AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

The Value of ITC under Climate Stabilization

Reyer Gerlagh

NOTA DI LAVORO 126.2005

OCTOBER 2005

CCMP – Climate Change Modelling and Policy
--

Reyer Gerlagh, *IVM/VU*

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
<http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm>

Social Science Research Network Electronic Paper Collection:
<http://ssrn.com/abstract=846311>

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei
Corso Magenta, 63, 20123 Milano (I), web site: www.feem.it, e-mail: working.papers@feem.it

This paper is one of a series published by FEEM on the theme of innovation modeling in the context of the challenge of stabilising atmospheric concentrations of greenhouse gases, as part of the Innovation Modeling Comparison Project. This is an international project launched and overseen by the Steering Committee of the informal International Programme on the Economics of Atmospheric Stabilisation. The broad aim of the collaboration is to advance understanding of the economic issues surrounding atmospheric stabilisation, and the specific aims of the IMCP are to provide insights into the "state of the art" and implications of endogenous modeling of technical change in global energy-environment models when applied to various levels of atmospheric stabilisation.

Members of the Steering Committee provided review comments on earlier drafts and the paper has been forwarded to external review, the final results will be published as a Special Issue of the Energy Journal. The papers have all been encouraged to draw on a common baseline (the "Common Poles-Image baseline") and to report results in comparable formats, so as to facilitate intercomparison of the different modeling results. All the results and judgements expressed here remain the responsibility of the authors.

The work presented in this paper was supported by the Netherlands Organization for Scientific Research (NWO) under contract nr. 016.005.040. FEEM fund the working papers series, and seed money for the coordination work of the Innovation Modeling Comparison Project was provided by UK Department of Environment, Food and Rural Affairs and the German Ministry of Environment.

The author is grateful to Ottmar Edenhofer and Claudia Kemfert for organizing the IMCP (Innovation Modelling Comparison Project) workshop, 23th-24th February 2005, Berlin, where this paper was presented, and to the participants for their comments.

The Value of ITC under Climate Stabilization

Summary

We assess the effect of ITC in a global growth model, DEMETER-1CCS, with learning by doing where energy savings, an energy transition, and carbon capturing and sequestration (CCS) are the main options for emissions reductions. The model accounts for technology based on learning by doing embodied in capital installed in previous periods. We have run five scenarios, one baseline scenario in which climate change policy is assumed absent, and four stabilization scenarios in which atmospheric CO₂ concentrations are stabilized at 550, 500, 450, and 400 ppmv. We find that the timing of emission reductions and the investment strategy is relatively independent of the endogeneity of technological change. The vintages structure of production is more important. But ITC reduces costs by about factor 2, though these benefits only materialize after some decades.

Keywords: Energy, Carbon taxes, Endogenous technological change, Niche markets

JEL Classification: Q43, Q54, Q55

Address for correspondence:

Reyer Gerlagh
IVM/VU
De Boelelaan 1087
1081 HV Amsterdam
The Netherlands
Phone: +31 20 44 49502
Fax: +31 20 44 49553
E-mail: reyer.gerlagh@ivm.vu.nl

1. Introduction

Until recently, most economic assessments of climate-change policies neglected policy's effects on economic performance through technological development. This omission is not surprising, as there is a substantial gap in our understanding of the determinants for both the level and the direction of technological change. Though already in the 1960s there were a few studies that looked into the theory for technological change induced by prices changes in factors of demand (e.g. Kennedy 1964), the topic did not receive much attention until the 1990s. In these years, a stream of so-called endogenous-growth models were developed, describing cumulating knowledge as a major determinant of long-term economic growth (Aghion and Howitt 1992, Mankiw 1995). Following the macro-economic literature on aggregate growth, environmental economics started to apply the insights and to build theoretic models of innovation in relation to environmental policy (Gradus and Smulders 1993; Bovenberg and Smulders 1995, 1996; Verdier 1995; Beltratti 1997; Smulders 1999, Goulder and Mathai 2000; Smulders and de Nooij 2003, Nakada 2004). Subsequently, these insights are now applied to an increasing number of economic models that assess the interplay between energy use, climate change, climate policy and technological change (Carraro and Galeotti 1997, Goulder and Schneider 1999, Nordhaus 2002, Manne and Richels 2002, van der Zwaan *et al.* 2002, Gerlagh and van der Zwaan 2003, 2004, Buonanno *et al.* 2003, Popp 2004, Gerlagh 2004, Gerlagh *et al.* 2004, Gerlagh and Lise 2005). A common finding in these studies is that the inclusion of technical change in the analysis decreases the costs of emission reductions, but whether the cost reduction is substantial, compared to an analysis without induced technological change (ITC), remains subject of debate (Fischer and Morgenstern 2003, Goulder 2004). While some authors suggest that ITC substantially cuts the costs (Manne and Richels 2002, Gerlagh and van der Zwaan 2003), or even renders a double dividend possible (Carraro and Galeotti 1997), others are more pessimistic and claim that ITC will have a relatively small impact compared to the contribution of factor substitution for given technology (Goulder and Schneider 1999, Nordhaus 2002). This paper contributes to that literature, assessing the effect of ITC in a global growth model with learning by doing where energy savings, an energy transition, and carbon capturing and sequestration (CCS) are the main options for emissions reductions. We specifically assess the required investments portfolio in fossil fuel and non-carbon energy sources and in CCS to reach various stabilization targets, and its relation to enhanced learning.

The outlay of the paper is as follows. In Section 2, we present our model, DEMETER-1CCS. It is a growth model with learning by doing for fossil fuels, non-carbon energy, and it contains a

decarbonisation option through CCS, and a simple climate module. The model is an extension of the DEMETER model that has been used for various climate change policy analysis (van der Zwaan *et al.* 2002, Gerlagh and van der Zwaan 2003, 2004, Gerlagh *et al.* 2004). This section presents the primal equations. Welfare and profit functions, and first order conditions are given in the appendix. In Section 3, we briefly elaborate on the calibration issues. In Section 4, we present and discuss calculations for a benchmark and various stabilization scenarios. In Section 5, we conclude.

2. DEMETER-1CCS

The DEMETER model has been used in a few papers already (van der Zwaan *et al.*, 2002, Gerlagh and van der Zwaan, 2003, Gerlagh and van der Zwaan 2004, Gerlagh *et al.* 2004). The model presented here extends the DEMETER-1 model with a description of carbon capturing and sequestration. The model has 30 distinct time periods of five years, each denoted by $t=1, \dots, 30$. The model distinguishes one representative consumer, three representative producers (also referred to as sectors), and a public agent that can set emission taxes to reduce carbon dioxide emissions. Producers are denoted by superscripts $j=C, F, N$, for the producer of the final good or consumption good, the producer of energy based on fossil-fuel technology, and the producer of energy based on carbon-free technology. The final good is produced by sector $j=C$, where output is denoted by Y^C . The same good is used for consumption, investments I in all three sectors and for operating and maintenance M (as usually distinguished in energy models, cf. McDonald and Schrattenholzer, 2001) in both energy sectors $j=F, N$ (1). We also distinguish a separate carbon capture and storage (CCS) activity for which investments and maintenance are required. We assume there is one representative consumer who maximizes welfare (18) subject to a budget constraint, and for the three sectors, we assume a representative producer who maximizes profits, which is equal to the net present value of the cash flows (19) and (20), subject to the production constraints (2)-(8), given below.

To describe production, DEMETER accounts for technology that is embodied in capital installed in previous periods. It therefore distinguishes between production that uses the vintages of previous periods, and production that uses the newest vintage for which the capital stock has been installed in the directly preceding period. The input and output variables, as well as prices, associated with the most recent vintages are denoted by tildes ($\sim$). For every vintage, the production of the final good is based on a nested CES-function, using a capital-labour composite, $\tilde{Z}_t$, and a composite measure for energy services, $\tilde{E}_t$, as intermediates (2), where A_t^1 and A_t^2 are technology coefficients, and γ is the substitution elasticity between $\tilde{Z}_t$ and $\tilde{E}_t$. Notice that the

Lagrange variable for the profit maximization program is given between brackets. The capital-labour composite $\tilde{Z}_t$ has fixed value share α for capital (3). Note that new capital is by definition equal to the investments of one period ahead, $\tilde{K}_t^j = I_{t-1}^j$. We model energy services $\tilde{E}_t$ as consisting of a CES aggregate of energy produced by the sectors F and N (4), where σ is the elasticity of substitution between F and N .

One part of production employs the new vintage, the other part employs the old capital stock that carries over from the previous period. All flows, output, use of energy, labour, and the output of emissions are differentiated between the old and the new vintages. The input/output flow in period t is equal to the corresponding flow for the new vintage, plus the corresponding flow for the old capital stock of the previous period, times a depreciation factor $(1-\delta)$, (5), (6), (7), and (8).

$$C_t + I_t^C + I_t^F + I_t^{CCS} + I_t^N + M_t^F + M_t^{CCS} + M_t^N = Y_t^C. \quad (1)$$

$$\tilde{Y}_t^C = ((A_t^1 \tilde{Z}_t)^{(\gamma-1)/\gamma} + (A_t^2 \tilde{E}_t)^{(\gamma-1)/\gamma})^{\gamma/(\gamma-1)}, \quad (\tilde{\lambda}_t^2) \quad (2)$$

$$\tilde{Z}_t = (I_{t-1}^C)^\alpha (\tilde{L}_t)^{1-\alpha}, \quad (\tilde{\theta}_t) \quad (3)$$

$$\tilde{E}_t = ((\tilde{Y}_t^F)^{(\sigma-1)/\sigma} + (\tilde{Y}_t^N)^{(\sigma-1)/\sigma})^{\sigma/(\sigma-1)}, \quad (\tilde{\chi}_t) \quad (4)$$

$$Y_t^C = (1-\delta)Y_{t-1}^C + \tilde{Y}_t^C, \quad (\tilde{\lambda}_t^1) \quad (5)$$

$$Y_t^j = (1-\delta)Y_{t-1}^j + \tilde{Y}_t^j, \quad (\tilde{\mu}_t^j; j=F,N) \quad (6)$$

$$L_t^j = (1-\delta)L_{t-1}^j + \tilde{L}_t^j, \quad (\tilde{w}_t) \quad (7)$$

$$Em_t = (1-\delta)Em_{t-1} + \tilde{Em}_t. \quad (\tilde{\tau}_t) \quad (8)$$

Both energy producers, the fossil fuel sector $j=F$ and the non-fossil fuel sector $j=N$ are treated almost symmetrically. The only difference is in the costs and in the option for fossil-fuel energy producers to decarbonize through carbon capturing and storage. We first describe the production process for the non-fossil fuel sector. Production of energy, $\tilde{Y}_t^j$ ($j=F,N$), requires investments I_{t-1}^j (in the previous period) and maintenance costs, M_t^j , see (6), (9), (10), (11), and (12). Each new vintage with output $\tilde{Y}_t^j$ requires a certain effort, measured through the variable Q , which is proportional to investments (one period ahead) and maintenance costs (9), where the variable h_t^j is a measure of technology variable over time, and a^j and b^j measure the constant investment and maintenance share in production costs.

$$Q_t^j = h_t^j \tilde{Y}_t^j, \quad (\varphi_{j,t}; j=F,N) \quad (9)$$

$$I_{t-1}^j = Q_t^j / a^j, \quad (\zeta_{j,t}; j=F,N) \quad (10)$$

$$\tilde{M}_t^j = Q_t^j / b^j. \quad (\eta_{j,t}; j=F,N) \quad (11)$$

$$M_t^j = (1-\delta)M_{t-1}^j + \tilde{M}_t^j. \quad (\xi_{j,t}; j=F,N) \quad (12)$$

We assume that knowledge is a public good that is non-rival and non-exclusive. Thus firms will not internalize the positive spill-over effects from their investments in their prices. Hence, the productivity parameter h_t^j is treated as exogenous by the firms, and the individual firms are confronted with constant returns to scale. Profit maximization of (20) subject to (6), (9), (10), (11), and (12) gives zero profits. First order conditions are listed in the appendix.

