

*Is there a case for aggressive,
near-term mitigation of greenhouse gases?*

A Critique of the Stern Report

BY ROBERT O. MENDELSON

Yale University

Economists usually present a rather gloomy view of climate change. They argue that efficient policies should only slow climate change this century, not stop it. Aggressive near-term policies lead to abatement costs that outweigh the avoided future climate damages. Strict abatement policies should be delayed into the future as damages increase. Only modest control programs are warranted in the near term.

The recently released *Stern Review on the Economics of Climate Change*, better known as the Stern Report, provides a much more upbeat view of the economics of climate change. Looking far out into the future, the report argues that if society were to put some muscle into solving this problem now, we could not only avoid a looming environmental catastrophe, but do so at a relatively modest cost. Immediate aggressive regulation would stimulate rapid technological improvements that would lead to ever-increasing reductions in emissions at virtually no additional cost. The reductions would be enough to stabilize greenhouse gases at 550 parts per million of carbon dioxide equivalents, thereby limiting long-term warming to 2°C–3°C and effectively ending global warming as a problem as early as the year 2050. Best of all, it would only cost 1 percent of income.

Economists have long argued that stabilizing greenhouse gases at 550 ppm is not efficient because the costs far outweigh the benefits. The Stern Report, however, argues that the earlier studies were mistaken. How did the report come to such a radically different conclusion? It makes numerous new assumptions that cause the estimated damages from climate change to be far more severe than previous estimates. The

report also makes several strong assumptions that lower the estimated abatement costs. Finally, the report does not consider any policy alternatives other than its own abatement strategy and doing nothing, thus ignoring the possibility of an optimal abatement path that is apart from its own proposal. These characteristics raise serious questions about the soundness of the report's policy recommendation.

EFFECTS

Several assumptions in the Stern Report have led to the conclusion that the damages from climate change are considerably higher than previously believed. Let us consider these assumptions carefully:

DEMOGRAPHICS The report examines only one baseline of demographic change over the next two centuries, the so-called "A2 scenario" presented in the International Panel on Climate Change's 2000 *Special Report on Emissions Scenarios*. This scenario assumes rapid population growth in the low latitudes. Further, instead of per capita income growing at recent rates of 3 percent, the scenario assumes income grows at only 1.3 percent per year. This combination of assumptions creates in the far future vast billions of poor people living in the low latitudes, the most sensitive region to warming. In contrast, if economic growth was assumed to continue at even 2 percent and population growth continued to slow, the vulnerable rural poor in the low latitudes would actually shrink in the future.

DISCOUNT RATE The report assumes that the discount rate (the "price" of time) for the cost of global change is 0.1 percent above the rate of growth of consumption. Because consumption is assumed to grow at 1.3 percent, the discount rate is 1.4 percent. The report argues that it is immoral to use

Robert O. Mendelsohn is the Edwin Weyerhaeuser Davis Professor in the School of Forestry and Environmental Studies at Yale University. He may be contacted by e-mail at robert.mendelsohn@yale.edu.



The Stern Report makes strong assumptions that cause the estimated damages from climate change to be much higher than previously thought.

higher discount rates because doing so would be unfair to future generations. However, using low discount rates is unfair to every generation; the welfare of future generations will be reduced by low discount rates just as much as current ones. But, critical to the Stern Report, the low discount rate implies far future events are important in the near term.

Despite arguing for the low discount rate in the impact analysis, the report does not use it when evaluating the cost of mitigation. To be consistent, the opportunity cost of investing in mitigation must also be valued using the same discount rate as was used to determine the cost of climate change. Because investing in mitigation substitutes for investing in other activities that can earn the market rate of interest, society loses the income that it could have gained from other valuable projects. Assuming that we use the his-

toric rate of return of 4 percent (that the mitigation program does not drive up interest rates), the value of \$1 of abatement is \$2.9 when evaluated at a discount rate of 1.4 percent. The mitigation costs reported in the study need to be multiplied by a factor of three to be consistent with how the damages are calculated.

