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# Hyperbolic discounting can be good for your health☆

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ABSTRACT

It has been argued that hyperbolic discounting of future gains and losses leads to time-inconsistent behavior and thereby, in the context of health economics, not enough investment in health and too much indulgence of unhealthy consumption. Here, we challenge this view. We set up a life-cycle model of human aging and longevity in which individuals discount the future hyperbolically and make time-consistent decisions. This allows us to disentangle the role of discounting from the time consistency issue. We show that hyperbolically discounting individuals, under a reasonable normalization, invest more in their health than they would if they had a constant rate of time preference. Using a calibrated life-cycle model of human aging, we predict that the average U.S. American lives about 4 years longer with hyperbolic discounting than he would if he had applied a constant discount rate. The reason is that, under hyperbolic discounting, experiences in old age receive a relatively high weight in life time utility. In an extension we show that the introduction of health-dependent survival probability motivates an increasing discount rate for the elderly and, in the aggregate, a u-shaped pattern of the discount rate with respect to age.

## 1. Introduction

According to conventional wisdom, when individuals discount future gains and losses at a hyperbolically declining discount rate, it implies time-inconsistent decisions (e.g. Angeletos, Laibson, Repetto, Tobacman, & Weinberg, 2001). The perpetual revision of current plans by future selves may then lead to suboptimal decision making because individuals place greater emphasis on immediate pleasures while postponing previously planned beneficial behavior. With respect to health, for example, individuals may overindulge in current pleasure by eating and drinking, and postpone their planned physical exercise such that they live less healthy and shorter lives than if their decisions had been time-consistent.

In this paper, we disentangle the issue of present bias of preferences from the time inconsistency problem by investigating a plausible way of hyperbolic discounting which, perhaps surprisingly, implies time-consistent decision making. We set up a life-cycle model of health behavior and endogenous longevity and show that – under a reasonable normalization – individuals live healthier and longer lives if they discount the future hyperbolically than if they had applied a constant rate of time preference (exponential discounting).

In order to avoid a misinterpretation of our results, we would like to ascertain that we fully agree that limited self-control and time-inconsistent decision making as well as other manifestations of bounded rationality are major causes of insufficient investment

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in financial assets as well as in health. Presumably, hyperbolic discounting is popular among behavioral economists precisely because they associate it with time inconsistent decision making and by eliminating time inconsistency we eliminate an important feature that behavioral economists really care about. The point that we wish to make is that the observation of hyperbolic discounting is *insufficient* in order to expect inferior investment decisions and health behavior. This is important because many studies observe hyperbolic discounting behavior but comparatively few studies explicitly show that individuals make time inconsistent decisions. The latter would require observing the same individuals over time and to conclude that their original plans are actually reversed at later dates. Inferring time inconsistency from the observation of hyperbolic discounting could be misleading. These considerations may be helpful for an assessment of the sometimes inconclusive studies on the impact of hyperbolic discounting on health behavior (e.g. Khwaja, Silverman, & Sloan, 2007).

Specifically, we take it as a well established fact that the way we discount future gains and losses affects our behavior and that people who discount the future at a higher rate tend to invest less in future gains in favor of immediate gratification. With respect to health, it has been known since Fuchs (1982) that the way of discounting affects our health and several studies have found that individuals who discount the future heavily are more likely to be obese (e.g. Komlos, Smith, & Bogin, 2004), to smoke (e.g. Scharff & Viscusi, 2011), and to perform fewer health maintenance activities (Bradford, 2010); for surveys, see Lawless, Drichoutis, and Nayga (2013) and Bradford, Courtemanche, Heutel, McAlvanah, and Ruhm (2014).