Energy production based on fossil fuels can be confronted with a carbon tax levied on carbon dioxide emissions, and producers can choose to decarbonize energy through carbon capturing and sequestration (CCS). Carbon dioxide emissions, Em_t , are proportional to the carbon content of fossil fuels, denoted by ε_t^F , but part of emissions, $CCSR$, is captured through a carbon capturing and storage activity (13). The variable $CCSR$ can be understood as the carbon capturing and sequestration ratio. When convenient, we use the acronym CCS for the carbon capturing and storage activity, measured in metric tons of carbon, and $CCSR$ for the ratio of emissions prevented through this activity. The tildes on top of the variable denote that emission intensities are vintage specific. Alternatively, we can interpret the $CCSR$ variable in a broader perspective as a broad decarbonization measure, where ε_t^F is the carbon intensity of a benchmark fuel mix that is optimal without carbon tax, and $CCSR$ includes all activities that reduce carbon dioxide emissions, including fuel-switching options.

Similar to the production of energy described above, the carbon capturing and sequestration process is described through an effort variable Q_t^{CCS} , which is assumed a second order polynomial function of the share of carbon that is captured and sequestered:

$$\tilde{Em}_t = \varepsilon_t^F (1 - CCSR) \tilde{Y}_t^F. \quad (\tilde{\tau}_t) \quad (13)$$

$$Q_t^{CCS} = h_t^{CCS} (CCSR_t + \frac{1}{2} \kappa CCSR_t^2) \varepsilon_t^F, \quad (\varphi_{j,t}; j=CCS) \quad (14)$$

Investments and maintenance costs are described through the same equations as for the production process: (10), (11), and (12). The quadratic cost curve implies that the amount of carbon that is captured and not emitted is linear in the carbon tax.

Technological change

The DEMETER model incorporates various insights from the bottom-up literature that stress the importance of internalizing learning-by-doing effects in climate change analyses. Energy production costs decrease as the experience increases through the installation of new energy vintages. In this version of DEMETER, the endogenous modelling of learning by doing is limited to the energy sectors; we have not included learning effects for overall productivity and energy

efficiency. Thus, A_t^1 and A_t^2 as employed in (2) are exogenously determined by a benchmark (business as usual) growth path.

For energy production and CCS, the variable h_t^j measures the state of technology. More specific, it defines the costs of one unit of output $\tilde{Y}_t^j$ as compared to potential long-term costs. For example, $h_t^j=2$ means that one unit of energy output of sector j costs twice as much investments and maintenance as compared to the situation in the far future when the learning effect has reached its maximum value.

To capture the process of gaining experience and a decreasing value of h_t^j , we introduce the variable X_t that represents experience; it counts accumulated installed new capacity (vintage) at the beginning of period t . For energy production, the new capacity is equal to the output of the new vintage (15). For carbon capturing and sequestration, the new capacity is the amount of emissions prevented (16). Furthermore, we use a scaling function that returns the value for h_t^j as dependent on cumulative experience at the beginning of the period, X_t^j (17). Our scaling function satisfies $\partial h_t^j / \partial X_t^j \leq 0$, that is, production costs decrease as experience increases, and we assume $h_t^j=1$ for $X_t^j \rightarrow \infty$ that is, production costs converge to a strictly positive floor price (minimum amount of input associated with maximum learning effect) given by the levels of a_∞^j and b_∞^j . Finally, we assume a constant learning rate for technologies at the beginning of the learning curve (that is, for small values of X), captured by the power d^j . This means that, initially, production costs decrease by a factor $2^{-d^j}=(1-lr)$, where lr is the so-called learning rate, for every doubling of installed capacity. Such decreases have been observed empirically for a large range of different technologies (IEA/OECD, 2000).

$$X_{t+1}^j = X_t^j + \tilde{Y}_t^j. \quad (j=F, N) \quad (15)$$

$$X_{t+1}^{CCS} = X_t^{CCS} + CCSR_t \varepsilon_t \tilde{Y}_t^F. \quad (16)$$

$$h_t^j = c^j (1-d^j) (X_t^j)^{-d^j} + 1, \quad (j=F, N, CCS) \quad (17)$$

Climate change

Emissions are included in the model through equations (8) and (13). The carbon cycle and climate change dynamics are included by linking emissions to atmospheric, upper ocean, and lower ocean CO₂ storage, and ocean and global average surface temperature, following the RICE model (Nordhaus and Boyer 2000).

3. Calibration and data for numerical analysis

For all parameters but for CCS, an extensive discussion on calibration issues can be found in earlier papers on the DEMETER 1 model (van der Zwaan *et al.*, 2002, Gerlagh and van der Zwaan, 2003, Gerlagh and van der Zwaan 2004, Gerlagh *et al.* 2004). Here we confine ourselves to the parameters that affect CCS. CCS costs consist of three parts: capturing of carbon, that is the separation and compression, its transport, and its storage. For a fossil fuel fired electricity plant, capturing carbon makes the major share in total costs. For this process, only limited commercial experience is available and the cost ranges quoted in the literature are large, dependent on specific capture technology and the power plant in case. But the capture technology part in CCS systems is similar to more common technologies used for sulphur and nitrous oxides removal from flue gases. Worldwide, the costs of applying these technologies have decreased considerably over the past decades (Rubin *et al.*, 2004a and 2004b) and learning rates for capital costs of 11% and 12% were found. We assume that CCS will follow the same route of technological progress, and we take a learning rate of 10%. As DEMETER does not distinguish between the capture and storage parts of CCS technologies, it is supposed that this 10% learning rate is applicable to the employment of CCS at large. Still, application of the learning rate requires an estimation of the initial level of cumulative experience and the initial costs per ton of carbon. To estimate initial cumulative experience, we consider existing carbon dioxide storage e.g. the Sleipner project (0.2-0.3 MtC/yr), in the Weyburn project (1-2 MtC/yr) and West Texas (5-10 MtC/yr), and assume that experience has cumulated to about 20 MtC/yr of CCS capacity installed.

In the first period, we assume that some CCS is economic feasible at costs of around 10 \$/tC (avoided, that is, 3 \$/tCO₂ avoided). This relatively low figure is justified by the assumption that, in some cases, CCS can increase the output of oil fields. At the high-cost end, it is assumed that if one nears the point of applying CCS to the use of all fossil fuel electricity generation, or about one third of total energy demand in primary energy equivalents, costs will be as high as 150 \$/tC.² For the intermediate range, we assume that the amount of CCS applied is linear in the carbon tax. We note that these values imply that the application of a full-cost CCS system would typically add some 2-5 cent/kWh to the costs of electricity.

² The IPCC (Intergovernmental Panel on Climate Change, Working Group III), in an envisaged Special Report on Carbon Dioxide Capture and Storage, is currently in the process of assembling a comprehensive overview of CCS technologies, including an assessment of their prospective costs.

4. Simulation Results

In this section, we will report on the model results of the emission stabilisation scenarios and how they vary with and without endogenous technological change. The overall objective of this part is to analyse the impact of technological change on crucial economic variables like gross world product (GWP), consumption, and investment strategies, that is the composition of the portfolio of technologies subject to emission stabilisation scenarios. Due to limited space, we cannot elaborate on a full sensitivity analysis or parameter study. We refer to Gerlagh and van der Zwaan (2004) and Gerlagh *et al.* (2004) for a discussion on sensitivity of results with respect to various parameters, including the elasticity of substitution between the fossil fuel and non-carbon energy source and the learning rates.

We have run five scenarios, one baseline or ‘business as usual’ (BAU) scenario in which climate change policy is assumed absent, and four stabilization scenarios in which atmospheric CO₂ concentrations are stabilized at 550, 500, 450, and 400 ppmv (Figure 1). Given the inertia of the energy system, e.g. due to past investments in capital for fossil fuel production and fossil fuel combustion, even a very stringent climate change policy cannot let emissions drop to zero immediately. Even when emissions immediately fall (Figure 2), the inertia of the climate system makes it impossible not to overshoot the 400 ppmv target. Therefore, for the 400 ppmv scenario, we demanded the atmospheric stabilization target to be binding from 2100 onwards. Consequently, in the last decades of the 21st century, emissions fall short of the steady state level that is consistent with a stable 400 ppmv concentrations, and can increase somewhat from 2100 onwards. From Figure 2, we also notice that the timing of emission reductions is relatively independent of the endogeneity of technological change. It turns out that the vintages structure of production is more important from the timing perspective. One has to wait for new vintages of capital that are either less energy intensive or are based on carbon-poor energy sources before emissions can drop. Consequently, emission reductions are somewhat delayed. Also, as we know from the literature, the discount rate employed will have a certain effect on timing.

FIGURE 1. *Atmospheric CO₂ concentration*

FIGURE 2. *Global CO₂ emissions*

The model recognizes three basic mechanisms for emission reduction: energy savings, a transition towards renewables, and carbon capturing and sequestration of fossil fuels. The latter two options both contribute to a decarbonisation of the energy system. Figure 3 compares energy savings and decarbonisation of energy in one chart. The figure shows that, for the first decades (one marker per 20 years), both options are equally important. But over time, the curve bends to the left, signifying that energy decarbonisation becomes a more important mechanism.

Figure 4 zooms in on the contribution of CCS on emission reductions; it portrays the annual amount of carbon captured and sequestered. After comparison of this figure with the emissions in Figure 2, we see that CCS substantially contributes to the emission reduction effort.

FIGURE 3. *Mechanisms for emission reductions* FIGURE 4. *Carbon capture and sequestration*

Figure 5 presents the costs of stabilization in terms of loss of Gross World Product (GWP) relative to the baseline scenario, while Figure 6 shows the costs in terms of loss of consumption. Comparing the two figures, an outstanding result is that consumption losses exceed GWP losses by about factor 2. The reason for this is that a stabilization policy substitutes investments for consumption (Figure 7). Carbon capturing and sequestration requires substantial investments (Figure 9), which counts as part of production so that it does not lead to a decrease in output, but it goes at the cost of consumption. Investments in fossil fuel energy supply decrease under a stabilization policy (Figure 8), but this is more than offset by increased investments in non-carbon energy sources (Figure 10). Not only are non-carbon energy sources more expensive than fossil fuels, but they also require a larger share of investments compared to maintenance costs.

Another conclusion we can draw from Figure 5 and Figure 6 is that, first, ITC reduces costs by about factor 2, but these benefits only materialize after some decades. The first twenty years, from 2000 to 2020, ITC has almost no effect on costs, but thereafter, the extra investments in CCS and non-carbon energy sources start to pay off, when they have contributed to an increase in knowledge, and consequently, to lower energy costs. By 2100, in all four stabilization scenarios,

under ITC, GWP is almost unaffected or is even increased compared to the baseline. In the two most-stringent stabilization scenarios, investments in technological change clearly start to pay off as consumption losses decrease during the second half of the 21st century.