Further, the Stern analysis was extended beyond 2100 to consider effects through 2200. Because the analysis assumes that the discount rate is just 1.4 percent, the present values of effects in 2200 are still important in the near term. One dollar of damage in 2200 is worth 6 cents in 2000 if discounted at 1.4 percent, but is worth only 0.03 cents if discounted at 4 percent.

The report also assumes that there will be more powerful positive feedbacks in the carbon cycle than previously thought. These feedbacks will cause temperatures to increase more rap-

idly, especially in the 22nd century. Changes that happen beyond 2100 affect current choices in this analysis because of the low discount rate.

ADAPTATION? Although there are several chapters in the report that talk about the importance of human adaptation to climate change, the damage estimates in the analysis do not take adaptation into account. For instance, the report's estimates of flood damage costs from earlier spring thaws do not consider the probability that people will build dams to control the flooding. Farmers are envisioned as continuing to grow crops that are ill suited for new climates. People do not adjust to the warmer temperatures they experience year after year, and they thus die from heat stroke. Protective structures are not built along the coasts to stop rising sea levels from flooding cities. No public health measures are taken to stop infectious diseases from spreading.

Compared to studies that include adaptation, the report overestimates damages by more than an order of magnitude.

EXTREME WEATHER The Stern Report assumes that climate change causes extreme weather events such as hurricanes. However, the International Panel on Climate Change is still not convinced that there is a link. Further, the report extrapolates from recent decades ending in 2005 with the Katrina hurricane, and it assumes that damages grow more harmful over time at an increasing rate. From a current level of damage of 0.2 percent of GDP, the damages are assumed to grow to 5 percent of GDP by 2200. That is, in 2000 the damages from extreme weather events were about \$70 billion per year; by 2200, the report estimates the damages from extreme weather events caused by climate change will be \$23 trillion per year.

NON-MARKET DAMAGES The Stern Report assumes that the non-market damages of climate change are very large. By 2200, the report claims they will have reached 5 percent of GDP, or \$23 trillion per year. Although the report contains miscellaneous examples of harmful non-market effects, the examples cover random places around the world and they suffer from sampling bias (only harmful effects are listed). Further, there is no evidence presented that suggests these effects could possibly sum to \$23 trillion per year.

KNOCK-ON DAMAGES The report assumes the large damages from climate change will cause additional "knock on" damages. Warming casts such a damper on the future economy that people reduce investment. This dampens future growth even further.

In the world envisioned in the baseline with the climate changes added on top, the report may be correct. However, if market damages are an order of magnitude smaller (much less than 1 percent of GDP), the mitigation program is just as likely to cause "knock on" damages as climate impacts.

UNCERTAINTY The Stern Report assumes that a risk premium should be added to damages because the report estimates there are large uncertainties surrounding the damages of climate

change. Economic analysis generally favors using the expected values of outcomes. However, when risks are large on a per capita basis, one may want to account for risk aversion. But it is not clear that one should therefore increase the value of damages. In financial decisions, investors generally want a discount if the benefits of a project are uncertain. In this case, the benefits of abatement (reduced damages) are highly uncertain.

EQUITY The report advocates adding an equity weight that automatically increases damages that happen to poor people. Recent research does suggest that the bulk of the damages from climate change will fall on poor people in the low latitudes. This does raise an important equity question. Emitters should feel responsible for compensating these victims. However, spending more on mitigation does very little to address this equity question.

If society is concerned about equity, it should help the poor adapt and receive compensation. If society instead spends compensation resources on mitigation, the victims are actually made worse off in the name of equity.

Given this long list of assumptions, the Stern Report then calculates that the constant percentage reduction in annual income that would equal the damages from unregulated greenhouse gases would be at least 5 percent of income per year, but more likely would be 20 percent of income for now and forever. According to the Stern Report, the present value of the damages from emitting the equivalent of one more ton of carbon dioxide is \$85.

