GEORGE C. Marshall INSTITUTE

8 December 2005

Sir Nicholas Stern
Stern Review
2nd Floor, Room 35/36
HM Treasury
1 Horse Guards Road
London SW1A 2HQ

Dear Sir:

The George C. Marshall Institute, a nonprofit research organization founded in 1984 that is dedicated to fostering and preserving the integrity of science in the development of public policy, is pleased to have the opportunity to submit the following evidence to your inquiry into aspects of the economics of climate change.

The Marshall Institute has addressed several issues identified by the Review as pertinent to its analysis.

How are current estimates of the scale of climate change damage derived?

1. Future climate change will have two components: a natural component and a human-induced component. While there is no doubt that climate has changed naturally in the past and will continue to change naturally in the future, both the magnitude and sign of future natural climate change are unknown. Both the IPCC[1] and the U.S. National Academy of Sciences[2] identify determination of the natural variability of climate as one of the great remaining challenges for climate science. At this time, it is still not possible to distinguish natural variability from human influence.

2. Estimates of climate change damages are estimates of the damages projected to be caused by the human- induced component of climate change. These are based on computer models that have not been validated and which are driven by hypotheses.

3. While the focus of this inquiry is on the economic assessment of climate change damages, it is important to remember that moderate climate change provides economic benefits in temperate zone countries, such as the UK.[3] A complete economic analysis should evaluate the degree to which these benefits offset any damages.

4. The most sophisticated projections of the potential damages from human-induced climate change are developed using the following process[4]:

a. One or more scenarios for future human emissions of greenhouse gases (GHGs) and aerosols, and for human-induced land-use change, are selected as input to a global climate model.
b. The global climate model is run to project a future global climate.
c. The results from the global climate model are downscaled to project a future regional climate.
d. Projections of regional climate are used as input to impacts models, e.g. models that project the effect of climate on water availability in a watershed.
e. The results of the various impact model studies are summed and monetary values assigned to develop an overall damage assessment. Alternatively, damages may be stated in non-monetary terms, number of farmers experiencing drought, or numbers of additional cases of disease.

This process will generate a damage estimate, but it is a highly uncertain estimate due to the reservations in each step of the calculation.

5. While the focus of this inquiry is on the uncertainty in economic projections, it is also important to realize that the climate models used in as input for these economic projections have many shortcomings. The IPCC[5] list of shortcoming includes:

- Discrepancies between the vertical profile of temperature change in the troposphere seen in observations and models.
- Large uncertainties in estimates of internal climate variability (also referred to as natural climate variability) from models and observations.
- Considerable uncertainty in the reconstructions of solar and volcanic forcing which are based on limited observational data for all but the last two decades.
- Large uncertainties in anthropogenic forcings associated with the effects of aerosols.
- Large differences in the response of different models to the same forcing.

Other lists typically add uncertainties about the role of clouds and ocean currents in the climate system, the inability to model El Niño and other observed cyclic phenomena in the climate system, and uncertainty about the sensitivity of the climate system to changes in GHG concentrations to IPCC's list.

How far do the estimates of damage depend on assumptions about future economic growth, and how valid are those growth assumptions?

6. Projections of both the magnitude and composition of future economic growth are critical to the development of damage estimates. The first step in the projection of damages is to pick one or more scenarios for future GHG and aerosol emissions, and for land-use change. These scenarios are based on models of economic growth and, as the IPCC Special Report on Emission Scenarios (SRES)[6] exhaustively detailed, can diverge dramatically. In SRES the IPCC described 40 scenarios projecting conditions in 2100. In these scenarios, cumulative CO_2 emissions between 1990 and

2100, the most important factor determining the human contribution to future atmospheric levels of GHGs, varied by a factor of more than three. Sulfur emissions in 2100, the most important factor determining the human contribution to future aerosol levels, varied by a factor of nearly eight. Overall, IPCC concluded that differences between SRES scenarios were as large a contributor to the uncertainty in projection of future climate as the differences between climate models. The use of projections in this manner requires the use of assumptions that are otherwise unknowable. According to Dr. David Henderson, the methods currently employed by the Intergovernmental Panel on Climate Change (IPCC) to estimate economic effects of climate change are seriously flawed.[7]

7. Economic growth will change the nature and cost of projected damages. Most projections of future climate change include projections of increases in extreme weather events, e.g. tropical storms. While these projections are even less certain than the projections of changes in mean climate[8], they are potentially the most costly impacts of future climate change. Extreme weather events tend to cause large economic losses but small loss of life in rich countries. The opposite is true in poor countries; economic damages may be small in monetary terms, but loss of life is typically much higher. A future consideration is the role of adaptation in determining future economic damages. While adaptation cannot eliminate climate change damages, it can greatly reduce the monetary damage and loss of life they cause. Rich countries have more ability to adapt to future climate change than do poor countries.