FIGURE 5. *Loss of Gross World Product*

FIGURE 6. *Loss of Consumption*

FIGURE 7. *Total Investments per GWP*

FIGURE 8. *Investments in fossil fuels energy*

When we specifically look at the implications of ITC on the investment strategy, we find limited effects only. Basically, investments in fossil fuels under ITC exceed the levels without ITC (Figure 8). The obvious reason is that ITC leads to an increase in costs of fossil fuels because of the foregone learning when the economy substitutes away from fossil fuels. On the other hand, because ITC reduces the costs of CCS and non-carbon energy sources, investments can slightly fall (Figure 9 and Figure 10). The changes brought about by ITC are, however, insubstantial compared to the significance of the stabilization target, especially in the first decades.

FIGURE 9. *Investments in CCS* FIGURE 10. *Investments in non-carbon energy technology*

5. Conclusion

In this paper, we developed a global growth model with learning by doing for fossil fuel energy supply, non-fossil fuel energy supply, and CCS. We used the model to assess the implications of ITC on output, consumption, and investments. Basically, the results suggest that ITC does not affect too much the strategy to follow when we strive for climate stabilization. Whether or not technology adjusts, for carbon dioxide emissions to come down, we will have to save on energy first, and apply CCS to fossil fuels, and finally move away from fossil fuels to alternative energy sources. But the recognition of ITC drastically changes our view on the costs of such policies. When acknowledging that technologies adjust to policy's demand through economic incentives, long-term costs of emission reductions can come down substantially. When we see climate stabilization as one part of a trajectory towards sustainable development, we can understand that such a transition is costly, but need not be a lasting burden.

Appendix. Further model conditions

Welfare maximization is given by (18), where W is total welfare, ρ is the pure time preference, and C_t / L_t is consumption per capita. Intertemporal profits are equal to intertemporal revenues, which, for the consumer good producer, consist of output Y_t^C , expenditures consist of investments, I_t^C (one period ahead), labour L_t at wage w_t , fossil-fuel energy Y_t^F at price μ_t^F , and carbon-free energy, Y_t^N at price μ_t^N (19). For the non-carbon energy producers, profits are equal to the value of output minus investments and maintenance costs (20). For the fossil fuel energy producer, the cash flows equation (20) is adjusted to account for additional costs of investments and maintenance for CCS, and for the carbon tax levied on emissions (21).

$$\text{Max } W = \sum_{t=1}^{\infty} (1+\rho)^{1-t} L_t \ln(C_t / L_t), \quad (18)$$

$$\text{Max } \sum_{t=1}^{\infty} \beta_0^t (Y_t^C - I_t^C - w_t L_t - \mu_t^F Y_t^F - \mu_t^N Y_t^N), \quad (19)$$

$$\text{Max } \sum_{t=1}^{\infty} \beta_0^t (\mu_t^N Y_t^N - I_t^N - M_t^N). \quad (20)$$

$$\text{Max } \sum_{t=1}^{\infty} \beta_0^t (\mu_t^F Y_t^F - I_t^F - M_t^F - I_t^{CSS} - M_t^{CSS} - \tau_t Em_t^F). \quad (21)$$

First order conditions

Welfare optimization gives the Ramsey rule as a first-order-condition for consumption, (22), where β_t is the price depreciation factor from period t to $t+1$. Maximizing net profits (19), subject to the constraints (2)-(8) yields the following first order conditions for Y_t^C , Y_t^j ($j=F,N$), L_t , Em_t , $\tilde{Z}_t$, I_t^C , $\tilde{L}_t$, $\tilde{E}_t$, $\tilde{Y}_t^j$:

$$\beta_t = (C_t / L_t) / ((1+\rho)(C_{t+1} / L_{t+1})). \quad (22)$$

$$\tilde{\lambda}_t = (1-\delta)\beta_t \tilde{\lambda}_{t+1} + 1, \quad (Y_t^C), \quad (23)$$

$$\tilde{\mu}_t^j = (1-\delta)\beta_t \tilde{\mu}_{t+1}^j + \mu_t^j. \quad (Y_t^j, j=F,N), \quad (24)$$

$$\tilde{w}_t^j = (1-\delta)\beta_t \tilde{w}_{t+1}^j + w_t^j. \quad (L_t), \quad (25)$$

$$\tau_t = \tilde{\tau}_t - (1-\delta)\beta_t \tilde{\tau}_{t+1}. \quad (Em_t), \quad (26)$$

$$\tilde{\theta}_t = \tilde{\lambda}_t^2 (A_t^1)^{(\gamma-1)/\gamma} (\tilde{Z}_t / \tilde{Y}_t^C)^{-1/\gamma} \quad (\tilde{Z}_t), \quad (27)$$

$$1 = \beta_t \tilde{\theta}_{t+1} \alpha \tilde{Z}_{t+1} / I_t^C \quad (I_t^C), \quad (28)$$

$$\tilde{w}_t \tilde{L}_t = (1-\alpha) \tilde{\theta}_t \tilde{Z}_{t+1} \quad (\tilde{L}_t), \quad (29)$$

$$\tilde{\chi}_t = \tilde{\lambda}_t^2 (A_t^2)^{(\gamma-1)/\gamma} (\tilde{E}_t / \tilde{Y}_t^C)^{-1/\gamma} \quad (\tilde{E}_t), \quad (30)$$

$$\tilde{\mu}_t^j = \tilde{\chi}_t (\tilde{Y}_t^j / \tilde{E}_t)^{-1/\sigma}. \quad (\tilde{Y}_t^j; j=N,F) \quad (31)$$

where the variables associated with the first order conditions are given between brackets, $\tilde{\lambda}_t$ is the shadow price for $\tilde{Y}_t^C$, that is the Lagrange variable for (5) which is the same as the Lagrange variable for (2), $\tilde{\mu}_t^j$ is the shadow price for $\tilde{Y}_t^j$, and the Lagrange variable for (6), $\tilde{w}_t$ is the shadow price for $\tilde{L}_t$, and the Lagrange variable for (7), $\tilde{\theta}_t$ is the shadow price for the labour/capital composite $\tilde{Z}_t$ and the Lagrange variable for (3), $\tilde{\chi}_t$ is the shadow price for the energy composite $\tilde{E}_t$ and the Lagrange variable for (4).

The non-carbon energy producers maximize net profits (20) subject to (6), (9), (10), (11), and (12). Calculating the first order conditions for Y_t^j , $\tilde{Y}_t^j$, Q_t^j , $\tilde{M}_t^j$, I_{t-1}^j , and M_t^j , we find (24) and

$$\tilde{\mu}_t^N = h_t^N \varphi_t^N, \quad (\tilde{Y}_t^N) \quad (32)$$

$$\varphi_t^j = \zeta_t^j + \eta_t^j, \quad (Q_t^j, j=F, N, CCS) \quad (33)$$

$$\tilde{\xi}_t^j = b^j \eta_t^j, \quad (\tilde{M}_t^j, j=F, N, CCS) \quad (34)$$

$$1 = a^j \beta_t \zeta_{t+1}^j, \quad (I_{t-1}^j, j=F, N, CCS) \quad (35)$$

$$\tilde{\xi}_t^j = (1 - \delta) \beta_t \tilde{\xi}_{t+1}^j + 1, \quad (M_t^j, j=F, N, CCS) \quad (36)$$

where $\tilde{\mu}_t^j$ is the shadow price for $\tilde{Y}_t^j$, and the Lagrange variable for (6), φ_t^j is the shadow price of Q_t^j and the Lagrange variable of (9), ζ_t^j and η_t^j are the Lagrange variables of (10), and (11), and $\tilde{\xi}_t^j$ is the shadow price of $\tilde{M}_t^j$.

The fossil fuel energy producers maximize net profits (21) subject to (6), (8), (9), (10), (11), (12), (13), and (14). Calculating the first order conditions for Y_t^j , Q_t^j , $\tilde{M}_t^j$, I_{t-1}^j , M_t^j , $\tilde{Y}_t^j$, and $CCSR_t$, we find (24) for $j=F$, (33), (34), (35), and (36) for $j=F, CCS$, and

$$\tilde{\mu}_t^F = h_t^F \varphi_t^F + (1 - CCSR_t) \tilde{\tau}_t \varepsilon_t^F + h_t^{CCS} \varphi_t^{CCS} \varepsilon_t^F (CCSR_t + \frac{1}{2} \kappa CCSR_t^2), (\tilde{Y}_t^F) \quad (37)$$

$$(1 + \kappa CCSR_t) \varphi_t^{CCS} h_t^{CCS} \geq \tau_t \perp CCSR_t \geq 0, \quad (CCSR_t) \quad (38)$$

respectively, where the Lagrange variable of (12), $\tilde{\tau}_t$ is the shadow price for $\tilde{E}m_t$ and the Lagrange variable for (8), which has the same value as the Lagrange variable for (13).

References

- Aghion P. and P. Howitt (1992) "A model of growth through creative destruction" in *Econometrica* **60**: 323-351.
- Beltratti, A., 1997, "Growth with Natural and Environmental Resources", in C. Carraro and D. Siniscalco, eds., *New Directions in the Economic Theory of the Environment*, Cambridge University Press, Cambridge.
- Bovenberg A.L. and S.A. Smulders (1995) "Environmental quality and pollution-augmenting technological change in a two-sector endogenous growth model" in *Journal of Public Economics* **57**: 369-391.
- Bovenberg, A.L., and S.A. Smulders, 1996, "Transitional Impacts of Environmental Policy in an Endogenous Growth Model", *International Economic Review* 37: 861-893.
- Carraro C. and M. Galeotti (1997) "Economic growth, international competitiveness and environmental protection: R&D innovation strategies with the WARM model" in *Energy Economics* **19**: 2-28.
- Carraro, C., B.C.C. van der Zwaan, and R. Gerlagh (2003), "Endogenous Technological Change in Economy-Environment Modeling, an Introduction", *Resource and Energy Economics*, 25, 1-10.

