********** EXECUTIVE SUMMARY **********

The nations of the world are preparing to gather in Kyoto, Japan this December to negotiate measures to slow climate change. Meanwhile, groups led by the fossil fuel industry have been actively lobbying against policy action. These groups initially directed their assault at the scientific research on global warming. However, the growing scientific consensus, strengthened by the conclusions of the 1995 IPCC reports, has undermined this approach.

As a result, fossil energy-related interests have increasingly emphasized economic arguments. They claim that any attempt to reduce greenhouse gas emissions will irreparably damage the economies of the U.S. and other nations. An increasing number of economists and policy experts believe, however, that measures are available that will slow climate change without harming economic growth. In fact, many conclude that carefully constructed policies can stimulate economic productivity and job growth.

This Information Update sheds light on critical aspects of climate change economics, clarifies the economic arguments for climate change mitigation, explains the weaknesses in the fossil industry's positions, and offers a promising view of the economic future under active climate change mitigation policy. As the global warming debate expands from the science to include the economics, economic arguments must not be allowed to obstruct scientists' active participation in the public discussion. This update will not turn most SSI members into economics experts, but it does provide a basic climate change economics "tool kit" to promote effective interaction with the media and policymakers.

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The Economics of Mitigating Climate Change: Boom or Bust?

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** *Underlying Concepts and their Impact in Economic Models*

To support their claims of economic hardship, fossil energy-related interests have relied on two mathematical models of the global economy which attempt to assess the economic impacts of climate change policy action. These modeling efforts suffer from a series of simplifications, assumptions, and gaps that systematically bias the outcome towards high costs and limited benefits.

The most common form of economic analysis applied to climate change policy is cost/benefit analysis (CBA). CBA expresses, in a common monetary unit, the costs and benefits of policy options and identifies those yielding the greatest net benefit. The analysis of policies to mitigate climate change has required the construction of mathematical models because of the complexity of both climate change and the macroeconomics of large economies such as the United States.

Like all models of complex systems, economic models employ a variety of assumptions and simplifications in order to compare different climate change policy options. For example, economic models typically assume that climate change policies are measured only via their impact on the production and consumption of marketed goods. Many assumptions and simplifications such as this one, it turns out, systematically support the contention that policies aimed at slowing climate change pose significant economic burdens -- a viewpoint favorably received by fossil fuel interests to support their campaign for policy inaction. In the remainder of this paper, this viewpoint will be referred to as the "can't do" stance.

The first limitation of the models embraced by the fossil fuel interests concerns the treatment of climate change damages. In comparing the costs and benefits of climate change policy, damages are considered on the benefit side of the ledger, and the benefits of policies to lessen the impacts of climate change are often referred to as "avoided damages." In modeling avoided damages, it is difficult to assign monetary value to impacts that are uncertain, hard

to measure, and not readily exchanged in a market setting, so some analyses have omitted damages altogether. Even those efforts that do include damages typically offer very limited treatment. "Non-market" impacts such as biodiversity loss are undervalued or simply not included precisely because they are not financially exchanged and are therefore difficult to price.

In contrast to damages, the costs of climate change policy are more easily identified and quantified. Economic models therefore typically include costs such as the premature retirement of carbon-intensive capital stock (such as a coal-fired power plant) and the increased cost of manufacturing due to proposed policy measures such as a carbon tax. The constituencies that would be affected by climate mitigation policies -- i.e. utilities, coal mining companies -- are well organized and highly vocal about the suggested costs of such policy measures.

Related to the bias generated by limited treatment of damages is the potential bias introduced by the choice of a "discount rate." This functions much like an interest rate in reverse. Most individuals value resources, or income, available now over the same income supplied in the future. In other words, "a bird in the hand is worth two in the bush." Because of this, economists "discount" resources available in the future to translate them into "present value" terms. This is done by reducing a future economic payment by a chosen percentage (the discount rate) each year starting at the time of the payment and working backwards to the present. A series of costs and benefits that are distributed over time can then be placed on an equal footing for direct comparison.

Many of the benefits of climate change mitigation (avoided damages) are deemphasized in the process of discounting (i.e. using a discount rate) while the costs are emphasized. This is because the presumed costs are expected to occur in the very near-term while the benefits of avoided damage "pay-off" at a later time. Similarly, high discount rates bias against energy resources like energy efficiency and renewables that have higher up-front capital costs but produce a stream of savings over time through reduced expenditures on fuel and electricity.

