

## Climate Economics in Four Easy Pieces

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**ABSTRACT** *Conventional economic analysis is rapidly replacing the arguments of the climate skeptics as the principal justification for inaction on climate change. It is important to create an alternative economics that is consistent with the urgency expressed by the latest climate science. Frank Ackerman presents four broad principles that are fundamental to a better analysis of climate economics. First, your grandchildren's lives are important; a low discount rate is needed to validate concern about far-future outcomes. Second, we need to buy insurance for the planet; prevention of catastrophic worst-case risks, not response to average, expected outcomes, should be the motivation for climate policy. Third, climate damages are too valuable to have prices; the impossibility of putting meaningful prices on human life, endangered species, and ecosystems defeats attempts at cost–benefit analysis of climate policy. Fourth, some costs are better than others; the 'costs' of active climate policies will create jobs, incomes, and new technologies, while avoiding the physical destruction of the much worse costs of an increasingly extreme climate.*

**KEYWORDS** *generations; discounting; insurance; wages; risk; costs*

### Introduction

Once upon a time, debates about climate policy were primarily about the science.<sup>1</sup> Initially, at least in the US, an inordinate amount of attention was focused on the handful of 'climate skeptics' who challenged the scientific understanding of climate change. The influence of the skeptics, however, is rapidly fading; few people were swayed by their arguments, and doubt about the major results of climate science is no longer important in shaping public policy.

As the climate *science* debate is reaching closure, the climate *economics* debate is heating up. The controversial issue now is the fear that overly ambitious climate initiatives could hurt the economy. Economists emphasizing that fear have, in effect, replaced the climate skeptics as the intellectual enablers of inaction.

For example, William Nordhaus, the US economist best known for his work on climate change, pays lip service to scientists' calls for decisive action. He finds, however, that the 'optimal' policy is a very small carbon tax that would reduce greenhouse gas emissions only 25 percent below 'business-as-usual' levels by 2050 – in other words, allowing emissions to rise well above current levels by mid-century.<sup>2</sup> Richard Tol,

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a European economist who has written widely on climate change, favors an even smaller carbon tax of just US\$2 per ton of carbon dioxide (Lomborg, 2007). That would amount to all of US\$0.02 per gallon of gasoline, a microscopic ‘incentive’ for change that consumers would simply ignore.

There are other voices in the climate economics debate; in particular, the Stern Review offers a different perspective (Stern, 2006). Stern’s analysis is much less wrong than the traditional Nordhaus-Tol approach, but even Stern has not challenged enough of the conventional wisdom. It is important to understand, challenge, and replace that conventional view, because economists’ doubts and conclusions about climate change echo throughout the public debate; economic analysis has a major impact on the decisions that politicians and governments are willing to take. There is much more than an academic theory at stake.

What will it take to build a better economics of climate change? The problem is not in the technicalities: economists of all stripes are generally quite good at working out the technical implications of their underlying assumptions. The question is, what underlying assumptions are required to create a climate economics that is consistent with the urgency expressed by the latest climate science? The assumptions that matter are big, non-technical principles, capable of being expressed in bumper-sticker format. Here are the four bumper stickers for a better climate economics:

Your grandchildren’s lives are important  
We need to buy insurance for the planet  
Climate damages are too valuable to have prices  
Some costs are better than others

Each of these is elaborated below.

### Your grandchildren’s lives are important

The most widely debated challenge of climate economics is the valuation of the very long run. The time spans involved are well beyond those encountered in most areas of economics. For ordinary loans and investments, both the costs today and the resulting future benefits typically

occur within a single lifetime. In such cases, it makes sense to think in terms of the same person experiencing and comparing the costs and the benefits.

In the case of climate change, the most important consequences of today’s choices will be felt by generations to come, long after all of us making those choices have passed away. As a result, the costs of reducing emissions today, and the benefits in the far future, will not be experienced by the same people. The economics of climate change is centrally concerned with our relationship to our descendants whom we will never meet. As a bridge to that unknowable future, consider your grandchildren – the last generation that most of us will ever know.

