Fondazione Eni Enrico Mattei

Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity

Robert N. Stavins, Alexander F. Wagner and
Gernot Wagner

NOTA DI LAVORO 61.2002

SEPTEMBER 2002

ETA – Economic Theory and Applications

Robert N. Stavins, Alexander F. Wagner and Gernot Wagner, *Harvard University*

Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity

Summary

Economists have expended considerable effort to develop economically meaningful definitions of the somewhat elusive concept of "sustainability." We relate such a definition of sustainability to well known concepts from neoclassical economics, in particular, potential Pareto improvements (in the Kaldor-Hicks sense) and inter-personal compensation. In the inter-temporal realm, we find that dynamic efficiency is a necessary but not sufficient condition for a notion of sustainability that has normative standing as a goal for public policy. We define sustainability as dynamic efficiency plus intergenerational equity. Further, we argue that it is not unreasonable for economists to focus on the efficiency element, leaving equity considerations to the political process. The analogy to the relationship between potential Pareto improvements and (intragenerational) transfers can facilitate discussions about sustainability, both within the economics community and as part of an interdisciplinary discourse, and makes the basic concepts easier to operationalize.

Keywords: Sustainability, dynamic efficiency, intergenerational equity

JEL: Q2, Q3

Address for correspondence:

Robert N. Stavins
John F. Kennedy School of Government
Harvard University
Cambridge, MA 02138
Phone: (617) 495-1820
E-mail: robert_stavins@harvard.edu, awagner@fas.harvard.edu
gwagner@post.harvard.edu

The authors thank Geir Asheim, Partha Dasgupta, John Hartwick, John Pezzey and Martin Weitzman for helpful comments on an earlier draft. The authors are responsible for any remaining errors.

Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity

Robert N. Stavins, Alexander F. Wagner, and Gernot Wagner*

1. Introduction

There has been much debate among economists, and between economists and nearly everyone else regarding the meaning of the frequently employed concept of "sustainability." In this note, we suggest that a broadly-accepted and normatively useful notion of sustainability can be better understood by breaking it into two components, both of which are well defined in economics: dynamic efficiency and intergenerational equity. Within this realm, there are sound reasons for economists to focus on policy criteria associated with the dynamic efficiency element of sustainability.

In 1987, the Brundtland Commission placed sustainability on international political and scientific agendas with its report, "Our Common Future" (World Commission on Environment and Development 1987). The Commission proposed the widely embraced definition that

* Stavins is the Albert Pratt Professor of Business and Government, John F. Kennedy School of Government, Harvard University, and a University Fellow of Resources for the Future; Alexander Wagner is a Ph.D. student in Political Economy and Government at Harvard University; and Gernot Wagner is a B.A. student at Harvard College. We thank Geir Asheim, Partha Dasgupta, John Hartwick, John Pezzey and Martin Weitzman for helpful comments on an earlier draft. The authors are responsible for any remaining errors.

"development is sustainable when it meets the needs of the present without compromising the ability of future generations to meet theirs" (WCED 1987). This is the definition we use as our starting point. We find that – contrary to some claims – sustainability is *not only* about intergenerational equity; rather, widely-held views of sustainability encompass elements of both efficiency and distributional equity. Furthermore, much as economists have long focused on potential rather than actual Pareto improvements, they need not be apologetic for focusing on dynamic efficiency, leaving (admittedly important) equity considerations to the political process.

2. Dynamic Efficiency

The definition of sustainability offered by the World Commission on Environment and Development (WCED) is broadly accepted and seems to have intuitive appeal: meeting the needs of the present without compromising the ability of future generations to meet their needs. In the absence of efficiency, constant consumption at no more than a subsistence level could satisfy this requirement, yet it would surely not be accepted as a reasonable social goal or target for public policy. Any appealing normative criterion for public policy in this domain ought to include some notion of "non-wastefulness." That is, a meaningful definition of sustainability which has normative standing as a social goal ought to include dynamic efficiency, expressed formally as the maximization of

$$W(t) \equiv \int_{t}^{\infty} U(\mathrm{c}(t))\, e^{-r(t-t)} dt, \tag{1}$$

over all feasible alternative consumption paths $\mathrm{c}(t)$, where $U(\mathrm{c}(t))$ denotes the most general, idealized utility function comprising both direct consumption as well as the enjoyment of non-

market goods and services, and ρ is the social rate of time preference.[1] If it is desirable to avoid unnecessarily degrading resources, and if sustainability has normative standing as a policy goal, then dynamic efficiency is a necessary condition for a normatively meaningful interpretation of this concept.

The important point here is that $W(t)$ must capture total welfare. Anything else can be misleading. Omitting contributions to welfare of any kind of capital will lead to an underestimate of the total value of $W(t)$, and omitting any form of capital depreciation will lead to an overestimate. The theoretical implications of technological and population change have been examined in this context, and the theory regarding ideal measures of $W(t)$ has been explored extensively.[2]

3. Intergenerational Equity

Although we have argued that dynamic efficiency is necessary for a normatively useful definition of sustainability, we do not believe that dynamic efficiency is a sufficient condition for sustainability.[3] It is also essential for consistency with widely embraced definitions of this concept that the maximized total welfare function not decrease over time. Formally, an optimized consumption path fulfills the condition of intergenerational equity if

---

[1] This formulation as well as the notation used in equation (2) are consistent with Arrow *et al*. (2002), which calls the solution of this problem the "present value of felicities." Weitzman (2002) refers to it as a measure of "welfare-equivalent sustainability."

