Notes from the Dismal Science:

THE GLOBAL WARMING DEBATE

Sherm Folland

Several months ago, Xie Zhu, our environmental economist, led an Economics Seminar on global warming that I found interesting; it provided several ideas worth writing about, with her help. Since by habit I read across the political spectrum in newspapers and magazines, I know that, at that media level, controversy continues as to whether global warming exists, and if it exists whether it is anthropogenic, that is, caused by humans. But this column directs its main attention to explaining the surprising and consequential arguments among environmental economists, all of whom assume as premise the existence of global warming and that humans contribute to it. As you will see, these economists argue, not over whether the planet has a problem, but about how much it will cost. Before digging into the economists' argument, however, I want to explain, for the benefit of those who are still skeptical about the global warming premise, why I have come to accept it.

Did We Cause Global Warming?

As I advise my students, when one is insufficiently trained to assess the evidence, go to sources with genuine credentials and

extensive experience. So, I ignored all newspapers and policy magazines (I ignored economists such as Paul Krugman and Thomas Sowell, too). Instead, I found a dozen items on JSTOR from *Science* and various other climate-related science journals. These viewed global warming as both serious and anthropogenic. On the internet, I found a recent issue of *Science* with an editorial describing this as a "consensus view" among climate scientists. Another issue of *Science* reported a survey in 2004 by Naomi Oreske of over 900 abstracts of science studies of climate change. It found that none rejected the view of a significant anthropogenic factor. Via Google I also found the report of the National Academy of Sciences, as well as the latest report of the International Panel on Climate Change, both of which supported the anthropogenic claim. My personal experience also helped; I teach Health Economics, a course in which I demonstrate for students, at the beginning, the astonishing magnitude of the world population growth since 1700. Once one sees these data, doubt dissolves: humanity could have effected a change in the greenhouse gas content of the Earth's atmosphere.

On What's The Future Worth? and How Do You Do Discounting?

Suppose that we knew a calamity would occur to the people of the United States 150 years from now, in the year 2157. How would we view the harm to those future people? We might get a hint by trying to imagine how our own forbearers would have viewed a calamity to us from the perspective of 150 years ago. Would they have cared about our well-being; do we care about the people in 2157? Of course! My emphasis is added to make clear that the economic, sometimes odd looking, results that follow have nothing whatsoever to do with our being uncaring, nor do they require that we be myopic, nor even unusually selfish.

The main reason that economists discount future values

is that economies tend to grow, capital gets invested, entrepreneurs start up, people become more educated, and technology advances. You can loan the economy $1 (you deposit it in the bank) today and expect to get it back with interest next year. Lenders and borrowers always exist, and if the interest rate, for example, is 5%, your $1 today will get you $1.05 next year. This means equivalently that $1.05 next year has a value of $1 in the present; that is, next year's $1.05 has to be discounted by a factor of (1.05) to assess its present value. More specifically, one divides next year's values by a "discount factor" of 1.05, when the "discount rate" is 0.05. Let's shift into a higher gear; it follows that $1 in the present is worth $(1.05)^5$ five years from now because we earn interest that "compounds." A higher gear yet: The present value of a Cost_t in any given year, t, is as follows: $\textit{Present Value} = \textit{Cost}_t/(1+d)^t$. That is, plug in the year (counting from 0 representing this year, so $t = 0,1,2,3, \ldots T$, where capital T is 150 in our example) and, replace the lower case d with your choice of discount rate (stated as a fraction so that our 5% example becomes a $d = 0.05$). Most pocket calculators are capable of making the needed calculations in the 5% example, and in any other example you wish to try.

A natural question to ask is: "What is the proper discount rate to use?" And this question is at the center of the controversy I will be describing. Some say that 5 percent is reasonable; some say that the rate of growth in the economy, more at 3 percent is more proper; others yet argue that environmental damage deserves a lower discount rate, more at 2 percent.

