Why We Should Be Willing to Devote More Resources to Avoid Climate Change

Larry Karp

An important body of empirical models recommends modest efforts to reduce greenhouse gases. Although ostensibly scientific, these conclusions are actually largely driven by a value judgement. A recently developed, more flexible modeling approach produces dramatically different policy advice.

An important class of economic models imply that only modest efforts should be made to reduce greenhouse gas (GHG) emissions in the near term. These results can be interpreted as support for opinions, expressed by several prominent economists in the late 1990s and early 2000s, that the United States should reject the Kyoto Protocol. The models' mathematical foundation gives them the imprimatur of science; this prestige, and the lack of an empirical alternative, have increased the audience for the models' policy recommendations. Unfortunately, those recommendations are extremely sensitive to a parameter that reflects an ethical judgement rather than a "scientific" view: the long run discount rate. The choice of the value of this parameter has typically been constrained by technical limitations. A recent paper promotes a flexible alternative to the standard modeling framework. This alternative makes it possible to incorporate different (and arguably more reasonable) ethical judgements, which lead to significantly different policy advice: society should more aggressively seek to reduce GHG emissions.

Climate change policy is controversial largely because of the many uncertainties regarding the costs of reducing GHG emissions, and the costs of allowing GHG atmospheric concentrations to increase. Integrated Assessment Models (IAMs) address the big question, "What is the optimal trajectory for GHG emissions?" These models "integrate" economic and climate modules. The climate module describes how GHG emissions alter the atmospheric GHG concentration, and how this changing concentration alters climate. The economic module describes the economic costs of reducing GHGs emissions, and the economic costs associated with climate change. These models provide machinery to perform a cost-benefit analysis for different climate change policies, thus providing a means of selecting the optimal policy.

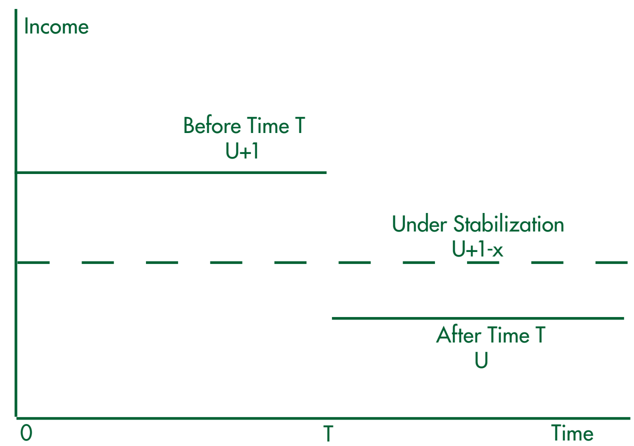
All components of these models are uncertain. Model builders do not claim that their model is "accurate"—an impossible standard—only that it is internally consistent. By incorporating the best estimates, or educated guesses, about the unknown parameters, the models might at least indicate the correct order of magnitude of the (unknown) optimal policy.

Many (but not all) economists think that significant reductions of GHG emissions will involve economic costs. These reductions would lead to lower future (not immediate) GHG concentrations, with correspondingly less climate change and lower future economic and environmental costs. Calculating the optimal climate change policy thus requires balancing current abatement costs with future benefits. Most cost-benefit analyses require this kind of comparison between current and future costs. However, the nature of the problem is more extreme in the case of climate change policy. In deciding whether it is worth building a bridge, for example, we need to compare the construction costs, which probably occur during the next five to ten years, with the stream of benefits that occur during the following several decades. Climate change policy, in contrast, requires comparing abatement costs which may occur over many decades, with the benefits (associated with reduced climate change) that may not begin for many decades but may last for centuries. With climate change policy, the time dimension of the tradeoff is vastly greater than for standard cost-benefit analyses of construction projects. Consequently, the assumption made about the willingness to exchange current costs for future benefits is much more important in climate change models.

We use the interest rate (also known as the discount rate) to compare dollar amounts at different points in time. For example, if the interest rate is five percent, a dollar one year from now is "equivalent" to $1/1.05 = 0.95$ dollars today; 0.95 is the "discount factor" corresponding to a five percent interest rate. A person who can borrow and lend at five percent would be willing to pay \$0.95 today to avoid a one dollar payment in one year; this is the amount that would have to be invested today to return one dollar in one year. A person would pay only 60 cents today to avoid a payment of one dollar in ten years, and would pay less than one cent to avoid the one dollar payment in 50 years.

