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Inferring discount rates from time-preference experiments☆

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HIGHLIGHTS

- Inferred discount rates in time-preference experiments depend on payment spreading.
- We calculate optimal spreading for a given set of behavioral and design parameters.
- Inferred discount rates are near risk-neutral rates under optimal spreading.
- Estimated discount rates mostly reflect pure rates of time preference.

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ABSTRACT

We observe that identification of the discount rate from experimental data requires an assumption about the consumption period, the length of time over which a payment will be turned into utility-providing consumption. We show that the optimal consumption period is substantially longer than assumed in previous studies. When the consumption period is allowed to take on more reasonable values, the discount rates implied by experimental choices are unreasonably large and relatively insensitive to assumptions about utility curvature.

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1. Introduction

A time preference experiment is one that asks individuals to choose between $\$X$ now and a larger amount of $\$Y$ in the future. As pointed out by researchers, these experiments elicit a combined discount rate/utility curvature parameter (e.g. Frederick et al., 2002 and Andersen et al., 2008). If utility is linear, i.e. zero utility-curvature, the implied discount rates from these experiments are often quite high, a finding that has broad implications. If researchers instead allow for risk aversion, typically inferred from a separate or related set of experiments, the implied discount rates are smaller and have less drastic implications. Andersen et al. (2008), for instance, show that implied average discount rates for the Danish population decrease from approximately 25% to 10% after controlling for utility curvature.[1]

In this paper we note that identification of the discount rate from experimental data further requires an assumption about the consumption period, the length of time over which some gift of money will be turned into utility-providing consumption. Previous researchers have assumed a consumption period of 1–10 days. We argue here that these are quite short and that they should vary with the individual's discount rate and utility curvature. When the consumption period is allowed to take on more reasonable values, the discount rates implied by experimental choices are again large and relatively insensitive to assumptions about utility curvature.

☆ The views expressed are those of the authors and should not be attributed to the Economic Research Service, the USDA, or the United States Treasury.

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[1] Laury et al. (2012) use a novel experimental design that attempts to eliminate the influence of utility curvature by having individuals make choices over time-delineated probabilistic payments. The researchers estimate discount rates of 11%–12% in two experiments.

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2. Optimal spreading and implied discount rates

We explore the inference of discount rates in the context of a time-preference experiment in which an individual chooses between an early payment, M_0, received at day t_0 and a later but larger payment, M_1 received at day $t_1 > t_0$. Present discounted utility of the early payment under exponential discounting and additively-separable per-period utility is:

$$\mathrm{PDU}_0 = \underbrace{\sum_{i=0}^{t_0-1}\left(\frac{1}{1+\delta}\right)^{\frac{i}{365}} U(\omega)}_{\text{background consmp.}} + \underbrace{\sum_{i=t_0}^{t_0+\lambda_0-1}\left(\frac{1}{1+\delta}\right)^{\frac{i}{365}} U\left(\omega+\frac{M_0}{\lambda_0}\right)}_{\lambda \text{ days of background consmp. plus experimental payment}} + \underbrace{\sum_{i=t_0+\lambda}^{T-1}\left(\frac{1}{1+\delta}\right)^{\frac{i}{365}} U(\omega)}_{\text{background consmp.}}, \quad (1)$$

where δ is the individual's annual discount rate, ω is background consumption, T is the time horizon, and $U(\cdot)$ is the instantaneous utility of consumption. Following Andersen et al. (2008), the individual spreads consumption of the payment evenly over λ_0 days and thus consumes M_0/λ_0 per day over that period. Define in a similar fashion the present discounted utility, PDU_1, under the later payment, M_1, and consumption period, λ_1. Similarly to other studies, we assume that background consumption is constant over time.

An individual's preferred spreading period is motivated by the two basic behavioral parameters of our model: the discount rate and risk-aversion. Risk-averse individuals will want to spread consumption over multiple days to increase the marginal value of instantaneous utility in each period, and therefore their total utility. This utility increase is offset by the additional discounting of utility that occurs for consumption on days further into the future from the present time. Our model suggests, for example, that risk-neutral individuals would choose not to spread at all.

