyses of market variables.	Information from a panel of experts is presented openly in group meetings to arrive at a consensus forecast. Again, a minimum is two sets of reports over time.
Cost of forecasting* With a computer Is calculation possible without a computer?	 $2,000+ Yes	 $5,000+ Yes	 $1,000+ Yes
Time required to develop an application & make a forecast	2 months+	3 months+	2 weeks +
References	North & Pyke, " 'Probes' of the Technological Future," HBR May–June 1969, p. 68.	Bass, King & Pessemeier, *Applications of the Sciences in Marketing Management* (New York, John Wiley & Sons, Inc., 1968).	———

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A. Qualitative Methods *(continued)*		B. Time Series Analysis & Projection	
4. Visionary Forecast	**5. Historical Analogy**	**1. Moving Average**	**2. Exponential Smoothing**
A prophecy that uses personal insights, judgment, and, when possible, facts about different scenarios of the future. It is characterized by subjective guesswork and imagination; in general, the methods used are non-scientific.	This is a comparative analysis of the introduction and growth of similar new products that bases the forecast on similarity patterns.	Each point of a moving average of a time series is the arithmetic or weighted average of a number of consecutive points of the series, where the number of data points is chosen so that the effects of seasonals or irregularity or both are eliminated.	This technique is similar to the moving average, except that more recent data points are given more weight. Descriptively, the new forecast is equal to the old one plus some proportion of the past forecasting error. Adaptive forecasting is somewhat the same except that seasonals are also computed. There are many variations of exponential smoothing: some are more versatile than others, some are computationally more complex, some require more computer time.
Poor Poor Poor	Poor Good to fair Good to fair	Poor to good Poor Very poor	Fair to very good Poor to good Very poor
Poor	Poor to fair	Poor	Poor
Forecasts of long-range and new-product sales, forecasts of margins.	Forecasts of long-range and new-product sales, forecasts of margins.	Inventory control for low-volume items.	Production and inventory control, forecasts of margins and other financial data.
A set of possible scenarios about the future prepared by a few experts in light of past events.	Several years' history of one or more products.	A minimum of two years of sales history, if seasonals are present. Otherwise, less data. (Of course, the more history the better.) The moving average must be specified.	The same as for a moving average.
$100+ Yes	$1,000+ Yes	$.005 Yes	$.005 Yes
1 week+	1 month+	1 day−	1 day−
———	Spencer, Clark & Hoguet, *Business & Economic Forecasting* (Homewood, Illinois, Richard D. Irwin, Inc., 1961).	Hadley, *Introduction to Business Statistics* (San Francisco, Holden-Day, Inc., 1968).	Brown, "Less Risk in Inventory Estimates," HBR July–August 1959, p. 104.

BASIC FORECASTING TECHNIQUES *(continued)*

Technique	B. Time Series Analysis & Projection *(continued)*		
	3. Box-Jenkins	**4. X-11**	**5. Trend Projections**
Description	Exponential smoothing is a special case of the Box-Jenkins technique. The time series is fitted with a mathematical model that is optimal in the sense that it assigns smaller errors to history than any other model. The type of model must be identified and the parameters then estimated. This is apparently the most accurate statistical routine presently available but also one of the most costly and time-consuming ones.	Developed by Julius Shiskin of the Census Bureau, this technique decomposes a time series into seasonals, trend cycles, and irregular elements. Primarily used for detailed time series analysis (including estimating seasonals); but we have extended its uses to forecasting and tracking and warning by incorporating other analytical methods. Used with special knowledge, it is perhaps the most effective technique for medium-range forecasting—three months to one year—allowing one to predict turning points and to time special events.	This technique fits a trend line to a mathematical equation and then projects it into the future by means of this equation. There are several variations: the slope-characteristic method, polynomials, logarithms, and so on.
Accuracy Short term (0–3 months) Medium term (3 months–2 years) Long term (2 years & up)	 Very good to excellent Poor to good Very poor	 Very good to excellent Good Very poor	 Very good Good Good
Identification of turning points	Fair	Very good	Poor
Typical applications	Production and inventory control for large-volume items, forecasts of cash balances.	Tracking and warning, forecasts of company, division, or department sales.	New-product forecasts (particularly intermediate- and long-term).
Data required	The same as for a moving average. However, in this case more history is very advantageous in model identification.	A minimum of three years' history to start. Thereafter, the complete history.	Varies with the technique used. However, a good rule of thumb is to use a minimum of five years' annual data to start. Thereafter, the complete history.
Cost of forecasting* With a computer Is calculation possible without a computer?	 $10.00 Yes	 $10.00 No	 Varies with application Yes
Time required to develop an application & make a forecast	1–2 days	1 day	1 day —
References	Box-Jenkins, *Time Series Analysis, Forecasting & Control* (San Francisco, Holden-Day, Inc., 1970).	McLaughlin & Boyle, "Time Series Forecasting," American Marketing Association Booklet, 1962, Marketing Research Technique Series No. 6.	Hadley, *Introduction to Business Statistics* (San Francisco, Holden-Day, Inc., 1968); Oliver & Boyd, "Techniques of Production Control," Imperial Chemical Industries, 1964.

