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Beyond Time Discounting

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Abstract

The intertemporal tradeoffs made by most persons appear inconsistent when viewed through the lens of the standard time-discounting model. At different times and in different decision contexts, the same individual will often display behavior suggestive of a wide range of discount rates, from strongly positive (indicative of a lack of concern of future consequences) to strongly negative (implying greater concern for the future than the present). We argue that many of these apparent inconsistencies can be attributed to three aspects of time preference that are not part of the conventional model: decreasing impatience, a preference for sequences of outcomes that improve over time, and preference interactions between consumption and payments.

Key words: time discounting, consumer savings, investment

1. Introduction

Time plays a role in almost all decisions, which makes intertemporal tradeoffs rather like speaking prose—something we do whether we are aware of it or not. Economic theory provides a simple and well-known rule for handling the temporal aspect of decisions. The rule says that for each course of action, compute the present value of the consequences, using a personal discount rate. Then choose the action that has the highest present value.

A frequently cited paper by Hausman (1979) shows how the assumption that consumers behave optimally is put to work. Hausman measured consumer preferences for air conditioning units differentiated by price and energy efficiency. A person who chooses a more efficient unit pays a higher immediate purchase price but lower delayed energy payments and thereby "reveals" a lower discount rate than a person who goes for a cheap, inefficient model.

Do such rates correspond to enduring personal characteristics, which could be recorded and then applied to predict choices in other situations? Even the evidence from appliance purchases suggests that the answer is no. Different appliances reveal radically different rates of time discount, ranging from 5 to 300 percent (Gately, 1980), as if discounting is product specific (Winer, 1996). More generally, a close tracking of any individual's behavior will reveal huge disparities in time discounting. The same person who smokes may also save for retirement; the person who can't execute a diet may also adhere to a carefully

crafted long-term career plan. We refer to such within-person variations as *intraindividual variability* in time discounting.

Intraindividual variability indicates that the discounting model is misspecified—that it fails to represent certain psychological motives that influence intertemporal tradeoffs. It is as if we are trying to measure people's food tastes by studying the first letter of the foods they like and dislike. Measured this way, food preferences will seem incoherent: a person who likes apples may also dislike abalone. As one's model of food preferences becomes specified more accurately—into national cuisines, for example—measured preferences will appear more consistent. Likewise, individual behavior with respect to intertemporal tradeoffs will appear more coherent as our intertemporal model becomes more accurately specified.

In the next three subsections of the article we describe, in order of increasing complexity, three psychological aspects of time preferences that are not part of the standard discounting formulation. Each of them, we believe, can help account for intraindividual variability.

2. Discounting: decreasing impatience

Consider the top panels of Figure 1, which depict a simple choice between two basketball outings—one (left panel) to a game next week against an average team, and the other (right panel) against a more interesting opponent in four months. Time here appears directly as an attribute that can be exchanged for improvement in the quality of the game. The question posed by the decision is whether the improvement in play is worth the increase in delay.

Empirical research on time preference has focused on these types of simple choices with the goal of estimating the subjective discount function (Benzion, Rapoport, and Yagil, 1989; Thaler, 1981). The main generalization that has emerged is that the discount rate for a fixed time interval (such as one year) is not constant, as required by compound discounting, but declines as the time interval is moved away from the present. Intuitively, the difference between having something now and having it in one year is more important than the difference between having it in five years or in six years. This "deviant" property of time preference has been discussed in many contexts, notably by Ainslie (1975, 1982), and it has been analyzed more generally as "decreasing impatience" (Prelec, 1989; Prelec and Loewenstein, 1991; Loewenstein and Prelec, 1992). The hyperbolic discount function, $f(t) = 1/(1 + at)$, is a convenient representation of decreasing impatience.

