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**A Difficulty in the Concept of a
Social Discount Rate**

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Abstract: It is shown that the use of a social discount rate to evaluate a (public) project is incompatible with the Pareto principle and a condition of consumer sovereignty.

Journal of Economic Literature classification: D90, H43

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1 Introduction

Whenever we have different options we must choose. Whatever decision we take it will affect the future. A decision criterion that gives at least some weight to the future must compare the states of affairs at different points in time. There are many problems involved. We cannot predict with certainty what the future states of affairs will be. We are confronted with different values – like welfare and freedom – and we do not know how to make them commensurable. Different individuals will be affected and we do not know how to compare their welfare or their freedom. This paper deals with just one problem: comparison of values across time.

To keep the analysis simple, let us assume that welfare is the only value that matters and that all welfare is derived from consumption. Every option or course of action – called a project in the following – generates a consumption path for each individual. The social decision problem is the selection of a best project when several projects are feasible. To facilitate this selection economists have developed cost-benefit analysis. To evaluate a project one must count all the costs and all the benefits of the project at each point in time. The standard procedure to make comparisons of costs and benefits across time is the discounting method. This method converts all value into present value. The benefits and costs at some point in time $t = 0, 1, 2, \dots$ are evaluated from the perspective of the present (the time of decision making) by giving them a weight $1/(1 + \rho)^t$; ρ is called the social discount rate. The value of a project from the perspective of the present is the sum of all weighted net benefits (benefits minus cost) of the project over time. From a sample of projects the project with the highest value is the socially preferred one.

Of course, for project selection the choice of the social discount rate is crucial; the larger it is the less weight is given to the future. With a positive rate benefits and costs count the less the later they occur. A zero rate gives equal weight to benefits and costs regardless of their time of occurrence. If the social discount rate is negative, future benefits and costs are more important compared to present ones. The debate about the

choice of an appropriate discount rate has been with us for more than a century. Böhm-Bawerk (1889), Ramsey (1928), Fisher (1930), Marglin (1963), Olson and Bailey (1981), Lind (1982), Broome (1992), Arrow et al. (1996), Weitzman (2001) and others have contributed to this debate, but the issue has not been settled.

It is shown in this paper that a debate about the proper social discount rate, whether it should be high or low, cannot have an answer, if the Pareto principle and a condition of consumer sovereignty are adopted. According to the Pareto principle a project should not be chosen, if there is another project that is (weakly) preferred by everyone and strictly preferred by someone. Consumer sovereignty means that individuals may differ in their individual time preference for consumption. It is shown that for some sample of projects the discounting method would select a project which violates the Pareto principle for every conceivable social discount rate.² The next section gives a concise formal account of the discounting method for intertemporal social choice. Section 3 proves the main result that there is *no* social discount rate which is compatible with the Pareto principle and a condition of consumer sovereignty. Discussion and conclusions follow.

2 The discounting method for intertemporal social choice

We consider an intertemporal social choice problem of society N . Individual members of society are denoted $i, j \in N$. The problem is to select a project x out of a set of feasible projects X . Formally, in a model of discrete time, a project is a course of action that generates a consumption path for each individual.³ Denote individual i 's consumption at time $t = 0, 1, 2, \dots$ generated by project x as $c_{it}(x)$. Hence, the consumption path of individual i generated by project x is a (finite or infinite) sequence $c_i(x) = \langle c_{i0}(x), \dots, c_{it}(x), \dots \rangle$. Then, each project corresponds to a profile of consumption

² This research was inspired by Broome's (1989) work.

³ Whether individuals have a finite or infinite lifetime, whether population is stable or changes over time, and whether the number of members of society is finite or infinite does not affect the argument.

paths $[c_1(x), \dots, c_t(x), \dots]$. We denote the total consumption at time t under project x as $C_t(x) = \sum_{i \in N} c_{it}(x)$.

The discounting method evaluates the path of total consumption generated by each project x as a weighted sum of consumption over time, the net present value of a project. The weight factor of consumption at time t is $\lambda(t)$. In the standard discounting procedure, called exponential discounting, it is assumed that $\lambda(t) = (1 + \rho)^{-t}$, where the social discount rate $\rho > -1$ is time-invariant. The net present value of project x is:

$$NPV(x) = \sum_{t=0}^{\infty} (1 + \rho)^{-t} C_t(x).$$

Competing projects are ranked according to their net present values. The discounting method can be characterised in the following way:

DISCOUNTING WITH A SOCIAL DISCOUNT RATE Project x is (strictly) socially preferred to project y , if and only if

$$\sum_{t=0}^{\infty} (1 + \rho)^{-t} C_t(x) > \sum_{t=0}^{\infty} (1 + \rho)^{-t} C_t(y).$$

Note that Strotz (1955) has shown that exponential discounting is the only way to obtain time-consistent decisions.

3 The incompatibility of a social discount rate and the Pareto principle.

Each individual evaluates her own consumption path as a weighted sum of consumption over time. Individual i 's weight factor of consumption at time t is $\lambda_i(t)$. The total value of consumption from project x for individual i is

$$V_i(x) = \sum_{t=0}^{\infty} \lambda_i(t) \cdot c_{it}(x).$$

We adopt the following axioms:

CONSUMER SOVEREIGNTY For all individuals $i \in N$ and all times $t = 0, 1, 2, \dots$, the weight individual i attaches to consumption at time t should be positive and less than infinity; $0 < \lambda_i(t) < \infty$. Otherwise there are no restrictions on $\lambda_i(t)$.

PARETO PRINCIPLE For any two feasible projects $x, y \in X$, if for all individuals $i \in N$ $V_i(x) \geq V_i(y)$ and for some individual $j \in N$ $V_j(x) > V_j(y)$, then y should never be chosen. We will say that y is a Pareto dominated project.

