International Institute for
Applied Systems Analysis
IIASA www.iiasa.ac.at

The Utility of Long-Term Forecasting

Helmer, O.

IIASA Professional Paper
May 1977

PP-77-5

THE UTILITY OF LONG-TERM FORECASTING

Olaf Helmer

May 1977

Abstract

Forecasts are an essential ingredient of the planning process. Although frequently of necessity inaccurate, they can nevertheless be of considerable utility; for they should not be judged by the degree of uncertainty they convey but by the degree to which they permit differentiation between genuine and avoidable uncertainty.

The Utility of Long-Term Forecasting

Futures research as an identifiable intellectual activity received much of its early impetus from the long-range forecasting studies conducted under Rand and TRW auspices in the middle Sixties and their subsequent emulations by numerous other organizations. Recently a slight disenchantment with long-range forecasting seems to have set in in some circles, caused largely--I think--by the realization of how inaccurate predictions have been concerning the future more than a few years hence, either because of altogether wrong prophecies (especially in economics) or because of a failure to foresee important developments (e.g., the OPEC oil embargo, which triggered a sudden awareness of the energy crisis among the oil-importing countries). This disenchantment may be based on some misconceptions, having to do largely with the role of uncertainty. While the task of the forecaster surely includes the removal of as much uncertainty about the future as can legitimately be accomplished, it equally should not neglect to bring genuine uncertainty, due to deficiencies in currently available information, to the attention of planners. Futures research, and long-range forecasting in particular, should not be judged by the degree of uncertainty it conveys but by the degree to which it is capable of differentiating between unnecessary and unavoidable uncertainty.

Futures research may be defined as that part of operations research which is concerned with the support of planning activities that relate to a future sufficiently far distant so that the operating environment at the time the plans are implemented differs substantially from the operating environment at the time the plans are being made. An essential aspect of futures research, therefore, is the forecasting (not the prediction!) of such changes in operating conditions. (In the terminology generally accepted by now, "forecasts" as distinct

from "predictions" are stated in probabilistic terms.)

For example, someone preparing to publish a new newspaper may safely rely on a survey of present preferences among the newspaper-reading public in order to decide what emphasis to give to various features. The operating environment is not likely to change very fast, and no futures research is required. On the other hand, someone growing trees for profit and having to decide between lumber, woodpulp, and other uses of his product decades hence, must be concerned over the continuing demand for wooden houses and newsprint at that time. Here, futures research may be of help, both by deriving relevant probabilistic forecasts and by establishing planning procedures that properly account for the expected changes and the uncertainties implied by such forecasts. In addition to providing nonconditional forecasts of exogenous developments which will constitute the setting against which plans for the long-term future have to be made, it is equally important, if not more so, for futures research to furnish conditional forecasts, that is, estimates of the probable implications of various alternative policies and of alternative action programs for implementing a given policy, and to do so in consideration of the previously established forecasts of external operating conditions. Such conditional forecasts are clearly needed when the planner operates in what is called the "exploratory" mode, that is, when a selective decision among competing policies or action programs has to be made; for it is by their implications that they will be judged. Conditional forecasts also play a role, though a somewhat different one, in the case of the so-called "normative" planning mode. Here the planner operates in reverse: he starts with what he considers a preferred end condition and then (if indeed he acts as a planner and not just a utopian dreamer) searches for ways and means of implementing the "policy" of attaining the wished-for state. In this case, a conditional forecasting analysis will serve to ascertain which implementation plan may be expected to come closest to achieving the desired end.

Thus, from a planner's point of view, the desirability of having both absolute and conditional long-term forecasts seems to be quite evident and, if none are supplied, it is inevitable that, in fact, the planner merely relies on his own, perhaps not even articulated, forecasts. We note in passing that even forecasts based merely on purely intuitive insight rather than on established theory are of some value here, provided there is reason to have some trust in their reliability. If a forecast does happen to be theory-based, in the sense of being an instance of a general law that derives explanatory force from being part of a coherent theory of the phenomena in question, this will be of additional utility to the planner; for it will not only enable him to choose the best among given alternative strategies but, because of its explanatory character, it will help him in designing strategies in the first place that are apt to influence the future in a desired direction. Since forecasts frequently fail to be explanatory in this sense, the burden of constructing candidate strategies tends to fall upon the inventive imagination of the planner--a creative aspect of planning which is often given inadequate attention.

In view of the planner's need for forecasts and their added utility to him when they incorporate explanations, the questions that remain are whether it is possible to obtain forecasts of sufficient reliability and precision to improve the planning process over what it would be if the planner were left to rely solely on his own intuitive expectations, and whether, in addition, such forecasts can be made within the framework of an explanatory theory.