- Gerlagh R., and W. Lise (2005), "Carbon taxes: a drop in the ocean, or a drop that erodes the stone? The effect of carbon taxes on technological change", *Ecological Economics* forthcoming.
- Gerlagh R. B.C.C. van der Zwaan, M.W. Hofkes, and G. Klaassen (2004), "Impacts of CO₂ taxes when there are niche markets and learning by doing", *Environmental and Resource Economics* 28:367-394.
- Gerlagh R., and B.C.C. van der Zwaan (2004), "A sensitivity analysis on timing and costs of greenhouse gas abatement, calculations with DEMETER", *Climatic Change* 65:39-71.
- Gerlagh R., and B.C.C. van der Zwaan (2003), "Gross World Product and Consumption in a Global Warming Model with Endogenous Technological Change", *Resource and Energy Economics*, 25:35-57.
- Goulder L.H. and S.H.Schneider (1999) "Induced technological change and the attractiveness of CO₂ abatement policies" in *Resource and Energy Economics* 21: 211-253.
- Goulder L.H. and K.Mathai (2000) "Optimal CO₂ abatement in the presence of induced technological change" in *Journal of Environmental Economics and Management* 39: 1-38.
- Gradus R.H.J.M. and S.A.Smulders, 1993, "The trade-off between environmental care and long-term growth; pollution in three prototype growth models" in *Journal of Economics* 58: 25-51.
- Kennedy, C. (1964) Induced bias in innovation and the theory of distribution, *Economic Journal*, 74, 803-19.
- Mankiw N.G. (1995) "The growth of nations" in *Brookings Papers on Economic Activity* 275-310.
- Manne and Richels 2002
- Nakada M. (2004) "Does Environmental Policy Necessarily Discourage Growth?" in *Journal of Economics* 81: 249-275.
- Nordhaus W.D. (2002) "Modeling induced innovation in climate-change policy" in *Modeling induced innovation in climate-change policy*, Ch. 9, edited by A.Grübler, N.Nakicenovic, and W.D.Nordhaus. Resources for the Future Press, Washington.
- Smulders S.A., 1999, "Endogenous growth theory and the environment" in *Handbook of environmental and resource economics*, Ch. 42, edited by J.C.J.M.v.d.Bergh. Edward Elgar,
- Smulders S.A. and M.de Nooij (2003) "The impact of energy conservation on technology and economic growth" in *Resource and Energy Economics* 25: 59-79.
- Verdier, T., 1995, "Environmental Pollution and Endogenous Growth", in C. Carraro and J. Filar, eds., *Control and Game-Theoretic Models of the Environment*, Birkhauser, Boston.
- Zwaan B.C.C. van der, R. Gerlagh, G. Klaassen, and L. Schrattenholzer (2002) Endogenous technological change in climate change modelling, *Energy Economics* 24:1-19.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

<http://www.feem.it/Feem/Pub/Publications/WPapers/default.html>

<http://www.ssrn.com/link/feem.html>

<http://www.repec.org>

NOTE DI LAVORO PUBLISHED IN 2004

IEM	1.2004	Anil MARKANDYA, Suzette PEDROSO and Alexander GOLUB: <u>Empirical Analysis of National Income and So2 Emissions in Selected European Countries</u>
ETA	2.2004	Masahisa FUJITA and Shlomo WEBER: <u>Strategic Immigration Policies and Welfare in Heterogeneous Countries</u>
PRA	3.2004	Adolfo DI CARLUCCIO, Giovanni FERRI, Cecilia FRALE and Ottavio RICCHI: <u>Do Privatizations Boost Household Shareholding? Evidence from Italy</u>
ETA	4.2004	Victor GINSBURGH and Shlomo WEBER: <u>Languages Disenfranchisement in the European Union</u>
ETA	5.2004	Romano PIRAS: <u>Growth, Congestion of Public Goods, and Second-Best Optimal Policy</u>
CCMP	6.2004	Herman R.J. VOLLEBERGH: <u>Lessons from the Polder: Is Dutch CO2-Taxation Optimal</u>
PRA	7.2004	Sandro BRUSCO, Giuseppe LOPOMO and S. VISWANATHAN (lxv): <u>Merger Mechanisms</u>
PRA	8.2004	Wolfgang AUSENNEGG, Pegaret PICHLER and Alex STOMPER (lxv): <u>IPO Pricing with Bookbuilding, and a When-Issued Market</u>
PRA	9.2004	Pegaret PICHLER and Alex STOMPER (lxv): <u>Primary Market Design: Direct Mechanisms and Markets</u>
PRA	10.2004	Florian ENGLMAIER, Pablo GUILLEN, Loreto LLORENTE, Sander ONDERSTAL and Rupert SAUSGRUBER (lxv): <u>The Chopstick Auction: A Study of the Exposure Problem in Multi-Unit Auctions</u>
PRA	11.2004	Bjarne BRENDSTRUP and Harry J. PAARSCH (lxv): <u>Nonparametric Identification and Estimation of Multi-Unit, Sequential, Oral, Ascending-Price Auctions With Asymmetric Bidders</u>
PRA	12.2004	Ohad KADAN (lxv): <u>Equilibrium in the Two Player, k-Double Auction with Affiliated Private Values</u>
PRA	13.2004	Maarten C.W. JANSSEN (lxv): <u>Auctions as Coordination Devices</u>
PRA	14.2004	Gadi FIBICH, Arie GAVIOUS and Aner SELA (lxv): <u>All-Pay Auctions with Weakly Risk-Averse Buyers</u>
PRA	15.2004	Orly SADE, Charles SCHNITZLEIN and Jaime F. ZENDER (lxv): <u>Competition and Cooperation in Divisible Good Auctions: An Experimental Examination</u>
PRA	16.2004	Marta STRYSZOWSKA (lxv): <u>Late and Multiple Bidding in Competing Second Price Internet Auctions</u>
CCMP	17.2004	Slim Ben YOUSSEF: <u>R&D in Cleaner Technology and International Trade</u>
NRM	18.2004	Angelo ANTOCI, Simone BORGHESI and Paolo RUSSU (lxvi): <u>Biodiversity and Economic Growth: Stabilization Versus Preservation of the Ecological Dynamics</u>
SIEV	19.2004	Anna ALBERINI, Paolo ROSATO, Alberto LONGO and Valentina ZANATTA: <u>Information and Willingness to Pay in a Contingent Valuation Study: The Value of S. Erasmo in the Lagoon of Venice</u>
NRM	20.2004	Guido CANDELA and Roberto CELLINI (lxvii): <u>Investment in Tourism Market: A Dynamic Model of Differentiated Oligopoly</u>
NRM	21.2004	Jacqueline M. HAMILTON (lxvii): <u>Climate and the Destination Choice of German Tourists</u>
NRM	22.2004	Javier Rey-MAQUIEIRA PALMER, Javier LOZANO IBÁÑEZ and Carlos Mario GÓMEZ GÓMEZ (lxvii): <u>Land, Environmental Externalities and Tourism Development</u>
NRM	23.2004	Pius ODUNGA and Henk FOLMER (lxvii): <u>Profiling Tourists for Balanced Utilization of Tourism-Based Resources in Kenya</u>
NRM	24.2004	Jean-Jacques NOWAK, Mondher SAHLI and Pasquale M. SGRO (lxvii): <u>Tourism, Trade and Domestic Welfare</u>
NRM	25.2004	Riaz SHAREEF (lxvii): <u>Country Risk Ratings of Small Island Tourism Economies</u>
NRM	26.2004	Juan Luis EUGENIO-MARTÍN, Noelia MARTÍN MORALES and Riccardo SCARPA (lxvii): <u>Tourism and Economic Growth in Latin American Countries: A Panel Data Approach</u>
NRM	27.2004	Raúl Hernández MARTÍN (lxvii): <u>Impact of Tourism Consumption on GDP. The Role of Imports</u>
CSRM	28.2004	Nicoletta FERRO: <u>Cross-Country Ethical Dilemmas in Business: A Descriptive Framework</u>
NRM	29.2004	Marian WEBER (lxvi): <u>Assessing the Effectiveness of Tradable Landuse Rights for Biodiversity Conservation: an Application to Canada's Boreal Mixedwood Forest</u>
NRM	30.2004	Trond BJORN DAL, Phoebe KOUNDOURI and Sean PASCOE (lxvi): <u>Output Substitution in Multi-Species Trawl Fisheries: Implications for Quota Setting</u>
CCMP	31.2004	Marzio GALEOTTI, Alessandra GORIA, Paolo MOMBRINI and Evi SPANTIDAKI: <u>Weather Impacts on Natural, Social and Economic Systems (WISE) Part I: Sectoral Analysis of Climate Impacts in Italy</u>
CCMP	32.2004	Marzio GALEOTTI, Alessandra GORIA, Paolo MOMBRINI and Evi SPANTIDAKI: <u>Weather Impacts on Natural, Social and Economic Systems (WISE) Part II: Individual Perception of Climate Extremes in Italy</u>
CTN	33.2004	Wilson PEREZ: <u>Divide and Conquer: Noisy Communication in Networks, Power, and Wealth Distribution</u>
KTHC	34.2004	Gianmarco I.P. OTTAVIANO and Giovanni PERI (lxviii): <u>The Economic Value of Cultural Diversity: Evidence from US Cities</u>
KTHC	35.2004	Linda CHAIB (lxviii): <u>Immigration and Local Urban Participatory Democracy: A Boston-Paris Comparison</u>