Models that evaluate social programs, such as bridge building or climate change policy, use a "social discount rate" rather than a private interest rate in order to be able to compare costs and benefits in different time periods. The following example shows why discounting is so important in climate change

Figure 1. Income Trajectory under BAU When Catastrophe Happens at time T and Trajectory under Stabilization



models. Suppose that under "business as usual" (BAU) there is a five percent chance of a catastrophe happening within a century. The catastrophe reduces yearly income by one unit (e.g., one hundred billion dollars); this one unit is the "value-at-risk." Prior to the catastrophe, society has the yearly income of U+1, and after the catastrophe occurs, the amount drops to U. The solid lines in Figure 1 shows the trajectory of income under BAU if the random event happens at time T. Suppose that society has the opportunity of pursuing a policy called "stabilization" that reduces yearly income by x and also eliminates the risk of the catastrophe. The dashed line in the figure shows the trajectory of income under this policy. Given a five percent yearly discount rate, and a five percent chance of the catastrophe occurring within a century, society would be willing to pay no more than one percent of the value-at-risk.

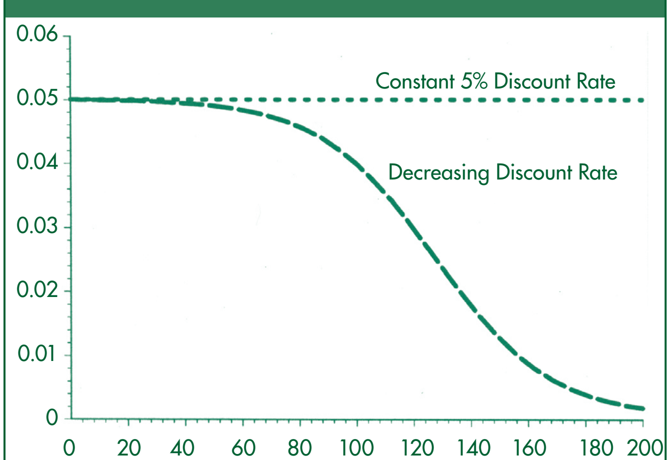
In the case of climate change where inertia is important, current actions could alter future but not current risk. By assuming that the policy has an immediate effect on the risk, this example actually overstates the amount that society would be willing to spend.

The message from this example is that if we use a constant discount rate with a "typical" magnitude, e.g., between three percent and seven percent, then society should not be willing to spend much to reduce the risk of low-probability events. "Low-probability events" are those that are not likely to occur in the near future; such events may be very likely to occur in the distant future. Discounting at a non-negligible rate makes the distant future almost irrelevant to policy today. In other words, the conclusion that society should not be willing to pay much to reduce the risk of a low-probability event is practically guaranteed by the assumption of constant discounting. That assumption is not grounded in science; rather, it reflects a value judgement that the distant future is unimportant.

Empirical evidence supports the use (in cost-benefit analyses) of a non-negligible discount rate for the next two or three decades. There is no empirical or theoretical reason why the very long-run discount rate should be anything like the short-run rate. For example, the statement that we have a five percent short-run social discount rate means that society is willing to give up $1.65 ten years from now in exchange for an additional one dollar today. Empirical evidence suggests that this is how we behave; therefore, economic models that reflect society's preferences should incorporate the willingness to make this kind of trade-off. This evidence says nothing about the trade-off that we would be willing to make between two points in time in the distant future. Consider the question "How much are we willing to take away from people living 210 years from now in order to give one extra dollar to people living 200 years from now?" Climate change modelers (implicitly) answer this kind of question in choosing values for the long-run discount rate. A plausible response is that we have no particular reason for preferring the welfare of people living 200 years from now to people living 210 years for now—both groups are strangers to us—so we would be willing to take only one dollar from the latter group in order to give one dollar to the former. If we accept this view, it means that our long-run discount rate approaches zero.

Figure 2 shows the graph of a constant discount rate at five percent, and a decreasing discount rate that begins at five percent and gradually declines to a number close to zero. These two discount rates are nearly the same for the first 80 years, but then they begin to diverge. Figure 3 shows the discounted value of one dollar, corresponding to these two rates beyond 75 years. A point on the curve tells us how much we would pay today to avoid a one dollar cost at some time in the future. For example, under constant discounting at five percent, we would pay slightly more than one-half of one cent (0.67 cents) today to avoid a one dollar cost one hundred years from now, and under the

Figure 2. Constant Five Percent Discount Rate and Decreasing Discount Rate



declining discount rate we would pay 0.84 cents (an increase of about 25 percent). The point of the two graphs is that these two models of discounting—constant and declining—imply similar trade-offs during the first century.

Despite this similarity, the two discount rates imply very different attitudes to the future. For example, suppose there is a value-at-risk of one unit (e.g., $100 billion) and society has a choice of decreasing this amount by 10 percent in perpetuity, or having no decrease for the first T years and eliminating the entire amount thereafter. Under constant discounting, society is willing to forgo the entire amount after 46 years in order to avoid the 10 percent reduction that begins immediately. Under the decreasing discount rate shown above, the cutoff date moves to 840 years. Even though the two discount rates are very similar for about a century, the model of decreasing discount rate values future welfare much more highly, compared to the model of constant discounting.