The extent to which this imbalance occurs depends on the size of the discount rate used. Models favored by the fossil fuel interests tend to use discount rates equivalent to current long-term market interest rates (5% - 7%), arguing that this is the "revealed preference" of individuals engaged in economic activity (for example, see Nordhaus 1994). Others have suggested that a much lower or zero discount rate is the only appropriate choice for a problem such as climate change in which the victims are members of another generation with no voice in current decisions (for example, see Cline 1992). Furthermore, the revealed preferences of current markets tend to reflect the interests of those with financial resources rather than those with little economic power who are far more likely to be the victims of climate change impacts.

"Can't do" analyses also generally ignore the role of innovation. In many of these models, the cost projections of low- or non-carbon technologies (wind power, efficient lighting) reflect current costs rather than future projections. Considerable evidence, empirical and theoretical, supports the contention that the costs of technologies fall, sometimes dramatically, with greater production and use. This reflects both "economies of scale" -- where greater production volumes impart lower per unit cost -- and cost reductions associated with "hands-on" production experience (often called "learning by doing"). Policy action on climate change will likely stimulate the expansion of many low- or non-carbon technologies both because of public investment in research and development and because of the elimination of current market imperfections which keep alternative technologies on the sidelines.

This last point hints at perhaps the most significant gap in analyses that recommend a "can't do" approach to slowing climate change -- the omission of "no regrets" policy options. No regrets policy options, also referred to as "double dividends," include a series of climate change mitigation measures that confer positive economic and environmental side benefits above and beyond those directly derived from avoided damages. For example, lowered emissions of air pollutants such as sulfur dioxide may be a considerable side benefit of greenhouse gas emission reductions (an "environmental double dividend"). Similarly, directing revenue gained from a carbon tax to lower taxes on capital and labor, commonly referred to as "tax shifting," can enhance economic productivity (an "economic double dividend"). No regrets policy options routinely omitted from "can't do" analyses include:

1) Subsidy reforms -- Remove existing subsidies to fossil-fuel energy production. One study found that primary fossil fuel subsidies worldwide are equivalent to a negative carbon tax (or bonus for emitting carbon) of U.S. $40 per ton (Larsen and Shah 1992 as referenced in IPCC 1996c, chapter 11).

2) Tax "shifting" or "recycling" -- Recycle revenue gained from taxing an economic "bad," such as

greenhouse gases, to lower the tax burden on economic "goods," such as capital and labor. Some forms of tax recycling can more than offset the economic impact of a carbon tax. Of the six recycling mechanisms considered in a recent study, encouraging capital formation by reducing taxes on capital investment earnings had the largest offsetting impact (Repetto and Austin 1997 provide an excellent summary of Shackleton et. al. 1992).

3) Elimination of market barriers and imperfections -- Many studies have identified barriers to the adoption of cost-effective low- or non-carbon technologies (DeCanio 1995, Jaffe and Stavins 1994). These barriers include such things as the cost of acquiring sufficient information to guide investment in energy efficient technology or the perceived risks -- real or not -- of installing, operating, or maintaining such technology. Eliminating such market distortions through information "pooling," financial incentive programs, or competitive procurement programs would speed the adoption of energy efficient and non-carbon technology.

4) Consideration of existing environmental externalities -- The use of fossil-based energy produces pollutants such as sulfur dioxide which impart significant harm to public health and the environment. Incorporation of these impacts, conventionally considered "external" to the cost-benefit framework of individual firms, can increase economic efficiency by more accurately pricing fossil-based energy. To the extent that this reduces the use of carbon-based energy, greenhouse gas emission reductions form a "collateral benefit." Conversely, greenhouse gas emission reductions impart collateral benefits by reducing regulated air pollutants. A recent evaluation of this effect concluded that medium to high (~70%) greenhouse gas emissions reductions would cost the same order of magnitude as the collateral benefit that would result from lower levels of traditionally regulated pollutants (Ekins 1996).

5) Innovation policy -- Increase public investment in research and development of low- or non-carbon technologies and enhance private investment through low risk financing, knowledge pooling, or incentive programs. Since individual firms are often hesitant to invest in research and development since their competitors can often "clone" the outcome of their efforts, public investment can speed the innovation process.