With regard to the first question, a number of comments are appropriate. First of all, it is important to keep in mind that perfection in planning, while a laudable ideal, is not a necessary criterion of the utility of forecasts to the planning process. Even if, statistically speaking, the systematic utilization of forecasts produces only a slight improvement in the expected results of planning, such forecasts may well be worth while. Secondly, experience has shown that long-range

forecasts obtained from professional experts can in fact be quite accurate. A survey conducted at the Institute for the Future a few years ago,* in which Delphi-generated forecasts made years earlier were examined, found that of all events which had been given a probability, say, of 60% of occurring by the time that survey was made about 60% had in fact occurred by then. Thirdly, it may be objected by some that, even if we could be sure that of all events forecasted with a probability of 60% to occur by a certain date exactly 60% did occur by that date, the uncertainty implied by this information would be so great as to render the forecast useless to the planner. In response to this objection it must be pointed out that it would be a delusion to think that planning does not proceed in an atmosphere of uncertainty. A probabilistic forecast, as opposed to a precise prediction, imposes a realistic awareness of the uncertainty of the future. This compels the planner to incorporate provisions for contingencies in his plans without which he might be courting disaster. Fourthly, and finally, it has been said quite correctly that it is the mark of a good executive to display sufficient acumen in discerning likely future contingencies to be able to make the right decisions without having to resort to outside advice in the form of forecasts. However, this phenomenon does not constitute testimony of the existence of some form of divination but more likely points to the presence of a relatively superior intelligence that enables the executive to judge the reliability of all sorts of signals he receives from the environment and thereby to form, implicitly or explicitly, his own set of forecasts. He is, in other words, himself the kind of professional expert whose forecasting talents one might wish to utilize beyond his own decision-making sphere.

Let us now consider the second question raised earlier, which concerns the feasibility of making forecasts that are supported by the explanatory framework of a coherent theory.

---

*Robert Ament, "Comparison of Delphi Forecasting Studies in 1964 and 1969", Futures, vol. 2 (1970).

The ideal case here is represented by astronomical forecasts (which virtually amount to predictions), such as that of the next reappearance of Halley's comet. What makes this such a high-probability forecast is its being based on well understood and well confirmed physical laws, plus the fact that deliberate intervention in the occurrence of this event is not a practical possibility. Most of our planning, of course, takes place in a sphere where a comparable degree of certainty is not present, and the kind of long-range forecasts on which we would like to rely inevitably involve some aspect of human affairs, either in the sense that the subject matter itself is societal in nature or that the probability of occurrence of whatever event is being forecasted is affected by the degree of human intervention. Typical examples are economic and technological forecasts. The occurrence, say, of another worldwide economic depression clearly concerns, and is affected by, human events. And even a purely technical forecast, say, of a breakthrough in solar-to-electric energy conversion obviously is influenced by the amount of research and development effort devoted to it. In cases of these kinds, the theoretical structures on which the forecasts are based are neither well understood nor well confirmed, which is typical of a context that is a multidisciplinary and at least partly a social-science one. Intuitive insight therefore plays as large a part as, if not a larger part than, reasoned arguments in obtaining such forecasts. Thus the answer to the question under discussion cannot be wholly in the affirmative: not all forecasts of interest in typical planning situations may be expected to occur within the explanatory framework of a coherent theory. Yet, while the reasons for a long-range forecast containing societal elements are apt to be largely intuitive, there are generally some law-like regularities, having a limited but nonnegligible degree of confirmation, which at least lend some support to purely intuitive insight. Thus there tends to be an explanatory element present that may carry enough weight to permit the planner to identify measures which have more than a random chance of influencing events in the desired direction. For example, a government

planner, wishing to bring about a reduction in the consumption of motor fuel, may propose a doubling of the gasoline tax, in the expectation that the demand will not be so inelastic as to be totally unresponsive to the resultant price rise. The implied forecast here is based on a "law" of economics which, though known to have exceptions, provides a certain amount of guidance for economic behavior. Moreover, reliance on past time series, in this case, will furnish some clues as to how much of a reduction in gasoline demand might be expected as a result of the proposed tax increase.

While in the field of economics such mildly confirmed regularities abound, often even in quantified form, the same is rarely the case in other social-science areas and even less so in multidisciplinary situations. It is here that the so-called cross-impact approach offers, if not a complete remedy, then at least a better-than-nothing substitute for law-like regularities. The cross-impact concept was invented, in the first place, in order to enrich the results of sets of intuitive forecasts (such as a series of technological forecasts that might be obtained through a Delphi survey of expert opinions). Instead of merely requiring estimates of the probabilities of occurrence of potential future events, considered in isolation from one another, a cross-impact analysis inquires, in addition, into the effects that the occurrence of any one of the events included in the survey would have on the probability of occurrence of the remaining events. Intuitive numerical estimates of these effects, called cross impacts, are recorded in a square matrix, (x_{ij}), where x_{ij} is a measure of the impact which the occurrence of the i-th event, E_i, has on the probability of occurrence of the j-th event, E_j. Thus, the cross-impact matrix represents a set of estimates of the causal relationships among the events under consideration. The quantities x_{ij} as a rule have to be obtained through intuitive estimation by experts and do not in themselves convey any information that would explain the reasons for the causal relationships they indicate. However, if the x_{ij} are generated through some kind of Delphi procedure, the respondents, in justifying a nonzero assignment to a particular x_{ij}, may

provide an intuitive argument for, and thus a possible explanation of, the claimed causal relationship. Moreover, while the x_{ij} individually and aside from any incidental explication given by their estimators are not explanatory in nature, the matrix (x_{ij}) as a whole represents a coherent pattern of causality assertions and may be regarded as the next best thing to a theory of the phenomena under consideration.

