Chapter 10: Jeffrey Sachs, Columbia University

Clearly Nick's Review has been having a huge and valuable political effect.

My main question is how much disagreement there really is in the rhetoric of the other panelists at this meeting. This is a bit hard to know, because most of the discussion has been about how fast the world should do what it needs to do in controlling harmful emissions, and about whether the Stern Review is calling for a crash course while mainstream opinion says do it gradually. When I read the Review, I certainly didn't feel that that's really the nub of the issue.

I read the Review's call to action as "Let's get started now, understanding that the job will take decades." There are powerful reasons for putting it that way, because what's entailed is a change in the core infrastructure of the world economy, and this will take several decades to achieve. To do it faster would impose marginal costs that would be extraordinarily hard to justify from the scientific evidence. The scientific evidence, at least as we know it now, suggests that if we act with all deliberate speed right now, planning by mid-century to have completed a huge changeover, we will have been able to keep the dangerous emissions below catastrophic level. According to the Review, stabilizing at 450 to 550 ppm of CO_2e would be possible in such a scenario of all deliberate speed, taking into account the time horizons of demonstration of new technologies and investment in long-lived infrastructure. What is also true is that if we wait another 20 years, then we could no longer, at all deliberate speed, reach the range of 450 to 550 ppm.

One major confusion should, I think, have been straightened out. The Review is talking about 450 to 550 parts per million of carbon *equivalent* (CO_2e), that is, representing all the greenhouse gases in this single number, but all the rest of us are talking about parts per million of *carbon* (CO_2). This is a big difference. I'm quite happy with the 450 to 550 ppm *carbon* target, but I don't have the same confidence in my views about a 450 to 550 ppm carbon *equivalent* level. Scientists at the Earth Institute argue strongly against simply adding the radiative forcing gases to the carbon computation, and for keeping the different types of emissions separate in public discussion and understanding. There are good reasons not to lump the different gases together. They need different prices. They have different systems. They have different residence times in the atmosphere, and it is a bit difficult, I think, to have a target that is a composite of six or more greenhouse gases.

Thus in what follows I will talk about a stabilization target of 450 to 550 parts per million of *carbon*. It would take a profoundly dislocating set of actions to stabilize below this range. And on the other hand, if we start now, it would be possible to stabilize in this range without severe dislocation.

One thing that almost none of the models of climate change formally takes into account is the putty-clay nature of almost everything we live with. Our fleet of automobiles turns over in 20 years; our power plants turn over in 40 to 50 years or a little longer; our residential and commercial structures, in 50 to 100 years. Most things can be retrofit, but retrofitting is much more expensive than investing in the prospective phase, whether for decarbonizing energy or for reducing emissions in other ways. So the low marginal cost pathway is one that takes the easy wins, where they can be found (and there is a lot of waste in the system), but invests as old capital is rolled off and new capital is rolled on.

Most importantly, this applies in electric power. To decommission existing well-functioning coal plants right now, and build wholly new power plants, would be a huge and really expensive change. If we insist, instead, that as power plants are moth-balled and new ones are built, they should satisfy the constraints of being carbon-effective or carbon-efficient, we shall be able to manage the transformation at a much lower marginal cost. Gigawatts of power plants are being built right now with old-fashioned coal-fired thermal technology all through China, India, and a lot of the rest of the world, threatening to lock us into a time path that will be devastating. But if we get started now—so that as capital is reinvested it is invested in efficient ways—the marginal cost of the needed transformation will be quite low.

My view is that the marginal cost of the transformation is going to be considerably lower than in Bill Nordhaus's model, which I take to be the state-of-the-art work-horse model of the profession. (Whenever I disagree with Bill Nordhaus I worry intensely about why that might be, because he is about the most reasonable person I know. And, so, I have spent a lot of time in the last few months, as he knows, sending him e-mails to try to understand the assumptions underneath the DICE model.)

My view is that even when using the DICE model, you must still put in the right parameters to have it come up with sensible answers. When you run the DICE model with what I think are more realistic parameters than those Bill has used, the debate on the Stern Review turns out not to be very much about the time-discount rate, or other profound features of the approach, but chiefly about the parameters that one is assuming—mainly about the costs of abatement and about several basic features of the world economy.

I apologize in advance if I have this wrong. As mentioned, I take the Stern Review to be saying "Let's get started seriously now, and reach the year 2050 with the chance of ending the century at 500 or 550 ppm and no higher." In contrast, Bill's model says, "We can be more gradual. We should make the adaptation over two centuries, and we can breach 550 ppm. Maybe we'll go to 600 or 700, and that's the right thing to do. Eventually, we will stabilize, but we don't have to do this within a century, and we don't have to do it within the limits that Nick is talking about." So I tried to understand the source of this difference.

The DICE model adopts a baseline path of emissions that is quite a bit lower than the rest of us have assumed. Under Bill's baseline of no control, atmospheric concentrations only reach 610 ppm of carbon by 2100. I know of no other model that uses such a low level. But if that's your baseline, you don't feel urgent about control because the world's already more or less controlling these things for you.

The underlying reason seems to be four assumptions in the model. One is that the assumed baseline economic growth rate is only about 2 % or so. This seems to me too low a basis for policy decision making, because it is reasonable to presume that China and India are going to grow quickly, and produce a lot more carbon than now.

Second, the population assumption is far outside the norm. It is for 7.7 billion by 2050, whereas the UN's median forecast, which—right or wrong—I would take to be a better one on which to base an assumption like this, is 8.9 billion.