[2] Pezzey and Toman (2001) provide a survey of these issues. Heal (1998, 2001), Solow (1991), and Weitzman (2002) also give reasons why narrow definitions of "economic" capital should be expanded to include, for example, human and natural capital.

[3] In fact, sustainability has frequently been defined as being exclusively about intergenerational equity. Most recently, Arrow *et al*. (2002) make a clear distinction between optimality as the "discounted present value of future well being" as presented in equation (1) and sustainability, defined as "the maintenance or improvement of well being over time," formally presented in equation (2). One exception in the current literature is Asheim, Buchholz and Tungodden (2001), who impose so-called efficiency and equity axioms and show that if social preferences fulfill these two axioms, any optimal path will lead to an efficient and non-decreasing path, thus implicitly including dynamic efficiency in the definition of sustainability. For an earlier discussion of sustainability and optimality, see Pezzey (1992).

(2) $$\frac{dW(t)}{dt} \geq 0,$$

where $W(t)$ represents the maximized total welfare function from equation (1).

This brings us to an economic definition of sustainability: an economy is sustainable if and only if it is dynamically efficient and the resulting stream of maximized total welfare functions is non-declining over time.

4. Sustainability

We acknowledge that the above definition provides a demanding pair of decision criteria that cannot be considered to be very useful as a guide for public policy. The same is true, however, of the benchmark of a Pareto-improving policy — one which makes some members of society better off, but makes *no one* worse off (1896). Actual Pareto improvements are exceptionally rare, of course, perhaps even non-existent. Hence, the strict Pareto criterion is virtually never taken as a guide for public policy, despite its considerable normative appeal. Economists resort instead to seeking "potential Pareto improvements" in the Kaldor-Hicks sense — the world is viewed as being made better off if the magnitude of gains and the magnitude of losses are such that the gainers can fully compensate the losers for their loses and still be better off themselves.[4] Note that under the Kaldor-Hicks criterion, the change is considered to be an improvement whether or not the compensation actually takes place. Actual compensation of losers by winners is essentially left to the political process.

What is key is that the Kaldor-Hicks criterion is a necessary condition for satisfying the strict Pareto criterion. If a policy proposal fails the Kaldor-Hicks test, it cannot pass the Pareto test. If a proposed change is not a potential Pareto improvement, it cannot be a Pareto

[4] The notion that a welfare improving change ought to be associated with a "potential Pareto imp rovement" was introduced by Kaldor (1939) and Hicks (1940).

improvement. This is the fundamental theoretical foundation — the normative justification — for employing benefit-cost analysis, that is, for searching for policies that maximize the positive difference between benefits and costs.

Similarly, we can think of an economy as having the *potential* to become sustainable if it fulfills the criterion of dynamic efficiency. It can then, in principle, be made sustainable by appropriate intergenerational transfers to achieve a non-declining total welfare path. One such economy that *can* be made sustainable has been formalized by Hartwick (1977), in which there exists the *possibility* of turning exhaustible resources into capital stock, a particular type of intergenerational transfer. If the Hartwick rule of investing all rents from exhaustible resources in reproducible capital is followed, then the economy can be made sustainable.[5]

Much as economists have long focused on potential rather than actual Pareto improvements, leaving the allocation of net gains among individuals (and, hence, the resolution of debates regarding distributional equity) to the political process, similar reasoning leads to an analogous approach to the sustainability debate. In theory, it may be argued that sustainability is ultimately the most desirable policy goal, but in practice it is more reasonable to aim for potential sustainability in the form of dynamic efficiency (of an all-encompassing societal welfare function).[6]

---

[5] The conditions under which the Hartwick rule holds, however, are restrictive. Asheim and Buchholz (2000) further explore the assumptions under which the Hartwick rule holds.

[6] Except for the elusive case of the Hartwick economy, utility transfers between generations are difficult to operationalize. Their abstractness provide a further reason why we can make more useful policy statements by being satisfied with potential transfers.

We recognize that this opens an avenue for criticism of economics as being excessively focused on efficiency rather than equity, but the efficiency criterion and related analytical methods are — ultimately — where the greatest strengths of economics lie.[7]

5. Conclusion

Sustainability is a broad concept, but it does not need to be "vague," as Solow (1991) has argued. Interpretations that are acceptable both to natural scientists and economists should be possible. We find that sustainability can be conceptualized simply and clearly by employing a conventional economics framework, based on discounted utilitarianism. In short, a sustainable growth path is one which is both dynamically efficient and which is non-decreasing over time. Much as a potential Pareto improvement in the Kaldor-Hicks sense can yield Pareto optimality when combined with appropriate compensation of losers by winners, so too can dynamic efficiency lead to the more ambitious goal of sustainability when it is combined with appropriate intergenerational transfers. And much as economics often resorts to seeking potential Pareto improvements, leaving the final allocation to the political process, so too may it focus on dynamic efficiency, leading to the possibility, at least, of actual sustainability.

