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Greenhouse Economics

The sky may not be falling, but it is getting warmer—maybe. The consequences will not be catastrophic, but they will be costly—maybe. We can reverse the process but should not spend very much to do so right now—maybe. Such is the state of the debate over the greenhouse effect—the apparent tendency of carbon dioxide (CO_2) and other gases to accumulate in the atmosphere, acting like a blanket that traps radiated heat, thereby increasing the earth's temperature. Before turning to the economics of the problem, let's take a brief look at the physical processes involved.

Certain gases in the atmosphere, chiefly water vapor and CO_2, trap heat radiating from the earth's surface. If they did not, the earth's average temperature would be roughly 0° F instead of just over 59° F, and everything would be frozen solid. Human activity helps create some so-called greenhouse gases, including CO_2 (mainly from combustion of fossil fuels), methane (from landfills and livestock), and chlorofluorocarbons (CFCs—from aerosol sprays, air conditioners, and refrigerators). We have the potential, unmatched in any other species, to profoundly alter our ecosystem.

There seems little doubt that humankind has been producing these gases at a record rate and that they are steadily accumulating in the atmosphere. Airborne concentrations of CO_2, for example, are increasing at the rate of about 0.5 percent per year; over the past 50 years, the amount of CO_2 in the atmosphere has risen a total of about 25 percent. Laboratory analysis of glacial ice dating back at least 160,000 years indicates that global temperatures and CO_2 levels in the atmosphere do, in fact, tend to move together, suggesting that the impact of today's rising CO_2 levels may be higher global

temperatures in the future. Indeed, the National Academy of Sciences (NAS) has suggested that by the middle of the twenty-first century, greenhouse gases could be double the levels they were in 1860, and that global temperatures could rise by as much as 2° to 9°F.[1] The possible consequences of such a temperature increase include the following: a rise in the average sea level, inundating coastal areas, including most of Florida; the spread of algal blooms capable of deoxygenating major bodies of water, such as the Chesapeake Bay; and the conversion of much of the midwestern wheat and corn belt into a hot, arid dust bowl.

When an individual drives a car, heats a house, or uses an aerosol hair spray, greenhouse gases are produced. In economic terms, this creates a classic **negative externality.** Most of the costs (in this case, those arising from global warming) are borne by individuals *other than* the one making the decision about how many miles to drive or how much hair spray to use. Because the driver (or sprayer) enjoys all the benefits of the activity but suffers only a part of the cost, that individual engages in more than the economically efficient amount of the activity. In this sense, the problem of greenhouse gases parallels the problem that occurs when someone smokes a cigarette in an enclosed space or litters the countryside with fast-food wrappers. If we are to get individuals to reduce production of greenhouse gases to the efficient rate, we must somehow induce them to act *as though* they bear all the costs of their actions. The two most widely accepted means of doing this are government regulation and taxation, both of which have been proposed to deal with greenhouse gases.

The 1988 Toronto Conference on the Changing Atmosphere, attended by representatives from 48 nations, favored the regulation route. The Conference recommended a mandatory cut in CO_2 emissions by 2005 to 80 percent of their 1988 level—a move that would have required a major reduction in worldwide economic output. The 1997 Kyoto conference on climate change, attended by representatives from 160 nations, made more specific but also more modest proposals. Overall, attendees agreed that by 2012, 38 developed

[1] This amount may not sound like much, but it does not take much to alter the world as we know it. The global average temperature at the height of the last ice age 18,000 years ago—when Canada and most of Europe were covered with ice—was 51°F, just 8° or so cooler than today.

nations should cut greenhouse emissions by 5 percent relative to 1990 levels. Developing nations, including China and India (the two most populous nations in the world), would be exempt from emissions cuts. On the taxation front, one prominent U.S. politician has proposed a tax of $100 per ton on the carbon emitted by fuels. It is estimated that such a tax would raise the price of coal by $70 per ton (about 300 percent) and elevate the price of oil by $8 per barrel, or about 20 percent. These proposals, and others like them, clearly have the potential to reduce the buildup of greenhouse gases but only at substantial costs. It thus makes some sense to ask, what are we likely to get for our money?

Perhaps surprisingly, the answer to this question is not obvious. Consider, for example, the raw facts of the matter. On average over the past century, greenhouse gases have been rising and so has the average global temperature. Yet most of the temperature rise occurred before 1940, whereas most of the increase in greenhouse gases occurred after 1940. In fact, global average temperatures fell about 0.5° F between 1940 and 1970; this cooling actually led a number of prominent scientists during the 1970s to forecast a coming ice age!

Just as disconcerting is that the facts of global temperature change appear different depending on how and where temperature is measured. For example, if one looks only at ground-based measurements, the decade of the 1990s was clearly the warmest on record. Yet the upward trend in temperature that appears to hold true in these data is directly at odds with the results from other sources. Measurements taken using satellites and balloons, for example, suggest that there is *no* tendency for the average temperature of the atmosphere to rise. Why these discrepancies exist and what they mean for the future are issues still unresolved.

Nevertheless, let us suppose for the moment that, barring a significant reduction in greenhouse gas emissions, global warming is either under way or on the way. What can we expect? According to the most comprehensive study yet of this issue, a report by the prestigious National Academy of Sciences, the answer is a "good news, bad news" story.