The fact that discounting exhibits decreasing impatience would not in itself be disturbing were it not for the implications of this fact for the stability of discounting across different products and situations (that is, for intraindividual variability). From a marketing point of view, one is interested in discount functions on the expectation that such functions will predict how consumers will choose in various settings, such as between currently available products and superior products that are still in development. In other words, one is interested not so much in a pure rate of time preference but in "devaluation" (Loewenstein and Prelec, 1992) or "product rate of time preference" (Sultan and Winer, 1993),

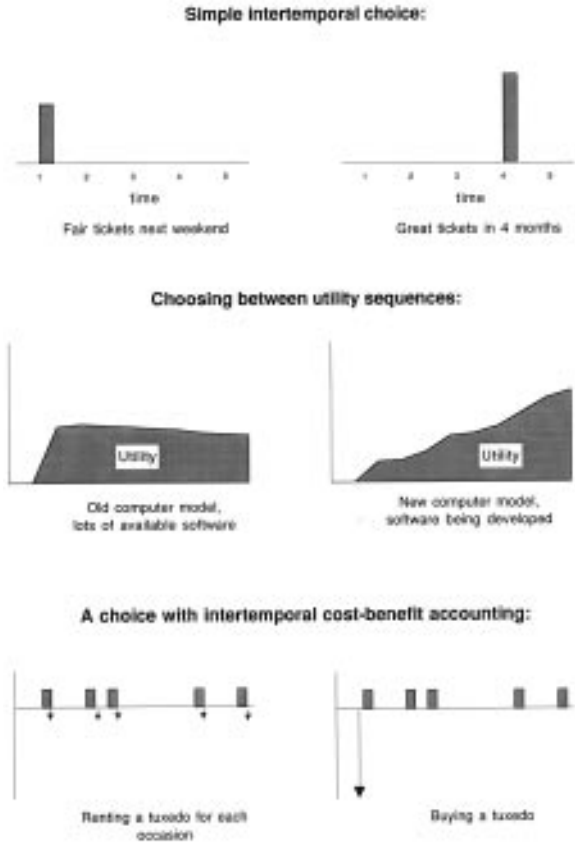


Figure 1. Three categories of intertemporal choice.

which is the proportional change in value as the purchase point is moved away in time. An important implication of decreasing impatience is that different categories of products should exhibit different devaluation rates even assuming a single underlying discount function.

Table 1 provides a numerical illustration. Imagine a consumer contemplating a stylized investment-type product (such as a piece of equipment). In return for an initial outlay of −40, the investment yields a benefit of +90 after one year. The consumer has three choices: to invest immediately, to invest in one year, or to invest in two years. The left side of the table calculates present values for each option, assuming an annual discount rate of 50 percent per year. The present value of starting immediately is +5.0, of delaying by one year +2.5, and of delaying by two years +1.25. Hence, the optimal choice is to invest right away. Note also that the present values (such as, 5, 2.5, 1.25 …) decline in exact proportion to the discount factors (1, .5, .25 …). This reveals a key property of compound discounting: the rate of devaluation for any product differs only by a scale factor from the

Table 1. Present values for different purchase times of equipment that has an initial cost of −40 and that provides afterwards a benefit of +90, delayed by one year. Present values are computed both with compound and hyperbolic discount functions.

	Compound discounting				Hyperbolic discounting			
Time	Discount factor $(.5)^t$	Option A: buy now	Option B: buy next year	Option C: buy in 2 years	Discount factor $(1 + t)^{-1}$	Option A: buy now	Option B: buy next year	Option C: buy in 2 years
Now	1	−40	0	0	1	−40	0	0
In 1 year	1/2	+90	−40	0	1/2	+90	−40	0
In 2 years	1/4	0	+90	−40	1/3	0	+90	−40
In 3 years	1/8	0	0	+90	1/4	0	0	+90
Present value		+5[a]	+2.5	+1.25		+5	+10[a]	+9.2

a. Highest present value.

underlying discount function. If the net value of buying the product now is +5, then the net value of buying the product in one year is exactly 50 percent of that (assuming a 50 percent discount rate), independent of the temporal structure of costs and benefits associated with the purchase.

The right side of the table goes through the same calculations but with a hyperbolic discount function, $f(t) = 1/(1 + t)$. The present value of starting immediately is +5.0, of delaying by one year +10.0, and of delaying by two years +9.2. Now there is no obvious relationship between these present values and the discount function. Furthermore, the devaluation rate is *negative*; the optimal choice is to purchase the product in exactly one year. This leads to a time-inconsistency (Strotz, 1956; Ainslie, 1975), for if the present values are recalculated when next year rolls around, then the optimal decision will again be to wait exactly one year. A person who keeps recomputing in this way will never buy the equipment.[1]

The problem that afflicts the person with a hyperbolic function is not impatience per se because the compound function in the example exhibits *more* impatience (as can be checked by comparing the discount factors on the left with those on the right). The problem rather is time inconsistency, produced by the fact that different consequences associated with the purchase undergo different degrees of discounting as the purchase date is delayed.