[7] One of the most prominent critiques of this focus of economics on efficiency has been offered by Sen (1970). He points out that a society may be efficient "even when some people are rolling in luxury and others are near starvation, as long as the starvers cannot be made better off without cutting into the pleasures of the rich. In short, a society can be Pareto optimal and still be perfectly disgusting." Our definition of sustainability does involve notion of distributional equity by including both dynamic efficiency and intergenerational equity. We argue only that the comparative advantage of economics lies in its focus on the first element, whereas the comparative advantage of politics lies in focusing on distributional considerations.

REFERENCES

Arrow, Kenneth; Daily, Gretchen; Dasgupta, Partha; Ehrlich, Paul; Goulder, Lawrence; Heal, Geoffrey; Levin, Simon; Mäler, Karl-Göran; Schneider, Stephen; Starrett, David and Walker, Brian. "Are We Consuming Too Much?" Discussion Paper, Beijer International Institute of Ecological Economics, Stockholm (February 2002).

Asheim, Geir; Buchholz, Wolfgang. "The Hartwick rule: Myths and facts." Discussion Paper, University of Regensburg (January 2000).

Asheim, Geir; Buchholz, Wolfgang and Tungodden, Bertil. "Justifying Sustainability." *Journal of Environmental Economics and Management* 41(3), 252–268 (2001).

Hartwick, John M. "Investment of Rents from Exhaustible Resources and Intergenerational Equity," *American Economic Review* 67(5), 972–974 (1977).

Heal, Geoffrey. "Valuing the Future: Economic Theory and Sustainability." Columbia University Press (1998).

Heal, Geoffrey. "Optimality or Sustainability." Plenary address to the annual conference of the European Association of Environmental and Resource Economists, Southampton (June 2001).

Hicks, John R. "The Valuation of the Social Income." *Economica* (New Series) 7(26), 105–124 (May 1940).

Kaldor, Nicholas. "Welfare Propositions of Economics and Interpersonal Comparisons of Utility." *The Economic Journal* 49(195), 549–552 (September 1939).

Pareto, Vilfredo. *Cours d'Economie Politique*, volume 2. Lausanne, (1896).

Pezzey, John C.V. *Sustainable Development Concepts: An Economic Analysis*. Washington, D.C.: World Bank. World Bank Environment Paper No. 2 (1992).

Pezzey, John C.V. and Toman, Michael A. "Progress and Problems in the Economics of Sustainability." Forthcoming in Tietenberg, Thomas H. and Folmer, Henk (Eds.). *International Yearbook of Environmental and Resource Economics 2002/2003*. Cheltenham: Edward Elgar. Draft copy (August 2001).

Sen, Amartya K. *Collective Choice and Social Welfare*. San Francisco: Holden-Day (1970).

Solow, Robert M. "Sustainability: An economist's perspective." The Eighteenth J. Seward Johnson Lecture to the Marine Policy Center, Woods Hole Oceanographic Institution, in Dorfman, Robert and Dorfman, Nancy S. (Eds.). *Economics of the Environment: Selected Readings*. New York: Norton. 179-187 (1991).

Weitzman, Martin L. *Income, Capital, and the Maximum Principle.* Draft copy, Harvard University (January 2002).

World Commission on Environment and Development. "Our Common Future." Oxford: Oxford University Press (1987).

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI
Fondazione Eni Enrico Mattei Working Papers Series
Our working papers are available on the Internet at the following addresses:
***Server WWW*: WWW.FEEM.IT**
***Anonymous FTP*: FTP.FEEM.IT**
http://papers.ssrn.com/abstract_id=XXXXXX

