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Discounting, risk and inequality: A general approach

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ABSTRACT

The common practice consists in using a unique value of the discount rate for all public investments. Endorsing a social welfare approach to discounting, we show how different public investments should be discounted depending on: the risk on the returns on investment, the systematic risk on aggregate consumption, the distribution of gains and losses, and inequality. We also study the limit value of the discount rate for very long term investments. We highlight the type of information that is needed about long-term scenarios in order to evaluate investments.

1. Introduction

Investments and policies having long term impacts are crucial for the development of the economy, and they often attract much attention in the public debate. Examples include the building of electricity or transport networks or investments in research and development (for reviews of the importance of public policies in those cases, see Hall et al., 2010; Gramlich, 1994). A classical reference on the choice of discount rates for public investments is Stiglitz (1982).

Another prominent example involves mitigation policies aimed at preventing dramatic future climate change that may threaten the mere survival of many species, including humankind. To assess such policy, we need to compare current costs and future benefits, which involves the practice of discounting. The issue of climate policy has recently revealed that there is no agreement among economists about the appropriate welfare framework for choosing the discount rate to be used in policy evaluation. The Stern review on the economics of climate change Stern (2006) has been heatedly debated on this ground (Nordhaus, 2007a,b; Weitzman, 2007; Dasgupta, 2008; Heal, 2007).

Although they reach very different conclusions, all these papers endorse the same basic welfare model, namely the Expected Discounted Utilitarian model

$$\sum_{t=0}^{\infty} e^{-\rho t} E u(c_t), \tag{1}$$

where c_t is, to simplify, the consumption of the representative agent of generation t. This criterion yields the well-known Ramsey equation (Ramsey, 1928): an investment from period 0 to period t that yields a sure rate of return r^* is worth doing, at the margin, if

$$u'(c_0) < e^{-\rho t} E u'(c_t) \times e^{r^* t},$$

i.e., if

$$r^* > \rho - \frac{1}{t} ln\left(\frac{Eu'(c_t)}{u'(c_0)}\right). \tag{2}$$

The debate around this welfare model has been mostly confined to a discussion of the parameters involved in Eq. (2), in particular the rate of pure time preference ρ and the elasticity of the marginal utility of consumption. It is assumed that there is a correct welfare model, namely the Discounted Utilitarian model, that would deliver a correct value of the social discount rate applicable to all public investments.

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In this paper we set out to study the general properties of the social discount rate for a wide range of possible social welfare criteria. Our analysis hence does not focus on a particular criterion but uncovers common features of all approaches that may embody different attitudes to inequalities and risk. The allocations to be evaluated are quite general. We allow both for a systematic risk that affects aggregate consumption and a risk on the returns of the policy, examining how their interactions affect social discounting. Our framework also covers catastrophic risks affecting the size of the population and possibly leading to extinction. We show that the discount rate should be specific to each category of investment, and depends on the risk on the rate of return, as well as the distribution of costs and benefits.

The main results of the paper are the following. First, we obtain general formulas for the discount rate, which decompose the main components related to growth, inequalities, and risks in consumption and in investment returns. Compared with the classical Ramsey formula, these formulas display important additional covariance terms. Second, we show that in the long run the key determinants of the discount rate are the situation of the worst-off individuals in the worst-case scenarios, as well as the maximum return on the investment. The third main lesson is that, in an OLG setting, the discount rate is a weighted average of market rates (individuals' own discount rates) and the social discount rate between different generations, implying that market rates are relevant for short-term investments but much less so in the long-run. Finally, we show that policies that change the probability of states of the world with different population sizes require a different sort of evaluation, which is generally not amenable to a simple discounting computation, and involves the "critical level", i.e., the threshold of well-being above which additions to the population are considered an improvement.

Let us briefly relate to the relevant literature. There already exists a prolific literature on the impact of risk on the social discount rate. In particular, it has been shown that the social discount rate is likely to be lower when there is a large risk on future growth (Weitzman, 1998; Gollier, 2002; Gollier and Weitzman, 2010). This kind of risk generally induces the 'Weitzman effect' (Weitzman, 1998) in that the social discount rate should decrease with the time horizon. Another kind of risk is that on the rate of return of the investment. It generally yields the opposite 'Gollier effect' (Gollier, 2004) that the social discount rate increases with the time horizon. In general, both kinds of risks co-exist, and they should be jointly studied (Gollier, 2012, contains a chapter on the issue but restricts attention to the discounted utilitarian approach). Catastrophic risks have also been studied recently. In an influential paper, Weitzman (2009) has indeed presented a 'dismal theorem' conveying the idea that in the presence of catastrophic fat-tail risks, any investment for the future should be undertaken, whatever the value of the parameters of the Ramsey equation. This conclusion has been much discussed (see Millner, 2013, for a recent discussion of the debates surrounding Weitzman's result), and we argue in a companion paper by Fleurbaey and Zuber (2015) that this issue is not devastating for the expected utility approach. In the present paper, we examine how to evaluate a policy that changes the probability of states of the world with different population sizes (in Weitzman's work, catastrophes reduce the consumption level to subsistence but do not affect the population size).