We can now prove the main result of the paper.

THEOREM *Discounting with a social discount rate is incompatible with the Pareto principle and consumer sovereignty.*

Proof. The proof is by construction of an example where discounting with a social discount rate selects a Pareto dominated project. Let us assume $N = \{1, 2\}$. By *consumer sovereignty* we assume $\lambda_1(t) = (1 + l)^{-t}$ and $\lambda_2(t) = (1 + h)^{-t}$ with $0 < l < h$, which means that person 1 has a low rate of time preference and person 2 has a high rate of time preference.

Consider the following individual consumption paths of length T :

$a = \langle 1, \dots, 1 \rangle$, i.e. $c_{it}(x) = 1$ for $t = 0, \dots, T - 1$ and $c_{it}(x) = 0$ for all $t \geq T$;

$b = \langle 0, \dots, 0, 2T \rangle$, i.e. $c_{iT-1}(x) = 2T$ and $c_{it}(x) = 0$ at all times other than $T - 1$.

Furthermore, let the consumption profiles of a sample of projects w, y, z be

$$[c_1(w), c_2(w)] = [b, a],$$

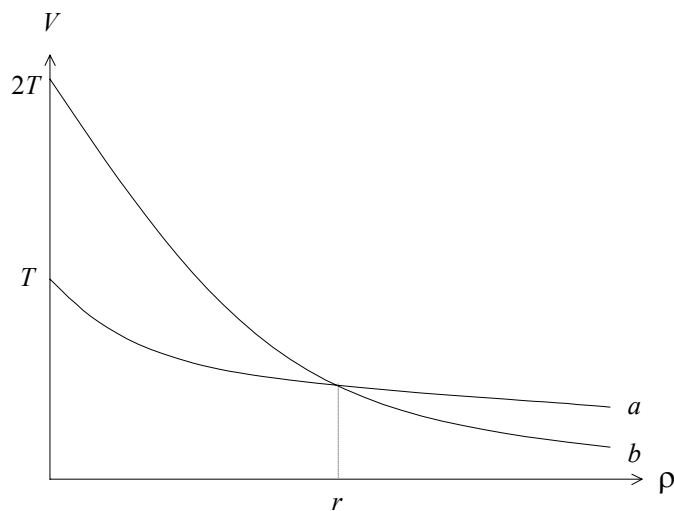
$$[c_1(y), c_2(y)] = [a, a],$$

$$[c_1(z), c_2(z)] = [b, b].$$

We show that the discounting method may select a Pareto dominated project. First notice that for a low social discount rate project z is preferred to w and y . z gives a higher total consumption, although at a later time. For a high social discount rate project y is preferred to w and z , because late consumption on path b is given little weight; cf. figure 1. In the special case where $\rho = r$ (see figure 1) $NPV(w) = NPV(y) = NPV(z)$. This also allows for the choice of y or z . However, for a pair of individual rates of time preference, l, h , such that $l > r > h$ w Pareto dominates y and z . Therefore, y and z should

never be chosen. Hence, the discounting method violates the Pareto principle for every conceivable social discount rate. ■

Figure 1: Value as a function of the discount rate



4 Discussion

The preceding section proves that the discounting method may violate the Pareto principle once individuals differ in their rate of time preference for consumption. What to conclude from this result? We must either question the axioms or reject the discounting method. The Pareto principle, while under discussion in other contexts, such as Sen's (1970) paradox of the Paretian Liberal, can be defended here. As we consider only the value of consumption, Pareto efficiency is a mild requirement. Very few economists would reject it in the case at hand.

Consumer sovereignty is more demanding, particularly in intertemporal choice problems. Individuals may have defective telescopic faculties, as Pigou (1920, 24-26) has argued. Hence, one can argue that they should not evaluate their own future, but rather each individual's consumption path should be evaluated using the same discount

rate. If the same time preference for consumption applies to all individuals, then the axiom of consumer sovereignty has no grip. Although consumer sovereignty may be rejected on such grounds as Pigou's, still there are good reasons to believe that time preference for consumption may differ between individuals. From a utilitarian perspective, for example, it is well possible that a well-nourished person should wait for a bigger meal, while a person close to starvation should eat sooner even at the cost of getting less.

A second objection against the axiom of consumer sovereignty says that the market equalises consumption discount rates. If consumers do not face any saving or borrowing constraints, they will be able to transfer current consumption into future consumption or vice versa at an equilibrium rate of interest. A rational consumer will then adopt a consumption pattern such that her marginal rate of substitution between current and future consumption is equal to the interest rate. Hence, all consumers discount future consumption at the same rate and the axiom consumer sovereignty loses its relevance.⁴ While this objection is correct, it relies on rather strong assumptions about the functioning of capital markets. Under such stronger assumptions discounting with the market interest rate as social discount rate will select Pareto efficient projects (Mas-Colell et al. 1995).

5 Conclusion

The discounting method is inconsistent with the Pareto principle and consumer sovereignty. Objections against the Pareto principle – discussed in the social choice literature – are not relevant for our case of intertemporal decision-making. Furthermore, it can be argued that individuals should be free in their valuation of consumption now and later. This principle of consumer sovereignty is a relevant condition whenever intertemporal transfers are restricted or different individuals face different interest rates. This, of course, is the case in economies with information imperfections and missing markets. The conclusion is straightforward. The discounting method must be rejected as

⁴ I owe this objection to Reyer Gerlagh.

a general method to select public projects. Instead, we might consider alternative social decision mechanisms, such as voting. However, voting mechanisms face the problem of Arrow's (1950) impossibility result.

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