The general implication is that a person with a hyperbolic discount function will not exhibit the same degree of devaluation across different products. To infer the devaluation rate for such a person requires examination of the specific benefits stream that a particular product provides. In rough terms, we can say that devaluation depends on the degree to which a purchase front-loads costs over benefits. At one extreme, products that front-load the cost induce very low, possibly negative rates of devaluation (as illustrated by the calculation in Table 1). Procrastination, in other words, is predicted for purchases that have an investment-like quality, such as home improvements, consumer durables, repairs, and nonemergency medical treatments. Measured discount or devaluation rates should be higher for items conferring benefits that are experienced rapidly. The highest rates of

devaluation should be observed for items that offer a benefit followed by even more delayed costs—the broad category of indulgences (as defined, for example, by Wertenbroch, 1996).[2]

The rate of devaluation should also interact with the method of financing. Suppose that you don't know whether to buy an item now or to wait, but you do know that this particular type of purchase will be made on credit. This creates a package that has the benefits front-loaded; consequently, hyperbolic discounting will tend to promote immediate purchase once the decision to purchase eventually is set. Conversely, if you have decided to buy something in cash but are again unsure exactly when to make the purchase—as might correspond to the decision situation in Table 1—then you are front-loading the costs, and so the timing decision is more likely to be to wait.

3. Interactions between events in a sequence: the importance of improvement

In the decision depicted in the top panel of Figure 1, time delay is an attribute that is traded off against value. Few decisions are that simple; intertemporal choices often involves a choice between alternative *sequences* of outcomes, defined over some given time interval. The distinction between choices involving one-outcome alternatives and those between explicit sequences is immaterial for conventional discounting but is important in reality because sequences give rise to new psychological motives. Specifically, our own research (Loewenstein and Prelec, 1991, 1993) has shown that people have a strong preferences for sequences that improve over time.

Consider the decision described by the middle panels in Figure 1. Your employer will install a new computer system that is expected to last for four years. There are two systems to choose from: option A is a system packed with software but based on an essentially obsolete computer architecture; option B is a new system that will eventually outperform the old one but that has little supporting software right now. The shaded areas in the figure indicate the anticipated utility flows associated with the two computer systems.

How is this situation different from the previous one? Here it is seems artificial to think of time as an attribute that is traded against something else. Rather, time orders events and in so doing gives rise to specific psychologically important patterns. Imagine that you have decided to go with the older system. Although the system works quite well right away, you know that the level of performance that you experience at that point in time is as good as the system will get. If anything, performance afterwards will deteriorate as support is withdrawn and as you start to experience compatibility problems when more co-workers shift to the new system. If you buy the new system, however, the situation is reversed: there may be initial inconveniences, but you can take comfort in thinking about the improvements right around the corner. In view of this, you might well reconsider the original decision. The experience of improvement produced by the new system is a strong argument in its favor, an argument that goes beyond assessing the performance level at each point in time.

The preference for improvement is probably overdetermined. People like improving sequences in part because they provide something to look forward to or savor (Loewen-

stein, 1987). There is also a tendency to frame sequences of outcomes in terms of changes, as opposed to levels, over time (Gilboa, 1989). If so, increasing sequences will be framed as a series of gains (positive changes) that, not surprisingly, people tend to prefer over a series of losses. Improvement is not, however, the only new psychological consideration that enters when we shift from simple outcomes to sequences. Besides the desire for improvement there seems to be a preference for interspersing good and bad outcomes evenly (Loewenstein and Prelec, 1993) and for ending on a good note (Kahneman, Fredrickson, Schreiber, and Redelmeier, 1993; Varey and Kahneman, 1992).