Economists routinely deal with future costs and benefits by ‘discounting’ them, or converting them to ‘present values’ – a process that is simply compound interest in reverse. Suppose that you want your grandchildren to receive \$100 (in today’s dollars, corrected for inflation), 60 years from now. How much would you have to put in a bank account today, to ensure that the \$100 will be there 60 years from now? The answer is \$55 at 1 percent interest, or \$17 at 3 percent, or just over \$5 at 5 percent. In the standard jargon, the present value of \$100, to be received 60 years from now, is \$55 at a 1 percent discount rate, or \$17 at a 3 percent discount rate, or about \$5 at a 5 percent discount rate. As this example shows, a higher discount rate implies a smaller present value.

The central problem of climate economics, in a cost–benefit framework, is deciding how much to spend today on preventing future harms. Applying the same logic as in the previous example, what should we spend to prevent \$100 of climate damages 60 years from now? The standard answer is, no more than the present value of that future loss: \$55 at a discount rate of 1 percent, \$17 at 3 percent, and \$5 at 5 percent. Thus the higher the discount rate, the less it is ‘worth’ spending today on protecting our grandchildren.

The effect becomes much more pronounced as the time period lengthens; at a 5 percent discount rate, damages of \$1 million occurring 200 years from now have a present value of only

about \$60. At a 1 percent discount rate, on the other hand, the present value of \$1 million of damages 200 years from now is more than \$130,000. The choice of the discount rate is all-important to our stance toward the far future: should we spend as much as \$130,000, or just \$60, to avoid one million dollars of climate damages in the early 23rd century?

For financial transactions within a single lifetime, it makes sense to use market interest rates as the discount rate. Climate change, however, involves public policy decisions with impacts spanning centuries; there is no market in which public resources are traded from one century to the next. The choice of an intergenerational discount rate is a matter of ethics and policy, not a market-determined result.

Using a framework that originated with Frank Ramsey (1928), it has become common to identify two separate aspects of long-term discounting, each contributing to the discount rate.

One component of the discount rate is based on the expected upward trend in income and wealth. If future generations will be much richer than we are, they will need less help from us, and they will get less benefit from an additional dollar of income than we do. So we can discount benefits that will flow to our wealthy descendants, at a rate based on the expected growth of per capita incomes. Among economists, the income-related motive for discounting may be the least controversial part of the picture.

The other component of the discount rate is the rate that would apply if all generations had the same per capita income, or the rate of 'pure time preference'. This is the subject of longstanding ethical, philosophical, and economic debate. On the one hand, there are reasons to think that pure time preference is greater than zero: both psychological experiments and common sense suggest that people are impatient, and prefer money now to money later. On the other hand, pure time preference of zero expresses the equal worth of people of all generations, and the equal importance of reducing climate impacts and other burdens on them (assuming that all generations have equal incomes).

Chapter 2 of the Stern Review provides an excellent discussion of the debate, and motivates

Stern's choice of a rate of pure time preference close to zero, and an overall discount rate of 1.4 percent. This discount rate alone is sufficient to explain Stern's support for a substantial programme of climate protection: at the higher discount rates used in more traditional analyses, the Stern programme would look 'inefficient', since the costs would outweigh the present value of the benefits.

### **We need to buy insurance for the planet**

Does climate science predict that things are certain to get worse? Or does it tell us that we are uncertain about what will happen next? Unfortunately, the answer seems to be yes to both questions. For example, the most likely level of sea level rise in this century, according to the latest IPCC reports, is no more than 1 m or so – a real threat to low-lying coastal areas and islands that will face increasing storm damages, but survivable, with some adaptation efforts, for most of the world. On the other hand, there is a worst-case risk of an abrupt loss of the Greenland ice sheet, or perhaps of a large portion of the West Antarctic ice sheet. Either one could cause an eventual 7 m of sea level rise – a catastrophic impact on coastal communities, economic activity, and infrastructure everywhere, and well beyond the range of plausible adaptation efforts in most places.