The role of time preferences for human behavior, however, can be discussed in at least three dimensions, which are sometimes not properly distinguished in the literature: (i) the magnitude of discounting as such (measuring the degree of impatience), (ii) the method of discounting (measuring the speed of declining impatience, i.e. present bias), and (iii) the issue of time-consistency.[1]

With respect to the discounting method, there seems to be consent in the behavioral economics literature that the conventional assumption of exponential discounting (at a constant discount rate) is made purely for simplicity and that actual behavior is better described by discount rates that are declining in the time horizon (for surveys, see DellaVigna, 2009; Frederick, Loewenstein, & O'Donoghue, 2002). The most popular functional forms of the latter are hyperbolic and quasi-hyperbolic discounting. Hyperbolic discounting assumes that the discount rate declines over the whole planning horizon while quasi-hyperbolic discounting assumes that the discount rate declines only in the immediate future (within the next unit of time) and stays constant afterwards. The few empirical studies that try to distinguish between discounting methods tend to find stronger support for hyperbolic discounting (Abdellaoui, Attema, & Bleichrodt, 2010; Van der Pol & Cairns, 2011).

In this paper, we try to assess the impact of the discounting method by controlling for the magnitude of discounting as such. Specifically, we compare predicted lifetime outcomes for hyperbolic and exponential discounting under the normalizing assumption that the present value of a constant flow (of, for example, income) experienced over the expected lifetime of a 20-year-old person is the same. This normalization is not arbitrary. When controlling for the magnitude of discounting in this way, any difference in behavior can be attributed to the discounting method, i.e. the feature that hyperbolic types apply high discount rates for the near future and low ones for the distant future. Notice that the normalization is a *necessary* device in order to disentangle the feature of high discounting (of which we know already that it is health damaging) from the feature of present bias (where we argue that so far the literature is inconsistent and incomplete).[2]

We, moreover, separate the choice of the discounting method from the issue of time inconsistency by investigating a reasonable time-consistent way of hyperbolic discounting. Strotz' (1956) seminal paper made it well-known that only exponential discounting leads to time-consistent decisions if the discount factor is a function of the algebraic distance ($\tau - t$) between planning time $t$ and payoff time $\tau$. The "if"-clause, however, has sometimes been forgotten in the following literature such that the conventional wisdom evolved that non-exponential discounting necessarily entails time inconsistency. For example, Angeletos et al. (2001) write that "When a household has a hyperbolic discount function, the household will have dynamically inconsistent preferences, so the problem of allocating consumption over time cannot be treated as a straightforward optimization problem" (p. 54). Likewise, with respect to health behavior, Cawley and Ruhm (2012) state in their handbook article that "Hyperbolic discounting results in time-inconsistent behavior" (p. 139). Here, we suggest a form of hyperbolic discounting to which the theorem of multiplicative separability in $t$ and $\tau$ applies (see Burness, 1976; Drouhin, 2009). As a result, decisions are time-consistent.

In order to appreciate the practical importance of our work, notice that behavioral studies on the present bias of preferences cannot distinguish between our method of hyperbolic discounting and the conventional method of hyperbolic discounting *unless* they provide evidence for time inconsistent behavior. The majority of studies, however, relies on one-time observations, which makes it impossible to observe the behavior of one person at different points in time (Sprenger, 2015). Therefore, time inconsistency cannot be inferred and "our" preferences of time-consistent hyperbolic discounting are equally well supported by the conventional preferences of time-inconsistent hyperbolic discounting.

In order to assess the impact of time-consistent hyperbolic discounting on health behavior, health outcomes, and longevity, we set up a life-cycle health model with hyperbolic discounting and calibrate it with data for an average (20-year-old male) American. We then perform the computational experiment of endowing the "Reference American" with an exponential discounting method. Employing the normalization introduced above, we show that the hyperbolically discounting Reference American saves more, invests

[1] There are also other dimensions that influence time consistent decision making, which are not addressed in this paper, specifically addiction (Becker & Murphy, 1988; Bernheim & Rangel, 2004; Gruber & Koeszegi, 2001; Kan, 2007; Strulik, 2018b) and endogenously generated time preferences (Shi & Epstein, 1993; Uzawa, 1968).

[2] The normalization can be conceptualized as a finite-time application of the equivalent present-value argument of Myerson, Green, and Warusawitharana (2001), see also Caliendo and Findley (2014) and Strulik (2015b).