KTHC	36.2004	<i>Franca ECKERT COEN and Claudio ROSSI (Ixviii): <u>Foreigners, Immigrants, Host Cities: The Policies of Multi-Ethnicity in Rome. Reading Governance in a Local Context</u></i>
KTHC	37.2004	<i>Kristine CRANE (Ixviii): <u>Governing Migration: Immigrant Groups' Strategies in Three Italian Cities – Rome, Naples and Bari</u></i>
KTHC	38.2004	<i>Kiflemariam HAMDE (Ixviii): <u>Mind in Africa, Body in Europe: The Struggle for Maintaining and Transforming Cultural Identity - A Note from the Experience of Eritrean Immigrants in Stockholm</u></i>
ETA	39.2004	<i>Alberto CAVALIERE: <u>Price Competition with Information Disparities in a Vertically Differentiated Duopoly</u></i>
PRA	40.2004	<i>Andrea BIGANO and Stef PROOST: <u>The Opening of the European Electricity Market and Environmental Policy: Does the Degree of Competition Matter?</u></i>
CCMP	41.2004	<i>Micheal FINUS (Ixix): <u>International Cooperation to Resolve International Pollution Problems</u></i>
KTHC	42.2004	<i>Francesco CRESPI: <u>Notes on the Determinants of Innovation: A Multi-Perspective Analysis</u></i>
CTN	43.2004	<i>Sergio CURRARINI and Marco MARINI: <u>Coalition Formation in Games without Synergies</u></i>
CTN	44.2004	<i>Marc ESCRIHUELA-VILLAR: <u>Cartel Sustainability and Cartel Stability</u></i>
NRM	45.2004	<i>Sebastian BERVOETS and Nicolas GRAVEL (Ixvi): <u>Appraising Diversity with an Ordinal Notion of Similarity: An Axiomatic Approach</u></i>
NRM	46.2004	<i>Signe ANTHON and Bo JELLES MARK THORSEN (Ixvi): <u>Optimal Afforestation Contracts with Asymmetric Information on Private Environmental Benefits</u></i>
NRM	47.2004	<i>John MBURU (Ixvi): <u>Wildlife Conservation and Management in Kenya: Towards a Co-management Approach</u></i>
NRM	48.2004	<i>Ekin BIROL, Ágnes GYÓVAI and Melinda SMALE (Ixvi): <u>Using a Choice Experiment to Value Agricultural Biodiversity on Hungarian Small Farms: Agri-Environmental Policies in a Transition al Economy</u></i>
CCMP	49.2004	<i>Gernot KLEPPER and Sonja PETERSON: <u>The EU Emissions Trading Scheme. Allowance Prices, Trade Flows, Competitiveness Effects</u></i>
GG	50.2004	<i>Scott BARRETT and Michael HOEL: <u>Optimal Disease Eradication</u></i>
CTN	51.2004	<i>Dinko DIMITROV, Peter BORM, Ruud HENDRICKX and Shao CHIN SUNG: <u>Simple Priorities and Core Stability in Hedonic Games</u></i>
SIEV	52.2004	<i>Francesco RICCI: <u>Channels of Transmission of Environmental Policy to Economic Growth: A Survey of the Theory</u></i>
SIEV	53.2004	<i>Anna ALBERINI, Maureen CROPPER, Alan KRUPNICK and Nathalie B. SIMON: <u>Willingness to Pay for Mortality Risk Reductions: Does Latency Matter?</u></i>
NRM	54.2004	<i>Ingo BRÄUER and Rainer MARGGRAF (Ixvi): <u>Valuation of Ecosystem Services Provided by Biodiversity Conservation: An Integrated Hydrological and Economic Model to Value the Enhanced Nitrogen Retention in Renaturated Streams</u></i>
NRM	55.2004	<i>Timo GOESCHL and Tun LIN (Ixvi): <u>Biodiversity Conservation on Private Lands: Information Problems and Regulatory Choices</u></i>
NRM	56.2004	<i>Tom DEDEURWAERDERE (Ixvi): <u>Bioprospection: From the Economics of Contracts to Reflexive Governance</u></i>
CCMP	57.2004	<i>Katrin REHDANZ and David MADDISON: <u>The Amenity Value of Climate to German Households</u></i>
CCMP	58.2004	<i>Koen SMEKENS and Bob VAN DER ZWAAN: <u>Environmental Externalities of Geological Carbon Sequestration Effects on Energy Scenarios</u></i>
NRM	59.2004	<i>Valentina BOSETTI, Mariaester CASSINELLI and Alessandro LANZA (Ixvii): <u>Using Data Envelopment Analysis to Evaluate Environmentally Conscious Tourism Management</u></i>
NRM	60.2004	<i>Timo GOESCHL and Danilo CAMARGO IGLIORI (Ixvi): <u>Property Rights Conservation and Development: An Analysis of Extractive Reserves in the Brazilian Amazon</u></i>
CCMP	61.2004	<i>Barbara BUCHNER and Carlo CARRARO: <u>Economic and Environmental Effectiveness of a Technology-based Climate Protocol</u></i>
NRM	62.2004	<i>Elissaios PAPYRAKIS and Reyer GERLAGH: <u>Resource-Abundance and Economic Growth in the U.S.</u></i>
NRM	63.2004	<i>Györgyi BELA, György PATAKI, Melinda SMALE and Mariann HAJDÚ (Ixvi): <u>Conserving Crop Genetic Resources on Smallholder Farms in Hungary: Institutional Analysis</u></i>
NRM	64.2004	<i>E.C.M. RUIJGROK and E.E.M. NILLESEN (Ixvi): <u>The Socio-Economic Value of Natural Riverbanks in the Netherlands</u></i>
NRM	65.2004	<i>E.C.M. RUIJGROK (Ixvi): <u>Reducing Acidification: The Benefits of Increased Nature Quality. Investigating the Possibilities of the Contingent Valuation Method</u></i>
ETA	66.2004	<i>Giannis VARDAS and Anastasios XEPAPADEAS: <u>Uncertainty Aversion, Robust Control and Asset Holdings</u></i>
GG	67.2004	<i>Anastasios XEPAPADEAS and Constadina PASSA: <u>Participation in and Compliance with Public Voluntary Environmental Programs: An Evolutionary Approach</u></i>
GG	68.2004	<i>Michael FINUS: <u>Modesty Pays: Sometimes!</u></i>
NRM	69.2004	<i>Trond BJØRNDAL and Ana BRASÃO: <u>The Northern Atlantic Bluefin Tuna Fisheries: Management and Policy Implications</u></i>
CTN	70.2004	<i>Alejandro CAPARRÓS, Abdelhakim HAMMOUDI and Tarik TAZDAÏT: <u>On Coalition Formation with Heterogeneous Agents</u></i>
IEM	71.2004	<i>Massimo GIOVANNINI, Margherita GRASSO, Alessandro LANZA and Matteo MANERA: <u>Conditional Correlations in the Returns on Oil Companies Stock Prices and Their Determinants</u></i>
IEM	72.2004	<i>Alessandro LANZA, Matteo MANERA and Michael MCALEER: <u>Modelling Dynamic Conditional Correlations in WTI Oil Forward and Futures Returns</u></i>
SIEV	73.2004	<i>Margarita GENIUS and Elisabetta STRAZZERA: <u>The Copula Approach to Sample Selection Modelling: An Application to the Recreational Value of Forests</u></i>

CCMP	74.2004	<i>Rob DELLINK and Ekko van IERLAND: <u>Pollution Abatement in the Netherlands: A Dynamic Applied General Equilibrium Assessment</u></i>
ETA	75.2004	<i>Rosella LEVAGGI and Michele MORETTO: <u>Investment in Hospital Care Technology under Different Purchasing Rules: A Real Option Approach</u></i>
CTN	76.2004	<i>Salvador BARBERÀ and Matthew O. JACKSON (lxx): <u>On the Weights of Nations: Assigning Voting Weights in a Heterogeneous Union</u></i>
CTN	77.2004	<i>Àlex ARENAS, Antonio CABRALES, Albert DÍAZ-GUILERA, Roger GUIMERA and Fernando VEGA-REDONDO (lxx): <u>Optimal Information Transmission in Organizations: Search and Congestion</u></i>
CTN	78.2004	<i>Francis BLOCH and Armando GOMES (lxx): <u>Contracting with Externalities and Outside Options</u></i>
CTN	79.2004	<i>Rabah AMIR, Effrosyni DIAMANTOUDI and Licun XUE (lxx): <u>Merger Performance under Uncertain Efficiency Gains</u></i>
CTN	80.2004	<i>Francis BLOCH and Matthew O. JACKSON (lxx): <u>The Formation of Networks with Transfers among Players</u></i>
CTN	81.2004	<i>Daniel DIERMEIER, Hülya ERASLAN and Antonio MERLO (lxx): <u>Bicameralism and Government Formation</u></i>
CTN	82.2004	<i>Rod GARRATT, James E. PARCO, Cheng-ZHONG QIN and Amnon RAPOPORT (lxx): <u>Potential Maximization and Coalition Government Formation</u></i>
CTN	83.2004	<i>Kfir ELIAZ, Debraj RAY and Ronny RAZIN (lxx): <u>Group Decision-Making in the Shadow of Disagreement</u></i>
CTN	84.2004	<i>Sanjeev GOYAL, Marco van der LEIJ and José Luis MORAGA-GONZÁLEZ (lxx): <u>Economics: An Emerging Small World?</u></i>
CTN	85.2004	<i>Edward CARTWRIGHT (lxx): <u>Learning to Play Approximate Nash Equilibria in Games with Many Players</u></i>
IEM	86.2004	<i>Finn R. FØRSUND and Michael HOEL: <u>Properties of a Non-Competitive Electricity Market Dominated by Hydroelectric Power</u></i>
KTHC	87.2004	<i>Elissaios PAPYRAKIS and Reyer GERLAGH: <u>Natural Resources, Investment and Long-Term Income</u></i>
CCMP	88.2004	<i>Marzio GALEOTTI and Claudia KEMFERT: <u>Interactions between Climate and Trade Policies: A Survey</u></i>
IEM	89.2004	<i>A. MARKANDYA, S. PEDROSO and D. STREIMIKIENE: <u>Energy Efficiency in Transition Economies: Is There Convergence Towards the EU Average?</u></i>
GG	90.2004	<i>Rolf GOLOMBEK and Michael HOEL: <u>Climate Agreements and Technology Policy</u></i>
PRA	91.2004	<i>Sergei IZMALKOV (lxv): <u>Multi-Unit Open Ascending Price Efficient Auction</u></i>
KTHC	92.2004	<i>Gianmarco I.P. OTTAVIANO and Giovanni PERI: <u>Cities and Cultures</u></i>
KTHC	93.2004	<i>Massimo DEL GATTO: <u>Agglomeration, Integration, and Territorial Authority Scale in a System of Trading Cities. Centralisation versus devolution</u></i>
CCMP	94.2004	<i>Pierre-André JOUVET, Philippe MICHEL and Gilles ROTILLON: <u>Equilibrium with a Market of Permits</u></i>
CCMP	95.2004	<i>Bob van der ZWAAN and Reyer GERLAGH: <u>Climate Uncertainty and the Necessity to Transform Global Energy Supply</u></i>
CCMP	96.2004	<i>Francesco BOSELLO, Marco LAZZARIN, Roberto ROSON and Richard S.J. TOL: <u>Economy-Wide Estimates of the Implications of Climate Change: Sea Level Rise</u></i>
CTN	97.2004	<i>Gustavo BERGANTIÑOS and Juan J. VIDAL-PUGA: <u>Defining Rules in Cost Spanning Tree Problems Through the Canonical Form</u></i>
CTN	98.2004	<i>Siddhartha BANDYOPADHYAY and Mandar OAK: <u>Party Formation and Coalitional Bargaining in a Model of Proportional Representation</u></i>
GG	99.2004	<i>Hans-Peter WEIKARD, Michael FINUS and Juan-Carlos ALTAMIRANO-CABRERA: <u>The Impact of Surplus Sharing on the Stability of International Climate Agreements</u></i>
SIEV	100.2004	<i>Chiara M. TRAVISI and Peter NIJKAMP: <u>Willingness to Pay for Agricultural Environmental Safety: Evidence from a Survey of Milan, Italy, Residents</u></i>
SIEV	101.2004	<i>Chiara M. TRAVISI, Raymond J. G. M. FLORAX and Peter NIJKAMP: <u>A Meta-Analysis of the Willingness to Pay for Reductions in Pesticide Risk Exposure</u></i>
NRM	102.2004	<i>Valentina BOSETTI and David TOMBERLIN: <u>Real Options Analysis of Fishing Fleet Dynamics: A Test</u></i>
CCMP	103.2004	<i>Alessandra GORIA e Gretel GAMBARELLI: <u>Economic Evaluation of Climate Change Impacts and Adaptability in Italy</u></i>
PRA	104.2004	<i>Massimo FLORIO and Mara GRASSEN: <u>The Missing Shock: The Macroeconomic Impact of British Privatisation</u></i>
PRA	105.2004	<i>John BENNETT, Saul ESTRIN, James MAW and Giovanni URGÀ: <u>Privatisation Methods and Economic Growth in Transition Economies</u></i>
PRA	106.2004	<i>Kira BÖRNER: <u>The Political Economy of Privatization: Why Do Governments Want Reforms?</u></i>
PRA	107.2004	<i>Pehr-Johan NORBÄCK and Lars PERSSON: <u>Privatization and Restructuring in Concentrated Markets</u></i>
SIEV	108.2004	<i>Angela GRANZOTTO, Fabio PRANOVI, Simone LIBRALATO, Patrizia TORRICELLI and Danilo MAINARDI: <u>Comparison between Artisanal Fishery and Manila Clam Harvesting in the Venice Lagoon by Using Ecosystem Indicators: An Ecological Economics Perspective</u></i>
CTN	109.2004	<i>Somdeb LAHIRI: <u>The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results</u></i>
NRM	110.2004	<i>Giuseppe DI VITA: <u>Natural Resources Dynamics: Another Look</u></i>
SIEV	111.2004	<i>Anna ALBERINI, Alistair HUNT and Anil MARKANDYA: <u>Willingness to Pay to Reduce Mortality Risks: Evidence from a Three-Country Contingent Valuation Study</u></i>
KTHC	112.2004	<i>Valeria PAPPONETTI and Dino PINELLI: <u>Scientific Advice to Public Policy-Making</u></i>
SIEV	113.2004	<i>Paulo A.L.D. NUNES and Laura ONOFR: <u>The Economics of Warm Glow: A Note on Consumer's Behavior and Public Policy Implications</u></i>
IEM	114.2004	<i>Patrick CAYRADE: <u>Investments in Gas Pipelines and Liquefied Natural Gas Infrastructure What is the Impact on the Security of Supply?</u></i>
IEM	115.2004	<i>Valeria COSTANTINI and Francesco GRACCEVA: <u>Oil Security. Short- and Long-Term Policies</u></i>