The bad news is this: the likely rise in the sea level by one to three feet will inundate significant portions of our existing coastline; the expected decline in precipitation will necessitate more widespread use of irrigation; the higher average temperatures will

compel more widespread use of air conditioning, along with the associated higher consumption of energy to power it; and the blazing heat in southern latitudes may make these areas too uncomfortable for all but the most heat-loving souls. The good news is that the technology for coping with changes such as these is well known and the costs of coping surprisingly small—on a scale measured in terms of hundreds of billions of dollars, of course. Moreover, many of the impacts that loom large at the individual level will represent much smaller costs at a societal level. For example, although higher average temperatures could prove disastrous for farmers in southern climes, the extra warmth could be an enormous windfall farther north, where year-round farming might become feasible. Similarly, the loss of shoreline due to rising sea levels would partly just be a migration of coastline inland—current beachfront property owners would suffer, but their inland neighbors would gain.[2]

None of these changes are free, of course, and there remain significant uncertainties about how global warming might affect species other than *Homo sapiens.* It is estimated, for example, that temperate forests can "migrate" only at a rate of about 100 kilometers per century, not fast enough to match the speed at which warming is expected to occur. Similarly, the anticipated rise in the sea level could wipe out between 30 and 70 percent of today's coastal wetlands. Whether new wetlands would develop along our new coastline and what might happen to species that occupy existing wetlands are issues that have not yet been resolved.

Yet the very uncertainties that surround the possible warming of the planet suggest that policy prescriptions of the sort that have been proposed—such as the cut in worldwide CO_2 emissions agreed to at Kyoto—may be too much, too soon. Indeed, the National Academy of Sciences recommended that we learn more before we leap too far. Caution seems particularly wise, because the exclusion of developing nations from any emissions cuts could result in huge costs for developed nations but little or no reduction in worldwide greenhouse gases. Some sense of the damage that can be wrought by ignoring such counsel and rushing into a politically popular response to a complex environmental issue is well illustrated by another atmospheric problem: smog.

[2] There would be a net loss of land area and thus a net economic loss. Nevertheless, the net loss of land would be chiefly in the form of less valuable inshore property.

Although gasoline is a major source of the hydrocarbons in urban air, its contribution to smog is plummeting because new cars are far cleaner than their predecessors. In the 1970s, cars spewed about 9 grams of hydrocarbons per mile; emissions controls brought this down to about 1.5 grams per mile by 1995. The cost of this reduction is estimated to be approximately $1000 for each ton of hydrocarbon emissions prevented—a number that many experts believe to be well below the benefits of the cleaner air that resulted. Despite the improvements in air quality, smog is still a significant problem in many major cities. Additional federal regulations aimed primarily at the nine smoggiest urban areas, including New York, Chicago, and Los Angeles, went into effect in 1995. Meeting these standards meant that gasoline had to be reformulated at a cost of about 6 cents per gallon. This brought the cost of removing each additional ton of hydrocarbons to about $10,000—some 10 times the per-ton cost of removing the first 95 percent from urban air.

Just as significantly, EPA rules require that gasoline have a minimum oxygen content to help it burn. But because gasoline does not naturally contain oxygen, these rules effectively require refiners to put additives in their gas. At this point, there are only two additives that meet the EPA requirements: ethanol (refined from corn), and methyl tertiary butyl ether (MTBE). Because adding ethanol would drive the cost of gas up sharply, refiners have felt compelled to add MTBE. Yet MTBE has contaminated water supplies, and concern over its possible carcinogenic properties had led officials in several states to ban its use.

The costs of the EPA oxygen standards for gasoline are estimated to add 21 cents per gallon to the price of gas. Moreover, the presence of multiple EPA standards across the country has left supplies of gasoline vulnerable to disruption, because fuel often cannot be transshipped from one area to another to meet temporary shortages. This fact has contributed substantially to large spikes in the price of gasoline in major Midwestern cities, such as Milwaukee and Chicago, every time there has been even a minor supply disruption.

Overall, the costs of EPA-mandated gasoline reformulation are huge, even though the EPA has never shown that the oxygen content requirement is necessary to meet its air quality standards. The potential benefits of reformulated gasoline appear to be trivial compared to the costs, yet we are stuck with this EPA mandate, because few politicians want to be accused of being in favor of smog.

There is no doubt that atmospheric concentrations of greenhouse gases are rising and that human actions are the cause. It is probable that, as a result, the global average temperature is, or soon will be, rising. If temperatures do rise significantly, the costs will be large, but the consequences are likely to be manageable. Given the nature of the problem, private action, taken on the individual level, will not yield the optimal outcome for society. Thus the potential gains from government action, in the form of environmental regulations or taxation, are substantial. But the key word here is *potential,* because government action, no matter how well intentioned, does not automatically yield benefits that exceed the costs. As we seek solutions to the potential problems associated with greenhouse gases, we must be sure that the consequences of action are not worse than those of first examining the problem further. If we forget this message, greenhouse economics may turn into bad economics—and worse policy.

DISCUSSION QUESTIONS

1. Why will voluntary actions, undertaken at the individual level, be unlikely to bring about significant reductions in greenhouse gases such as CO_2?
2. Does the fact that the CO_2 produced in one nation results in adverse effects on other nations have any bearing on the likelihood that CO_2 emissions will be reduced to the optimal level? Would the problem be easier to solve if all the costs and benefits were concentrated within a single country? Within a single elevator?
3. The policy approach to greenhouse gases will almost certainly involve limits on emissions, rather than taxes on emissions. Can you suggest why limits rather than taxes are likely to be used?
4. It costs about $80,000 per acre to create wetlands. How reasonable is this number as an estimate of what wetlands are worth?