Possible scenarios of the future, which a planner may be considering, are formulated in terms not only of events (such as technological breakthroughs, acts of legislation, earthquakes, elections, etc.) which take place at specific times, but also of trends representing gradual developments (such as population growth, GNP, degree of pollution, etc.). Cross-impact analysis has been extended to include trends as well as events* (essentially by interpreting as an "event" a trend's deviation from its anticipated value); the estimation of causal connections ("cross impacts") can thus be extended to all of the elements that make up a scenario of the future.

The utility, to a planner, of a long-range forecasting study augmented by a cross-impact analysis becomes very apparent in a situation where the subject area in which plans are to be made is essentially multidisciplinary, because conventional extrapolative analyses, in such a case, almost certainly will fail to provide the kind of explanatory information from which a sound strategy can be constructed. A good example is a recently conducted study in the area of long-range transportation planning.** Here the planning agency was confronted with the need to forecast not only developments in transportation technology but also in its future operating environment, i.e., in communication technology, demography, economic conditions, land use policies, energy availability,

---

*See my paper on "Problems in Futures Research--Delphi and Causal Cross-Impact Analysis", Futures, February 1977.

**Paul Gray and Olaf Helmer, "The California Transportation System", Report by the Center for Futures Research, University of Southern California, November 1974.

people's changing values, and so on. In a planning situation of this kind, where there are no well confirmed regularities covering the different areas of concern and, especially, their interconnections, the planner can attempt to put together his own surrogate theory, in the form of a cross-impact analysis, and thus build a foundation upon which to design strategies that have at least a slightly better chance of coping with future contingencies than those arrived at without the benefit of this kind of systematic underpinning.

The procedural steps he would have to follow in such an undertaking might be described very briefly as follows:

1. Identify potential future developments (either events or trends) whose occurrence or whose deviation from expected values would have a significant effect on the future operating environment of the planner's subject area.
2. Obtain forecasts (through Delphi or otherwise) regarding these developments.
3. Estimate the cross impacts among these developments.
4. Use cross-impact analysis* to establish the relative sensitivity of the developments to one another.
5. Estimate the influenceability of the developments, that is, the degree to which the event probabilities or the trend values can be influenced by deliberate intervention on the part of the decision-maker (or decision-making agency) on whose behalf plans are being made. In doing so, separate the relatively uninfluenceable from the highly influenceable developments. The former establish the spectrum of exogenous, uncontrollable characteristics of the future environment for which plans are being made. The latter are the "operative" developments through the manipulation of which the planner can hope to influence the course of future events in a desired direction.

---

*For a detailed description, see the two previously cited papers (footnotes on page 7).

6. Establish the resource constraints which prospective plans must be designed to accommodate.

7. Using the sensitivities ascertained earlier and the developments identified as operative, select (or invent) alternative action programs within the stated resource constraints that seem to be promising candidates for attaining desired objectives.

8. Use cross-impact analysis to determine the relative merits of these alternative action programs in terms of expected results and their dispersion, and thus select one or several of the most promising alternatives.

For many obvious reasons (the surrogate character of the cross-impact analysis as a theory substitute; the possibly inadequate selection of developments for inclusion in the analysis; the relative unreliability of the forecasts as well as of the cross-impact estimates, even if obtained from experts; the possibly incomplete selection of action programs included in the comparative analysis) the outcome of this approach may not, in fact, be the optimal strategy. Yet the procedure represents a selection process which, if carried out judiciously and conscientiously, may yield a set of strategies from which, through a process of further analysis, a satisfactory strategy can be distilled.

The points I have tried to make may be summarized as follows: Forecasts, whether explicit or merely implicit, are an essential ingredient of the planning process. In the case of long-range planning, the planner needs two kinds of long-range forecasts: those concerning the expected, changed operating environment; and those concerning the consequences of contemplated policies. The utility of such forecasts depends on their precision and reliability, and is further enhanced if they are developed within an explanatory setting that enables the planner to understand the causal relationships that are present and to utilize these to design appropriate strategies. Forecasts are rarely very precise, especially if

they concern societal and/or interdisciplinary matters, but their precision as well as their reliability can be at least slightly enhanced if they are obtained through a systematic solicitation of expert opinions (such as might be provided by a Delphi survey). An explanatory setting for forecasts in the form of a well confirmed theory is generally absent; however, a substitute having some, though limited, utility can be constructed through the vehicle of a cross-impact analysis.