ITEM	116.2004	<i>Valeria COSTANTINI and Francesco GRACCEVA: <u>Social Costs of Energy Disruptions</u></i>
ITEM	117.2004	<i>Christian EGENHOFER, Kyriakos GIALOGLOU, Giacomo LUCIANI, Maroeska BOOTS, Martin SCHEEPERS, Valeria COSTANTINI, Francesco GRACCEVA, Anil MARKANDYA and Giorgio VICINI: <u>Market-Based Options for Security of Energy Supply</u></i>
ITEM	118.2004	<i>David FISK: <u>Transport Energy Security. The Unseen Risk?</u></i>
ITEM	119.2004	<i>Giacomo LUCIANI: <u>Security of Supply for Natural Gas Markets. What is it and What is it not?</u></i>
ITEM	120.2004	<i>L.J. de VRIES and R.A. HAKVOORT: <u>The Question of Generation Adequacy in Liberalised Electricity Markets</u></i>
KTHC	121.2004	<i>Alberto PETRUCCI: <u>Asset Accumulation, Fertility Choice and Nondegenerate Dynamics in a Small Open Economy</u></i>
NRM	122.2004	<i>Carlo GIUPPONI, Jaroslaw MYSLAK and Anita FASSIO: <u>An Integrated Assessment Framework for Water Resources Management: A DSS Tool and a Pilot Study Application</u></i>
NRM	123.2004	<i>Margaretha BREIL, Anita FASSIO, Carlo GIUPPONI and Paolo ROSATO: <u>Evaluation of Urban Improvement on the Islands of the Venice Lagoon: A Spatially-Distributed Hedonic-Hierarchical Approach</u></i>
ETA	124.2004	<i>Paul MENSINK: <u>Instant Efficient Pollution Abatement Under Non-Linear Taxation and Asymmetric Information: The Differential Tax Revisited</u></i>
NRM	125.2004	<i>Mauro FABIANO, Gabriella CAMARSA, Rosanna DURSI, Roberta IVALDI, Valentina MARIN and Francesca PALMISANI: <u>Integrated Environmental Study for Beach Management: A Methodological Approach</u></i>
PRA	126.2004	<i>Irena GROSFELD and Iraj HASHI: <u>The Emergence of Large Shareholders in Mass Privatized Firms: Evidence from Poland and the Czech Republic</u></i>
CCMP	127.2004	<i>Maria BERRITTELLA, Andrea BIGANO, Roberto ROSON and Richard S.J. TOL: <u>A General Equilibrium Analysis of Climate Change Impacts on Tourism</u></i>
CCMP	128.2004	<i>Reyer GERLAGH: <u>A Climate-Change Policy Induced Shift from Innovations in Energy Production to Energy Savings</u></i>
NRM	129.2004	<i>Elissaios PAPYRAKIS and Reyner GERLAGH: <u>Natural Resources, Innovation, and Growth</u></i>
PRA	130.2004	<i>Bernardo BORTOLOTTI and Mara FACCIO: <u>Reluctant Privatization</u></i>
SIEV	131.2004	<i>Riccardo SCARPA and Mara THIENE: <u>Destination Choice Models for Rock Climbing in the Northeast Alps: A Latent-Class Approach Based on Intensity of Participation</u></i>
SIEV	132.2004	<i>Riccardo SCARPA Kenneth G. WILLIS and Melinda ACUTT: <u>Comparing Individual-Specific Benefit Estimates for Public Goods: Finite Versus Continuous Mixing in Logit Models</u></i>
ITEM	133.2004	<i>Santiago J. RUBIO: <u>On Capturing Oil Rents with a National Excise Tax Revisited</u></i>
ETA	134.2004	<i>Ascensión ANDINA DÍAZ: <u>Political Competition when Media Create Candidates' Charisma</u></i>
SIEV	135.2004	<i>Anna ALBERINI: <u>Robustness of VSL Values from Contingent Valuation Surveys</u></i>
CCMP	136.2004	<i>Gernot KLEPPER and Sonja PETERSON: <u>Marginal Abatement Cost Curves in General Equilibrium: The Influence of World Energy Prices</u></i>
ETA	137.2004	<i>Herbert DAWID, Christophe DEISSENBERG and Pavel ŠEVČIK: <u>Cheap Talk, Gullibility, and Welfare in an Environmental Taxation Game</u></i>
CCMP	138.2004	<i>ZhongXiang ZHANG: <u>The World Bank's Prototype Carbon Fund and China</u></i>
CCMP	139.2004	<i>Reyer GERLAGH and Marjan W. HOFKES: <u>Time Profile of Climate Change Stabilization Policy</u></i>
NRM	140.2004	<i>Chiara D'ALPAOS and Michele MORETTO: <u>The Value of Flexibility in the Italian Water Service Sector: A Real Option Analysis</u></i>
PRA	141.2004	<i>Patrick BAJARI, Stephanie HOUGHTON and Steven TADELIS (lxxi): <u>Bidding for Incomplete Contracts</u></i>
PRA	142.2004	<i>Susan ATHEY, Jonathan LEVIN and Enrique SEIRA (lxxi): <u>Comparing Open and Sealed Bid Auctions: Theory and Evidence from Timber Auctions</u></i>
PRA	143.2004	<i>David GOLDREICH (lxxi): <u>Behavioral Biases of Dealers in U.S. Treasury Auctions</u></i>
PRA	144.2004	<i>Roberto BURGUET (lxxi): <u>Optimal Procurement Auction for a Buyer with Downward Sloping Demand: More Simple Economics</u></i>
PRA	145.2004	<i>Ali HORTACSU and Samita SAREEN (lxxi): <u>Order Flow and the Formation of Dealer Bids: An Analysis of Information and Strategic Behavior in the Government of Canada Securities Auctions</u></i>
PRA	146.2004	<i>Victor GINSBURGH, Patrick LEGROS and Nicolas SAHUGUET (lxxi): <u>How to Win Twice at an Auction. On the Incidence of Commissions in Auction Markets</u></i>
PRA	147.2004	<i>Claudio MEZZETTI, Aleksandar PEKEČ and Ilia TSETLIN (lxxi): <u>Sequential vs. Single-Round Uniform-Price Auctions</u></i>
PRA	148.2004	<i>John ASKER and Estelle CANTILLON (lxxi): <u>Equilibrium of Scoring Auctions</u></i>
PRA	149.2004	<i>Philip A. HAILE, Han HONG and Matthew SHUM (lxxi): <u>Nonparametric Tests for Common Values in First-Price Sealed-Bid Auctions</u></i>
PRA	150.2004	<i>François DEGEORGE, François DERRIEN and Kent L. WOMACK (lxxi): <u>Quid Pro Quo in IPOs: Why Bookbuilding is Dominating Auctions</u></i>
CCMP	151.2004	<i>Barbara BUCHNER and Silvia DALL'OLIO: <u>Russia: The Long Road to Ratification. Internal Institution and Pressure Groups in the Kyoto Protocol's Adoption Process</u></i>
CCMP	152.2004	<i>Carlo CARRARO and Marzio GALEOTTI: <u>Does Endogenous Technical Change Make a Difference in Climate Policy Analysis? A Robustness Exercise with the FEEM-RICE Model</u></i>
PRA	153.2004	<i>Alejandro M. MANELLI and Daniel R. VINCENT (lxxi): <u>Multidimensional Mechanism Design: Revenue Maximization and the Multiple-Good Monopoly</u></i>
ETA	154.2004	<i>Nicola ACOCELLA, Giovanni Di BARTOLOMEO and Wilfried PAUWELS: <u>Is there any Scope for Corporatism in Stabilization Policies?</u></i>
CTN	155.2004	<i>Johan EYCKMANS and Michael FINUS: <u>An Almost Ideal Sharing Scheme for Coalition Games with Externalities</u></i>
CCMP	156.2004	<i>Cesare DOSI and Michele MORETTO: <u>Environmental Innovation, War of Attrition and Investment Grants</u></i>

CCMP	157.2004	<i>Valentina BOSETTI, Marzio GALEOTTI and Alessandro LANZA: <u>How Consistent are Alternative Short-Term Climate Policies with Long-Term Goals?</u></i>
ETA	158.2004	<i>Y. Hossein FARZIN and Ken-Ichi AKAO: <u>Non-pecuniary Value of Employment and Individual Labor Supply</u></i>
ETA	159.2004	<i>William BROCK and Anastasios XEPAPADEAS: <u>Spatial Analysis: Development of Descriptive and Normative Methods with Applications to Economic-Ecological Modelling</u></i>
KTHC	160.2004	<i>Alberto PETRUCCI: <u>On the Incidence of a Tax on PureRent with Infinite Horizons</u></i>
IEM	161.2004	<i>Xavier LABANDEIRA, José M. LABEAGA and Miguel RODRÍGUEZ: <u>Microsimulating the Effects of Household Energy Price Changes in Spain</u></i>