8. Almost all recent studies of climate change damages rely on the SRES scenarios. These scenarios are base case scenarios, i.e., they assume that no overt actions will be taken to reduce the human contribution to climate change. This is an obvious shortcoming, since nations of the world are taking action today to reduce GHG emissions and can be expected to take significantly more action as the 21st century proceeds. However, this is not the only problem with the SRES scenarios. The most dramatic estimates of climate change damages result from the SRES scenarios with the highest GHG emissions in 2100. These high emission scenarios have been broadly criticized as unrealistic.[9] IPCC has decided to retain the SRES scenarios for its Fourth Assessment Report (AR4), scheduled for publication in 2007, but has begun a process to develop new scenarios for its Fifth Assessment Report, which will not be published until 2012 or later. This decision means that most of the information on climate change damages in AR4 will be based on suspect economic scenarios.

9. Human emissions of GHGs and aerosols over the next century will depend on rates of population and economic growth, and technological change. These rates are unknowable that far in the future, but some aspects of the future are certain. These include:

    - For the next several decades the world will depend on fossil fuels for 80% or more of its primary energy.
    - Until productivity growth rates and innovation of non-carbon technology overtake economic growth, CO_2 emissions will continue to grow.

- Developing countries will place a higher priority on economic growth than on control of CO_2 emissions until they have reached an economic level comparable to the richer countries of the world.
- Over the long-run, economic growth and advances in technology are associated with fairly continuous reduction in energy intensity. A steady de-carbonization trend has been documented as far back as the 1860s.[10]

10. The Review asks for input on the "appropriate modeling of growth and demand." In reviewing economic estimates derived for the U.S. government regarding various climate change policy, Dr. Michael Canes examined why there was such a wide variance between the prevailing analyses produced.[11] Dr. Canes' review found that the modeling approaches and baseline assumptions were the cause for the varying final outputs. He recommends that subsequent efforts more clearly spell out the structural features of the model, their appropriateness to measure the issues in question, clarify the baseline assumptions and discuss the implications of changes in those assumptions, clearly identify the uncertainties in the modeling process and results, and explicitly identify whether the modeler has assumed the presence of other policy actions and discuss the implications of those policies.

    The scenario approach used by IPCC is the only manageable way to address the uncertainties in economic projections. However, the scenarios have to be realistic. At present, there are no generally accepted economic scenarios for the 21st century that include potential policy actions to reduce GHG emissions.

How does uncertainty about the scale of the problem and its impacts affect the economics of climate change?

11. Due to uncertainties in projections of climate change and on the cost of climate change damages, there are no reliable cost-benefit analyses for climate change. The current state of understanding can be summarized by two statements from the Summary for Policymakers of the Synthesis Report of the IPCC's Third Assessment Report: "Comprehensive, quantitative estimates of the benefits of stabilization at various levels of atmospheric concentrations of greenhouse gases do not yet exist"[12] and "For a variety of reasons, significant differences and uncertainties surround specific quantitative estimates of mitigation costs."[13] A variety of justifications are provided for current and proposed climate change policies, but rigorous economic analysis is not one of them.

Is there sufficient collaboration between scientific and economic research?

12. No. The economists in the IPCC process are in either WG II or WG III. The climate scientists are in WG I. Participants in the different Working Groups learn of each others work largely by reading reports. There are few opportunities in the IPCC process for interactions between the three WGs. But there is also a fundamental problem in the way the IPCC generates assessment reports. Ideally, IPCC should

work on a cyclic basis. WG I should assess the state of scientific knowledge. Based on WG I's assessment, WG II should assess impacts and vulnerability, and opportunities for adaptation. Finally, based on WG II's assessment, WG III should consider need and opportunities for mitigation. Instead, all three WGs work in parallel. As a result WG II considers science from the last IPCC Assessment, not the current one, and WG III looks only at opportunities for mitigation.

What role may technology play in mitigating emissions and how does that alter policies toward developing nations?

13. Developing countries are quickly becoming the dominant source of emissions. Aiding their economic development through the introduction of new technologies addresses the environmental concerns most cost effectively as well as enabling a rising standard of living. Much larger improvements in the quality of life of poor people in developing countries could be achieved by investing in poverty-alleviation projects than by investing in greenhouse gas mitigation. For example, the recently released report: *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*[14] concluded that a program to cut extreme poverty in half and radically improve the lives of at least one billion people in poor developing countries by 2015 would require disbursement of $138 billion in development aid in 2006, an increase over existing commitments of $48 billion, rising to $195 billion in 2015. This is still less than the global target for development aid -- 0.7% of GDP -- pledged by developed nation at the 2002 Monterrey Conference. By comparison, recent economic studies indicate that it would cost the U.S. about $130 billion in GDP loss in 2010 to meet its Kyoto Protocol target provided there was full Annex I trading.[15] It is widely recognized that meeting the targets in the Kyoto Protocol will have only a miniscule effect on the buildup of GHGs in the atmosphere and the potential for human-induced climate change.

