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# Executives' perceived environmental uncertainty shortly after 9/11

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ABSTRACT

Environmental uncertainty refers to situations when decision makers experience difficulty in predicting their organizations' environments. Prediction difficulty is mapped by closeness of decision makers' probability distributions of environmental variables to the uniform distribution. A few months after the 9/11 terrorist attacks, we solicited probabilities for three environmental variables from 93 business executives by a mail survey. Each executive assigned probabilities to the future *state* of the economy specified as categories of growth projected for a year after the 9/11 jolt, conditional probabilities of its *effect* on her/his organization, and conditional probabilities of her/his organizational *response* capability to each economic condition. Shannon entropy maps uncertainty, but the data do not provide trivariate state-effect-response distribution. We use maximum entropy method to impute the trivariate distributions from the data on state-effect and state-response bivariate probabilities. Uncertainty about each executive's probability distribution is taken into account in two ways: using a Dirichlet model with each executive's distribution as its mode, and using a Bayesian hierarchical model for the entropy. Both models reduce the observed heterogeneity among the executives' environmental uncertainty. A Bayesian regression examines the effects of two organizational characteristics on uncertainty. Presentation of results includes uncertainty tableaux for visualizations of the joint and marginal entropies and mutual information between variables.



## 1. Introduction

The concept of environmental uncertainty in management research provides interesting probability modeling and data analysis problems. An example illustrates the analysis of data collected from a sample of business executives shortly after 9/11 terrorist attacks.

### 1.1. Background

Organizations survive by obtaining input resources from their environments, and then transforming these inputs into outputs desired in their environments (Pfeffer and Salancik, 1978). Environments that shift in more unpredictable ways (Wholey and Brittain, 1989) generate greater uncertainty, and uncertainty is a central problem confronting executives (Thompson, 1967). Executives respond by redesigning their organization structures and processes so that they match better

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with the environmental uncertainty (Lawrence and Lorsch, 1967; Mintzberg, 1979). Executives scan their environments (Yasai-Ardekani and Nystrom, 1996), engage in sense-making activities (Weick, 1995), and then take actions to modify exchange relationships with their environments.

Organization environment consists of the "totality of physical and social factors that are taken directly into consideration in the decision-making behavior of individuals in the organization" (Duncan, 1972, p. 314). Organizational environment is typically represented by more than one variable. For instance, Milliken (1987) refined Duncan's ideas, delineating three types: *State* uncertainty refers to the degree of unpredictability about the nature of the environmental conditions existing now or in the future; *Effect* uncertainty refers to a perceived lack of knowledge about the anticipated effects of the environment upon the focal organization; and *Response* uncertainty refers to understanding the options available to the focal organization as it seeks to cope with the environment, and the predictability of consequences likely to flow from those organizational actions. *Unpredictability* therefore is a key attribute in the conceptualizations of environmental uncertainty (Duncan, 1972; Miles and Snow, 1978; Leblebici and Salancik, 1981; Argote, 1982; Milliken, 1987).

Despite management scholars' interest in the ubiquitous concept of environmental uncertainty, numerous attempts to conceptualize it scientifically and then measure the concept precisely have demonstrated that environmental uncertainty is an elusive concept. A summary of the earlier literature on environmental uncertainty (Argote, 1982) noted vagueness about what scholars meant by uncertainty. Even after many further studies, conflicting definitions and measurement continue according to Beckman et al. (2004) and Doty et al. (2006). Although the notion of unpredictability led some researchers to solicit probabilities of outcomes of environmental variables, many studies continue to use Likert-type scales to measure uncertainty or use varieties of surrogate variables believed to make the environment uncertain. There remains a pressing need for a framework that will allow for a precise conceptualization and measurement of environmental uncertainty.

Information theory provides a formal framework for study of the concept of uncertainty (Shannon, 1948; Lindley, 1956; Jaynes, 1957, 1968, 1982; Kullback, 1959; DeGroot, 1962; Zellner, 1971, 1997; Soofi, 1994). Information theoretic approaches have been shown to be useful for analysis of business and economics problems; see for example, Brockett (1991); Brockett et al. (1995), and special issues of *Journal of Econometrics* (Golan, 2002; Golan and Kitamura, 2007) and *Econometric Reviews* (Golan and Maasoumi, 2008). However, information theoretic concepts and measures associated with probability distributions have not been developed for capturing environmental uncertainty beyond some early attempts by Leblebici and Salancik (1981) and Argote (1982). Grounding the concept of environmental uncertainty in information theory has important implications for management research. The conflicting results reported in prior studies of environmental uncertainty (e.g., Doty et al. (2006)) may stem from their noted lack of agreement on the concept of uncertainty and thus their lack of precise measures. The information theory approach provides a unified framework that can be used for examining to what extent past conflicting results emanated from vague concepts of uncertainty and imprecise measures of environmental uncertainty. In this paper we present applications of various information measures and methods through mapping the environmental uncertainty of business executives after the 9/11 terrorist attacks.

### 1.2. Motivating example: The 9/11 study

Immediately after 9/11, many business executives and public policy makers began expressing deep concerns about the uncertainty generated by this politico-economic jolt. How would these terrorist attacks affect the national economy? And how would the altered economic outlook affect business organizations? If an outcome of the jolt were to be a pervasive increase in fear amongst the population, that could reduce consumer confidence and alter household spending patterns which, in turn, could adversely impact economic growth. Business executives could lose confidence in the economic outlook and this would lead to reductions in their equipment spending, hiring, and inventory stocking. Public policy efforts to counteract an economic slump could lead to lower interest rates and greater government spending. Business executives were confronted with the task of quickly predicting potential changes in the national economy.

In the aftermath of the 9/11 jolt, business executives were also confronted with the task of quickly predicting how potential changes in the economy would affect their own organizations. For instance, would an economic slowdown mean a change in demand for their products or services, a need to downsize or to reallocate budgets? In such circumstances, business executives also faced the task of assessing their organizational readiness to respond appropriately to the situations that could arise.

Five months after 9/11, we conducted an empirical study of environmental uncertainty perceived by business executives. We collected data from executives in 93 companies. The participants in our 9/11 study are alumni of an Executive MBA program in operation for over 25 years. Their organizations ranged in size from 20 to 15,000 employees (median 250) and from $2 million to $16 billion in sales revenue (median $60 million). About half of the organizations are manufacturing companies (44) whereas the service organizations (49) are mostly in financial services, health care, product distribution or telecommunications. A majority of the executives work in the Midwestern US. Almost two-thirds of their organizations had exposure to one or more of the following aspects of the 9/11 terrorist attacks: operations or employees in the New York City or Washington DC areas; important customers or other stakeholders in the New York City or Washington DC areas; a large dependency on airlines; overseas operations.

The environmental uncertainty after 9/11 mapped by our analysis is inclusive of the effect of the 9/11 jolt on the business environment, however, it is not attributed solely to this event. The business environment during the historic period after 9/11 consists of many constituent factors. For example, the 9/11 jolt occurred after the US economy had ended a long