A recent comparison of 16 widely used economic models employed in climate change policy analysis found that most of their high-cost bias was the result of omitting no regrets options (Repetto and Austin 1997). The precise magnitude of the benefits of no regrets measures is certainly difficult to quantify. Many analysts are confident, however, that such options can significantly offset the potential costs of climate change mitigation. Regardless of the magnitude, complete omission of these potential benefits undoubtedly biases analyses towards higher costs and lower benefits.

*** The Potential of No Regrets Policies*

A major portion of the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 1996c) was dedicated to an extensive review of the economic and social dimensions of climate change by leading economists and policy experts. Despite holding quite varied views on the overall costs of climate change policies, the experts concluded their analysis in agreement that the implementation of no regrets options can minimize costs while increasing the flexibility of further policy choices. In fact, delaying measures to combat climate change may leave nations poorly prepared to deal with adverse impacts and may increase the possibility of irreversible or very costly consequences. The IPCC pointed out that significant reductions in greenhouse gas emissions are technically possible and can be achieved cost-effectively through energy efficiency, consumer incentives, improvements in vehicle technologies, eliminating fuel subsidies, and increased support for renewable energy technologies.

Internationally, programs of "joint implementation" and "emissions trading" can also facilitate least-cost investments in reducing greenhouse gas emissions. Both concepts would allow industrialized countries to seek greenhouse gas offsets in other countries where costs are lower than they are domestically. In practice, the industrialized nation, or firm, would fund an emissions reduction project -- for example, reforestation or renewable energy -- in another country and use the offset credit to help meet its own binding emissions reductions commitment. The advantage of this approach is that an industrialized country faced with a large, politically difficult price tag for domestic emissions reductions can still meet a substantive reduction target at a lower cost.

A recent letter signed by over 2000 economists, including six Nobel Laureates, also pointed out the importance of no regrets policies (Redefining Progress 1997). The letter, titled the "Economists' Statement on Climate Change," noted that "For the United States, in particular, sound economic analysis shows that there are policy options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the long run."

The IPCC-described policy instruments and many of the no regrets options were incorporated into a recent study produced by the Union of Concerned Scientists and four other groups active in the climate and energy debate. "Energy Innovations" describes a set of U.S. programs and policies that would guide the economy toward a more secure, lower cost, less polluting way of producing and using energy.

Using the U.S. Department of Energy's modeling framework as a starting point, "Energy Innovations" concludes that U.S. greenhouse gas emissions can be reduced 10% below 1990 levels in about 12 years and 46% by 2030, while delivering savings of roughly $530 per household per year in 2010. Nearly 800,000 jobs would be created by 2010 due to the added consumption stimulated by electricity and fuel savings which would be spent largely outside the energy sector on much more labor-intensive goods.

At the core of this and similar studies is the inclusion of market-based policies carefully tailored to different sectors of the economy, overcoming existing imperfections and inefficiencies. "Energy Innovations" suggests policies that would stimulate the diffusion of energy efficient technologies into the U.S. economy and would develop renewable energy technologies. The analysis also reinvigorates policies that have been successful in the past such as a gradual strengthening of gas mileage standards for automobiles. This results in lowered air pollution in addition to cutbacks on greenhouse gas emissions.

** *The Economic Doomsayers*

The Global Climate Coalition -- the most prominent lobby group representing fossil fuel-intense industry on the climate issue -- has based its recent lobbying campaign on two different modeling efforts: a U.S. national economic analysis and an international trade analysis, both developed primarily by the Charles River Associates (EPRI/CRA 1996, CRA 1997, respectively). The GCC has claimed that these studies prove that actions to mitigate climate change will significantly burden the U.S. economy. Yet, both these studies vastly overestimate the costs of mitigation policies. In particular, the Charles River Associates (CRA) results fall far outside the range of results found in 14 other economic models (Krause 1997). In terms of cost estimates for cutting U.S. carbon emissions, CRA results were roughly five times higher than the next most pessimistic model in the study -- results that emerge from the kinds of omissions noted in the first section of this update and a series of more specific biases that further exacerbate its negative outcome.

Perhaps its most glaring bias was an unusually high carbon tax. The CRA report assumes that a tax of approximately $200 per ton of carbon will represent the main policy instrument by which the US curtails greenhouse gas emissions. This is an inappropriate assumption, however, since neither economists nor the Clinton Administration advocate reliance on a single policy measure; those that do favor a carbon tax don't proscribe one of such magnitude. Yet the model implications of CRA's unrealistic carbon tax alarm both the public and policymakers.