We have observed in numerous surveys, and intuition confirms, that as soon as an intertemporal tradeoff is embedded in the context of alternative sequences of outcomes, the psychological perspective, or frame, shifts. The result of this shift is that individuals become more far-sighted, often preferring the sequence that postpones better things to the end. Sometimes only a small change in wording is sufficient to cause a change in frame.

In Loewenstein and Prelec (1992) we report the following series of questions, answered by individuals prescreened for a preference for dinner at "a fancy French restaurant" over a dinner at "a local Greek restaurant:"

Item 1. Which would you prefer:

A. Dinner at the French restaurant on Friday in one month.
B. Dinner at the French restaurant on Friday in two months.

Item 2. Which would you prefer:

C. Dinner at the French restaurant on Friday in one month and dinner at the Greek restaurant on Friday in two months.
D. Dinner at the Greek restaurant on Friday in one month and dinner at the French restaurant on Friday in two months.

While a majority of subjects (80 percent) preferred to have the French dinner sooner (A) rather than later in Item 1, the same group of subjects also preferred the sequence (D) which gave them the better dinner in two months (57 percent).

Whether or not a person perceives outcomes as integrated parts of a sequence thus need not depend on any objective feature of the situation but rather on whether a person is "reminded" of the possibility of perceiving outcomes in this way. In the real world, people surely differ in their propensity to integrate outcomes into sequences, and it is this difference, we believe, that accounts for much of the otherwise surprising variations in impatience across individuals and across situations.

4. Interactions between cost and benefit sequences

People generally prefer sequences that improve, but certain types of sequences bring additional motives into play. One type of sequence that is especially important for mar-

keting consists of the series of payments and consumption episodes that together constitute a purchase. Debt financing, for example, typically involves a series of consumption episodes that either coincide with, or are followed by, outlays to pay off the debt. Saving involves a payment or series of payments that are followed by a series of consumption episodes. New financial instruments, such as credit cards, debit cards, and, most recently, "smart cards," produce purchase sequences of ever-increasing complexity.

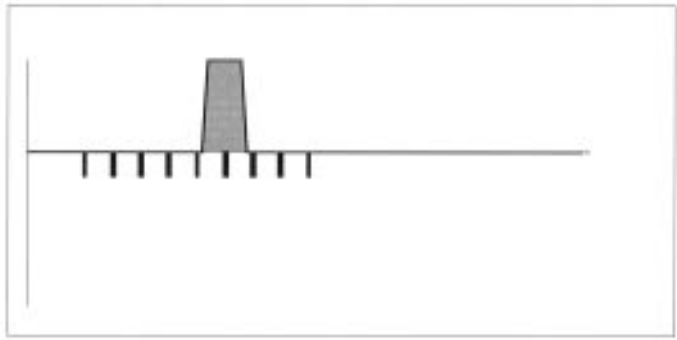
Consider the decision represented in the bottom panel of Figure 1, which depicts the temporal relations between consumption events and payment transactions for the rental or purchase of a tuxedo. Suppose that your social activities require black tie dress about once every few years. The decision is whether to buy the tuxedo (right panel) or rent (left panel). From an economic perspective, the decision criterion should be the cost of the tuxedo relative to the discounted present value of the rental payments. The analysis could be elaborated by making allowances for convenience, risk, liquidity and so forth. Even with these refinements, however, the economic model leaves out aspects of the problem that are important psychologically. Specifically, it is possible that you will enjoy the occasional black tie events more because they will not need to "cover" the rental cost of the tux. You might say to yourself, "Let me make this one-time investment and then never again have to think about the cost of dressing up for these silly parties."

A statement like this alludes to a certain kind of mental accounting rule (Thaler, 1985)—namely, that when renting, the costs of each rental are to be "charged" to the corresponding social event, while when owning the tux can be enjoyed as if it were "free." Furthermore, this rule affects both the pleasures of consumption (attending parties and wearing the tux is more enjoyable when you are an owner) and the psychological burden of paying for it (writing the rental check will be especially painful if the party is boring).