The evaluation of climate damages thus depends on whether we focus on the most likely outcomes or the credible worst-case risks; the latter, of course, are much larger. Cost-benefit analysis conventionally rests on average or expected outcomes. But this is not the only way that people make decisions.

Faced with uncertain, potentially large risks, people do not normally act on the basis of average outcomes; instead, they typically focus on protection against worst-case scenarios. When you go to the airport, do you leave just enough time for the average amount of traffic delays (so that you would catch your plane, on average, half of the time)? Or do you allow time for some estimate of worst-case traffic jams? Once you get there, of course, you will experience additional delays due to security, which is all about worst cases: your *average* fellow passenger is not a threat to anyone's safety.

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The annual number of residential fires in the US is about 0.4 percent of the number of housing units.<sup>3</sup> This means that a fire occurs, on average, about once every 250 years in each home, not even close to once per lifetime. By far the most likely number of fires a homeowner will experience next year, or even in a lifetime, is zero. Why don't these statistics inspire you to cancel your fire insurance? Unless you are extremely wealthy, the loss of your home in a fire would be a devastating financial blow; despite the low probability, you cannot afford to take any chances on it.

What are the chances of the ultimate loss? In the US, the probability that you will die next year is under 0.1 percent if you are in your 20s, under 0.2 percent in your 30s, under 0.4 percent in your 40s.<sup>4</sup> It is not until age 61 that you have as much as a 1 percent chance of death within the coming year. Yet most US families with dependent children buy life insurance.<sup>5</sup> Without it, the risk to the children of losing the parents' income would be too great – even though the parents are, on average, extraordinarily likely to survive.

The very existence of the insurance industry is evidence of the desire to avoid or control worst-case scenarios. It is impossible for an insurance company to pay out in claims as much as its customers pay in premiums; if it did, there would be no money left to pay the costs of running the company, or the profits received by its owners. People who buy insurance are therefore guaranteed to get back less than they, on average, have paid; they (we) are paying for the security that insurance provides, if the worst should happen. This way of thinking does not apply to every decision: in casino games, people make bets based on averages and probabilities, and no one has any insurance against losing the next round. But life is not a casino, and public policy should not be a gamble.

Should climate policy be based on the most likely outcomes, or on the worst case risks? Should we be investing in climate protection as if we expect sea level rise of 1 m, or as if we are buying insurance to be sure of preventing 7 m?

In fact, the worst-case climate risks are even more unknown than the individual risks of fire and death that motivate insurance purchases. You

do not know whether or not you will have a fire next year or die before the year is over, but you have very good information about the likelihood of these tragic events. So does the insurance industry, which is why they are willing to insure you. In contrast, there is no body of statistical information about the probability of Greenland-sized ice sheets collapsing at various temperatures; it is not an experiment that anyone can perform over and over again.

A recent analysis by Martin Weitzman argues that the probabilities of the worst outcomes are inescapably unknowable and this deep uncertainty is more important than anything we do know in motivating concern about climate change (Weitzman, 2008). There is a technical sense in which the expected value of future climate damages could be infinite, because we know so little about the probability of the worst, most damaging possibilities. Informally, if we had less than 100 empirical observations bearing on how fast the climate will worsen, we would have essentially no information about the 99th percentile risk. Yet the US insurance statistics make it clear that people care a great deal about risks that are worse than the 99th percentile. The practical implication of infinite expected damages is that the most likely outcome is irrelevant; the only thing that matters is buying insurance for the planet, that is, understanding and controlling the worst-case risks.

