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Testing the scenario hypothesis: An experimental comparison of scenarios and forecasts for decision support in a complex decision environment

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ABSTRACT

Decision support tools are known to influence and facilitate decisionmaking through the thoughtful construction of the decision environment. However, little research has empirically evaluated the effects of using scenarios and forecasts. In this research, we asked participants to recommend a fisheries management strategy that achieved multiple objectives in the face of significant uncertainty. A decision support tool with one of two conditions—Scenario or Forecast—encouraged participants to explore a large set of diversified decision options. We found that participants in the two conditions explored the options similarly, but chose differently. Participants in the Scenario Condition chose the strategies that performed well over the full range of uncertainties (robust strategies) significantly more frequently than did those in the Forecast Condition. This difference seems largely to be because participants in the Scenario Condition paid increased attention to worst-case futures. The results offer lessons for designing decision support tools.

1. Introduction

Which is better for decision support: scenarios or probabilistic forecasts? Those designing decision support systems for complex decision problems often face this question when considering how best to characterize uncertainty for their users. Some commentators stress the importance of probabilistic forecasts, arguing that decisionmakers ultimately need this information to choose wisely among options.[1] In this view, scenarios are merely an intermediate stage in a hierarchy of increasingly more comprehensive uncertainty characterizations that culminate in probabilistic forecasts. Others argue that scenarios (defined in more detail below) represent a fundamentally different approach to uncertainty characterization. In this view, scenarios help decisionmakers expand their understanding of the challenges they face. As claimed by a pioneer of the method, "scenarios can change decision makers' assumptions about how the world works, compelling them to reorganize their mental models of reality (Wack, 1985a,b)". This paper reports on a laboratory experiment that examines the influence of using scenarios versus forecasts as part of decision support tools in complex decision environments.

The selection among scenarios or forecasts represents an example of choice architecture. As is well known, the design of decision support tools can influence and facilitate decisionmaking through the thoughtful construction of the decision environment (see, e.g., Johnson et al., 2012). The way information is presented can affect, for instance, how intuitively or systematically users process information (Kahneman, 2011), what they regard as default options, their focus on worst cases, and their willingness to

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[1] See, for instance, the long-standing debate in the climate change assessment literature on the merits of placing probabilistic forecasts on scenarios (Parson et al., 2007). One school argues that decisionmakers require information on the relative likelihood of scenarios to make decisions and, as the best source of such probabilistic forecasts, experts have a responsibility to provide them (Schneider, 2001; Morgan and Keith, 2008). Others oppose placing probabilities on scenarios, arguing that such information would undercut the scenarios' cognitive and organizational benefits (Grubler and Nakicenovic, 2001; Dessai and Hulme, 2004).

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invest in protective measures (Kunreuther et al., 2014). However, studies that experimentally contrast the effects of using scenarios and forecasts in decision support tools are rare, because the literature on scenarios and forecasts emphasizes differences between the two approaches that are difficult to capture in an experimental setting.

To understand these differences, it is useful to consider the broad set of elements that are often key to an effective decision process.[2] These elements can be usefully grouped into a set of *choice* tasks that includes selecting the best decision among a menu of available options, given estimates of their consequences, and a set of *decision structuring* tasks that includes defining the problem in a way that opens it up to thoughtful consideration, defining the objectives to be achieved, and assembling a menu of options that might achieve those objectives. Note that the literature uses the term *decision structuring* in two ways: (1) as an equivalent to the term choice architecture, meaning choices made by decision analysts in how to present information to decisionmakers (e.g., von Winterfeldt, 1980); and (2) as choices by the decisionmakers themselves in what factors to highlight and which to ignore (e.g., Parker and Fischhoff, 2005; Del Missier et al., 2014). This study uses the latter meaning of the term and notes that experimental environments that present users with both decision structuring and choice tasks may highlight more differences between forecasts and scenarios than would experiments that present choice tasks alone.