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C. Causal Methods			
1. Regression Model	**2. Econometric Model**	**3. Intention-to-Buy & Anticipations Surveys**	**4. Input-Output Model**
This functionally relates sales to other economic, competitive, or internal variables and estimates an equation using the least-squares technique. Relationships are primarily analyzed statistically, although any relationship should be selected for testing on a rational ground.	An econometric model is a system of interdependent regressiuon equations that describes some sector of economic sales or profit activity. The parameters of the regression equations are usually estimated simultaneously. As a rule, these models are relatively expensive to develop and can easily cost between $5,000 and $10,000, depending on detail. However, due to the system of equations inherent in such models, they will better express the causalities involved than an ordinary regression equation and hence will predict turning points more accurately.	These surveys of the general public (a) determine intentions to buy certain products or (b) derive an index that measures general feeling about the present and the future and estimates how this feeling will affect buying habits. These approaches to forecasting are more useful for tracking and warning than forecasting. The basic problem in using them is that a turning point may be signaled incorrectly (and hence never occur).	A method of analysis concerned with the interindustry of interdepartmental flow of goods or services in the economy or a company and its markets. It shows what flows of inputs must occur to obtain certain outputs. Considerable effort must be expended to use these models properly, and additional detail, not normally available, must be obtained if they are to be applied to specific businesses. Corporations using input-output models have expended as much as $100,000 and more annually to develop useful applications.
Good to very good Good to very good Poor	Good to very good Very good to excellent Good	Poor to good Poor to good Very poor	Not applicable Good to very good Good to very good
Very good	Excellent	Good	Fair
Forecasts of sales by product classes, forecasts of margins.	Forecasts of sales by product classes, forecasts of margins.	Forecasts of sales by product class.	Forecasts of company sales and division sales for industrial sectors and subsectors.
Several years' quarterly history to obtain good, meaningful relationships. Mathematically necessary to have two more observations than there are independent variables.	The same as for regression.	Several years' data are usually required to relate such indexes to company sales.	Ten or fifteen years' history. Considerable amounts of information on product and service flows within a corporation (or economy) for each year for which an input-output analysis is desired.
$100 Yes	$5,000+ Yes	$5,000+ Yes	$50,000+ No
Depends on ability to identify relationships.	2 months+	Several weeks	6 months+
Clelland, de Cani, Brown, Bush & Murray, *Basic Statistics with Business Applications* (New York, John Wiley & Sons, Inc., 1966).	Evans, *Macro-economic Activity: Theory, Forecasting & Control* (New York, Harper & Row Publishers, Inc., 1969).	Publications of Survey Research Center, Institute for Social Research, University of Michigan; and of Bureau of the Census.	Leontief, *Input-Output Economics* (New York, Oxford University Press, 1966).

BASIC FORECASTING TECHNIQUES *(continued)*

Technique	C. Causal Methods *(continued)*			
	5. Economic Input-Output Model	**6. Diffusion Index**	**7. Leading Indicator**	**8. Life-Cycle Analysis**
Description	Econometric models and input-output models are sometimes combined for forecasting. The input-output model is used to provide long-term trends for the econometric model; it also stabilizes the econometric model.	The percentage of a group of economic indicators that are going up or down, this percentage then becoming the index.	A time series of an economic activity whose movement in a given direction precedes the movement of some other time series in the same direction is a leading indicator.	This is an analysis and forecasting of new-product growth rates based on S-curves. The phases of product acceptance by the various groups such as innovators, early adapters, early majority, late majority, and laggards are central to the analysis.
Accuracy Short term (0–3 months) Medium term (3 months–2 years) Long term (2 years & up)	Not applicable Good to very good Good to excellent	Poor to good Poor to good Very poor	Poor to good Poor to good Very poor	Poor Poor to good Poor to good
Identification of turning points	Good	Good	Good	Poor to good
Typical applications	Company sales for industrial sectors and subsectors.	Forecasts of sales by product class.	Forecasts of sales by product class.	Forecasts of new-product sales.
Data required	The same as for a moving average and X-11.	The same as an intention-to-buy survey.	The same as an intention-to-buy survey + 5 to 10 years' history.	As a minimum, the annual sales of the product being considered or of a similar product. It is often necessary to do market surveys.
*Cost of forecasting With a computer Is calculation possible without a computer?	$100,000 No	$1,000 Yes	$1,000 Yes	$1,500 Yes
Time required to develop an application & make a forecast	6 months +	1 month +	1 month +	1 month +
References	Evans & Preston, "Discussion Paper #138," Wharton School of Finance & Commerce, The University of Pennsylvania.	Evans, *Macro-economic Activity: Theory, Forecasting & Control* (New York, Harper & Row Publishers, Inc., 1969).	Evans, *Macro-economic Activity: Theory, Forecasting & Control* (New York, Harper & Row Publishers, Inc., 1969).	Bass, "A New Product Growth Model for Consumer Durables," *Management Science*, January 1969.

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