### Climate damages are too valuable to have prices

To decide whether climate protection is worthwhile, in cost–benefit terms, we would need to know the monetary value of everything important that is being protected. There are, however, no meaningful prices for many of the benefits of health and environmental protection. What is the dollar value of a human life saved? How much is it worth to save an endangered species from extinction, or to preserve a unique location or ecosystem? Economists have made up price tags for such priceless values, but the results do not always pass the laugh test. I have written at length about this elsewhere, and will offer only a brief summary here (Ackerman and Heinzerling, 2004; Ackerman, 2008b).

Is a human life worth US\$6.1 million, as estimated by the Clinton administration, based on small differences in the wages paid for more and less risky jobs? Or is it worth US\$3.7 million, as the (second) Bush administration concluded on the basis of questionnaires about willingness to pay for reducing small, hypothetical risks? Are lives of people in rich countries worth much more than those in poor countries, as some economists infamously argued in the IPCC's 1995 report? Can the value of an endangered species be determined by survey research on how much people would pay to protect it? Are large mammals and birds worth much more than other species, as such surveys suggest? If, as one study found, the US population as a whole would pay US\$18 billion to protect the existence of humpback whales, would it be acceptable for someone to pay US\$36 billion for the right to hunt and kill the entire species?

The only sensible response to such nonsensical questions is that there are many crucially important values that do not have meaningful prices. This is not a new idea: as Immanuel Kant put it, some things have a price, or relative worth, while other things have a dignity, or inner worth (Kant, 2005 [1785]). No price tag does justice to the dignity of human life or the natural world.

Since some of the most important benefits of climate protection are priceless, any monetary value for total benefits will necessarily be incomplete. The corollary is that it can be important to take action, even in the absence of a complete monetary measure of the benefits of doing so.

### **Some costs are better than others**

The language of cost–benefit analysis embodies a clear normative slant: benefits are good, costs are bad. The goal is always to have larger benefits and smaller costs. Measurement and monetary valuation is easier for costs than for benefits; the costs of environmental protection often involve changes in such areas as manufacturing, construction, and fuel use, all of which have well-defined prices. Yet conventional economic theory distorts the interpretation of costs, in ways that exaggerate the burdens of environmental policy and hide the positive features of some of the costs.

The distortion and exaggeration of costs occurs across a range of time scales. In the short run, bottom-up studies of energy use and carbon emissions repeatedly find significant opportunities for emissions reduction at zero or negative net cost – the so-called ‘no regrets’ options.<sup>6</sup>

Costless energy savings are, according to a long-standing tradition in economic theory, impossible. In the textbook theory of competitive markets, every resource is productively employed in its most valuable use, and every no-regrets option has already been taken. As the saying goes, there are no free lunches; there are no \$20 bills on the sidewalk, because someone would have picked them up already. Traditional models of climate costs, based on economic theory, do not include free lunches. In these models, all emission reductions have positive costs. This leads to greater estimates of climate policy costs than the bottom-up studies with their extensive opportunities for costless savings.

In the medium term, we will need to move beyond the no-regrets options; how much will it cost to finish the job of climate protection? Again, there are rival interpretations of the costs based on rival assumptions about the economy. The same economic theory that proclaimed the absence of \$20 bills on the sidewalk is responsible for the idea that all costs are bad. Since the free market lets everyone spend their money in whatever way they choose, any new cost must represent a loss: it leaves people with less to spend on whatever purchases they had previously selected to maximize their satisfaction in life. Climate damages are one source of loss, and spending on climate protection is another; both reduce the resources available for the desirable things in life.

Are the two kinds of costs really comparable? Are we indifferent between spending \$1 billion on bigger and better levees, or not building the levees and losing \$1 billion to storm damages? In the imperfect, real-world economy, money spent on building levees creates jobs and incomes. The construction workers buy groceries, clothing, and so on, indirectly creating other jobs. With more people working, tax revenues increase while unemployment compensation payments decrease.



