

# A Comment on Cooper

*Kenneth J. Arrow*

Richard Cooper has written an excellent survey on the economic implications of climate change, stressing the possibilities and limits of international policy. I comment here only on one part of the analysis, Cooper's choice of discount rates. I differ sharply with the basis of the analysis and wish to call attention to the extensive literature, dating back more than 40 years, on the choice of discount rates for public investment, which Cooper has disregarded.

Cooper refers to and then dismisses abruptly what may be called the *consumption* viewpoint. Investment is a sacrifice of consumption, and therefore the rate of return on a new investment should be at least equal to the implicit rate of return on consumption. (In this note, as in Cooper, all rates of return are real, not nominal.) This idea is hardly new; it is Marshall's "price of waiting." Böhm-Bawerk famously gave three grounds for the existence of a positive interest rate. First, if consumption is growing over time, the marginal utility of consumption must be falling; therefore, a sacrifice of consumption today must be compensated for by a greater increase in consumption in the future. Second, future consumption is automatically less valuable than the same consumption today, even if their marginal utilities are equal. Third, an increased lag of production behind inputs leads to an increase in production. The first two grounds together define the consumption rate of interest, as expressed in the formula (due, I believe, to Ragnar Frisch)  $r = \rho + \theta g$ , where  $\rho$  is the pure rate of time preference (corresponding to Böhm-Bawerk's second ground),  $\theta$  is the elasticity of the marginal utility of consumption, and  $g$  is the rate of growth of consumption. The third is represented in modern language by the marginal productivity of capital,  $F_K$ , where  $F(K)$  is output as a function of capital (taking labor and natural resources as given). The condition for optimal allocation over time, and the outcome of an intertemporal competitive equilibrium, is  $r = F_K$ .

Clearly, at an optimum, the rate of return on capital equals the consumption rate of interest, so that it would make no difference which rate is used for discounting. In fact, these two numbers seem to be very unequal. While estimating  $r$  is not straightforward, most estimates of the rate of return on consumption are on the order of 3 or 4 percent; the rate of return on capital is usually estimated (as by the U.S. Office of

Management and Budget) as 7–10 percent. Cooper also cites studies which argue that the rate of return on certain other public investments is 10–12 percent. He concludes that these rates represent alternative uses of capital and therefore that efficiency demands that the rates found in private investment or alternative public investments be used to evaluate climate change policies, in particular, abatement.

I believe this argument is fundamentally flawed, as pointed out some time ago by Eckstein (1957). There is no reason why the investment to prevent climate change must be drawn from other kinds of investment. It can be drawn from consumption, and the consumption rate of interest is the alternative value of those resources. The more general situation is that the resources are drawn from both consumption and investment and therefore that the rate of return for evaluating public investment projects should be a weighted average of the consumption rate and the rate of return on capital. Since consumption is much larger than investment, it is reasonable to assume that the appropriate hurdle rate should be closer to the consumption rate.

The matter is further complicated by the fact that investments, public or private, spin off returns which, in turn, induce further saving and therefore investment, a point argued by Arrow and Kurz (1970). A full discussion of these points is well beyond the scope of this note, but the underlying structure of the approach has been set forth by Bradford (1975), and a complete explanation with a way of making the procedures operational is shown in Lind (1982).

Cooper quotes Maurice Scott as pointing out that the rate of return on risk-free securities is on the order of 4 percent. This observation is completely consistent with the previous estimates of the consumption rate of return. Cooper refuses to consider this rate as relevant, on the grounds that the investment should be made at the highest rate available. Of course, the correct conclusion is that *all* public investments that yield more than the consumption rate of return should be made, not that one should be made rather than the other. If the financing of public investments does not displace private investment, the rate of return on the latter is irrelevant.

The question that arises is, why does the market permit the discrepancy between the two rates of return? Two reasons are found in the literature. One is simply the corporate income tax, as stressed by Eckstein. The other is risk. For many reasons, including asymmetric information and moral hazard, the rate of return on private investments reflects a risk premium. The rate of return on public investments that we have been discussing is a riskless rate; the adjustment for uncertainty should come in the measurement of benefits and costs, not in the rate of return used in benefit-cost analysis. For these two reasons, the observed rate of return in the private sector is not the correct one for assessing public investment projects.

A final note: when considering investments for the very long future, the discussion has a strongly ethical component. I would argue that ethical preferences are subject to the same rules of rationality as private preferences, so that the *form* of the argument is much the same, although some of the parameters, particularly the rate of

pure time preference, may have different values  $\rho$ . But I believe the results will be quantitatively very similar.

## Notes

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## References

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