14. The Review asks for information on "the dynamics of cost and technological change over time." Dr. David Montgomery demonstrated how increased investment and technology transfer could reduce greenhouse gas emissions from developing countries while promoting, rather than retarding, economic growth.[16] The paper develops a model of economic growth with embodied technology and estimates parameters of the model from historical energy and economic statistics. The estimated model is used to examine the implications of increasing the rate of investment in developing countries, using that investment to speed the retirement of old technology, and upgrading new investment to include the technologies now being chosen in OECD countries. Montgomery finds that accelerating technology transfer (of existing technological assets) from the developed world to the developing world would greatly benefit efforts to stabilize greenhouse has emissions.

15. In another piece, Dr. Montgomery consider whether regulatory approaches would generate the kind of technological innovation needed to address climate change in the long-run.[17] He considers this question by analyzing the technology development assumptions of the cap-and-trade program and concludes that the pricing structure of

an emissions trading system actually undermines the incentives to invest in long-term R&D. He will then outline several options for devising effective R&D policies and programs.

When are damages likely to occur and how satisfactory is the economic approach to dealing with costs and benefits that are distant in time?

16. No one can predict when damages might occur or how sever they might be. Most damage projections are based on assuming climate change near or at the upper end of the IPCC's projections for 2100. These projections are unrealistic for three reasons:

    - They are based on scenarios that assume that no action is taken to control GHG emissions to 2100, when such action is already being taken.
    - They assume unrealistically high growth rates in GHG emissions, CO_2 emissions in 2100 that are five time current CO_2 emissions.
    - They assume that the climate system shows a high sensitivity to increases in GHG concentrations. Reports from a recent IPCC workshop indicate that while there is still a great deal of uncertainty, climate modelers now believe that the climate system is less responsive to GHGs than previous high end estimates.[18]

Respectfully submitted,

Jeffrey Kueter
President

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[1] Houghton, J.T., *et al.*, (2001): *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, p. 698.
[2] NAS (2001): *Climate Change Science: An Analysis of Some Key Questions.* 24 pp.
[3] McCarthy, J.J., *et al.*, (2001): *Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, p. 6.
[4] Lu, X., (2004): The methods for impact study on climate change in China. Presented at UNFCCC SB-20, Bonn, Germany, 18 June 2004. http://unfccc.int/meetings/wprkshops/other_meetings/items/2950.php
[5] Houghton, J.T., *et al.*, (2001): op. cit, pp. 59-61.
[6] Nakićenović, N., *et al.* (2000): *Special Report on Emissions Scenarios.* Cambridge University Press., 599 pp.
[7] Henderson, D. (2004): *Are the IPCC's Global Warming Forecasts based on Faulty Economics?* George Marshall Institute, http://www.marshall.org/article.php?id=275.
[8] Houghton, J.T., *et al.*, (2001): op. cit, pg. 15.
[9] See, for example: Ausubel, J. (2002): *Does Energy Policy Matter?* George C. Marshall Institute. (http://www.marshall.org/article.php?id=7), and copies correspondence from I. Castles and D. Henderson to the Chair of IPCC and their presentations at IPCC technical meetings, available at www.lavoisier.co.au/papers/articles/IPCC issues.html
[10] Ausubel, op. cit.
[11] Canes, M. (2003): *Unraveling the Puzzle: Differing Economic Estimates of Climate Policy*. George Marshall Institute, http://www.marshall.org/article.php?id=192.

[12] Watson, R.T. (ed.), (2001): *Climate Change 2001: Synthesis* Report. Cambridge University Press. Pg.22
[13] *Ibid.*, Pg 24.
[14] Sach, J.D., *et al.* (2005): Investing in development: A practical plan to achieve the UN millennium development goals. http://unmp.forumone.com
[15] Canes, M. (2003): Unraveling the Puzzle: Differing economic estimates of climate policy. www.marshall.org/materials/192.pdf
[16] Montgomery, D. (2004): *Potential for Reducing Carbon Emissions from Non-Annex B Countries through Changes in Technology*. George Marshall Institute, http://www.marshall.org/article.php?id=199.
[17] Montgomery, D. (2005): *Creating Technologies to Reduce Greenhouse Gas Intensity: Policy Options and Opportunities*. George Marshall Institute, http://www.marshall.org/article.php?id=274.
[18] Kerr, R.A. (2004): Three degrees of consensus. *Science*, 305:932-934.

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