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ABSTRACTS for PARALLEL SESSIONS 1-1-1 and 1-1-2

MANAGING UNCERTAINTY AND CLIMATE CHANGE

CHAIRPERSONS: ***Ton Manders and Sonia Yeh***

Uncertainty of Air Pollution Cost Estimates: To What Extent Does It Matter?

Ari RABL[a], Joseph SPADARO[a], Bob van der ZWAAN[b,c]

[a] Centre d'Energétique, Ecole des Mines, Paris, FRANCE
[b] Policies Studies Department, ECN, Energy research Centre of the Netherlands, Petten, The NETHERLANDS
[c] John F. Kennedy School of Government, Harvard University, Cambridge MA, USA
Corresponding author: "Bob van der Zwaan" <vanderzwaan@ecn.nl>

How large is the social cost penalty if one makes the wrong choice because of uncertainties in the estimates of the costs and benefits of environmental policy measures? For discrete choices there is no general rule other than the recommendation to always carefully compare costs and benefits when introducing policies for environmental protection. For continuous choices (e.g., the ceiling for the total emissions of a pollutant by an entire sector or region), it is instructive to look at the cost penalty as a function of the error in the incremental damage cost estimate. Using abatement cost curves for NO_x, SO_2, dioxins, and CO_2, this paper evaluates the cost penalty for errors in the following: national emission ceilings for NO_x and SO_2 in each of 12 countries of Europe, an emission ceiling for dioxins in the UK, and limits for the emission of CO_2 in Europe. The cost penalty turns out to be remarkably insensitive to errors. An error by a factor of 3 due to uncertainties in the damage estimates for NO_x and SO_2 increases the total social cost by at most 20% and in most cases much less. For dioxins, the total social cost is increased by at most 10%. For CO_2, several different possible cost curves are examined: for some the sensitivity to uncertainties is greater than for the other pollutants, but even here the penalty is less than 30% and in most case much less if the true damage costs are twice as high as the ones estimated. The paper also quantifies the benefit of improving the accuracy of damage cost estimates by further research.

Keywords: Uncertainty, social cost, damage cost, air pollution, climate change

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An Analysis Using Cost-Loss-Table to Manage Uncertainty of Global Environmental Damages

Hiromi YAMAMOTO

Central Research Institute of Electric Power Industry (CRIEPI) and the University of Tokyo, Tokyo, JAPAN
Corresponding author: "Hiromi Yamamoto" <yamamoth@criepi.denken.or.jp>

The author re-arranged the damage functions developed in RICE model, using the concept of 'measure functions and oncoming functions', and conducted integrated analyses of global warming using the modified damage functions and analyzed the results using a cost-loss-table (CL table). In the results, they will not be able to avoid the catastrophic damages when they use the damage functions in RICE model. An option of no measure will pay the zero measure cost but the highest loss of the global warming. A measure option using the damage function that supposes the catastrophic impact will happen will pay the highest measure cost but the lowest loss.

Keywords:Integrated assessment model, Global environmental damages, Decision-making, Uncertainty, Catastrophic impacts

Energy Policy, Uncertainty and Collapse of the Atlantic Thermohaline Circulation (THC)

Olivier BAHN[a], A. LEACH[b]

[a] *GERAD and Department of Management Sciences, HEC Montréal, CANADA*
[b] *CRT and Institute of Applied Economics, HEC Montréal, CANADA*
Corresponding author: "Olivier Bahn" <olivier.bahn@hec.ca>

Most climate models indicate the possibility of a complete THC collapse in response to global warming. Climate sensitivity is one of the key parameter influencing such response. The purpose of this presentation is to examine the impact of uncertainty (in particular over climate sensitivity) on the choice of energy policies. We first follow a stochastic programming approach to design, with the MERGE model of Manne and Richels, hedging policies that satisfy THC preservation constraints. We then use a probabilistic optimisation approach to analyse the costs of uncertainty over threshold levels within an adapted version of the DICE model of Nordhaus and Boyer which captures the dynamics of a THC collapse.