SUST	1.2001	*Inge MAYERES and Stef PROOST*: Should Diesel Cars in Europe be Discouraged?
SUST	2.2001	*Paola DORIA and Davide PETTENELLA*: The Decision Making Process in Defining and Protecting Critical Natural Capital
CLIM	3.2001	*Alberto PENCH*: Green Tax Reforms in a Computable General Equilibrium Model for Italy
CLIM	4.2001	*Maurizio BUSSOLO and Dino PINELLI*: Green Taxes: Environment, Employment and Growth
CLIM	5.2001	*Marco STAMPINI*: Tax Reforms and Environmental Policies for Italy
ETA	6.2001	*Walid OUESLATI*: Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital
CLIM	7.2001	*Umberto CIORBA, Alessandro LANZA and Francesco PAULI:* Kyoto Commitment and Emission Trading: a European Union Perspective
MGMT	8.2001	*Brian SLACK* (xlv): Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy
VOL	9.2001	*Giulia PESARO:* Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors
VOL	10.2001	*Cathrine HAGEM*: Climate Policy, Asymmetric Information and Firm Survival
ETA	11.2001	*Sergio CURRARINI and Marco MARINI*: A Sequential Approach to the Characteristic Function and the Core in Games with Externalities
ETA	12.2001	*Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS*: Inflation and Welfare in an OLG Economy with a Privately Provided Public Good
KNOW	13.2001	*Paolo SURICO:* Globalisation and Trade: A "New Economic Geography" Perspective
ETA	14.2001	*Valentina BOSETTI and Vincenzina MESSINA:* Quasi Option Value and Irreversible Choices
CLIM	15.2001	*Guy* ENGELEN (xlii): Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making
SUST	16.2001	*Julie Catherine SORS:* Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches
SUST	17.2001	*Julie Catherine SORS:* Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools
CLIM	18.2001	*Johan ALBRECHT and Niko GOBBIN*: Schumpeter and the Rise of Modern Environmentalism
VOL	19.2001	*Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO* (xliii): Participation Incentives and the Design of Voluntary Agreements
ETA	20.2001	*Paola ROTA*: Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs
ETA	21.2001	*Paola ROTA*: Empirical Representation of Firms' Employment Decisions by an (S,s) Rule
ETA	22.2001	*Paola ROTA*: What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes
PRIV	23.2001	*Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD:* Optimal Privatisation Design and Financial Markets
KNOW	24.2001	*Giorgio BRUNELLO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI*: Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy
ETA	25.2001	*Klaus CONRAD:* Locational Competition under Environmental Regulation when Input Prices and Productivity Differ
PRIV	26.2001	*Bernardo BORTOLOTTI, Juliet D'SOUZA, Marcella FANTINI and William L. MEGGINSON:* Sources of Performance Improvement in Privatised Firms: A Clinical Study of the Global Telecommunications Industry
CLIM	27.2001	*Frédéric BROCHIER and Emiliano RAMIERI:* Climate Change Impacts on the Mediterranean Coastal Zones
ETA	28.2001	*Nunzio CAPPUCCIO and Michele MORETTO:* Comments on the Investment-Uncertainty Relationship in a Real Option Model
KNOW	29.2001	*Giorgio BRUNELLO*: Absolute Risk Aversion and the Returns to Education
CLIM	30.2001	*ZhongXiang ZHANG:* Meeting the Kyoto Targets: The Importance of Developing Country Participation
ETA	31.2001	*Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN*: An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control
MGMT	32.2001	*Roberta SALOMONE and Giulia GALLUCCIO:* Environmental Issues and Financial Reporting Trends
Coalition Theory Network	33.2001	*Shlomo WEBER and Hans WIESMETH:* From Autarky to Free Trade: The Impact on Environment
ETA	34.2001	*Margarita GENIUS and Elisabetta STRAZZERA*: Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods

NRM	35.2001	*Carlo GIUPPONI*: The Substitution of Hazardous Molecules in Production Processes: The Atrazine Case Study in Italian Agriculture
KNOW	36.2001	*Raffaele PACI and Francesco PIGLIARU*: Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe
PRIV	37.2001	*Bernardo BORTOLOTTI:* Privatisation, Large Shareholders, and Sequential Auctions of Shares
CLIM	38.2001	*Barbara BUCHNER*: What Really Happened in The Hague? Report on the COP6, Part I, 13-25 November 2000, The Hague, The Netherlands
PRIV	39.2001	*Giacomo CALZOLARI and Carlo SCARPA*: Regulation at Home, Competition Abroad: A Theoretical Framework
KNOW	40.2001	*Giorgio BRUNELLO*: On the Complementarity between Education and Training in Europe
Coalition Theory Network	41.2001	*Alain DESDOIGTS and Fabien MOIZEAU* (xlvi): Multiple Politico-Economic Regimes, Inequality and Growth
Coalition Theory Network	42.2001	*Parkash CHANDER and Henry TULKENS* (xlvi): Limits to Climate Change
Coalition Theory Network	43.2001	*Michael FINUS and Bianca RUNDSHAGEN* (xlvi): Endogenous Coalition Formation in Global Pollution Control
Coalition Theory Network	44.2001	*Wietze LISE, Richard S.J. TOL and Bob van der ZWAAN* (xlvi): Negotiating Climate Change as a Social Situation
NRM	45.2001	*Mohamad R. KHAWLIE* (xlvii): The Impacts of Climate Change on Water Resources of Lebanon- Eastern Mediterranean
NRM	46.2001	*Mutasem EL-FADEL and E. BOU-ZEID* (xlvii): Climate Change and Water Resources in the Middle East: Vulnerability, Socio-Economic Impacts and Adaptation
NRM	47.2001	*Eva IGLESIAS, Alberto GARRIDO and Almudena GOMEZ* (xlvii): An Economic Drought Management Index to Evaluate Water Institutions' Performance Under Uncertainty and Climate Change
CLIM	48.2001	*Wietze LISE and Richard S.J. TOL* (xlvii): Impact of Climate on Tourist Demand
CLIM	49.2001	*Francesco BOSELLO, Barbara BUCHNER, Carlo CARRARO and Davide RAGGI*: Can Equity Enhance Efficiency? Lessons from the Kyoto Protocol
SUST	50.2001	*Roberto ROSON* (xlviii): Carbon Leakage in a Small Open Economy with Capital Mobility
SUST	51.2001	*Edwin WOERDMAN* (xlviii): Developing a European Carbon Trading Market: Will Permit Allocation Distort Competition and Lead to State Aid?
SUST	52.2001	*Richard N. COOPER* (xlviii): The Kyoto Protocol: A Flawed Concept
SUST	53.2001	*Kari KANGAS* (xlviii): Trade Liberalisation, Changing Forest Management and Roundwood Trade in Europe
SUST	54.2001	*Xueqin ZHU and Ekko VAN IERLAND* (xlviii)*:* Effects of the Enlargement of EU on Trade and the Environment
SUST	55.2001	*M. Ozgur KAYALICA and Sajal LAHIRI* (xlviii): Strategic Environmental Policies in the Presence of Foreign Direct Investment
SUST	56.2001	*Savas ALPAY* (xlviii): Can Environmental Regulations be Compatible with Higher International Competitiveness? Some New Theoretical Insights
SUST	57.2001	*Roldan MURADIAN, Martin O'CONNOR, Joan MARTINEZ-ALER* (xlviii): Embodied Pollution in Trade: Estimating the "Environmental Load Displacement" of Industrialised Countries
SUST	58.2001	*Matthew R. AUER and Rafael REUVENY* (xlviii): Foreign Aid and Direct Investment: Key Players in the Environmental Restoration of Central and Eastern Europe
SUST	59.2001	*Onno J. KUIK and Frans H. OOSTERHUIS* (xlviii): Lessons from the Southern Enlargement of the EU for the Environmental Dimensions of Eastern Enlargement, in particular for Poland
ETA	60.2001	*Carlo CARRARO, Alessandra POME and Domenico SINISCALCO* (xlix): Science vs. Profit in Research: Lessons from the Human Genome Project
CLIM	61.2001	*Efrem CASTELNUOVO, Michele MORETTO and Sergio VERGALLI:* Global Warming, Uncertainty and Endogenous Technical Change: Implications for Kyoto
PRIV	62.2001	*Gian Luigi ALBANO, Fabrizio GERMANO and Stefano LOVO:* On Some Collusive and Signaling Equilibria in Ascending Auctions for Multiple Objects
CLIM	63.2001	*Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH:* A Note on Testing for Environmental Kuznets Curves with Panel Data
CLIM	64.2001	*Paolo BUONANNO, Carlo CARRARO and Marzio GALEOTTI*: Endogenous Induced Technical Change and the Costs of Kyoto
CLIM	65.2001	*Guido CAZZAVILLAN and Ignazio MUSU* (l): Transitional Dynamics and Uniqueness of the Balanced-Growth Path in a Simple Model of Endogenous Growth with an Environmental Asset
CLIM	66.2001	*Giovanni BAIOCCHI and Salvatore DI FALCO* (l): Investigating the Shape of the EKC: A Nonparametric Approach
CLIM	67.2001	*Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI* (l): Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence
CLIM	68.2001	*Alexey VIKHLYAEV* (xlviii): The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context
NRM	69.2001	*Gary D. LIBECAP and Zeynep K. HANSEN* (li): U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s