NOTE DI LAVORO PUBLISHED IN 2005

CCMP	1.2005	<i>Stéphane HALLEGATTE: <u>Accounting for Extreme Events in the Economic Assessment of Climate Change</u></i>
CCMP	2.2005	<i>Qiang WU and Paulo Augusto NUNES: <u>Application of Technological Control Measures on Vehicle Pollution: A Cost-Benefit Analysis in China</u></i>
CCMP	3.2005	<i>Andrea BIGANO, Jacqueline M. HAMILTON, Maren LAU, Richard S.J. TOL and Yuan ZHOU: <u>A Global Database of Domestic and International Tourist Numbers at National and Subnational Level</u></i>
CCMP	4.2005	<i>Andrea BIGANO, Jacqueline M. HAMILTON and Richard S.J. TOL: <u>The Impact of Climate on Holiday Destination Choice</u></i>
ETA	5.2005	<i>Hubert KEMPF: <u>Is Inequality Harmful for the Environment in a Growing Economy?</u></i>
CCMP	6.2005	<i>Valentina BOSETTI, Carlo CARRARO and Marzio GALEOTTI: <u>The Dynamics of Carbon and Energy Intensity in a Model of Endogenous Technical Change</u></i>
IEM	7.2005	<i>David CALEF and Robert GOBLE: <u>The Allure of Technology: How France and California Promoted Electric Vehicles to Reduce Urban Air Pollution</u></i>
ETA	8.2005	<i>Lorenzo PELLEGRINI and Reyer GERLAGH: <u>An Empirical Contribution to the Debate on Corruption Democracy and Environmental Policy</u></i>
CCMP	9.2005	<i>Angelo ANTOCI: <u>Environmental Resources Depletion and Interplay Between Negative and Positive Externalities in a Growth Model</u></i>
CTN	10.2005	<i>Frédéric DEROLAN: <u>Cost-Reducing Alliances and Local Spillovers</u></i>
NRM	11.2005	<i>Francesco SINDICO: <u>The GMO Dispute before the WTO: Legal Implications for the Trade and Environment Debate</u></i>
KTHC	12.2005	<i>Carla MASSIDDA: <u>Estimating the New Keynesian Phillips Curve for Italian Manufacturing Sectors</u></i>
KTHC	13.2005	<i>Michele MORETTO and Gianpaolo ROSSINI: <u>Start-up Entry Strategies: Employer vs. Nonemployer firms</u></i>
PRCG	14.2005	<i>Clara GRAZIANO and Annalisa LUPORINI: <u>Ownership Concentration, Monitoring and Optimal Board Structure</u></i>
CSRM	15.2005	<i>Parashar KULKARNI: <u>Use of Ecolabels in Promoting Exports from Developing Countries to Developed Countries: Lessons from the Indian LeatherFootwear Industry</u></i>
KTHC	16.2005	<i>Adriana DI LIBERTO, Roberto MURA and Francesco PIGLIARU: <u>How to Measure the Unobservable: A Panel Technique for the Analysis of TFP Convergence</u></i>
KTHC	17.2005	<i>Alireza NAGHAVI: <u>Asymmetric Labor Markets, Southern Wages, and the Location of Firms</u></i>
KTHC	18.2005	<i>Alireza NAGHAVI: <u>Strategic Intellectual Property Rights Policy and North-South Technology Transfer</u></i>
KTHC	19.2005	<i>Mombert HOPPE: <u>Technology Transfer Through Trade</u></i>
PRCG	20.2005	<i>Roberto ROSON: <u>Platform Competition with Endogenous Multihoming</u></i>
CCMP	21.2005	<i>Barbara BUCHNER and Carlo CARRARO: <u>Regional and Sub-Global Climate Blocs. A Game Theoretic Perspective on Bottom-up Climate Regimes</u></i>
IEM	22.2005	<i>Fausto CAVALLARO: <u>An Integrated Multi-Criteria System to Assess Sustainable Energy Options: An Application of the Promethee Method</u></i>
CTN	23.2005	<i>Michael FINUS, Pierre v. MOUCHE and Bianca RUNDSHAGEN: <u>Uniqueness of Coalitional Equilibria</u></i>
IEM	24.2005	<i>Wietze LISE: <u>Decomposition of CO2 Emissions over 1980–2003 in Turkey</u></i>
CTN	25.2005	<i>Somdeb LAHIRI: <u>The Core of Directed Network Problems with Quotas</u></i>
SIEV	26.2005	<i>Susanne MENZEL and Riccardo SCARPA: <u>Protection Motivation Theory and Contingent Valuation: Perceived Realism, Threat and WTP Estimates for Biodiversity Protection</u></i>
NRM	27.2005	<i>Massimiliano MAZZANTI and Anna MONTINI: <u>The Determinants of Residential Water Demand Empirical Evidence for a Panel of Italian Municipalities</u></i>
CCMP	28.2005	<i>Laurent GILOTTE and Michel de LARA: <u>Precautionary Effect and Variations of the Value of Information</u></i>
NRM	29.2005	<i>Paul SARFO-MENSAH: <u>Exportation of Timber in Ghana: The Menace of Illegal Logging Operations</u></i>
CCMP	30.2005	<i>Andrea BIGANO, Alessandra GORIA, Jacqueline HAMILTON and Richard S.J. TOL: <u>The Effect of Climate Change and Extreme Weather Events on Tourism</u></i>
NRM	31.2005	<i>Maria Angeles GARCIA-VALIÑAS: <u>Decentralization and Environment: An Application to Water Policies</u></i>
NRM	32.2005	<i>Chiara D'ALPAOS, Cesare DOSI and Michele MORETTO: <u>Concession Length and Investment Timing Flexibility</u></i>
CCMP	33.2005	<i>Joseph HUBER: <u>Key Environmental Innovations</u></i>
CTN	34.2005	<i>Antoni CALVÓ-ARMENGOL and Rahmi İLKILIÇ (Ixxii): <u>Pairwise-Stability and Nash Equilibria in Network Formation</u></i>
CTN	35.2005	<i>Francesco FERI (Ixxii): <u>Network Formation with Endogenous Decay</u></i>
CTN	36.2005	<i>Frank H. PAGE, Jr. and Myrna H. WOODERS (Ixxii): <u>Strategic Basins of Attraction, the Farsighted Core, and Network Formation Games</u></i>

CTN	37.2005	<i>Alessandra CASELLA and Nobuyuki HANAKI</i> (lxxii): <u>Information Channels in Labor Markets. On the Resilience of Referral Hiring</u>
CTN	38.2005	<i>Matthew O. JACKSON and Alison WATTS</i> (lxxii): <u>Social Games: Matching and the Play of Finitely Repeated Games</u>
CTN	39.2005	<i>Anna BOGOMOLNAIA, Michel LE BRETON, Alexei SAVVATEEV and Shlomo WEBER</i> (lxxii): <u>The Egalitarian Sharing Rule in Provision of Public Projects</u>
CTN	40.2005	<i>Francesco FERI</i> : <u>Stochastic Stability in Network with Decay</u>
CTN	41.2005	<i>Aart de ZEEUW</i> (lxxii): <u>Dynamic Effects on the Stability of International Environmental Agreements</u>
NRM	42.2005	<i>C. Martijn van der HEIDE, Jeroen C.J.M. van den BERGH, Ekko C. van IERLAND and Paulo A.L.D. NUNES</i> : <u>Measuring the Economic Value of Two Habitat Defragmentation Policy Scenarios for the Veluwe, The Netherlands</u>
PRCG	43.2005	<i>Carla VIEIRA and Ana Paula SERRA</i> : <u>Abnormal Returns in Privatization Public Offerings: The Case of Portuguese Firms</u>
SIEV	44.2005	<i>Anna ALBERINI, Valentina ZANATTA and Paolo ROSATO</i> : <u>Combining Actual and Contingent Behavior to Estimate the Value of Sports Fishing in the Lagoon of Venice</u>
CTN	45.2005	<i>Michael FINUS and Bianca RUNDSHAGEN</i> : <u>Participation in International Environmental Agreements: The Role of Timing and Regulation</u>
CCMP	46.2005	<i>Lorenzo PELLEGRINI and Reyer GERLAGH</i> : <u>Are EU Environmental Policies Too Demanding for New Members States?</u>
IEM	47.2005	<i>Matteo MANERA</i> : <u>Modeling Factor Demands with SEM and VAR: An Empirical Comparison</u>
CTN	48.2005	<i>Olivier TERCIEUX and Vincent VANNETELBOSCH</i> (lxx): <u>A Characterization of Stochastically Stable Networks</u>
CTN	49.2005	<i>Ana MAULEON, José SEMPERE-MONERRIS and Vincent J. VANNETELBOSCH</i> (lxxii): <u>R&D Networks Among Unionized Firms</u>
CTN	50.2005	<i>Carlo CARRARO, Johan EYCKMANS and Michael FINUS</i> : <u>Optimal Transfers and Participation Decisions in International Environmental Agreements</u>
KTHC	51.2005	<i>Valeria GATTAI</i> : <u>From the Theory of the Firm to FDI and Internalisation: A Survey</u>
CCMP	52.2005	<i>Alireza NAGHAVI</i> : <u>Multilateral Environmental Agreements and Trade Obligations: A Theoretical Analysis of the Doha Proposal</u>
SIEV	53.2005	<i>Margaretha BREIL, Gretel GAMBARELLI and Paulo A.L.D. NUNES</i> : <u>Economic Valuation of On Site Material Damages of High Water on Economic Activities based in the City of Venice: Results from a Dose-Response-Expert-Based Valuation Approach</u>
ETA	54.2005	<i>Alessandra del BOCA, Marzio GALEOTTI, Charles P. HIMMELBERG and Paola ROTA</i> : <u>Investment and Time to Plan: A Comparison of Structures vs. Equipment in a Panel of Italian Firms</u>
CCMP	55.2005	<i>Gernot KLEPPER and Sonja PETERSON</i> : <u>Emissions Trading, CDM, JI, and More – The Climate Strategy of the EU</u>
ETA	56.2005	<i>Maia DAVID and Bernard SINCLAIR-DESGAGNÉ</i> : <u>Environmental Regulation and the Eco-Industry</u>
ETA	57.2005	<i>Alain-Désiré NIMUBONA and Bernard SINCLAIR-DESGAGNÉ</i> : <u>The Pigouvian Tax Rule in the Presence of an Eco-Industry</u>
NRM	58.2005	<i>Helmut KARL, Antje MÖLLER, Ximena MATUS, Edgar GRANDE and Robert KAISER</i> : <u>Environmental Innovations: Institutional Impacts on Co-operations for Sustainable Development</u>
SIEV	59.2005	<i>Dimitra VOUVAKI and Anastasios XEPAPADEAS</i> (lxxiii): <u>Criteria for Assessing Sustainable Development: Theoretical Issues and Empirical Evidence for the Case of Greece</u>
CCMP	60.2005	<i>Andreas LÖSCHEL and Dirk T.G. RÜBBELKE</i> : <u>Impure Public Goods and Technological Interdependencies</u>
PRCG	61.2005	<i>Christoph A. SCHALTEGGER and Benno TORGLER</i> : <u>Trust and Fiscal Performance: A Panel Analysis with Swiss Data</u>
ETA	62.2005	<i>Irene VALSECCHI</i> : <u>A Role for Instructions</u>
NRM	63.2005	<i>Valentina BOSETTI and Gianni LOCATELLI</i> : <u>A Data Envelopment Analysis Approach to the Assessment of Natural Parks' Economic Efficiency and Sustainability. The Case of Italian National Parks</u>
SIEV	64.2005	<i>Arianne T. de BLAEIJ, Paulo A.L.D. NUNES and Jeroen C.J.M. van den BERGH</i> : <u>Modeling 'No-choice' Responses in Attribute Based Valuation Surveys</u>
CTN	65.2005	<i>Carlo CARRARO, Carmen MARCHIORI and Alessandra SGOBBI</i> : <u>Applications of Negotiation Theory to Water Issues</u>
CTN	66.2005	<i>Carlo CARRARO, Carmen MARCHIORI and Alessandra SGOBBI</i> : <u>Advances in Negotiation Theory: Bargaining, Coalitions and Fairness</u>
KTHC	67.2005	<i>Sandra WALLMAN</i> (lxxiv): <u>Network Capital and Social Trust: Pre-Conditions for 'Good' Diversity?</u>
KTHC	68.2005	<i>Asimina CHRISTOFOROU</i> (lxxiv): <u>On the Determinants of Social Capital in Greece Compared to Countries of the European Union</u>
KTHC	69.2005	<i>Eric M. USLANER</i> (lxxiv): <u>Varieties of Trust</u>
KTHC	70.2005	<i>Thomas P. LYON</i> (lxxiv): <u>Making Capitalism Work: Social Capital and Economic Growth in Italy, 1970-1995</u>
KTHC	71.2005	<i>Graziella BERTOCCHI and Chiara STROZZI</i> (lxxv): <u>Citizenship Laws and International Migration in Historical Perspective</u>
KTHC	72.2005	<i>Elsbeth van HYLCKAMA Vlieg</i> (lxxv): <u>Accommodating Differences</u>
KTHC	73.2005	<i>Renato SANSA and Ercole SORI</i> (lxxv): <u>Governance of Diversity Between Social Dynamics and Conflicts in Multicultural Cities. A Selected Survey on Historical Bibliography</u>
IEM	74.2005	<i>Alberto LONGO and Anil MARKANDYA</i> : <u>Identification of Options and Policy Instruments for the Internalisation of External Costs of Electricity Generation. Dissemination of External Costs of Electricity Supply Making Electricity External Costs Known to Policy-Makers</u> <u>MAXIMA</u>