It is interesting to compare these results with the most recent empirical analyses of climate impacts that I have produced together with Larry Williams. If climate change does not cause large increases in extreme events and non-market effects are small, the expected impacts from global warming are only 0.1 percent of GDP by 2100. These new estimates capture the benefits as well as the damages of warming. They also include adaptation. Further, our newest studies suggest that the damages of higher temperatures over the next 50 years cannot be distinguished from zero. That is, warming would cause equal amounts of global damages and benefits as long as concentrations remain below 550 ppm. It is only in the second half of the century, when temperatures begin to climb above 2°C, that warming becomes clearly harmful. That is, the marginal damages from warming first become harmful (different from zero) at about the temperatures that would be reached with a greenhouse gas ceiling of 550 ppm.

ABATEMENT COSTS

The Stern Report argues that it is far less costly to control greenhouse gases than economists earlier estimated. It claims that spending just 1 percent of income every year would be enough to stabilize atmospheric concentrations by 2050 at 550 ppm.

The stabilization target requires that greenhouse gas emissions be cut gradually at first and then sharply by 2050. By 2050, emissions would have to be 25 percent below

today's levels. In comparison, if current economic growth patterns and emissions patterns continue, greenhouse gas emissions will more than double between now and 2050, which means emissions in that year would have to fall 62 percent from their expected levels in order to meet the Stern Report target.

The report claims that such deep cuts in emissions are technologically possible through a combination of energy technologies and non-carbon emissions reductions. The energy technology gains can be achieved by adding renewable energy sources (42 percent from primarily wind, solar, and biofuels), nuclear power (15 percent), carbon recapture (15 percent), and increased energy efficiency (27 percent). The non-carbon reductions can be met through a combination of eliminating deforestation, reforestation, burning waste for energy in place of fossil fuels, and reducing agricultural emissions.

But there are problems with this proposed program of mitigation. For one thing, carbon recapture is not yet a proven

would have on land, there would be no increase in the price of land, no increase in the price of traditional agricultural crops and timber, and no increase in the cost of preventing deforestation or encouraging reforestation.

Another concern is that the report underestimates the negative environmental effects of its proposed energy program. Burning ethanol raises ozone and particulate levels. Burning municipal waste leads to high levels of particulates because the heterogeneous waste flows cannot be burned efficiently. There are few remaining sites for new hydroelectric dams that do not have serious environmental costs. Hydrogen cars have serious safety concerns. Doubling the number of nuclear plants raises questions of safety and nuclear waste disposal; there has not been a new nuclear plant built in the United States in several decades because of those concerns.

DECLINING PRICE? The report does acknowledge that the cost of abatement may be quite high today. It presents a mar-

One of the critical, and questionable, linchpins of the Stern Report is that technological change will drive down the cost of abatement six-fold by 2050.

technology and the cost of implementing it is highly uncertain. Further, it is not clear whether carbon can be safely stored for long periods of time. Vast quantities of stored carbon could find their way back into the atmosphere, creating the very future catastrophe that the abatement program is intended to prevent. It is possible that carbon recapture must be taken off the list.

If carbon recapture is taken off the list, a vast proportion of the remaining fossil fuels in the world would have to remain in the ground for fear that, if extracted and consumed, they would add to emissions. Virtually all the coal, tar sands, and high-cost oil in the world will be made worthless by strict carbon regulations. The report does not value this loss. It measures only the difference between using renewable energy and fossil fuels at their current price. By failing to value the lost fossil fuels, the report grossly underestimates the cost of the program.