The literature makes clear that probabilistic forecasts provide a powerful foundation for choosing among alternative decision options under conditions of uncertainty. Such forecasts use a single joint probability distribution to represent the likelihood of alternative future states of the world. When uncertainties are well-characterized, probabilistic forecasts provide both a concise summary of what is known and the normatively correct basis for choice among options (Morgan and Henrion, 1990). But the literature also makes clear that in at least some contexts probabilistic forecasts can prove less effective in helping decisionmakers structure the decision situations they face. For example, some people misinterpret very small probabilities, either overestimating the risks they imply or sometimes ignoring them entirely (Camerer and Kunreuther, 1989; Kahneman and Tversky, 1979). More broadly, a narrow framing of complex decisions can cause problems for individuals and in groups when the uncertainty and other features are not well structured (Tversky and Kahneman, 1981; Russo and Schoemaker, 1989; Gigone and Hastie, 1993; Levin et al., 1998). Using a single joint probability distribution may lead decisionmakers to believe they understand risks better than they do. It may also heighten disagreement among parties to a decision with differing policy preferences who may very well understand that the recommendations from the analysis will be driven by the choice of probability distribution.

The scenarios literature is more sprawling and less structured than the literature on forecasts (EEA, 2009; Wright et al., 2013a, b), but it tends to focus on benefits related to helping decisionmakers structure the decisions they face. One popular definition characterizes scenarios as descriptions of plausible future conditions presented as plausible and worthy of consideration to users faced with a challenge of decisionmaking under uncertainty (Parson et al., 2007). Such scenarios may offer strengths, including simplicity, concreteness, and an ability to foster consensus among people with differing worldviews and policy preferences. Complex and contentious policy issues can generate significant cognitive load, particularly under conditions of deep uncertainty, defined here as the condition in which decisionmakers do not know, or do not agree upon, the predictive models that relate action to consequences and the probability distributions on key parameters of those models (Lempert et al., 2003). Under such conditions, the psychological and social costs of considering futures with implications seemingly inconsistent with ones' policy preferences and values can complicate an appropriate framing (Kahan and Braman, 2006; Jones et al., 2014). Scenarios may help counteract such pressures by presenting alternative futures as possibilities rather than firm predictions, thus making them psychologically less threatening to those holding different worldviews and making it easier for decisionmakers to consider a wider range of potentially inconvenient or contentious futures, as well as new decision options that might effectively address them (Schoemaker, 1993). In particular, scenarios may help decisionmakers identify robust options that perform well compared to the alternative over a wide range of futures (van der Heijden, 1996). Relatedly, scenarios may naturally draw greater attention to small-probability, high-consequence outcomes, which are often under-attended to by decisionmakers (Slovic et al., 1977; Kunreuther, 1978). However, the concreteness of scenarios may also mislead decisionmakers into believing that low-probability futures are more likely than there is any good reason to believe that they actually are (Morgan and Keith, 2008). In addition, scenarios may prove insufficient for effective choice, in that decisionmakers may ultimately require information about the probabilities of alternative futures to choose among alternative decision options.

Overall, the literature includes claims that scenarios, in contrast to forecasts, can describe uncertainty about the future in a way that decisionmakers find easy to understand, can reduce overconfidence, and encourage individuals and groups to reflect on a broader range of futures and decision options than they might otherwise consider (Wack, 1985a,b; van der Heijden, 1996; Bishop et al., 2007; Wright et al., 2013a,b).

Based on such observations from the literature, and our own experience using decision support tools to help policymakers make decisions, we offer what we call the scenario hypothesis:

> *Decision support processes that employ scenarios, as opposed to probabilistic forecasts, to characterize deep uncertainty will help decisionmakers consider a wider range of futures and attributes, and this broader vantage will encourage the choice of more robust options that perform reasonably well in a wide range of futures.*

To test this scenario hypothesis, we conducted a laboratory experiment that tasked participants with both structuring the decision they faced and then choosing among the resulting options. To do so, we created an experimental setting that encouraged participants to explore a large set of diversified decision options and gave them considerable freedom in what decision options to consider and in how they structured the comparisons among them. The decision context is purposely complex; the intent is to simulate the high cognitive load people often face in the real world. We chose this configuration because while much of the experimental judgment and decision making (JDM) literature relevant to uncertainty characterization is attentive to context, it often focuses on choices among a small menu of fixed decision options. However, many real-world decision challenges involve a larger, more fluid set of options, such that a critical decision task is ascertaining the appropriate set

[2] Different views exist on how to characterize these elements (e.g., Parker and Fischhoff, 2005; Yates and Tschirhart, 2006). A useful taxonomy, and one motiving the current research, comes from the National Research Council (2009) and includes defining the problem, having clear objectives, having alternatives linked to those objectives, assessing consequences, and confronting tradeoffs.