The value of the future: Discounting in random environments

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ABSTRACT

How can we value the future? In economics, the answer to this question is given by a process called "discounting" which weights the future relative to the present. The weighting procedure is carried through a discount function which usually takes the simple form of a decreasing exponential.

Let us call r the real interest rate: the nominal interest rate for lending or borrowing money corrected by inflation. Under a steady state, a dollar invested today will yield e^{rt} at time t, in terms of present dollars. In other words, the same dollar in any future time t is worth e^{-rt} today. This simple example shows the great importance of discounting not only in finance but also in long-run environmental planning. Thus, an environmental problem that costs X to fix at time t is only worth an investment of $e^{-rt}X$ now. Letting interest rates be a proxy for economic growth, a different version of the same argument is that the technologies of the future will be so powerful that they will dwarf anything we can achieve with present-day technologies. Thus it is more effective to follow policies that foster economic growth than to try to combat global warming now.

The choice of a discount rate has, therefore, enormous consequences for long-run environmental planning. For example, in a highly influential report on climate change commissioned by the UK government, Stern uses a discounting rate of 1.4%, which on a 100 year horizon implies a present value of 25% —meaning the future is worth 25% as much as the present. In contrast, Nordhaus argues for a discount rate of 4%, which implies a present value of 2%, and at other times has advocated rates as high as 6%, which implies a present value of 0.3%. The choice of discount rate is perhaps the biggest factor influencing the debate on the urgency of the response to global warming and this issue is far from being settled.

For environmental problems normative approaches to choosing discount rates are based on ethical grounds and assumptions about economic growth. They also depend on arguments involving the maximization of utility functions that are chosen for mathematical convenience. Economists present a variety of reasons for discounting, including impatience, economic growth and declining marginal utility; all of them embedded in the Ramsey formula, which forms the basis for standard approaches to discounting.

However, rates are uncertain and it is not realistic to represent discounting by a deterministic function of time such as the decreasing exponential with a fixed rate and, therefore, some kind of average over all interest rate paths must be taken. This problem is particularly severe for environmental problems, where in problems such as global warming one must consider costs and benefits 100 or more years in the future. It also occurs in finance, where discounting times are typically thirty years or less, where it has long been recognized that interest rates must be modeled as random processes.

Our purpose in this talk is to introduce the subject for the nonspecialist by using the language of statistical physics.