Without good data or experimental evidence on the time path of consumption flows, most experimental studies eliciting discount rates have assumed individuals consume their payments in one day (e.g., Andersen et al., 2008, Tanaka et al., 2010, Andreoni and Sprenger, 2012 and Meier and Sprenger, 2012).[2] We show that this consumption period is woefully sub-optimal given the other parameters estimated or assumed in these studies. Suppose the individual has CRRA utility, $U(c) = c^{1-\rho}/(1-\rho)$ and suppose the individual chooses the period over which to consume M_0 (or M_1) given discount rate δ and utility curvature ρ. Fig. 1 shows the value of λ that maximizes (1) for a range of $\{\delta, \rho\}$ values given background consumption of \$20 and an early payment of \$405, denoted λ^*.[3] For comparison to previous work, we examine $\delta = 0.1$ and $\rho = 0.75$, which are approximately the values estimated by Andersen et al. under the assumption of $\lambda = 1$ for the Danish population. For this $\{\delta, \rho\}$ pair, we find the optimal spreading period, λ^*, is 234 days.[4]

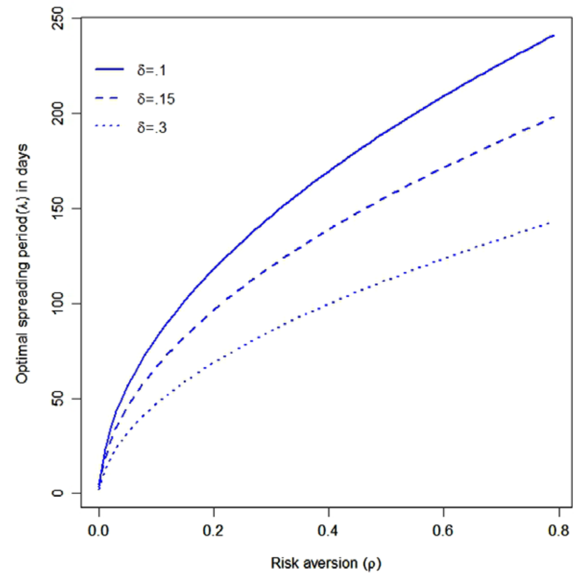

Fig. 1. Optimal consumption spreading.

Time-preference experiments attempt to infer δ from individuals' choices between the earlier (M_0) and later (M_1) payments, based on some other knowledge of (or assumption about) ρ. To see the implications of optimal spreading for this inference, we look at the set of the $\{\delta, \rho\}$ that would be consistent with an individual being indifferent between an earlier payment of $M_0 = \$405$ at $t_0 = 14$ and a later payment of $M_1 = \$515$ at $t_1 = 270$, assuming $\omega = \$20$ and setting $\lambda_0 = \lambda_0^*$ and $\lambda_1 = \lambda_1^*$. Results are in Fig. 2. A risk-neutral individual who was indifferent between these two payments would have a discount rate of $\delta \approx 0.41$.[5] Higher ρ's are, of course, associated with lower δ's, but the extent to which the inferred δ varies is quite small when λ is chosen optimally. As Fig. 2 shows, an individual with risk aversion $\rho = 0.75$ would need a discount rate only slightly below the risk-neutral individual's, 0.38, to be indifferent between the two payments.

Fig. 2 shows for comparison the same curve when λ is constrained to equal 1. This curve is the set of $\{\delta, \rho\}$ that would be consistent with the individual being indifferent between our early and late payments conditional on $\lambda = 1$. Here, an individual with risk aversion $\rho = 0.75$ who was indifferent between the two payments would have an inferred discount rate $\delta = 0.16$. This inferred rate is substantially lower than implied by optimal consumption spreading. Studies which adjust inferred discount rates so as to account for utility-curvature may be finding much lower estimates of δ than are truly representative of individuals' time preferences because these studies do not allow for optimal (or even reasonable) consumption spreading.

[2] Andersen et al. (2008) examine periods of greater than one day but their main results are based on a consumption period of one day since this one day period maximized the log-likelihood of their estimates; their log-likelihood is quite flat in this dimension, however. Andersen et al. further assumed the spreading period to be the same for the early and late payment.

[3] Our figures show values for a relative risk-aversion parameter between 0 and 0.8. The patterns we find apply at all levels of ρ: higher ρ implies a lower discount rate and more consumption spreading, all else equal. The lack of capital markets in our model constrains spreading to being non-negative.

[4] Our comparison to Andersen et al. (2008) is not exact because they use a slightly larger payment amount of \$458 for their early payment. Higher payments sizes, however, will only increase the optimal spreading period. Our choice of \$405 in 14 days is based on a time preference experiment we conducted with a sample of 208 US farmers (Duquette et al., 2012).

[5] In Duquette et al. (2012), we estimated an average discount rate of 0.34 under continuous compounding and risk neutrality. Our choice of a risk-neutral rate of 0.41 here is based upon estimates using daily compounding, which makes for easier comparison to other estimates in the literature.