The literature on climate change policy has also addressed equity issues. The usual technique to deal with equity considerations has been to introduce equity weights putting greater emphasis on the damages affecting the poor than on the damages affecting the rich. Early references include Azar and Sterner (1996), Azar (1999), Fankhauser et al. (1997) and Pearce (2003). Anthoff et al. (2009) is a more recent and complete study. These approaches do not directly incorporate equity considerations in the discount rate. Gollier (2015) is an attempt in that direction, which shows that equity considerations may yield an increase of the discount rate in the long run, when there is economic convergence, or even when inequalities are persistent. That paper however considers discount rates associated with a Utilitarian formula, where the costs and benefits of the investment are equally shared within generations. We consider a more general case allowing unequal sharing of the costs and benefits, and not restricted to the Utilitarian approach. To the best of our knowledge, the interaction of risk and inequality in the social discount rate has never been studied. The present paper offers general results about their interaction.

A few papers have studied the question of discounting using alternative welfare frameworks. Some have considered non-expected utility models (Gollier, 2002, 2012; Gierlinger and Gollier, 2014; Traeger, 2009) and a few papers suggesting alternatives to Utilitarianism (Bommier and Zuber, 2008; Fleurbaey and Zuber, 2015; Zuber and Asheim, 2012). The papers abandoning the expected utility framework studied the impact of ambiguity aversion or preference for the timing of the resolution of uncertainty on the discount rate (Gollier, 2002, 2012; Gierlinger and Gollier, 2014; Traeger, 2009). In the present paper, we shall stick to the expected utility framework, and provide a general welfare evaluation model in that case. In the last section of the paper, we also consider overlapping generations, while most of the literature has focused on successive generations, often represented by a single agent (the only exception, in a Utilitarian framework, is Dasgupta, 2012). We provide new results in that case.

Our paper is organized as follows. Section 2 introduces a general setting and proposes a definition of the social discount rate. Section 3 discusses how three aspects of the risk — the systematic risk on aggregate consumption, the risk on returns and the risk on the planning horizon — affect the social discount rate. Section 4 tackles the issue of intragenerational inequalities in consumption and the distribution of costs and benefits. Section 5 derives an approximation formula for the social discount rate in the long run, showing that the key figures are the maximum return of the investment and the maximum net return for a poor-to-poor investment. Section 6 provides further extensions. First it considers an OLG economy where individuals live for several periods and shows how individuals' own discount rates enter the general formula for social discounting. Second it discusses the limitations of the social discount rate, in particular when policies affect the prospect of future catastrophes.

2. A general framework and the definition of the social discount rate

2.1. The framework

We let $\mathbb{N}_0$ denote the set of non-negative integers, $\mathbb{N}$ the set of positive integers, $\mathbb{R}$ the set of real numbers, and $\mathbb{R}_+$ the set of non-negative real numbers. For a set X and any $n \in \mathbb{N}$, X^n is the n-fold Cartesian product of X.

We focus on evaluating distributions of consumption (or income) at the individual level across periods. An alternative c is a collection of consumption levels, one for each individual alive in the alternative. The set of potential individuals is $\mathbb{N}$, so that alternatives are elements of $\mathcal{C} = \cup_{N \subset \mathbb{N}\, \varnothing} \prod_{i \in N} \mathbb{R}_+$. We therefore consider a variable-population framework, in which the size of the population may vary from one alternative to another, depending on the subset of individuals alive in the alternative. For any $c \in \mathcal{C}$, we let $N(c)$ be the set of individuals alive in the alternative and $n(c) = |N(c)|$ be the number of individuals in the alternative.

We also need to know to which generation the people alive in an alternative belong. To do so, we assume that there exists a partition of $\mathbb{N}$ into subsets N^t containing the potential individuals of generation $t \in \mathbb{N}_0$. Hence, for each potential individual $i \in \mathbb{N}$, there exists a unique $t \in \mathbb{N}_0$ such that $i \in N^t$, meaning that individual i belongs to generation t. We will restrict attention to $C = \left\{ c \in \mathcal{C} | N^0 \subset N(c) \right\}$, which means that all the members of the current generation are present in all the alternatives we consider. For any $c \in C$ and any $t \in \mathbb{N}_0$, we denote $N^t(c) = N^t \cap N(c)$ and $n^t(c) = |N^t(c)|$.