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None of this happens if the levees are not built, and the storm damages are allowed to occur. The costs of prevention are good costs, with numerous indirect benefits; the costs of climate damages are bad costs, representing pure physical destruction. One worthwhile goal is to keep total costs as low as possible; another is to have as much as possible of good costs rather than bad costs. Think of it as the cholesterol theory of climate costs.

In the long run, the deep reductions in carbon emissions needed for climate stabilization will require new technologies that have not yet been invented, or at best exist only in small, expensive prototypes. How much will it cost to invent, develop, and implement the low-carbon technologies of the future?

Lacking a rigorous theory of innovation, economists modelling climate change have often assumed that new technologies simply appear, making the economy inexorably more efficient over time. A more realistic view observes that costs of producing a new product typically decline as industry gains more experience with it, in a pattern called 'learning by doing', or the 'learning curve' effect. Wind power is now relatively cheap and competitive, in suitable locations; this is a direct result of decades of public investment in the US and Europe, starting when wind turbines were still quite expensive. The costs of climate policy, in the long run, will include doing the same for other promising new technologies, investing public resources in jump-starting a set of slightly different industries than we might have chosen in the absence of climate change. If this is a cost, many communities would be better off with more of it.

### Conclusion

A widely publicized, conventional economic analysis recommends inaction on climate change, claiming that the costs currently outweigh the benefits for anything more than the smallest steps

toward reducing carbon emissions. There are four big things wrong with this theory, four bumper stickers for a better economics of climate change.

First, your grandchildren's lives are important. Climate policy involves costs incurred now with their greatest benefits far in the future; the discount rate determines how large those benefits appear to be. As the Stern Review demonstrates, a low discount rate is required to validate the belief that your grandchildren, and other generations to come, matter to us today.

Second, we need to buy insurance for the planet. The predictable damages from climate change are large enough; the credible worst cases are disastrously greater. In private life, people routinely buy insurance against events that are worse than 99th percentile bad outcomes. Thus the average, expected climate damages are virtually irrelevant; all that matters is preventing the worst cases from occurring.

Third, climate damages are too valuable to have prices. Climate policy is aimed at saving human lives, protecting species and ecosystems, and ensuring the survival of a natural world that is essential to our existence. Cost-benefit analysis utterly fails to comprehend these priceless values; the benefits of climate policy include many things that have a dignity rather than a price.

Finally, some costs are better than others. In the short run, there are no-regrets options that can save emissions at no net cost; in the medium term, there are job and income creation benefits of spending on climate protection; in the long run, public investment is needed to create and launch the new technologies of a low-carbon future. These costs are constructive, unlike the physical destruction caused by an increasingly extreme climate.

Put these four pieces together, and we have the outline of an economics that complements the science of climate change and endorses active, large-scale climate protection.

### Notes

1 This article draws heavily on my forthcoming book (Ackerman, 2008a).

2 Nordhaus (2008: 15). His Figure 5.6, p. 102 suggests that 'optimal' emissions in 2055 would be about one-third higher than in 2005.

- 3 In 2005, there were 511,000 fires in structures (US Census Bureau, 2008, Table 346, <http://www.census.gov/statab/www/>, accessed 1 March 2008) and 124 million housing units in the US (US Census Bureau, 2008, Table 953).
- 4 Based on US average death rates by age, as of 2004 (US Census Bureau, 2008 Table 101).
- 5 LIMRA International, an insurance industry research group, reports that in families with dependent children, 'Twenty-eight percent of wives and 15 percent of husbands have no life insurance at all. Ten percent of families with children under 18 have no life insurance protection.' From 'Facts About Life 2007', <http://www.limra.com/pressroom/pressmaterials/07USFAQ.pdf>.
- 6 For example, see the recent studies of the costs of reduction by McKinsey & Company, an international consulting firm: Enkvist *et al.* (2007), Creyts *et al.* (2007) (copies on file with author).

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