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Random intertemporal choice ☆

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Abstract

We provide a theory of random intertemporal choice. Agents exhibit stochastic choice over consumption due to preference shocks to discounting attitudes. We first demonstrate how the distribution of these preference shocks can be uniquely identified from random choice data. We then provide axiomatic characterizations of some common random discounting models, including exponential and quasi-hyperbolic discounting. In particular, we show how testing for exponential discounting under stochastic choice involves checking for both a stochastic version of stationarity and a novel axiom characterizing decreasing impatience.

JEL classification: D8; D9

Keywords: Stochastic choice; Intertemporal choice; Discounting; Stationarity

1. Introduction

In many economic situations, it is useful to model intertemporal choices, i.e. decisions involving tradeoffs between earlier or later consumption, as stochastic or random. For instance, in typical models of random utility used in discrete choice estimation, this randomness is driven by

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unobserved heterogeneity where the econometrician is not privy to all the various determinants of discounting attitudes.[1] Even when considering the behavior of a single individual, intertemporal choices can still be stochastic.[2] Decisions involving tradeoffs at different points in time are heavily influenced by visceral factors which are often of an uncertain nature even from the perspective of the decision-maker.[3]

In addition to being descriptively more accurate, a model of random intertemporal choice would also be useful for welfare analysis. An agent whose discounting is random but his utility is deterministic may behave as if his discounting is deterministic but his utility is random.

However, the welfare analysis of an agent whose discounting is random would naturally be different from that of an agent with deterministic discounting. Given all these issues, any careful analysis and interpretation of behavioral patterns in intertemporal choice would require a probabilistic, or random model of discounting.

In this paper, we provide a theoretical framework to study random intertemporal choice. We model random discounting as a distribution of preference shocks to discounting attitudes. Importantly, we focus on random discounting as the sole source of stochastic choice. This allows us to precisely characterize the relationship between random discounting and stochastic choice data.[4] In applications such as demand estimation where the relevant variable of economic interest is probabilistic choice, this is a useful and important exercise. Moreover, since random discounting is modeled as preference shocks on discounting attitudes, our theory yields robust comparative statics as demonstrated in recent work by Apesteguia and Ballester (2018).

Our model is flexible enough to allow for random discounting to be interpreted in two ways. In the first interpretation, we consider stochastic choice as the aggregated choice frequencies made by agents in a group. Aggregated choices are random due to unobserved heterogeneity in the population from the perspective of an outside observer such as an econometrician. This is the case in most applications of discrete choice estimation or in typical intertemporal choice experiments.

In the second interpretation, we consider stochastic choice as probabilistic choice from a single agent due to individual shocks to discounting attitudes. For instance, the agent is asked to choose from a menu of consumption streams repeatedly over a short interval of time. Under this interpretation, we can obtain stochastic data from experiments such as in Tversky (1969), Camerer (1989), Ballinger and Wilcox (1997), and more recently Regenwetter et al. (2011) and Agranov and Ortoleva (2017).[5] In this case, final payoffs are randomized across the agent's choices, so the agent considers each choice problem independently of the others.[6] Random choice is then obtained from the frequency of the agent's repeated choices.

In both interpretations, we interpret stochastic choice as arising from *ex-ante* choices with commitment. By *ex-ante*, we mean that we observe choices before any consumption is realized. Indeed, this is the case in the experiments mentioned above. For example, in

1 For further discussions on random utility and discrete choice estimation, see McFadden (2001) and Train (2009).

2 For some recent evidence, see Short Experiments 2 of Agranov and Ortoleva (2017).

3 Frederick et al. (2002) provides a detailed discussion on such visceral influences on intertemporal choice.

4 In Section 6, we generalize our model to allow for taste shocks as well.

5 See the introduction of Agranov and Ortoleva (2017) for more experiments on stochastic data.

6 Assuming the agent is an expected utility maximizer, this payment procedure means that he considers each choice problem separately.