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Decreasing term structure of psychological discount rates:
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ABSTRACT

Many empirical and behavioral studies identify a decreasing slope in the term structure of subjective discount rates. Using an experimental methodology based on “free-time” relative comparisons, this paper aims to identify in individual behaviors whether agents see their psychological value of time as decreasing or not. We elicit the negative shape of the subjective discount rates. They can be parameterized using two variables, one specifying the instantaneous time preference and the other characterizing the slope of the term structure. A trade-off law is identified between these two parameters. We show that the term structure of psychological rates depends strongly on gender, but appears not to be linked with life expectancy. We also question the cross-relationship between risk aversion and time preference. From a theoretical point of view, these two variables stand as two different and independent dimensions. However, empirically, the time preference attitude seems to be directly influenced by the risk attitude.

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0. Introduction

If risk aversion is an important feature of economic and financial behaviors, the attitude of an agent with regard to time is also a fundamental empirical question. According to Thaler and Shefrin (1981), in the long term, individuals are relatively patient; for instance, I would prefer 2 apples within 101 days from now to 1 apple within 100 days. However, in a short-term view, the rate of impatience is different: I would prefer 1 apple now to 2 apples tomorrow. This dynamic inconsistency has often been seen as supporting decreasing or hyperbolic discount functions (Laibson, 1997).

The alternative hypothesis of a unique and constant subjective discount rate is very useful for equilibrium models of investment–consumption (Samuelson, 1937). However, it involves a very poor view of intertemporal behavioral choices. The time dimension is rooted in the economic process of choice because the individual considers different periods in the future. Therefore, he needs not only one subjective rate to discount his future utility, but several subjective discount rates because his time horizon expands in the future. This leads to a subjective or psychological discount function. This theoretical issue has been reinforced by empirical research developed to ascertain whether individual subjective discount rates are constant regardless of the time horizon of the choice. These tests generally invalidate the idea of flat impatience rates and lead to the conclusion of a decreasing term structure (Angeletos et al., 2001; Laibson, 1997; O'Donoghue and Rabin, 1999). Many empirical and behavioral studies underline the idea of a structural bias toward the present, explaining a decreasing slope to the term structure of subjective discount rates.

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However, the shape of this term structure has to be crossed with individual behaviors and personal determinants.

The genetic determinants of saving behaviors seem to influence both the utility function shape and the individual's attitude toward the future (Cronqvist and Siegel, 2010). Von Mises (1949) recognized the time preference hypothesis much earlier on.¹ He mentions that individuals give a psychological value to time and their impatience rate should not be assimilated with the interest rates in the financial markets. Interest rates are the social price of time and are used to compare alternative consumption and investment opportunities. The psychological rate of impatience is used to discount the subjective valuation of choices by individuals, which he calls "economization". For Von Mises, "The economization of time is independent of the economization of economic goods and services. Even in the land of Cockaigne man would be forced to economize time, provided he were not immortal and not endowed with eternal youth and indestructible health and vigor. Although all his appetites could be satisfied immediately without any expenditure of labor, he would have to arrange his time schedule, as there are states of satisfaction which are incompatible and cannot be consummated at the same time. For this man, too, time would be scarce and subject to the aspect of sooner and later".² The analysis of the determinants that may explain individual time preferences is very rich: the remaining duration of life, health, or youth will affect the level of the subjective discount rates. It opens the way to subjective discount rates, which are variable through time for the same individual according to his expected duration of life or his health. A major theoretical question is set. Is intertemporal attitude dependent on visceral features and constant or, as suggested by Von Mises, does it depend on contingent variables?

The aim of the paper is not only to determine whether a negative slope exists in the term structure of discount rates, but also to elicit its curvature. Is it hyperbolic? Although the literature has addressed the first question through the idea of hyperbolic discounting or experimental approaches, very few studies have analyzed the term structure of discount rates. Prelec (2004), with the introduction of the impatience function, and Rohde (2010) are notable exceptions at the axiomatic level. Zauberman and Lynch (2005) empirically identify a decreasing term structure and present bias in subjective discount rates, but they do not elicit the shape of the individual term structure, which we intend to do.

Another issue of interest after identifying the term structure of discount rates is the analysis of its individual determinants. Psychologists and behavioral economists have considered this question but they have focused on the difference in time preferences between individuals. For instance, they compare the time preference of alcohol-addicted or wealthy people with that of others. Few studies have been undertaken empirically with regard to the determinants not of the level, but of the shape, of

the discount rates' curve. In that sense, we contribute to the extant literature by analyzing the demographic and personal determinants of the slope of the discount rates, that is, the strength of the present bias. The relationship between risk aversion and time preferences has not been studied extensively. Tanaka et al. (2010) are an exception; they consider the demographic determinants of the present bias as well as the relationship between the above factors and risk aversion.

We have questioned a sample of 185 individuals to analyze their attitude with regard to time. They were asked to give different psychological values at different points in the future. From a methodological point of view, we want to stay at the psychological time value level and avoid investigating the time value of monetary rewards. In that sense, we depart from experiments based on monetary outcomes. We introduce the idea of "free time" as a pure time dimension measure, independent of the utility function of a primary reward (i.e. a given good) or a secondary reward, such as money. We develop our empirical studies independently from monetary measures of delay preferences, which are mostly dominant in the previous empirical literature (for instance, Andersen et al., 2008; Attema et al., 2010). We empirically show that the subjective discount rates are specific to each individual. They have a decreasing form coherent with a negatively sloped term structure. Their shape and curvature can be parameterized using two individual parameters, one specifying the immediate term preference and the other characterizing the slope appearing as a measure of the impatience rate. A trade-off law is documented between the two parameters, which appear to follow a log–log relationship common to any individuals. Some demographic determinants of the term structure of psychological discount rates are empirically identified: its shape strongly depends on gender but is not linked with life expectancy. A cross-relationship between risk aversion and time preference is often questioned, at least on theoretical grounds. Empirically, we show that the time preference attitude, more precisely the size of the present bias and the slope of the discount function, seems to be directly influenced by the personal attitude with regard to risk.

The paper is divided into four sections. The first presents a review of the literature. Section 2 raises methodological issues and introduces the concept of free time. Section 3 estimates the term structure of subjective discount rates. The determinant variables explaining the slope of discount rates are analyzed in Section 4.

1. The literature

Experimental tests of the psychological discount function have been conducted considering an hyperbolic curve $\delta(t) = (1 + \alpha \cdot t)^{-\gamma/\alpha}$, with t being the time horizon (Ainslie, 1992; Loewenstein and Prelec, 1992). This curve gives decreasing equivalent annual discount rates. The immediate subjective discount rate is equal to the parameter γ . Long-term psychological rates converge toward zero. The decreasing term structure, as suggested by a hyperbolic model, would entail overdiscounting the immediate future vis-à-vis the far distant future, also called present bias. The characteristic of a hyperbolic (or any decreasing)

¹ Op. cit. chap. 18, p. 481; "Time preference is a categorical requisite of human action".

² Op. cit. chap. 5, p. 102.

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