Then there are two economic assumptions. One is that a good deal of automatic decarbonization goes on over the long term. (This is a better assumption than in an earlier variant, which assumed 100 % automatic decarbonization at no pain in three centuries.) Now the assumption is that after substantial decarbonization, by the end of two centuries you arrive at a point where you don't really have to control emission levels because technology at zero marginal cost controls a lot of them already.

The fourth point, and the nub of the issue, is that the assumed abatement costs in the DICE model are much too high. I think that in the discussion over the last ten weeks we have focused too much on the discount rate, as if that is the only thing really going on. What seems to me to be even more important is the assumption on the cost of cleaning up. In the DICE model, the parameter for abatement costs varies over time but implies that, as of mid-century, 100 % abatement would cost 3.9 % of GNP and 75 % abatement would cost 1.7 % of GNP. I am living among technological optimists in the Earth Institute, in a world of engineers, who think that that 1.7 % is roughly five times too high. If you change this assumption and say that you can do 75 % abatement at something like 0.6 % of GNP, you get a completely different estimate of the cost of doing what is needed, and this has nothing to do with the time discount.

Now, here's my attempt to put in an alternative set of estimates.

…My colleagues at the Earth Institute place a lot of hope in certain technologies. One is nuclear power: whether we like it or not, China and India and many other places are going to go nuclear, and this will solve a lot of the emissions problem at quite low cost, maybe even at zero marginal cost compared to a baseline of thermal power.

Carbon capture and sequestration (CCS) is the second obvious technology. The IPPC *Special Review on Carbon Dioxide Capture and Storage* judges it extremely likely that there are enough sedimentary geological sites to safely sequester gigatons of carbon dioxide. IPCC gives a cost estimate of $10 to $30 per ton of CO_2, or roughly one to three cents a kilowatt hour for electricity, so this is a proposed technology with a very low marginal cost. We do not know yet whether it works; I think the mechanics are quite well understood but the geology needs to be proved. And, so, if I were choosing a decision right now, the first thing I would do would be to build some prototype CCS plants and have geologists measure tracer gases coming out of the deposits to see whether they are leaking or not. If we cannot do carbon capture and sequestration, we have a real problem: the next-best technology is a lot worse than this.

But if carbon capture and sequestration works—that is, turns out to be stable geologically—the world will face prices of $25 or $30 per ton of carbon dioxide, on the margin, for maybe up to 60 or 70 %of the total abatement in the economy. And CCS would also allow another significant change: the conversion of existing local site-based fossil fuel users like furnaces and boilers into users of electricity that is cleanly produced. The costs of that kind of that conversion—say, for home heating, away from oil or natural gas to heat pumps powered by electricity coming from a clean power plant—are quite favorable as well.

As regards automobiles—another major area needing huge improvement—we already know that a plug-in hybrid system can work off the existing infrastructure and probably at quite low cost. The social cost may even be zero or negative, because you trade off higher battery costs against lower petroleum or carbon costs, and the net trade at $60 a barrel of oil is favorable at any fairly low interest rate. There may be zero social costs to switching over, if consumers see the hedonic aspects of plug-in hybrids as acceptable.

The point is, there are technologies applicable on a large scale (not to mention, say, cellulosic ethanol and other biofuels, and solar energy) with huge potential.

What is the bottom line of all this? If you assume that all of the CO_2 that needs to be disposed of can be disposed of at $25 dollars per ton, on average, the cost of doing this is only 0.3 % of world GNP. The technologies just mentioned, from plug-in hybrids to CCS and nuclear power, each imply costs of $25 to $30 per ton of CO_2 or less. Some simple experiments show that if you allocate the rights to emission on an equal per capita basis, for example so that the 0.3 % of world GNP is to be paid more by the rich countries than the poor, the US cost turns out to be about 0.7 % of US GNP, assuming a $25 per ton carbon dioxide abatement cost.

If these cost estimates are right, they suggest two very simple policy prescriptions: to put on a $25 tax per ton of carbon for the next 40 years and to undertake research, development, and demonstration projects. Our models will never show us whether a technology works or not; we shall only learn this by testing in real life. And we need demonstration projects more than anything right now, because we have close-to-market technologies that need to be demonstrated. If we do these two things, my guess is that we shall see a massive conversion of the power sector, especially in the rapidly growing developing countries.

This is the essence of the story: we cannot calculate the cost of abatement from economic models, but only from thinking about how to promote a system of technological change. So we as economists need to talk to engineers much more than we do now, to understand the options and what their marginal costs are. The technology is not very expensive and not likely to be so. The chances for major technological improvements are enormous at present. If you ask me whether engineers could make energy far more efficient, I would doubt it. But I would say yes, they could decarbonize, because this is a new problem. And there are so many margins to work on that the marginal costs of decarbonization are going to be quite small.

I will end with a prediction. This is that by 2010 we shall have a post-Kyoto international agreement that has a globally agreed target for mid-century on CO_2 ppm (not CO_2e ppm), of perhaps 500 or so, aiming to stabilize at less than two times the pre-industrial carbon level. My guess is that in 2008 all American presidential candidates will have a very strong climate change policy in their platforms. At the political level, we'll enter into post-Kyoto negotiations in December 2007 at the conference of the parties of the UN Framework Convention on Climate Change in Bali in December. That will open a debate that will last through the US presidential elections and through the Chinese Olympics. Nothing is going to happen in 2008 on this. And then, in 2009, there will be a new US president. There will be post-Olympic cleanup and hangover, and the US, China, and India will agree on how to share the costs of doing this. And in 2010, the post-Kyoto protocol will be signed. It will take two years to ratify, and go into effect January 1, 2013.