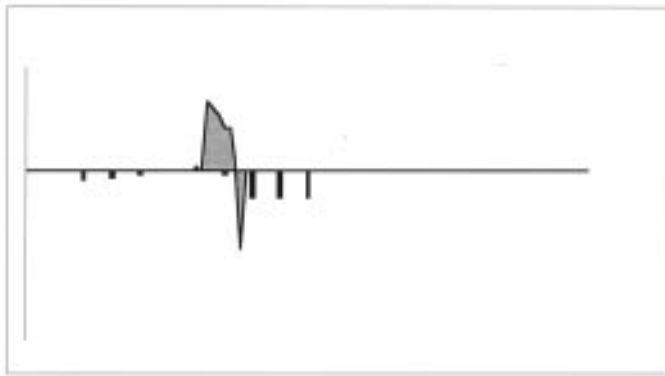
In a recent paper (Prelec and Loewenstein, 1995) we propose a number of mental accounting principles that, we believe, regulate the hedonic relationship between consumption and payment and express these principles in the context of a formal model. The model assumes that when consumption benefits and individual payment transactions are linked together or *coupled* (for example, through an act of purchase) then the satisfaction of consumption depends on when and how the product is paid for, and, likewise, displeasure with payments depends on when and how the product is consumed.

The critical behavioral assumption that governs such hedonic interactions between consumption and payments is *prospective accounting*, which emphasizes the forward-looking nature of mental accounting: anticipated future payments have a greater capacity to corrupt the pleasures of consumption than do past payments, and, likewise, making payments toward future consumption is more agreeable than paying back old debts. Our model assumes that consumption episodes or payments are pleasurable or aversive depending on whether the balance of residual consumption derived from the purchased item exceeds in utility terms the balance of residual payments still due for that purchase.

The quantitative model generated by this premise[3] can be illustrated by means of a simple graphical example. Imagine a person who purchases a vacation package, to be paid for in nine equal installments. Five installments precede the vacation, one coincides with it, and three are due after the vacation has been completed. The entire situation is visually presented in the top half of Figure 2, where the vertical bars indicate payments, and the



Paying for a vacation in 9 equal installments:
The unadjusted consumption and payment stream



Corresponding hedonics,
with prospective accounting

Figure 2. Consumption and payment streams, as scheduled (top panel) and as actually experienced (bottom panel).

shaded area indicates the utility derived from the vacation. The data in the top half of the figure are, thus, the initial inputs to the mental accounting model, which then transforms them to indicate how both types of events might actually be experienced. The bottom half of the figure specifies the hedonic stream that is predicted on the basis of prospective accounting.

Consider, first, the hedonics of payment. The first four vacation prepayments are relatively neutral hedonically because they are made in anticipation of the vacation pleasures. The three payments after coming home are unpleasant because the vacation in now in the past and there are no further benefits to "justify" the expense. A similar effect is evident for the hedonics of the vacation period. It starts out positive, but at some point the balance

of remaining vacation time is no longer sufficient to cover the three remaining payments, at which point the account moves into "the red" and the last few days are thoroughly spoiled by the thought of payment.

This is of course a stylized example, but it is consistent with the financing preferences that we have observed. For certain kinds of items, such as vacations, most people claim to want to prepay even if there is no compensating price reduction. When probed further, they indicate that the primary reason for prepayment is to protect the vacation experience from thoughts of cost. For other types of items, such as consumer durables, people prefer to buy on an installment plan, with payments starting when the durable is delivered. Unlike the vacation, a durable good has an extended lifespan and so a financially attractive credit plan allows the consumer to delay payments without getting into the unattractive position of having the payment balance exceed the residual value of the durable. Overall, the desirability of leasing versus ownership ought to depend intrinsically on net value (Hauser and Urban, 1986) of a product. High net value (or "sensible") items are good candidates for leasing and low net value (or "frivolous") items for owning because with lower net value products it is more essential to put the costs out of mind with a single upfront payment.

One might think that credit card debt presents a counterexample to this argument because credit cards are notoriously associated with impulsive, low net-value purchases. What distinguishes credit card debt from conventionally "earmarked" debt, however, is that with credit cards the connection between specific purchases and specific payments is obscured. A consumer who has maintained a credit balance for some time, making payments while also adding new charges to the account, may not have any clear idea what purchases account for the debt or which items have been paid off. In that case, the consumer may treat an acquisition as if it were fully paid off, while at the same time regarding payments for that and other acquisitions as a sort of cost-of-living "tax." By so decoupling payments from consumption, credit cards become the payment method of choice for those hard-to-justify items.