NRM	70.2001	*Lee J. ALSTON, Gary D. LIBECAP and Bernardo MUELLER* (li): Land Reform Policies, The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon
CLIM	71.2001	*Claudia KEMFERT*: Economy-Energy-Climate Interaction – The Model WIAGEM -
SUST	72.2001	*Paulo A.L.D. NUNES and Yohanes E. RIYANTO*: Policy Instruments for Creating Markets for Bodiversity: Certification and Ecolabeling
SUST	73.2001	*Paulo A.L.D. NUNES and Erik SCHOKKAERT* (lii): Warm Glow and Embedding in Contingent Valuation
SUST	74.2001	*Paulo A.L.D. NUNES, Jeroen C.J.M. van den BERGH and Peter NIJKAMP* (lii): Ecological-Economic Analysis and Valuation of Biodiversity
VOL	75.2001	*Johan EYCKMANS and Henry TULKENS* (li): Simulating Coalitionally Stable Burden Sharing Agreements for the Climate Change Problem
PRIV	76.2001	*Axel GAUTIER and Florian HEIDER*: What Do Internal Capital Markets Do? Redistribution vs. Incentives
PRIV	77.2001	*Bernardo BORTOLOTTI, Marcella FANTINI and Domenico SINISCALCO*: Privatisation around the World: New Evidence from Panel Data
ETA	78.2001	*Toke S. AIDT and Jayasri DUTTA* (li): Transitional Politics. Emerging Incentive-based Instruments in Environmental Regulation
ETA	79.2001	*Alberto PETRUCCI*: Consumption Taxation and Endogenous Growth in a Model with New Generations
ETA	80.2001	*Pierre LASSERRE and Antoine SOUBEYRAN* (li): A Ricardian Model of the Tragedy of the Commons
ETA	81.2001	*Pierre COURTOIS, Jean Christophe PÉREAU and Tarik TAZDAÏT*: An Evolutionary Approach to the Climate Change Negotiation Game
NRM	82.2001	*Christophe BONTEMPS, Stéphane COUTURE and Pascal FAVARD:* Is the Irrigation Water Demand Really Convex?
NRM	83.2001	*Unai PASCUAL and Edward BARBIER*: A Model of Optimal Labour and Soil Use with Shifting Cultivation
CLIM	84.2001	*Jesper JENSEN and Martin Hvidt THELLE*: What are the Gains from a Multi-Gas Strategy?
CLIM	85.2001	*Maurizio MICHELINI* (liii): IPCC "Summary for Policymakers" in TAR. Do its results give a scientific support always adequate to the urgencies of Kyoto negotiations?
CLIM	86.2001	*Claudia KEMFERT* (liii): Economic Impact Assessment of Alternative Climate Policy Strategies
CLIM	87.2001	*Cesare DOSI and Michele MORETTO:* Global Warming and Financial Umbrellas
ETA	88.2001	*Elena BONTEMPI, Alessandra DEL BOCA, Alessandra FRANZOSI, Marzio GALEOTTI and Paola ROTA:* Capital Heterogeneity: Does it Matter? Fundamental Q and Investment on a Panel of Italian Firms
ETA	89.2001	*Efrem CASTELNUOVO and Paolo SURICO*: Model Uncertainty, Optimal Monetary Policy and the Preferences of the Fed
CLIM	90.2001	*Umberto CIORBA, Alessandro LANZA and Francesco PAULI*: Kyoto Protocol and Emission Trading: Does the US Make a Difference?
CLIM	91.2001	*ZhongXiang ZHANG and Lucas ASSUNCAO:* Domestic Climate Policies and the WTO
SUST	92.2001	*Anna ALBERINI, Alan KRUPNICK, Maureen CROPPER, Nathalie SIMON and Joseph COOK* (lii): The Willingness to Pay for Mortality Risk Reductions: A Comparison of the United States and Canada
SUST	93.2001	*Riccardo SCARPA, Guy D. GARROD and Kenneth G. WILLIS* (lii): Valuing Local Public Goods with Advanced Stated Preference Models: Traffic Calming Schemes in Northern England
CLIM	94.2001	*Ming CHEN and Larry KARP*: Environmental Indices for the Chinese Grain Sector
CLIM	95.2001	*Larry KARP and Jiangfeng ZHANG*: Controlling a Stock Pollutant with Endogenous Investment and Asymmetric Information
ETA	96.2001	*Michele MORETTO and Gianpaolo ROSSINI*: On the Opportunity Cost of Nontradable Stock Options
SUST	97.2001	*Elisabetta STRAZZERA, Margarita GENIUS, Riccardo SCARPA and George HUTCHINSON*: The Effect of Protest Votes on the Estimates of Willingness to Pay for Use Values of Recreational Sites
NRM	98.2001	*Frédéric BROCHIER, Carlo GIUPPONI and Alberto LONGO*: Integrated Coastal Zone Management in the Venice Area – Perspectives of Development for the Rural Island of Sant'Erasmo
NRM	99.2001	*Frédéric BROCHIER, Carlo GIUPPONI and Julie SORS*: Integrated Coastal Management in the Venice Area – Potentials of the Integrated Participatory Management Approach
NRM	100.2001	*Frédéric BROCHIER and Carlo GIUPPONI*: Integrated Coastal Zone Management in the Venice Area – A Methodological Framework
PRIV	101.2001	*Enrico C. PEROTTI and Luc LAEVEN*: Confidence Building in Emerging Stock Markets
CLIM	102.2001	*Barbara BUCHNER, Carlo CARRARO and Igor CERSOSIMO*: On the Consequences of the U.S. Withdrawal from the Kyoto/Bonn Protocol
SUST	103.2001	*Riccardo SCARPA, Adam DRUCKER, Simon ANDERSON, Nancy FERRAES-EHUAN, Veronica GOMEZ, Carlos R. RISOPATRON and Olga RUBIO-LEONEL*: Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yucatan
SUST	104.2001	*R. SCARPA, P. KRISTJANSON, A. DRUCKER, M. RADENY, E.S.K. RUTO, and J.E.O. REGE:* Valuing Indigenous Cattle Breeds in Kenya: An Empirical Comparison of Stated and Revealed Preference Value Estimates
SUST	105.2001	*Clemens B.A. WOLLNY*: The Need to Conserve Farm Animal Genetic Resources Through Community-Based Management in Africa: Should Policy Makers be Concerned?
SUST	106.2001	*J.T. KARUGIA, O.A. MWAI, R. KAITHO, Adam G. DRUCKER, C.B.A. WOLLNY and J.E.O. REGE:* Economic Analysis of Crossbreeding Programmes in Sub-Saharan Africa: A Conceptual Framework and Kenyan Case Study
SUST	107.2001	*W. AYALEW, J.M. KING, E. BRUNS and B. RISCHKOWSKY*: Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program