A $100 Trillion Environmental Damage Coming in the Year 2157

Discounting itself is all very commonplace, in that most people whose job it is to work with future dollar values know this and agree that discounting should be done, at least in most cases. But consider its surprising implication. Suppose we assume that a calamity from global warming will hit the U.S. (I choose

the U.S. here mainly because this permits some familiar comparisons, but of course global warming affects the entire planet) 150 years from now causing $100,000,000,000,000, or $100 trillion worth of damage. Suppose further that the proper discount rate were in fact 5%; applying the present value formula, *Present Value = $100 trillion/(1.05)^{150} =* $66,313,986,950 or $66.314 billion.

This demonstrates a logical criterion; if it costs less than $66.314 billion to fix the problem we should fix it; if it were to cost more than the $66.314 billion in present dollars to save the $66.314 billion of environmental damage valued in present dollars, then we should not bother. In other words, economists apply essentially the same logic to countering global warming damage as you might apply in deciding whether to buy an energy saving light bulb. If the new bulb cost less than the value of the energy it saves, you buy it; if it costs more than that, you don't.

In the example case, is $66 billion (and some cents) big money? The late Senator Dirksen suggested that it is: "A billion here, a billion there; pretty soon you're talking real money." But just recently (in 2004), Americans spent $329 billion on clothing & shoes; and $249.9 billion on gasoline. Consider also the usual suspects: $86.6 billion on tobacco; $116.2 billion on alcohol; and $121.3 billion on video/audio materials. Saving the world would be small potatoes compared to these expenditure levels. Some people might respond that "Even if the world is worth saving, it doesn't seem like anything to get alarmed about." Nevertheless, I will shortly argue why it is often very much worth doing.

We see that discounting future damage costs to present day terms can make them seem like small potatoes. Yet, if this strikes you as an economic oddity, you are likely to find the large differences that the choice of discount rate makes seem even odder. The following brief table shows the present value of the $100 trillion example calculated at the three discount rate options I described previously. The points of these exercises—1) that discounting can reduce large future costs to

manageable present day values, and 2) that the choice of discount rate can make a big difference to the size of present value calculations—are at the center of the current arguments among environmental economists.

The Choice of Discount Rate Makes a Huge Difference

Cost in the year 2157	Discount Rate	Present Value in 2007
$100 trillion	5 percent	$ 66.314 billion
$100 trillion	3 percent	$ 1.186 trillion
$100 trillion	2 percent	$ 5.128 trillion

The Stern Report, Discounting and Mr. Nordhaus

Her Majesty's Treasury, United Kingdom, issued the world's most calamitous vision of the consequences of unchecked global warming. The Report foresees a global reduction of 5% in income on a permanent basis, and it warns of a worst case reduction of 20% of income, a worldwide Great Depression. Aside from experts sifting through the Report's climate science, economists, especially environmental economist William Nordhaus fromYale, ripped into the author Nicholas Stern's economic assumptions. Stern assumed that the proper discount rate for a future cost of environmental damage is 0.1 percent; much lower than applied elsewhere, in fact, his rate is virtually zero. To see that this makes a huge difference, consider what happens to the previous example were we to apply the Stern Report's low discount rate, $d = 0.001$ (instead of any of the examples I discussed above) and discount $100 trillion in the year 2157 to its present day equivalent value. The result is *Present Value = $100 trillion/(1.001)*^{150} = $ 86.077 trillion, or about 6.5 times the entire GDP of the United States! This is not just "clothing & shoes" anymore. It is easy to see that if Stern were correct about the proper discount rate, then our future is

much more likely to be calamitous than we thought at first. (These numbers apply to $100 trillion in 150 years, my example case. The same point of comparison applies to Stern's cost numbers, which are given in a later section).