Even in the absence of an actual prepayment transaction, a person could capture some of the hedonic benefits of prepayment by mentally setting aside or "budgeting" the requisite amount. The attractiveness of prix fixe menus, especially for expensive restaurants, may derive from such "mental prepayment." Because the price is set in advance, you can mentally absorb the full cost of the event before the actual dinner takes place and then enjoy your dinner as if it were prepaid. Token currencies, such as the beads used to pay for drinks at Club Med vacation resorts or the chips in gambling casinos, are yet another class of prepayment arrangements.

A billboard ad for long-distance telephone debit card currently runs the slogan, "Now you can call your loved ones and not think about how much it costs." The ad points to a fundamental dilemma in consumers' attitudes to payment. From a hedonic standpoint, one wants to minimize thoughts of payment. From a decisional standpoint, however, one definitely wants to know "how much it costs." One could formulate the paradox by saying that the consumer wants *to know* how much each bit of consumption costs but also does not want to have to unduly *think about* how much it costs. The reconciliation of these

somewhat conflicting desires should be a fundamental objective of any pricing arrangement.

4. Conclusion

Logically, all three decisions displayed in Figure 1 create an intertemporal tradeoff, and all three could be analyzed with the economic discounting model. We have argued here that the decisions are different psychologically and that, consequently, there is large gap between the analytical scope of the time discounting model and its descriptive validity. The mere fact that consequences can in each case be represented along a time line does not mean that these decisions will be treated similarly by consumers or that the rates of discount estimated in one setting will transfer to others. Consumer choices in different domains—such as choices between savings plans, consumer financing options, renting versus owning, cash versus charge purchasing, and so forth—will in general depend on the fine-grained temporal structure of consumption and payments and will require a more complex, and probably domain-specific, type of modeling.

We envision two broad strategies for continued research in intertemporal choice. The first strategy would focus on understanding why some intrinsic features of a good, or of a consumption event, have influence over the discount rate. The research on decreasing impatience (Section 2), on cross-product and cross-attribute differences in discounting (Sultan and Winer, 1993) and on the impact of visceral factors, such as emotions, drives and somatic states (Loewenstein, 1995), contributes to this general strategy, as indeed does the pioneering work of Mischel and his collaborators (Mischel, Shoda, and Rodriguez, 1989).

The second strategy would depart more fundamentally from the discounting paradigm, and would instead focus on the compensatory mechanisms, such as self-rationing (Wertenbroch, 1996), that arise in response to excessive impatience. The models discussed in Sections 3 and 4 have this flavor, in that the desire for improvement (Section 3) and the negative payment hedonics (Section 4) are both functional inhibitors of impulsive, myopic behavior. Private rules are another, insufficiently studied category of such inhibitors (Ainslie, 1975, 1982). Indeed, it is plausible to regard much of consumer behavior as governed by rules (such as "Never take a taxi unless it's an emergency") or higher-order principles ("frugality"), which *substitute for* rather than merely complement intertemporal cost-benefit tradeoffs (Prelec, 1991). The domain of consumer rules is empirically rich and may give rise to models quite far removed from the traditional utility maximization paradigm (Bodner and Prelec, 1996; Gilboa and Schmeidler, 1995).

Notes

1. This, of course, is only one of many reasons to postpone purchase (see, e.g., Greenleaf and Lehmann, 1995, Dhebar, 1996).

2. The one empirical study that has compared devaluation rates across consumer products (Sultan and Winer, 1993) has indeed found different rates for different products and for different attributes. Winer (1997) develops a multiattribute model with differential attrubute discounting. To the extent that a product is a unique bundles of attributes, it will also then have a unique, product-specific devaluation rate. Loewenstein (1987) has shown that the high savorability of certain events can produce intrinsic negative discounting. The conjecture that visceral satisfaction is susceptible to especially strong discounting is elaborated in Loewenstein (1995). The impact of external stimuli on impatience is described in Mischel, Shoda, and Rodriguez (1989).
3. See Prelec and Loewenstein (1995) for a fuller exposition.

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