SUST	108.2001	*Gianni CICIA, Elisabetta D'ERCOLE and Davide MARINO*: Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse
SUST	109.2001	*Clem TISDELL*: Socioeconomic Causes of Loss of Animal Genetic Diversity: Analysis and Assessment
SUST	110.2001	*M.A. JABBAR and M.L. DIEDHOU*: Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa
SUST	1.2002	*K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW*: Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa
ETA	2.2002	*Efrem CASTELNUOVO and Paolo SURICO*: What Does Monetary Policy Reveal about Central Bank's Preferences?
WAT	3.2002	*Duncan KNOWLER and Edward BARBIER*: The Economics of a "Mixed Blessing" Effect: A Case Study of the Black Sea
CLIM	4.2002	*Andreas LÖSCHEL*: Technological Change in Economic Models of Environmental Policy: A Survey
VOL	5.2002	*Carlo CARRARO and Carmen MARCHIORI*: Stable Coalitions
CLIM	6.2002	*Marzio GALEOTTI, Alessandro LANZA and Matteo MANERA*: Rockets and Feathers Revisited: An International Comparison on European Gasoline Markets
ETA	7.2002	*Effrosyni DIAMANTOUDI and Eftichios S. SARTZETAKIS*: Stable International Environmental Agreements: An Analytical Approach
KNOW	8.2002	*Alain DESDOIGTS*: Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus
NRM	9.2002	*Giuseppe DI VITA:* Renewable Resources and Waste Recycling
KNOW	10.2002	*Giorgio BRUNELLO*: Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries
ETA	11.2002	*Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE*: Endogenous Fluctuations and the Role of Monetary Policy
KNOW	12.2002	*Reyer GERLAGH and Marjan W. HOFKES:* Escaping Lock-in: The Scope for a Transition towards Sustainable Growth?
NRM	13.2002	*Michele MORETTO and Paolo ROSATO*: The Use of Common Property Resources: A Dynamic Model
CLIM	14.2002	*Philippe QUIRION*: Macroeconomic Effects of an Energy Saving Policy in the Public Sector
CLIM	15.2002	*Roberto ROSON*: Dynamic and Distributional Effects of Environmental Revenue Recycling Schemes: Simulations with a General Equilibrium Model of the Italian Economy
CLIM	16.2002	*Francesco RICCI* (l): Environmental Policy Growth when Inputs are Differentiated in Pollution Intensity
ETA	17.2002	*Alberto PETRUCCI*: Devaluation (Levels versus Rates) and Balance of Payments in a Cash-in-Advance Economy
Coalition Theory Network	18.2002	*László Á. KÓCZY* (liv*):* The Core in the Presence of Externalities
Coalition Theory Network	19.2002	*Steven J. BRAMS, Michael A. JONES and D. Marc KILGOUR* (liv): Single-Peakedness and Disconnected Coalitions
Coalition Theory Network	20.2002	*Guillaume HAERINGER* (liv): On the Stability of Cooperation Structures
NRM	21.2002	*Fausto CAVALLARO and Luigi CIRAOLO:* Economic and Environmental Sustainability: A Dynamic Approach in Insular Systems
CLIM	22.2002	*Barbara BUCHNER, Carlo CARRARO, Igor CERSOSIMO and Carmen MARCHIORI*: Back to Kyoto? US Participation and the Linkage between R&D and Climate Cooperation
CLIM	23.2002	*Andreas LÖSCHEL and ZhongXIANG ZHANG:* The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech
ETA	24.2002	*Marzio GALEOTTI, Louis J. MACCINI and Fabio SCHIANTARELLI*: Inventories, Employment and Hours
CLIM	25.2002	*Hannes EGLI:* Are Cross-Country Studies of the Environmental Kuznets Curve Misleading? New Evidence from Time Series Data for Germany
ETA	26.2002	*Adam B. JAFFE, Richard G. NEWELL and Robert N. STAVINS*: Environmental Policy and Technological Change
SUST	27.2002	*Joseph C. COOPER and Giovanni SIGNORELLO*: Farmer Premiums for the Voluntary Adoption of Conservation Plans
SUST	28.2002	*The ANSEA Network*: Towards An Analytical Strategic Environmental Assessment
KNOW	29.2002	*Paolo SURICO*: Geographic Concentration and Increasing Returns: a Survey of Evidence
ETA	30.2002	*Robert N. STAVINS:* Lessons from the American Experiment with Market-Based Environmental Policies
NRM	31.2002	*Carlo GIUPPONI and Paolo ROSATO:* Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon
NRM	32.2002	*Robert N. STAVINS*: National Environmental Policy During the Clinton Years
KNOW	33.2002	*A. SOUBEYRAN and H. STAHN* : Do Investments in Specialized Knowledge Lead to Composite Good Industries?
KNOW	34.2002	*G. BRUNELLO, M.L. PARISI and Daniela SONEDDA:* Labor Taxes, Wage Setting and the Relative Wage Effect
CLIM	35.2002	*C. BOEMARE and P. QUIRION* (lv): Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences

