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Methodological and Ideological Options

Discounting, climate and sustainability

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ABSTRACT

Climate policy recommendations differ widely because of disagreements over what discount rates to use. Disagreement reduces the impact of economic models and signals a need for improved methodology. The problem is related to the choice of intergenerational welfare functions. A first questionnaire finds that the standard welfare function (SWF) fails to capture people's dislike of overshooting and fluctuating consumption paths. A second questionnaire reveals that when very-long-term sustainability of well-being is threatened, people's implicit discount rates resemble the low estimates used by the Stern Review. An alternative welfare function (AWF) reflecting consumption growth can potentially capture the preference structure revealed in both questionnaires. This makes the AWF an interesting candidate when searching for policies for sustainable development under uncertainty. Importantly, the questionnaires demonstrate that people are able to choose among policies by inspecting time graphs of policy consequences. Thus, it is possible to circumvent the complexities and disagreements introduced by welfare functions and discounting.

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1. Introduction

According to Heal (1997) discounting has always been a source of controversy within the economics profession. Extensive advanced analyses of welfare economics have not resolved the underlying issues. Dasgupta (2008, p.167) remarks that "[i]ntergenerational welfare economics raises more questions than it is able to answer satisfactorily." This article, while focused on climate change and sustainability, takes a closer look at underlying assumptions that have not been properly tested until now.

It needs to be resolved whether the standard (social) welfare function (SWF) is representative of people's preferences regarding long-term developments. Of particular interest are preferences regarding overshoots in consumption (or well-being) in the form of fluctuations or unsustainable developments. If the SWF is not representative, are there better alternatives? One may even ask if it is possible to do without welfare functions and discounting. Could decision-makers simply rank order policies by inspecting graphs showing simulated policy consequences over time? In case welfare functions are used to search for or to rank policy proposals, what parameters do people's preferences for different time developments imply?

The practical problem of using the SWF is illustrated by the widely differing tax rates for greenhouse gases (GHGs) recommended by Nordhaus (2001) and the Stern Review (2007) (hereafter, "Nordhaus" and "Stern"). The fact that these tax rates differ by a factor of ten can predominantly be explained by the divergent arguments behind the authors' choices of discount rates (Nordhaus, 2007, p.700). Pronounced disagreements are present and problematic. While both studies do recommend positive GHG taxes, the wide gap between the recommended tax rates is likely to reduce policy makers' confidence in both the results and in the methods of analysis. Consistent with the academic debate, a recent report by the US Administration presents estimates of the social costs of carbon emissions that differ by a factor of five due to the same doubt about what discount rate to use (Interagency Working Group on Social Cost of Carbon, 2013).

The article is organized as follows. First, hypotheses regarding welfare functions are presented: the standard (SWF) and an alternative welfare function (AWF). Then comes the experimental design with two questionnaires and a discussion of the potential for overshoots and unsustainable developments in future per capita consumption or well-being. Third, results from the first questionnaire show that people dislike overshoots, an effect captured by the AWF but not by the SWF. The second questionnaire reveals very low implicit discount rates when subjects are confronted with unsustainable very-long-term developments. Fourth, the results are discussed in light of the academic debate over discounting. A distinction is made between the deterministic case and the case of uncertainty. The questionnaires demonstrate that people are able to choose between policies by inspecting their consequences in terms of time developments. Thus, one could avoid complexities and uncertainties introduced by welfare functions and

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discounting. The search for desirable policies can benefit from the use of the AWF, particularly in the case of uncertainty.

2. Hypotheses

How do people evaluate the welfare effects of various developments in per capita consumption? In particular, how do they react to overshoots in terms of fluctuations or unsustainable developments? One possibility is that they discount future utility according to a now standard (social) welfare function (SWF):

$$W = \sum_{t=0}^{\infty} u[c_t(P)]/(1+\delta)^t. \tag{1}$$

Here $u[c_t(P)]$ denotes utility derived from per capita consumption c_t in year t for policy P, and δ denotes the *utility* discount rate (also called the "pure rate of social time preference").[1] Single period utility is given as:

$$u[c_t(P)] = c_t^{1-\eta}/(1-\eta) \tag{2}$$

where η is the elasticity of the marginal utility of consumption, or *consumption elasticity* for short. For positive values of η, utility increases more and more slowly as per capita consumption increases (concave). When $\eta = 0$, utility equals consumption and δ will represent the more familiar *consumption* discount rate. The null hypothesis is:

H10. People make choices between per capita consumption developments according to the SWF. The SWF is followed consistently in that δ and η do not change with consumption scenarios.

