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Note

Revealed time preference ☆

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ABSTRACT

Suppose a researcher observes a *finite* number of preference comparisons between pairs (x,t) of rewards x delivered at time t. We provide necessary and sufficient conditions under which such a dataset can be rationalised with the most common specifications of the discounted utility model. The distinctive feature of our characterisation is that it refers to notions of stochastic dominance among empirical distributions defined over the observed rewards and time delays.

1. Introduction

Suppose that in an experiment or an empirical study a subject is reporting her preference over delayed rewards, i.e., pairs (x,t) of prizes $x \in \mathbb{R}^{\ell}_{+}$ delivered at some date $t \in \mathbb{Z}_{+}$. Whenever she picks an option (x,t) over some alternative (y,s), we say that the former is revealed preferred to the latter and denote it by $(x,t)R^*(y,s)$. Given a finite number of such observations, when can we rationalise this dataset with a discounted utility model? Specifically, we are interested in conditions on the revealed preference relation R^* under which there exists a felicity function u and a discounting function γ such that

$$(x,t)R^*(y,s) \text{ implies } u(x)\gamma(t) \geq u(y)\gamma(s).$$

Moreover, what can we say about the discounting function γ? In particular, under what conditions on R^* it is weakly present-biased or exponential?

The objective of this paper is to establish the testable restrictions for different specifications of discounted utility, i.e., we provide tight conditions on the revealed preference R^* that allow us to falsify these models with directly observable

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data. Our approach is nonparametric and focuses on the most fundamental implications of discounted utility. However, we do not limit our attention to algorithms that enable us to perform such tests on empirical observations; rather, we explore the economic content of different models of time preference by analysing conditions on the data alone, without referring to unobservable concepts such as utility or marginal rate of substitution.

We characterise time preference in a framework where the domain of choices is restricted to prize-time pairs. There is an extensive decision theory literature that provides axiomatic foundations for choice over dated rewards, as discussed in the literature review below. The objective of those papers is to characterise complete preference relations that admit a particular utility representation. Notably, these studies assume that the researcher can observe comparisons between any two alternatives. In contrast, our analysis focuses on properties of a finite and incomplete revealed preference relation R^*. Since such a dataset provides limited information on consumer taste, answering the question of representation requires different techniques. In particular, apart from inferring the subject's preference nonparametrically, we ask when rationalising the data is even possible. Given that data is inherently finite in any empirical setting, we find our approach especially useful from the practical perspective.

The distinctive feature of our analysis is that it refers to notions of stochastic dominance among empirical distributions over observable rewards and time delays. Specifically, we focus on finite collections of elements $(x,t)R^*(y,s)$ in the revealed preference relation R^*, henceforth *samples*. In order to characterise a time preference of interest, we evaluate independently empirical distributions over rewards x, y and time delays t, s in the superior (i.e., on the left-hand side of R^*) and inferior pairs (on the right) that correspond to such a sample. In our axioms we determine the form of stochastic dominance among these distributions that is inadmissible by the particular model of discounted utility. In addition, we show that such a restriction is both necessary and sufficient for a revealed preference relation to be rationalisable in the specified sense. This technique allows us to present the axioms in a compact and transparent way, while generalising the existing characterisations of intertemporal choice that pertain to complete preference relations.

This paper is organised as follows. After the literature review below, in Section 2 we introduce our framework, necessary notation, and auxiliary definitions. In Section 3 we characterise the most general class of discounted utility models. Then, in Section 4 we focus on discounting that exhibits some level of present bias, including the most commonly known exponential discounting. We conclude in Section 5, where we discuss issues related to identification and indeterminacy of preferences. Proofs are presented in Appendix A. The Online supplement includes auxiliary results omitted from the main text.

Related literature Stemming from the work by Koopmans (1960), a significant share of the economic literature was devoted to axiomatic characterisation of models of intertemporal choice. An important part of this research focuses on preferences defined over pairs (x,t) of reward vectors $x \in \mathbb{R}^\ell_+$ and time delays $t \in \mathbb{Z}_+$. This includes, e.g., Fishburn and Rubinstein (1982), Prelec (2004), Ok and Masatlioglu (2007), Halevy (2008), Bleichrodt et al. (2009), or Noor (2011).[1] Unlike in our analysis, the above papers adopt a complete preference relation as a premise. Hence, they assume that it is possible to monitor a binary comparison between any two prize-time pairs that belong to the domain. In contrast, we assume that only a finite number of comparisons is observable, which makes our approach particularly useful for practical applications.

In the past three decades there has been an abundance of experimental studies that investigated consumer preference over prize-time pairs. See Table 1 in Frederick et al. (2002) or Table 1 in Takeuchi (2011) for an extensive list of such experiments. It is also worth mentioning Chabris et al. (2008, 2009), Dohmen et al. (2012), Andersen et al. (2014, 2013), and Halevy (2015). Even though the above studies differed in their designs, the objective of each one of them was to determine preferences of individual subjects over dated rewards. In almost all of these experiments the data were used to estimate parametrically a particular model of time preference using econometric methods. A notable exception is Halevy (2015) where the study was tailored to test directly for particular axioms characterising different discounted utility models. Our nonparametric approach is largely applicable to data from all of the above studies. Moreover, it does not only allow to elicit time preference from the observable choices, but foremost determine whether rationalising the data is even possible.

We consider Echenique et al. (2017) to be the closest to our work. It provides a characterisation of various forms of time-separable preferences defined over streams of consumption, rather than prize-time pairs. This paper adopts an Afriat-type framework in which an observation consists of a path of one-dimensional consumption goods acquired at prevailing time-contingent prices. The main results introduce tight conditions under which such a finite dataset can be rationalised by several forms of discounted utility.

An obvious difference between this paper and ours follows from the distinction in domains over which a time preference is defined. However, also our approach to axiomatisation is fundamentally different. The testable restrictions developed in Echenique et al. (2017) are induced by first-order conditions corresponding to the consumer optimisation problem. This requires convexity of preferences and sets of alternatives from which subjects make their choices. By restricting our attention to dated rewards, we are able to characterise discounted utility without the additional conditions on time preference. Nevertheless, as the framework in the two papers is distinct and prescribed for different empirical applications, the results are not comparable.

[1] Alternatively, Fishburn and Edwards (1997), Hayashi (2003), Olea and Strzalecki (2014), Galperti and Strulovici (2017) characterise time preference over consumption streams rather than dated rewards.