CLIM	36.2002	*T.TIETENBERG* (lv): The Tradable Permits Approach to Protecting the Commons: What Have We Learned?
CLIM	37.2002	*K. REHDANZ and R.J.S. TOL* (lv): On National and International Trade in Greenhouse Gas Emission Permits
CLIM	38.2002	*C. FISCHER* (lv): Multinational Taxation and International Emissions Trading
SUST	39.2002	*G. SIGNORELLO and G. PAPPALARDO:* Farm Animal Biodiversity Conservation Activities in Europe under the Framework of Agenda 2000
NRM	40.2002	*S .M. CAVANAGH, W. M. HANEMANN and R. N. STAVINS:* Muffled Price Signals: Household Water Demand under Increasing-Block Prices
NRM	41.2002	*A. J. PLANTINGA, R. N. LUBOWSKI and R. N. STAVINS:* The Effects of Potential Land Development on Agricultural Land Prices
CLIM	42.2002	*C. OHL* (lvi): Inducing Environmental Co-operation by the Design of Emission Permits
CLIM	43.2002	*J. EYCKMANS, D. VAN REGEMORTER and V. VAN STEENBERGHE* (lvi): Is Kyoto Fatally Flawed? An Analysis with MacGEM
CLIM	44.2002	*A. ANTOCI and S. BORGHESI* (lvi): Working Too Much in a Polluted World: A North-South Evolutionary Model
ETA	45.2002	*P. G. FREDRIKSSON, Johan A. LIST and Daniel MILLIMET* (lvi): Chasing the Smokestack: Strategic Policymaking with Multiple Instruments
ETA	46.2002	*Z. YU* (lvi): A Theory of Strategic Vertical DFI and the Missing Pollution-Haven Effect
SUST	47.2002	*Y. H. FARZIN*: Can an Exhaustible Resource Economy Be Sustainable?
SUST	48.2002	*Y. H. FARZIN*: Sustainability and Hamiltonian Value
KNOW	49.2002	*C. PIGA and M. VIVARELLI*: Cooperation in R&D and Sample Selection
Coalition Theory Network	50.2002	*M. SERTEL and A. SLINKO* (liv): Ranking Committees, Words or Multisets
Coalition Theory Network	51.2002	*Sergio CURRARINI* (liv): Stable Organizations with Externalities
ETA	52.2002	*Robert N. STAVINS*: Experience with Market-Based Policy Instruments
ETA	53.2002	*C.C. JAEGER, M. LEIMBACH, C. CARRARO, K. HASSELMANN, J.C. HOURCADE, A. KEELER and R. KLEIN* (liii): Integrated Assessment Modeling: Modules for Cooperation
CLIM	54.2002	*Scott BARRETT* (liii)*:* Towards a Better Climate Treaty
ETA	55.2002	*Richard G. NEWELL and Robert N. STAVINS*: Cost Heterogeneity and the Potential Savings from Market-Based Policies
SUST	56.2002	*Paolo ROSATO and Edi DEFRANCESCO*: Individual Travel Cost Method and Flow Fixed Costs
SUST	57.2002	*Vladimir KOTOV and Elena NIKITINA* (lvii): Reorganisation of Environmental Policy in Russia: The Decade of Success and Failures in Implementation of Perspective Quests
SUST	58.2002	*Vladimir KOTOV* (lvii): Policy in Transition: New Framework for Russia's Climate Policy
SUST	59.2002	*Fanny MISSFELDT and Arturo VILLAVICENCO* (lvii): How Can Economies in Transition Pursue Emissions Trading or Joint Implementation?
VOL	60.2002	*Giovanni DI BARTOLOMEO, Jacob ENGWERDA, Joseph PLASMANS and Bas VAN AARLE:* Staying Together or Breaking Apart: Policy-Makers' Endogenous Coalitions Formation in the European Economic and Monetary Union
ETA	61.2002	*Robert N. STAVINS, Alexander F.WAGNER and Gernot WAGNER*: Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity

