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Interacting mechanisms of time inconsistency ☆

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ABSTRACT

We interact two prominent behavioral mechanisms of time inconsistency that have been used to study inadequate saving: *hyperbolic discounting* and *short-term planning*. Hyperbolic discounting is a conventional way to model impulsive decision making, and short planning horizons have been used to represent myopia. One might expect that interacting both mechanisms within the same model would compound the inadequacy of saving. However, our key finding takes the form of a paradox: hyperbolic discounting does not affect consumption and saving allocations if the planning horizon is short and fixed, although it will affect allocations if the planning horizon is equal to the remaining life span. We demonstrate analytically that this finding is robust to the shape of the disposable income path, to the coarseness of the time grid, and to alternative forms of the period utility function.

1. Introduction

Behavioral economists have utilized findings from psychology to provide new insight into many important economic questions. The usual *modus operandi* is to examine the effects of a single modification to the standard neoclassical assumptions, while leaving intact all other characteristics of rational choice. While this effort has led to new insights about decision making, a deeper understanding of intertemporal choice can come from interacting multiple motives, processes, or "pathologies" (Frederick, Loewenstein, & O'Donoghue, 2002). In the context of consumption and saving over the life cycle, two prominent mechanisms that could be nested in the same model are *hyperbolic discounting* and *short-term planning*. In fact, Strotz (1955/1956, p.170) himself suggested this possibility in his influential study on time inconsistency. Although these uniquely different mechanisms of time inconsistency have been widely studied in isolation, so far these efforts have not been connected.

There is a large literature that uses the hyperbolic discount function to help explain intertemporal choice data.[1] A key characteristic of the hyperbolic discount function is that the discount rate declines in the delay, which engenders present-biased time-inconsistent behavior. Accordingly, hyperbolic discounting has become a conventional way to represent impulsivity and it

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[1] For an overview of the evidence on hyperbolic discounting, see Ainslie and Haslam (1992), Loewenstein and Prelec (1992), Frederick et al. (2002), and Madden and Johnson (2010).

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has therefore been applied to a wide array of research topics such as excessive borrowing and insufficient saving for retirement.[2]

At the same time, other studies have considered the independent idea that individuals use short planning horizons when making consumption and saving decisions.[3] Caliendo and Aadland (2007) formalized this concept in the life-cycle consumption and saving domain by assuming that individuals continually plan ahead by only a short distance into the future. Similar to hyperbolic discounting, this assumption implies time-inconsistent decision making because formulated plans are abandoned as the planning horizon slides forward with age. As such, short-term planning has also been used to explain inadequate saving for retirement.[4]

In the belief that we can gain new insight about household decision making by interacting multiple behavioral processes, our objective is to characterize saving outcomes when these two mechanisms of time inconsistency are jointly nested within the same model. We construct a life-cycle consumption and saving model that is set in continuous time. The model features an individual who uses a hyperbolic discount function and a short planning horizon and is naive about his time-inconsistent preferences.[5,6] We derive a closed-form analytical solution for the many intended consumption paths. We also derive a closed-form solution to the consumption and savings paths that are actually followed, which is the envelope of infinitely many initial values from a continuum of planned paths.

One might expect *a priori* that hyperbolic discounting will reinforce the effects of short-term planning on consumption and saving. After all, adding a present bias to an inability to plan very far into the future would seem to compound the inadequacy of saving. Yet, we uncover a paradox: the form of the discount function does not affect consumption and saving allocations if the planning horizon is short and fixed, though it will affect allocations if the planning horizon equals the remaining life span. In other words, replacing the hyperbolic discount function with its exponential counterpart has no effect on consumption and saving allocations when the planning horizon is short and fixed. We demonstrate analytically that this finding is robust to alternative assumptions about the time grid (continuous time versus discrete time) and to alternative forms of the period utility function. It is also robust to any assumption about the shape of the disposable income path, implying robustness to the manner in which tax and transfer programs (such as social security) rearrange the timing and magnitude of cash flows across the life cycle. By interacting these two mechanisms of time inconsistency, we have learned an important lesson: hyperbolic discounting matters for consumption and saving allocations when the individual plans for the lifetime, but it does not matter if the planning horizon is short and fixed.

Our findings can be viewed as a generalization and extension of the equivalence result in Barro (1999). He reports that hyperbolic and exponential discounting lead to equivalent consumption and saving allocations within an infinite-horizon setting. We show that *any* planning horizon that is fixed and rolls forward with the passage of time will deliver this result. We now present our model of life-cycle consumption and saving with dual layers of time inconsistency.

2. Model with interacting mechanisms

2.1. Analytical findings

Time is continuous and is indexed by t. A continuously differentiable flow of disposable income, $y(t)$, is received by the individual over the economic life span, $t \in [0, \overline{T}]$. This income flow is divided between consumption, $c(t)$, which is the control variable, and savings, $k(t)$, which is the state variable. The representative individual discounts future utility over the planning horizon according to the discount function $F(\tau)$ for a delay of length τ, where $F(0) = 1$ and $dF(\tau)/d\tau < 0$. The savings account grows at a continuously differentiable rate, $r(t)$. The individual starts and finishes the life cycle with no assets, $k(0) = k(\overline{T}) = 0$. This model is "general" in the sense that we do not make any assumptions about the particular functional

[2] See Tanaka and Murooka (2012) for a survey of hyperbolic discounting and saving outcomes.

[3] For example, Carroll and Summers (1991) state, "We suggest that both our data and the available time-series evidence are consistent with Milton Friedman's view that people save to smooth consumption over several years but, because of liquidity constraints, caution, or shortsightedness do not seek to smooth consumption over longer horizons, etc. Indeed, Milton Friedman explicitly rejected the idea that consumers had horizons as long as a lifetime in discussing the permanent income hypothesis" (p. 307, 335). See Carroll (2001) for additional commentary on Milton Friedman's views about short planning horizons. Goldman (1968), Kaganovich (1985, 1996), and Hori (1987) examine the effects of short-term planning in a neoclassical growth setting. See also Diamond (2009) concerning the need to study the effects of various government fiscal policies under the assumption that individuals use short planning horizons.

[4] Findley and Caliendo (2009) study optimal public pension design in an overlapping-generations model with individuals who are inadequately prepared for retirement due to the use of short planning horizons.

[5] An interesting alternative to examine (which we do not consider in this study) is the case where the use of a short planning horizon is an intentional strategy by a sophisticated individual.

[6] Although some examples of real-world behavior better reflect an awareness assumption of sophistication, a sizable literature suggests that naiveté is an important feature of real-world decision making. For example, Loewenstein and Angner (2003) report that mistakes in predicting future preferences are common and too "regressive" in the direction of current preferences. This is due to the idea that current preferences are an innate part of personal identity and because current preferences are perceived to be "just right" (Ross & Ward, 1996; Akerlof & Kranton, 2000; Frederick et al., 2002). Indeed, Loewenstein and Angner (2003) state, "Imagining oneself with different preferences is similar to imagining oneself as a different person, which is a difficult mental exercise" (p.352). This is related to the concepts of "projection bias" and "empathy gap" in which one's current self fails to empathize with the idea that future incarnations will have different preferences (Read & van Leeuwen, 1998; Loewenstein & Schkade, 1999; Loewenstein, 2000; Loewenstein, O'Donoghue, & Rabin, 2003).