Keywords: Abrupt climate change, DICE model, Dynamic programming, Energy policy, MERGE model, Stochastic programming, Thermohaline circulation

Stochastic Integrated Assessment Modelling: the Climate Risk Premium

Georg MUELLER-FUERSTENBERGER

Applied Microeconomics, Economics Department, Bern University, Bern, SWITZERLAND
Corresponding author: "Georg Mueller-Fuerstenberger" <georg.mueller@vwi.unibe.ch>

Climate policy faces uncertainty with respect to both economic and ecological parameters. To date, the inherently stochastic nature is captured mostly by sensitivity analysis and scenario based analysis. This paper provides an innovation to the Integrated Assessment framework by adopting a stochastic growth model. Risk-sensitive agents attach probability distributions to key parameters which feed back into optimal policy design. Key parameters relate to climate damages, – in particular to major disruptions with small probability - long-run economic growth and technological improvements. The stochastic growth approach allows to compute a climate risk-premium on interest rates and energy prices similar to the risk premium on uncertain physical capital returns.

Keywords: Stochastic growth, integrated assessment modelling, climate risk-premium

The Role of Carbon Taxes and R&D Subsidies in Climate Policy

Thomas F. RUTHERFORD

Department of Economics at the University of Colorado, Boulder, CO, USA
Corresponding author: "Thomas F. Rutherford" <rutherford@colorado.edu>

We study the role of technology subsidies in climate policies, using a simple dynamic equilibrium model with learning by doing. The optimal subsidy rate of a carbon-free technology is high when the technology is first adopted, but falls significantly over the next decades. However, the efficiency costs of uniform instead of optimal subsidies, may be low if there are introduction or expansion constraints for a new technology. Finally, supporting existing energy technologies only, may lead to technology lock-in, and the impacts of lock-in increase with the learning potential of new technologies as well as the possibilities for early entry and tight carbon constraints.

Assessment of the economic impact of high energy costs. Comparison between a general and a partial equilibrium model

Francesco GRACCEVA, Umberto CIORBA

Italian National Agency for New Technologies Energy and the Environment (ENEA), Rome, Italy
Corresponding author: "Francesco Gracceva" <francesco.gracceva@casaccia.enea.it>

The general mechanism by which oil prices affect economic performance is generally well understood. But the precise dynamics and especially the magnitude of these effects are uncertain. This study addresses the issue of the economic impact of high energy costs on the Italian energy system by using the MARKAL model generator, a useful tool to understand the interplay between macroeconomy and energy use. The assessment has been carried out through a comparison between the results of a general and a partial equilibrium version of the MARKAL-Italy model.

The general equilibrium version, MARKAL-MACRO-Italy, is a dynamic optimization model that links MARKAL, the 'bottom-up' specification of a country's energy system, with MACRO, a top-down macroeconomic growth model. The principle that guides the computation of the CGE is the maximization of a nonlinear aggregate Welfare function. On the practical side, this means that the solution requires a non-linear optimizer. The linkage between the two models is based upon the concept of an economy-wide production function, whose inputs (capital, labor, energy) may be substituted for each other, but with diminishing returns. Price-induced changes in the production structure will then occur as the relative prices of the factor inputs change. However, the simplified expression of the macroeconomy implies that the model is only able to roughly capture many of the changes in energy demand resulting from changes in exogenous variables.

The partial equilibrium approach, MARKAL-ED Italy, do not represent the whole economic system, but presents the theoretical advantage to allow each energy service demand to be elastic to its own price. The computational approach is based on the Equivalence Theorem (Samuelson, 1952; Takayama and Judge, 1971), stating that "a supply-demand equilibrium is reached when the sum of the producers' and consumers' surpluses is maximized". The analysis of the loss in net social surplus due to higher energy costs (with respect to the base case) represents an alternative way to estimate the effects on GDP. On the practical side, as the model's objective function is to maximize net social surplus, a nonlinear function which is separable and easily linearized (by piecewise linear functions), the optimization problem becomes linear, with large computational advantages.

The MARKAL-Italy model used for this study (developed in the early nineties, see Contaldi, Tosato, 1995, Tosato et al., 1999) represents the domestic energy system and its main emissions from 2004 to 2048 by 4 years periods. About 70 demands for energy services are included, divided in five main sectors: agriculture, industry, transport, commercial and households. The present version includes about 50 power plants types, end-use efficiency and mitigation technologies, fuel levies. The model calculates equilibrium quantities and prices of more than 300 flows of energy goods and materials.