A main reason to question this hypothesis is that the SWF does not discriminate against all types of non-monotonic consumption developments. Think of a consumption path that fluctuates around a monotonically increasing path. If both paths yield the same discounted utility, it seems likely that people would prefer the monotonic development. Hourcade et al. (2009) make the same point with illustrating examples.

One possible alternative welfare function (AWF) that is averse to fluctuations and overshoots is the discounted utility of relative *growth* in per capita consumption:

$$W = \sum_{t=0}^{\infty} u[g_t(P)]/(1+\delta)^t \tag{3}$$

where $g_t = (c_t - c_{t-1}) / c_{t-1}$ denotes the growth rate of per capita consumption in year t for policy P. As before, δ denotes the *utility* discount rate. The following single period exponential utility function is assumed:

$$u[g_t(P)] = \left(1-e^{-g_t/\alpha}\right) \tag{4}$$

where the parameter α determines the concavity of the utility function. Since it seems that the AWF has not been used in intertemporal welfare economics before, it needs some further explanation and prior justification.

First, consider a situation where all allowable policies produce constant per capita consumption growth rates. Then there would be a fixed relationship between the constant growth rate and the consumption path that would follow. Hence, maximizing the sum of growth rates (AWF) would lead to the same result as maximizing the sum of per capita consumption (SWF) over time. Since both utility functions are increasing monotonically, this conclusion is not changed by the introduction of utility. Nor does the utility discount rate matter in this case.

Second, consider minor deviations from the constant growth rate scenario. Since consumption accumulates growth rates over time, consumption will react only gradually to deviations in growth rates. Intuitively, this suggests that the SWF must operate with lower utility discount rates than the AWF to yield similar conclusions. This intuition can be tested by the use of Nordhaus' DICE model.[2] The standard version of DICE makes use of the SWF with $\delta = 1.5\%$ p.a. and $\eta = 2$. When the SWF is replaced with the AWF with $\delta = 1.5\%$ p.a. and $\alpha = 0.02$, the savings rate ends up about 15% above the one for the SWF. With a higher discount rate for the AWF of $\delta = 2.5\%$ p.a. the two welfare functions give nearly identical results.

Third, the above test worked well because DICE produces positive consumption growth rates that do not change much over time. If the model had produced fluctuations or overshoots in consumption, the AWF would have led to different policy recommendations. While both welfare functions make use of concave utility functions, much larger relative variations in growth rates than in yearly consumption explain the difference.

The AWF is supported by several empirical findings. The Easterlin paradox says that the level of consumption does not matter for happiness, except when basic needs are not satisfied (Easterlin, 1974). While this may be true and should be taken into consideration, it is not obvious that it is fully reflected in people's preferences. Most people seem to prefer more to less. However, such preference may to some extent be cast in terms of preferences for growth. Frederick et al. (2002) refer to research showing that people prefer improving sequences of wages to declining sequences, present values being equal. Scitovsky (1976) argues that pleasure derived from change is more important for well-being than comfort. If change is stimulated by growth, while comfort relates to the stock of durable consumer goods, growth matters more than the level of consumption. According to prospect theory (Kahneman and Tversky, 1979) people consider projects in terms of losses and gains around reference points rather than in terms of effects on total wealth. Duesenberry's ratchet effect (Duesenberry, 1949) suggests that negative growth may have a stronger absolute effect on utility than positive growth (concave utility function).

A few more clarifying comments are needed. First, leaving out considerations of basic needs in the AWF is probably of limited concern in aggregate models with a minimum of growth potential. It seems far more important when considering distributions between groups. Second, exponential utility means that the AWF does not show diminishing sensitivity to negative growth rates, different from the treatment of losses in prospect theory. However, in aggregate *planning* models it does not seem desirable to play down the importance of large negative growth rates.

The null hypothesis reads:

H20. People make choices between per capita consumption developments according to the AWF. The AWF is used consistently in that δ and α do not change with consumption scenarios.

A second type of question concerns the *sizes* of implicit utility discount rates and consumption elasticities that can be derived from subjects' choices among scenarios for per capita consumption or well-being. How do the implicit parameters compare to the assumptions made by Nordhaus and Stern?

3. Experimental Design

The first questionnaire with questions Q1 and Q2 deals with overshooting and fluctuating consumption developments. The second, with questions Q3, Q4, and Q5, deals with very-long-term unsustainable developments where well-being never recovers after an overshoot.

[1] The welfare function represents a situation with a constant population or one where population size only influences per capita consumption.

[2] Version DICE-2007.delta.v8 (Nordhaus, 2008).

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