IEM	75.2005	<i>Margherita GRASSO and Matteo MANERA: <u>Asymmetric Error Correction Models for the Oil-Gasoline Price Relationship</u></i>
ETA	76.2005	<i>Umberto CHERUBINI and Matteo MANERA: <u>Hunting the Living Dead A “Peso Problem” in Corporate Liabilities Data</u></i>
CTN	77.2005	<i>Hans-Peter WEIKARD: <u>Cartel Stability under an Optimal Sharing Rule</u></i>
ETA	78.2005	<i>Joëlle NOAILLY, Jeroen C.J.M. van den BERGH and Cees A. WITHAGEN (lxxvi): <u>Local and Global Interactions in an Evolutionary Resource Game</u></i>
ETA	79.2005	<i>Joëlle NOAILLY, Cees A. WITHAGEN and Jeroen C.J.M. van den BERGH (lxxvi): <u>Spatial Evolution of Social Norms in a Common-Pool Resource Game</u></i>
CCMP	80.2005	<i>Massimiliano MAZZANTI and Roberto ZOBOLI: <u>Economic Instruments and Induced Innovation: The Case of End-of-Life Vehicles European Policies</u></i>
NRM	81.2005	<i>Anna LASUT: <u>Creative Thinking and Modelling for the Decision Support in Water Management</u></i>
CCMP	82.2005	<i>Valentina BOSETTI and Barbara BUCHNER: <u>Using Data Envelopment Analysis to Assess the Relative Efficiency of Different Climate Policy Portfolios</u></i>
ETA	83.2005	<i>Ignazio MUSU: <u>Intellectual Property Rights and Biotechnology: How to Improve the Present Patent System</u></i>
KTHC	84.2005	<i>Giulio CAINELLI, Susanna MANCINELLI and Massimiliano MAZZANTI: <u>Social Capital, R&D and Industrial Districts</u></i>
ETA	85.2005	<i>Rosella LEVAGGI, Michele MORETTO and Vincenzo REBBA: <u>Quality and Investment Decisions in Hospital Care when Physicians are Devoted Workers</u></i>
CCMP	86.2005	<i>Valentina BOSETTI and Laurent GILOTTE: <u>Carbon Capture and Sequestration: How Much Does this Uncertain Option Affect Near-Term Policy Choices?</u></i>
CSRM	87.2005	<i>Nicoletta FERRO: <u>Value Through Diversity: Microfinance and Islamic Finance and Global Banking</u></i>
ETA	88.2005	<i>A. MARKANDYA and S. PEDROSO: <u>How Substitutable is Natural Capital?</u></i>
IEM	89.2005	<i>Anil MARKANDYA, Valeria COSTANTINI, Francesco GRACCEVA and Giorgio VICINI: <u>Security of Energy Supply: Comparing Scenarios From a European Perspective</u></i>
CCMP	90.2005	<i>Vincent M. OTTO, Andreas LÖSCHEL and Rob DELLINK: <u>Energy Biased Technical Change: A CGE Analysis</u></i>
PRCG	91.2005	<i>Carlo CAPUANO: <u>Abuse of Competitive Fringe</u></i>
PRCG	92.2005	<i>Ulrich BINDSEIL, Kjell G. NYBORG and Ilya A. STREBULAIEV (lxv): <u>Bidding and Performance in Repo Auctions: Evidence from ECB Open Market Operations</u></i>
CCMP	93.2005	<i>Sabrina AUCI and Leonardo BECCHETTI: <u>The Stability of the Adjusted and Unadjusted Environmental Kuznets Curve</u></i>
CCMP	94.2005	<i>Francesco BOSELLO and Jian ZHANG: <u>Assessing Climate Change Impacts: Agriculture</u></i>
CTN	95.2005	<i>Alejandro CAPARRÓS, Jean-Christophe PEREAU and Tarik TAZDAÏT: <u>Bargaining with Non-Monolithic Players</u></i>
ETA	96.2005	<i>William BROCK and Anastasios XEPAPADEAS (lxxvi): <u>Optimal Control and Spatial Heterogeneity: Pattern Formation in Economic-Ecological Models</u></i>
CCMP	97.2005	<i>Francesco BOSELLO, Roberto ROSON and Richard S.J. TOL (lxxvii): <u>Economy-Wide Estimates of the Implications of Climate Change: Human Health</u></i>
CCMP	98.2005	<i>Rob DELLINK, Michael FINUS and Niels OLIEMAN: <u>Coalition Formation under Uncertainty: The Stability Likelihood of an International Climate Agreement</u></i>
CTN	99.2005	<i>Valeria COSTANTINI, Riccardo CRESCENZI, Fabrizio De FILIPPIS, and Luca SALVATICI: <u>Bargaining Coalitions in the Agricultural Negotiations of the Doha Round: Similarity of Interests or Strategic Choices? An Empirical Assessment</u></i>
IEM	100.2005	<i>Giliola FREY and Matteo MANERA: <u>Econometric Models of Asymmetric Price Transmission</u></i>
IEM	101.2005	<i>Alessandro COLOGNI and Matteo MANERA: <u>Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries</u></i>
KTHC	102.2005	<i>Chiara M. TRAVISI and Roberto CAMAGNI: <u>Sustainability of Urban Sprawl: Environmental-Economic Indicators for the Analysis of Mobility Impact in Italy</u></i>
ETA	103.2005	<i>Livingstone S. LUBOOBI and Joseph Y.T. MUGISHA: <u>HIV/AIDS Pandemic in Africa: Trends and Challenges</u></i>
SIEV	104.2005	<i>Anna ALBERINI, Erik LICHTENBERG, Dominic MANCINI, and Gregmar I. GALINATO: <u>Was It Something I Ate? Implementation of the FDA Seafood HACCP Program</u></i>
SIEV	105.2005	<i>Anna ALBERINI and Aline CHIABAI: <u>Urban Environmental Health and Sensitive Populations: How Much are the Italians Willing to Pay to Reduce Their Risks?</u></i>
SIEV	106.2005	<i>Anna ALBERINI, Aline CHIABAI and Lucija MUEHLENBACHS: <u>Using Expert Judgment to Assess Adaptive Capacity to Climate Change: Evidence from a Conjoint Choice Survey</u></i>
CTN	107.2005	<i>Michele BERNASCONI and Matteo GALIZZI: <u>Coordination in Networks Formation: Experimental Evidence on Learning and Salience</u></i>
KTHC	108.2005	<i>Michele MORETTO and Sergio VERGALLI: <u>Migration Dynamics</u></i>
NRM	109.2005	<i>Antonio MUSOLESI and Mario NOSVELLI: <u>Water Consumption and Long-Run Urban Development: The Case of Milan</u></i>
SIEV	110.2005	<i>Benno TORGLER and Maria A. GARCIA-VALIÑAS: <u>Attitudes Towards Preventing Environmental Damage</u></i>
SIEV	111.2005	<i>Alberto LONGO and Anna ALBERINI: <u>What are the Effects of Contamination Risks on Commercial and Industrial Properties? Evidence from Baltimore, Maryland</u></i>
SIEV	112.2005	<i>Anna ALBERINI and Alberto LONGO: <u>The Value of Cultural Heritage Sites in Armenia: Evidence from a Travel Cost Method Study</u></i>
CCMP	113.2005	<i>Mikel GONZÁLEZ and Rob DELLINK: <u>Impact of Climate Policy on the Basque Economy</u></i>
NRM	114.2005	<i>Gilles LAFFORGUE and Walid OUESLATI: <u>Optimal Soil Management and Environmental Policy</u></i>

NRM	115.2005	<i>Martin D. SMITH and Larry B. CROWDER</i> (lxxvi): <u>Valuing Ecosystem Services with Fishery Rents: A Lumped-Parameter Approach to Hypoxia in the Neuse River Estuary</u>
NRM	116.2005	<i>Dan HOLLAND and Kurt SCHNIER</i> (lxxvi): <u>Protecting Marine Biodiversity: A Comparison of Individual Habitat Quotas (IHQs) and Marine Protected Areas</u>
PRCG	117.2005	<i>John NELLIS</i> : <u>The Evolution of Enterprise Reform in Africa: From State-owned Enterprises to Private Participation in Infrastructure — and Back?</u>
PRCG	118.2005	<i>Bernardo BORTOLOTTI</i> : <u>Italy's Privatization Process and Its Implications for China</u>
SIEV	119.2005	<i>Anna ALBERINI, Marcella VERONESI and Joseph C. COOPER</i> : <u>Detecting Starting Point Bias in Dichotomous-Choice Contingent Valuation Surveys</u>
CTN	120.2005	<i>Federico ECHENIQUE and Mehmet B. YENMEZ</i> : <u>A Solution to Matching with Preferences over Colleagues</u>
KTHC	121.2005	<i>Valeria GATTAI and Corrado MOLTENI</i> : <u>Dissipation of Knowledge and the Boundaries of the Multinational Enterprise</u>
KTHC	122.2005	<i>Valeria GATTAI</i> : <u>Firm's Intangible Assets and Multinational Activity: Joint-Venture Versus FDI</u>
CCMP	123.2005	<i>Socrates KYPREOS</i> : <u>A MERGE Model with Endogenous Technological Change and the Cost of Carbon Stabilization</u>
CCMP	124.2005	<i>Fuminori SANO, Keigo AKIMOTO, Takashi HOMMA and Toshimasa TOMODA</i> : <u>Analysis of Technological Portfolios for CO₂ stabilizations and Effects of Technological Changes</u>
CCMP	125.2005	<i>Fredrik HEDENUS, Christian AZAR and Kristian LINDGREN</i> : <u>Induced Technological Change in a Limited Foresight Optimization Model</u>
CCMP	126.2005	<i>Reyer GERLAGH</i> , <u>The Value of ITC under Climate Stabilization</u>

- (lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003
- (lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003
- (lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003
- (lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003
- (lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003
- (lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004
- (lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004
- (lxxii) This paper was presented at the 10th Coalition Theory Network Workshop held in Paris, France on 28-29 January 2005 and organised by EUREQua.
- (lxxiii) This paper was presented at the 2nd Workshop on "Inclusive Wealth and Accounting Prices" held in Trieste, Italy on 13-15 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics
- (lxxiv) This paper was presented at the ENGIME Workshop on “Trust and social capital in multicultural cities” Athens, January 19-20, 2004
- (lxxv) This paper was presented at the ENGIME Workshop on “Diversity as a source of growth” Rome November 18-19, 2004
- (lxxvi) This paper was presented at the 3rd Workshop on Spatial-Dynamic Models of Economics and Ecosystems held in Trieste on 11-13 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics
- (lxxvii) This paper was presented at the Workshop on Infectious Diseases: Ecological and Economic Approaches held in Trieste on 13-15 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics.

2004 SERIES

CCMP	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
GG	<i>Global Governance</i> (Editor: Carlo Carraro)
SIEV	<i>Sustainability Indicators and Environmental Valuation</i> (Editor: Anna Alberini)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KTHC	<i>Knowledge, Technology, Human Capital</i> (Editor: Gianmarco Ottaviano)
IEM	<i>International Energy Markets</i> (Editor: Anil Markandya)
CSRM	<i>Corporate Social Responsibility and Sustainable Management</i> (Editor: Sabina Ratti)
PRA	<i>Privatisation, Regulation, Antitrust</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)
CTN	<i>Coalition Theory Network</i>

2005 SERIES

CCMP	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
SIEV	<i>Sustainability Indicators and Environmental Valuation</i> (Editor: Anna Alberini)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KTHC	<i>Knowledge, Technology, Human Capital</i> (Editor: Gianmarco Ottaviano)
IEM	<i>International Energy Markets</i> (Editor: Anil Markandya)
CSRM	<i>Corporate Social Responsibility and Sustainable Management</i> (Editor: Sabina Ratti)
PRCG	<i>Privatisation Regulation Corporate Governance</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)
CTN	<i>Coalition Theory Network</i>