But is Stern correct? The best answer that I can give is "no." Let me explain. I can think of two ways to look at this. First, let's imagine we Americans were "lazy" and "carefree," and we decided to wait until 2157 at which time we let the future Americans pay cash for it. At a reasonable growth rate assumption for the U.S. economy, say 3% per year, our US GDP, currently $13.22 trillion, would grow to be about $1,113.82 trillion by 2157, making even the $100 trillion out-of-pocket expense quite affordable. Since many people in the public don't fully grasp the need for discounting of future cost values, Nordhaus finds it useful to "undiscount" (ie grow via compounding) income values into the future, like I have done here.

A more bizarre sounding example provides another way to see the need for discounting. Suppose we know that the universe will collapse into a black hole in 500 billion years. The "cost" to Americans at that occurrence would be pretty substantial to say the least. There will be too many zeroes in the cost number to bother writing it out, so let me just call that cost, *COST!* If we discounted *COST!* into its present value using a discount rate of zero (that is, if we equivalently decided that discounting is for the birds) then its *Present Value = COST!*, that is, it's the whole thing. Believe me if we humans felt a universe collapse to weigh on us with this immediacy, we would not see anybody smiling today. But people are reasonably happy today; clearly in practice we humans discount future costs.

This reminds me of a scene from a Woody Allen movie some years ago. The red-headed kid playing the Allen character's self as a child explains to his mom and dad that since the universe is going to collapse in 500 billion years, there was really no point in him doing his homework.

"Ramping Up" Greenhouse Gas Reduction

Stern's calamity, if true, would clearly be a clarion call for national policy change on global warming. He recommends pouring money and effort into greenhouse gas reductions in each year for the next 50 years. The Nordhaus approach more reflects current expert policy thinking (I am not referring to current U.S. administration policy), which would make a much more modest beginning investment in greenhouse gas control. Substantial costs apply were we to overdo it. Drastic reductions in emissions globally would threaten developing countries, cutting their economic growth; already short lives would get shortened even more. Fortunately, policy experts recognize these damages that arise from the overzealous focus on environmental consequences alone. They realize that they are not playing games, that the side consequences are real. If a more gradual approach proves tenable, the world ought to take it.

One more modest approach looks interesting, one identified by the phrase "ramping up." Consider the role of technology in reducing emissions from coal-burning plants; more effective abatement technology makes reductions less costly—a boon to China especially, which plans to build over 600 coal-burning plants. But technology grows, too, and our economy already has evolved toward reliance on and growth in hi-tech industry. The projected path of abatement technology improvements promises that emissions abatement will grow less costly. The optimal pattern of emissions regulation, in this view, begins required reductions at modest levels and then "ramps the requirements up" as technology improves.

How Hard Will It Be To Reduce Greenhouse Gases?

One of the semi-bright spots of the calamitous Stern report is that the costs of damage reduction even on his scale at least lie

within the planetary budget. Consider the costs in the Stern Report, which provides a range of abatement cost estimates for reaching its target for greenhouse gases concentration (550 parts per million). To achieve this target in the next 50 years, the planet would need to expend $78 to $667 billion a year for each of the 50 years. That is a great deal of money to spend each year, especially the larger of the two amounts, but it is clearly less than world income. The world Gross Product is currently $35 trillion.

How is this abatement done? Both Prof. Nordhaus and Prof. Stern place a significant emphasis on the replacement of dirty, often older, technologies with cleaner ones: for example, nuclear, wind power, solar and better ways to extract energy from fossil fuels. These substitutes generally cost more than the technology they displace, hence no free lunch. Government might invest, say via its grant mechanisms, to develop abatement technologies. Critics could keep the government honest, producing long lists of cases where government has picked the wrong technology, the foolish subsidy, or the wrong war. But I start with government because global warming is a classic case of market failure. There are certainly examples of winners, too; especially government support for academic research, the Manhattan Project and the early NASA space program. Private enterprise also carries much promise, and it may prove the most responsive when more affordable abatement technologies appear.