In order to test the impact of high energy prices on the Italian energy system, we defined an alternative scenario in which oil price is 10$/bbl higher than in BAU, for the whole of the projection period. Gas price is assumed to remain strictly linked to the oil price, while coal price increases less. The result of the general equilibrium model is that higher oil prices have a significant adverse impact, already in the short term. In the first period GDP is 0.3% lower compared to the base case, and decreases slightly more afterwards. Even if these values must be considered cautiously, they are similar to other recent estimates (IEA, 2004).

Among the factors explaining this impact there is the ability of end-users to reduce their consumption and switch away from the more expensive fuel, which is quite low in the Italian system. The main result of the simulations carried out through the partial equilibrium version of the model is indeed the possibility to analyse how social surplus changes in response to assumptions about price elasticities of different energy service demands. As a matter of fact, the reduction of social surplus is very different according to the degree of rigidity assumed for the various sectors of the energy system.

Climate Change and Security of Energy Supply: Long-term Synergies and Trade-offs

Hal TURTON[a], Leonardo BARRETO[b]

[a] Environmentally Compatible Energy Strategies (ECS) Program
International Institute for Applied Systems Analysis (IIASA), Laxenburg, AUSTRIA
[b] Energy Economics Group, Paul Scherrer Institute (PSI), Villigen, SWITZERLAND
Corresponding author: "Hal Turton" <turton@iiasa.ac.at>

Security of energy supply and climate change are central concerns for policy makers and important dimensions of the long-term quest for a sustainable global energy system. In this analysis we use the multi-regional energy-systems and technology model ERIS to examine the role of several policy instruments in managing security and climate risks and stimulating technological change towards a more sustainable global energy system in the long-term future. Our analysis provides some policy insights and identifies synergies and trade-offs relating to the potential for security of supply policies to reduce the cost of pursuing climate change mitigation policies, promote the uptake of new technologies, and facilitate a possible transition to a hydrogen economy.

Keywords: climate change, security of supply, technological change

Uncertainty in the Saving – Quantifying the "Rebound Effect"

Mark HOWELLS[a], John "Skip" LAITNER[b], Tom ALFSTAD[a]

[a] Energy Research Centre, University of Cape Town, Cape Town, SOUTH AFRICA
[b] Office of Atmospheric Pollution, Environmental Protection Agency, Washington, DC., USA
Corresponding author: "Tom Alfstad" <talfstad@ebe.uct.ac.za>

GHG-mitigation measures may reduce emissions directly. However, due to knock on effects through the economy, total emissions reductions (direct and indirect) may be different to the direct reductions, introducing uncertainty. We compute the relationship between direct emissions savings and indirect emissions and compare the difference – or the "rebound effect". To do so, we employ a case study and use a straightforward input-output model to track the effect of energy-efficiency measures through the economy of South Africa. We conclude that though the positive "rebound" effects can be significant, the contribution ranges from being limited to encouraging more climate friendly economic development.

An Integrated Model of Energy Use and Carbon Emissions

Youngcho CHANG[a], James A. Roumasset[b]

[a]Department of Economics, National University of Singapore
[b]Department of Economics, University of Hawaii at Manoa, USA
Corresponding author: "Youngcho Chang" <ecscyh@nus.edu.sgl>

This paper constructs a two-sector growth model of the Uzawa-type, albeit with energy resources as well as capital in the production functions. By doing so, unlike other top-down models, we endogenize energy use including substitution among energy resources within a model of optimal growth. This study shows that patterns of resource use are governed by the least price condition. In contrast to other bottom-up studies, we solve for the optimal trajectory of a carbon tax. The carbon tax lasts at least until the year 2185. However, since change in temperature lags behind carbon stock in the atmosphere, the maximum carbon tax occurs before the maximum carbon stock and is reached between the year 2185 and 2305. With the minimal progress in backstop technology, the calculated change in global mean surface temperature relative to the pre-industrial level reaches a maximum (6.2 degrees C) in the year 2305 and then declines. However, under drastic progress in backstop technology for non-carbon emitting resources, the global temperature will rise by only about 1.5 – 2 degrees by the middle of this century and decline steadily. Hence, switching to non-carbon emitting fuels would be a solution for mitigating the atmospheric accumulation of carbon though costs for realizing such technologies are to be verified. It is also found that policies like stabilizing carbon emissions at a certain level are not effective in mitigating temperature rise and they are far costly.

Keywords:Two-Sector Energy Model, Pattern of Energy Use, Temperature Change, Carbon Tax

JEL Codes: Q32, Q42