Available online at www.sciencedirect.com

ScienceDirect

Journal of Economic Theory 153 (2014) 287–312

JOURNAL OF Economic Theory

www.elsevier.com/locate/jet

A theory of subjective learning ☆,☆☆

David Dillenberger [a,*], Juan Sebastián Lleras, Philipp Sadowski [b], Norio Takeoka [c]

[a] *Department of Economics, University of Pennsylvania, United States*
[b] *Department of Economics, Duke University, United States*
[c] *Department of Economics, Yokohama National University, Japan*

Received 28 May 2014; final version received 2 July 2014; accepted 3 July 2014

Available online 8 July 2014

Abstract

We study an individual who faces a dynamic decision problem in which the process of information arrival is unobserved by the analyst. We elicit subjective information directly from choice behavior by deriving two utility representations of preferences over menus of acts. One representation uniquely identifies information as a probability measure over posteriors and the other identifies information as a partition of the state space. We compare individuals who expect to learn differently in terms of their preference for flexibility. On the extended domain of dated-menus, we show how to accommodate gradual learning over time by means of a subjective filtration.

JEL classification: D80; D81

Keywords: Subjective learning; Partitional learning; Preference for flexibility; Valuing insurance acts; Subjective filtration; Dated-menus

☆ This paper extends, combines, and supersedes the working papers by Takeoka, N. [21], and Lleras, J.S. [18]. The analysis in Section 2.2 previously appeared in Dillenberger, D. and Sadowski, P. [8].

☆☆ We thank David Ahn, Brendan Daley, Henrique de Olivera, Larry Epstein, Kazuya Hyogo, Atsushi Kajii, Shachar Kariv, Peter Landry, Jian Li, Atsushi Nishimura, Wolfgang Pesendorfer, Todd Sarver, Marciano Siniscalchi, and Chris Shannon for useful comments and suggestions.

* Corresponding author.
E-mail addresses: ddill@sas.upenn.edu (D. Dillenberger), jslleras@gmail.com (J.S. Lleras), p.sadowski@duke.edu (P. Sadowski), takeoka@ynu.ac.jp (N. Takeoka).

http://dx.doi.org/10.1016/j.jet.2014.07.003
0022-0531/

1. Introduction

The study of dynamic models of decision making under uncertainty when a flow of information on future risks is expected over time is central in all fields of economics. For example, investors decide when to invest and how much to invest based on what they expect to learn about the distribution of future cash flows. The concepts of value of information and value of flexibility (option value) quantify the positive effects of relying on more precise information structures.[1]

A standard dynamic decision problem has three components: the first component is a set of states of the world that capture all relevant aspects of the decision environment. The second component is a set of feasible intermediate actions, each of which determines the payoff for any realized state. The third component is a description of what the decision maker expects to learn; this component is formalized as an information structure, which is the set of possible signals about the states that are expected to arrive over time and the joint distribution of signals and states.

In many situations, the analyst may be confident in his understanding of the relevant state space and the relevant set of actions. He may, however, not be aware of the information structure people perceive. People may have access to private data which is unforeseen by others; they may interpret data in an idiosyncratic way; or they may be selective in the data they observe, for example by focusing their attention on specific signals. We collectively refer to those situations as "subjective learning". Since information plays a key role in most decision-making processes, if it is not observed, then it should be derived.

In this paper we show how one can infer an individual's subjectively perceived information structure (in addition to his subjective probabilities over states and cardinal utilities over outcomes) solely from his observed choice behavior prior to the resolution of uncertainty. We confine our attention to the study of two canonical ways of describing information, namely identifying signals with the posterior beliefs they produce, and partitional-learning. For each model, we provide an axiomatic foundation and show that the relevant parameters are uniquely identified. The identification of anticipated arrival of information allows us to compare the behavior of individuals who perceive different information structures. Such comparisons are the subjective versions of the comparative statics for incremental increases in informativeness when learning is objective. Lastly, we propose a new domain that allows studying the behavioral implications of uncertainty that is anticipated to gradually resolve over time by means of a subjective filtration.

The standard subjective expected utility models of Savage [20] and Anscombe and Aumann [1] characterize subjective probabilities from observable choices among acts (state-contingent payoffs). These models, however, are not rich enough to also identify unobserved information. The reason is that information has instrumental value only when some aspect of choice can be conditioned on it, which is not the case in the static domain of acts. For example, in environments with potentially asymmetric information, the standard model is not equipped to distinguish which side is better informed. Simultaneously identifying beliefs and information thus requires us to enrich the choice domain, as we now describe.[2]

We consider an objective state space. Actions correspond to acts and preferences are defined over sets (or menus) of acts. The interpretation is that the decision maker (henceforth DM) ini-

[1] For a comprehensive survey of the theoretical literature, see Gollier [11, Chapters 24 and 25].

[2] In the body of the paper we will abstract from deriving the cardinal utility over outcomes and focus on the identification of information and beliefs. We comment on this modeling choice in Remark 1, and supply the most general model, in which all three components can be identified, in Appendix A.