Because of this difference in the value given to the future, the two models lead to very different policies to deal with climate change. We noted above that society is not willing to spend much to avoid low-probability catastrophic events under constant discounting. With a decreasing discount rate, it may be optimal to spend a significant amount to reduce or eliminate risk.

We currently are not able to measure the risks of catastrophic climate change. In the absence of such measures, we cannot construct genuinely empirical models of catastrophic risk. However, examples give us a sense of how we should respond to these risks. Figure 4 shows graphs of a (hypothetical) example of the risk of occurrence (of a catastrophic event) under two policies: stabilization and Business as Usual (BAU). The risks begin at the same low level, and increase under both policies, but they increase much more rapidly under BAU. For this example the risk of occurrence within a century is one percent under stabilization, and 17 percent under BAU.

Suppose, as above, that if the event occurs it reduces (in perpetuity) society's annual income by one unit (e.g., $100 billion). Under constant discounting, society would be willing to spend (each year) about one percent of the value-at-risk in order to follow the stabilization path, rather than the BAU path; under the decreasing discount rate, society is willing to spend about 18 percent of the value-at-risk to follow stabilization.

Figure 3. Discount Factor under Five Percent Discount Rate and Decreasing Discount Rate

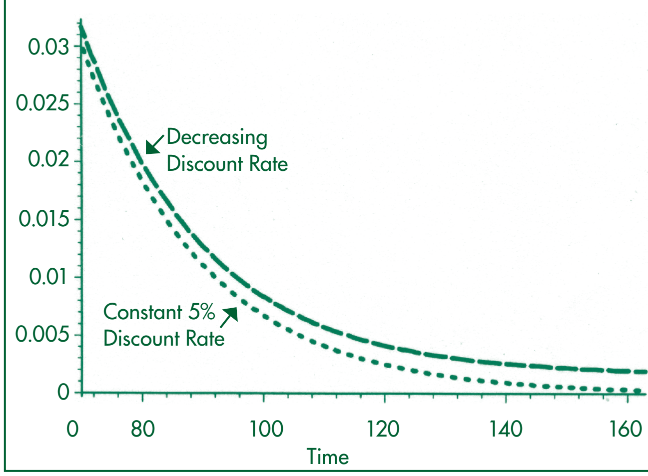
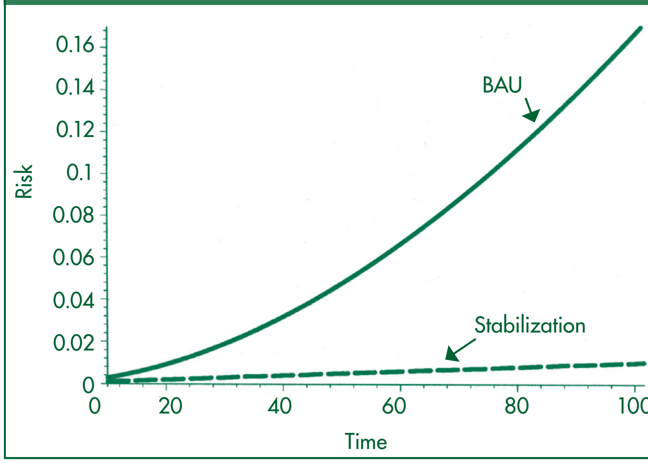


Figure 4. Probablility of Catastrophic Event Occuring on or before Time *t*, under BAU and Stabilization



This example, and others like it, cannot provide a precise guide for policy advice. They do, however, illustrate an important lesson. Climate change models that use (non-negligible) constant discount rates effectively assume that we should not undertake significant efforts to reduce the risk of low-probability catastrophic events. Since there is no scientific basis for the use of these long-run discount rates, this conclusion is essentially an ethical judgement, not a scientific one. A model that values the future more highly recommends a more aggressive policy to reduce GHG emissions.

These points are well understood by climate change modelers. The widespread use of constant social discount rates for climate change models is largely due to a technical problem that arises in models with non-constant discounting (the "time consistency problem"). The paper by Karp and Tsur shows how to overcome this technical problem, making it possible to explore more fully climate change models that use a "typical" short-run discount rate, and much smaller long-run rates. This alternative gives more weight to the welfare of future generations, compared to standard integrated assessment models.

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For further information, the author recommends

Climate Policy When the Distant Future Matters: Catastrophic Events with Hyperbolic Discounting," http://are.berkeley.edu/~karp/.