The Stern Report also does not consider the potential problem associated with using large quantities of land for renewable energy. It is one thing to imagine a windmill here and there or solar panels on the top of a few buildings. However, to reach the renewable goals of the report, 5–10 million hectares of solar panels would have to be installed, preferably in sunny locations near the equator. A total of 2 million windmills would have to be installed across 33 million hectares of land. The biofuel sector would need an additional 500 million hectares of land. The report assumes that despite the considerable pressure these additional demands

ginal cost figure that shows an \$85 per ton carbon tax would only reduce emissions by about 8 percent in the United Kingdom. Taxes would have to reach \$250 per ton to achieve the envisioned two-thirds reduction in emissions by 2050. Assuming that the average cost of abatement is the average of these two figures (\$168 per ton) and multiplying by the number of tons removed yields a rough cost estimate of \$8.9 trillion per year. This is roughly equal to 6.5 percent of GDP. Using the discount rate advocated by the report, the displaced investment would be worth about 20 percent of GDP.

The report argues, however, that technological change will drive the costs down over time. By 2020, the report hypothesizes that the costs of reaching the 62 percent reduction would be only 3 percent of GDP, and by 2050 they would be only 1 percent of GDP.

The idea is that if people and firms are forced to buy the new technologies, the costs will automatically fall. The report cites many examples where the costs of technologies have fallen over time. However, the costs of some technologies have not fallen over time. Nuclear power, for example, is more expensive now than before because regulations have required the plants to be safer. Many technologies have been abandoned precisely because their costs have not fallen. Moreover, one must be careful projecting how far costs will fall because one will eventually exhaust all the possible improvements that can be made. One of the critical linchpins of the Stern Report is that technical change will drive down the cost of abatement six-fold by 2050.

EFFICIENT ABATEMENT PATHS

Regardless of the merits of the estimates of costs and damages made in the Stern Report, the analysis makes a serious logical error. The report compares the effects of never regulating greenhouse gases to the abatement costs of stabilizing concentrations at 550 ppm. The analysis ignores the continuum of choices between the two policies. That is, it does not examine whether the net benefits would be higher if concentrations were stabilized at 650 ppm, 750 ppm, or some other level.

Economic theory suggests that one should check whether making small changes in a plan could improve the result. For

analyses did not examine what would happen as the climate system approached a dangerous level. An efficient marginal analysis would always consider future damages. As dangerous levels of climate change approach, the present value of marginal damages would increase dramatically. Regulations would tighten, reducing emissions and avoiding the dangerous level of climate before it comes to pass.

CONCLUSION

The Stern Report shows, given certain assumptions, that adopting an aggressive near-term policy may be better than

The Stern Report does not examine whether the net benefits of regulating emissions would be higher if concentrations were stabilized at some other level.

example, let us add one ton of emissions to the 550 ppm stabilization plan. The catastrophic damages associated with the no-regulation scenario would not occur because the added ton of carbon would not cause temperatures to climb high enough to impose such damages. The marginal damage of that one ton of emissions would effectively be near zero because there are hardly any damages associated with a 2°C increase in temperature. However, if the marginal damages of emissions are near zero, it no longer makes sense to have high marginal costs of abatement. The marginal analysis suggests that more emissions should be allowed; the stabilization plan target is too low. The stabilization plan promoted in the Stern Report is clearly not the best choice available to society.

If this marginal logic (central to economics) encourages society to abandon the 550 ppm stabilization plan suggested in the report, does it necessarily take the world to dangerous levels of climate change? As was stated in the introduction, the seminal economic analysis of climate change did allow greenhouse gases to accumulate for this century. However, earlier

never doing anything at all. However, the question policy-makers should be asking is how aggressive do policies need to be in the near term. Society needs to weigh a number of alternatives besides just stabilizing concentrations at 550 ppm. The risks of climate damages go up with ever-higher stabilization targets, but the mitigation costs fall rapidly. Society needs to settle on the best tradeoff.

The Stern Report helpfully identifies assumptions that could justify spending more on mitigation. If the assumptions about damages prove to be valid, society should be prepared to mitigate more. However, the analysis needs to be based on solid science and economics before hundreds of billions of dollars per year are invested in abatement. **R**

Readings

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