(xlii) This paper was presented at the International Workshop on "Climate Change and Mediterranean Coastal Systems: Regional Scenarios and Vulnerability Assessment" organised by the Fondazione Eni Enrico Mattei in co-operation with the Istituto Veneto di Scienze, Lettere ed Arti, Venice, December 9-10, 1999.

(xliii)This paper was presented at the International Workshop on "Voluntary Approaches, Competition and Competitiveness" organised by the Fondazione Eni Enrico Mattei within the research activities of the CAVA Network, Milan, May 25-26,2000.

(xliv) This paper was presented at the International Workshop on "Green National Accounting in Europe: Comparison of Methods and Experiences" organised by the Fondazione Eni Enrico Mattei within the Concerted Action of Environmental Valuation in Europe (EVE), Milan, March 4-7, 2000

(xlv) This paper was presented at the International Workshop on "New Ports and Urban and Regional Development. The Dynamics of Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, May 5-6, 2000.

(xlvi) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium, January 26-27, 2001

(xlvii) This paper was presented at the RICAMARE Workshop "Socioeconomic Assessments of Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits", organised by the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001

(xlviii) This paper was presented at the International Workshop "Trade and the Environment in the Perspective of the EU Enlargement ", organised by the Fondazione Eni Enrico Mattei, Milan, May 17-18, 2001

(xlix) This paper was presented at the International Conference "Knowledge as an Economic Good", organised by Fondazione Eni Enrico Mattei and The Beijer International Institute of Environmental Economics, Palermo, April 20-21, 2001

(l) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy "The International Dimension of Environmental Policy", organised with the collaboration of the Fondazione Eni Enrico Mattei , Acquafredda di Maratea, October 6-11, 2001

(lvii) This paper was presented at the First Workshop of "CFEWE – Carbon Flows between Eastern and Western Europe", organised by the Fondazione Eni Enrico Mattei and Zentrum fur Europaische Integrationsforschung (ZEI), Milan, July 5-6, 2001

2002 SERIES

CLIM *Climate Change Modelling and Policy* (Editor: Marzio Galeotti)

NRM *Natural Resources Management* (Editor: Carlo Giupponi)

SUST *Sustainability Indicators and Environmental Evaluation* (Editor: Carlo Carraro)

KNOW *Knowledge, Technology, Human Capital* (Editor: Dino Pinelli)

PRIV *Privatisation, Regulation, Antitrust* (Editor: Bernardo Bortolotti)

MGMT *Corporate Sustainable Management* (Editor: Andrea Marsanich)

ETA *Economic Theory and Applications* (Editor: Carlo Carraro)