Why Regulation Often Disappoints

Neglect of the knotty problems that still need to be solved, however, provides no utility. Pollution, a harmful "side effect" of production, also called a "harmful externality," affords itself to regulation in the usual case but global warming presents an unusual case. For example, suppose that steel produced in Gary, Indiana, caused harmful smoke to permeate the neigh-

borhoods. If we imagine that such factory smoke only occurs in Gary, and nowhere else in the United States, it would make sense for the City of Gary to regulate the emissions. In contrast, what if factories across the U.S. similarly polluted, and the smoke spread over wide areas; it would make sense for the U.S. government to regulate it. But global warming, which affects the entire planet, raises a different problem: there is no world government, no world sovereign to enforce world emissions regulation. Let's face it, controlling emissions requires the power to coerce.

Cooperative agreements, like Kyoto, offer the only available alternative. Please understand in what follows that I think we (the U.S.) should have joined Kyoto, if only to show leadership in this potentially beneficial world cause. But I also want to point out the fundamental difficulty. Getting the U.S. states to cooperate on the environment means to get solidarity among people who all speak English, share a common history, share mostly a common climate, have high incomes by world standards, and so on. Getting 150 diverse countries to enter into the Kyoto Treaty was much more daunting.

We cannot claim that the whole world agreed to Kyoto, with just the U.S. and a few other "miscreants" holding out. At least not in the sense of "walking the walk." The table below shows selected nations that signed to Kyoto, showing as well the U.S. and Australia, which didn't. None approached the attainment of their assigned goals. The countries were required to meet the goals listed in the first numeric column, which are expressed as percentage changes from the country's 1990 levels of greenhouse emissions. These goals were to be met by 2008–2012, but we see from the right hand column that none was headed towards that achievement by the year 2003. The United States, the "bad guy" nation in popular opinion, actually performed as well as several prominent Kyoto signatories.

Emissions: Countries with Kyoto Commitments

Country	Kyoto Commitment	2003 Emissions Relative to 1990
Western Europe	–8%	+ 6.5%
Japan	–6%	+19.2%
Canada	–6%	+25.4%
Iceland	+10%	+29.6%
US*	–7%	+16.0%
Australia*	+8%	+43.4%

*The US and Australia did not sign the treaty. The Kyoto Commitment assigns a goal to achieve by 2008–2012 as a percentage difference from the country's 1990 level of greenhouse gases.

I merely suggest that voluntary, cooperative agreements across different countries generally lack the powers to make the constraints binding. The fact that Kyoto gave a free pass to India and China figured just as much as a weakness of the treaty. Are Earthlings perhaps caught at a time when a serious global problem occurred before a mature and widely supported global authority had a chance to evolve? "Coercion" is an unpleasant word, but unfortunately, many of the best pollution control measures—tradable pollution permits, carbon taxes –work when there is a sovereign, or an agency with the power to invoke penalties when clear air requirements are not met.

The Optimistic Economist

Some social scientists claim to find human responses to disaster that seem to make one downright optimistic. The idea relies on the fundamental fact that people respond to incentives. For example, as public information about global warming be-

comes clearer and better accepted, goes the theory, people will take stronger steps to counteract the risk: stronger international agreements, greater stimulus to abatement technology development, abatement technology subsidies to developing countries, perhaps even a step toward a more mature United Nations.

My own sentiment wishes that the US take a beneficial leadership role. My generation grew up while America still basked in the pride of having fought fascist states on two fronts and beat both of them. We developed the Marshall Plan and flew a massive airlift to feed the Berliners, while our pilots dropped bubblegum out their windows for German kids. In 1969, having a beer after work in the US Army Enlisted Men's Club in Frankfurt, Germany, I watched as the TV program cut to news of the moon landing. I remember exactly where I was when I first saw the moon landing report. What ever happened to the US knack for developing world class plans that evoke an unmixed appreciation? Sentiment, I think, requires that we once again take leadership in the world but in a way that actually and clearly does the world some good. The task of learning how to stabilize greenhouse gases and curb global warming seems to fit the bill.