Based on the assumption of a very high carbon tax, CRA then concludes that many industries will be threatened by the tax and will simply relocate overseas, particularly to developing countries. In fact, relatively few industries are so carbon intense so as to be severely impacted by a carbon tax. A more balanced analysis than CRA's has shown that energy and energy-intensive industries contribute less than 9 percent to U.S. gross domestic product (GDP) (Krause 1997, Muller 1997). For all other industries -- which represent approximately 90 percent of jobs and economic output in the U.S. -- energy costs are but a small percentage (less than 3 percent) of their total costs.

Even in carbon-intense industries, however, a more realistic tax level ($20 to $50 per ton of carbon) combined with no regrets policies would significantly reduce the likelihood of relocation. Industry may also be able to earn carbon credits through joint implementation or emissions trading that could reduce the economic impact of carbon taxes. If impacts on a small portion of carbon-sensitive U.S. industries cannot be avoided, policies aimed at retaining these industries -- such as border tax adjustments or energy efficiency credits -- could be implemented.

The CRA also overstates the potential for job loss overseas -- likely the biggest threat perceived by the U.S. public. Once again, however, both Krause's and Muller's analyses have shown that the number of jobs represented by energy and energy-intensive industries in this country amount to less than 5 percent of U.S. workers. Still, attention should be paid to those jobs that could be threatened by an emissions reduction policy. This can be done in two ways.

First, the estimated economic gains from no regrets measures could more than pay for the impact suffered by coal miners, oil drillers, and others affected. Investment in retraining and restructuring could alleviate local employment adjustments. For example, estimated economic benefits of $50-200 billion per year from no regrets policies would be 10 to 40 times the entire payroll of the U.S. coal mining industry. Second, with a well-designed no regrets policy, the estimated number of jobs created in less carbon intense industrial sectors are larger than those projected to be lost. The result is a net gain in employment in the overall economy rather than a net loss -- one of the main points of the "Energy Innovations" study.

With their excessively large cost estimates in hand, the GCC goes on to claim that the pain to the U.S. economy won't even achieve any environmental benefit. In their opinion, the current scope of the international climate negotiations -- to produce binding emissions reductions commitments only for developed countries and delayed and/or differential commitments for developing nations -- will only produce international "emissions leakage." In essence, emissions-intense activities in industrialized countries, according to their scenario, will simply be displaced to those nations without binding commitments, resulting in no real emissions reductions on a global scale. Furthermore, the GCC argues that reductions in fossil-fuel consumption in the developed world would cause fossil-fuel prices to drop, leading to greater fossil fuel consumption in developing countries and thereby producing greater carbon emissions.

The concern about international emissions leakage is a legitimate one and is shared by many in the environmental community. However, the real world potential for leakage is poorly characterized, and several modeling studies have come to different conclusions about its magnitude. The 1995 IPCC assessment noted that "currently, there is no consensus among economists about the magnitude of leakage. More research is needed and it would be particularly helpful if leakage rates were calculated for identical simulations employing a consistent set of assumptions, as has already been done in estimating the costs of climate change policies" (IPCC 1996c). In the meantime, it would be more useful to devise policy measures to address leakage and limit the hyperbole around the subject.

** *Conclusion*

Reducing greenhouse gas emissions will undoubtedly have an impact on the economies of the world. A growing number of economists and policy experts, however, has concluded that policies exist which both reduce emissions and contribute to economic growth. Many of these policies incorporate no regrets options -- instruments which simultaneously promise greenhouse gas reductions and other economic and environmental benefits.

The modeling work promoted by the fossil interests suffers from a series of simplifications and omissions which consistently bias the consideration of climate change policy towards high costs and limited benefits. The most important of these omissions is the lack of no regrets policy measures. A number of additional simplifications contribute as well, such as the use of market discount rates, the limited interaction between policy and industrial innovation, the lack of powerful international mechanisms such as emissions trading, and the limited consideration of damages to the environment and economies of the world as a result of climate change.

On the other hand, much recent analytical work incorporating no regrets and other policy approaches shows that greenhouse gas emissions can be reduced while the economy grows. The bottom line is that modernizing our energy use is good for the economic well-being of the country and will improve our health and environment .

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