

Jensen, Jesper; Thelle, Martin Hvidt

Working Paper

What are the gains from a multi-gas strategy?

Nota di Lavoro, No. 84.2001

Provided in Cooperation with:

Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Jensen, Jesper; Thelle, Martin Hvidt (2001) : What are the gains from a multi-gas strategy?, Nota di Lavoro, No. 84.2001, Fondazione Eni Enrico Mattei (FEEM), Milano

This Version is available at:

<https://hdl.handle.net/10419/155247>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



Fondazione Eni Enrico Mattei

What are the Gains from a Multi-Gas Strategy?

Jesper Jensen* and Martin Hvidt Thelle*
NOTA DI LAVORO 84.2001

OCTOBER 2001

CLIM – Climate Policy and Modelling Policy

*Copenhagen Economics

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
http://www.feem.it/web/activ/_activ.html

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

Fondazione Eni Enrico Mattei
Corso Magenta, 63, 20123 Milano, tel. +39/02/52036934 – fax +39/02/52036946
E-mail: letter@feem.it
C.F. 97080600154

SUMMARY

The Kyoto Protocol assigns limits for the aggregate emissions of six greenhouse gases, but most economic analyses focus on CO₂ abatement. What are the potential gains if policy makers exploit the flexibility in a multi-gas abatement strategy? We extend the EDGE model to include sinks and non-CO₂ gases and show that a multi-gas strategy reduces costs by 20-35% in the Western Annex B countries. Marginal abatement costs decrease around 30%, and the cost-effective abatement mix involves relatively more abatement of the non-CO₂ gases, which offers many low costs abatement options. Lower marginal abatement costs decrease domestic action by reducing the costs of emissions imports, whereas more low cost abatement options increases domestic action. The low cost abatement options increase domestic action, whereas lower marginal abatement costs reduces domestic action by making imports of emissions cheaper. The net effect of a multi-gas strategy on domestic action is therefore not given a priori. We show that a multi-gas strategy reduces domestic action around 2% in the United States and increases domestic action by around 8% in the European Union. Our sensitivity analyses finally show that the relatively weak growth in non-CO₂ baseline emissions accounts for a large share of the savings associated with a multi-gas strategy.

CONTENTS

1. Introduction	2
2. Economic analysis of multi-gas abatement and sinks	3
3. The EDGE model	14
4. Scenarios	14
5. Results	16
6. Sensitivity analysis	20
7. Concluding remarks	27
8. References	28
9. Appendix: Database for sinks and non-CO ₂ gases	30

1. Introduction

The Kyoto Protocol assigns emissions limits to all countries listed in Annex B to the protocol. The limits apply to the *aggregate* emissions of six greenhouse gases and this give each country the flexibility to individually control the emissions of each gas. Most of the existing economic analyses of the Kyoto Protocol focus exclusively on controlling the most important gas, CO₂, but our analysis shows that a multi-gas control strategy may lower costs significantly.

Specifically, most of the existing analyses ignore the effects of abatement of the five non-CO₂ greenhouse gases included in the Kyoto Protocol: CH₄, N₂O, HFCs, PFCs and SF₆.¹ This naturally raises the question: What are the effects on costs and abatement if policy makers exploit the multi-gas flexibility in the Kyoto protocol?

We address this question by extending the EDGE model (Jensen *et al.* [2000a]) to include emissions data and abatement options for the five non-CO₂ gases. We assume unlimited trading among all Annex B countries with emissions of all six gases and our results focus on some of the key concerns to policy makers when designing climate policies: Marginal costs, welfare costs, domestic action, and the abatement mix of the six gases.

Our preliminary results suggest that a multi-gas strategy reduces costs significantly. Marginal abatement costs decrease around 30%, when replacing a strategy of controlling CO₂ only with a multi-gas strategy. Welfare costs in the Western Annex B countries decrease 20-35%, whereas the countries in the Former Soviet Union and Eastern Europe experience a loss in welfare of almost 40% due to lower revenues from emissions exports.

In most regions, non-CO₂ emissions account for less than 20% of total greenhouse gas emissions in 2010, but the non-CO₂ emissions offer many low cost abatement options. The non-CO₂ gases therefore account for a relatively larger share in a cost-effective abatement mix.

We also analyse the consequences for domestic action, which we define as the share of domestic abatement divided by total abatement, where the latter equals the difference between the (hypothetic) baseline emissions and the Kyoto commitment. More low cost abatement options tend to increase domestic action, whereas lower marginal abatement costs reduces domestic action by making imports of emissions cheaper. The net effect of a multi-gas strategy on domestic action is therefore not given a priori. Our results show that domestic action increases slightly in all Western Annex B regions, except in the United States where domestic action decreases as higher imports of emissions dominate the effects of domestic non-CO₂ abatement.

Our results are generally consistent with the few existing analyses of multi-gas abatement. Burniaux [2000] and Manne and Richels [2000] extend the GREEN and the MERGE models, respectively, to cover CO₂, CH₄ and N₂O, but both models ignore the other three gases. Their analyses apply different aggregate emissions targets when comparing the

¹ See for example the multi-model evaluation in Weyant [1999].

multi-gas strategy with the strategy of controlling CO₂ only; that is, the two strategies do not imply the same environmental improvement. Reilly *et al.* [1999] extend the MIT-EPPA model to include CO₂ sinks and all six greenhouse gases. Their analyses apply identical emissions targets, which make their results comparable to ours, but they do not analyse the potential gains from international trade with emissions in the case of multi-gas abatement.

We extend this literature in several respects. First, our comparison of a multi-gas strategy with a single-gas (CO₂) strategy applies identical emissions targets *and* assumes unlimited emissions trading among the Annex B countries. Second, we review the literature on the costs of abating the five non-CO₂ gases and estimate continuous marginal abatement cost curves for use in the analyses. Third, we include sensitivity analyses of some of the key assumptions regarding non-CO₂ abatement. These analyses have been motivated by some of the uncertainties surrounding the limited data on non-CO₂ emissions, and similar analyses are only available in Reilly *et al.* [1999]. Finally, our results include the effects on domestic action, which have not been reported by any of the existing analyses.

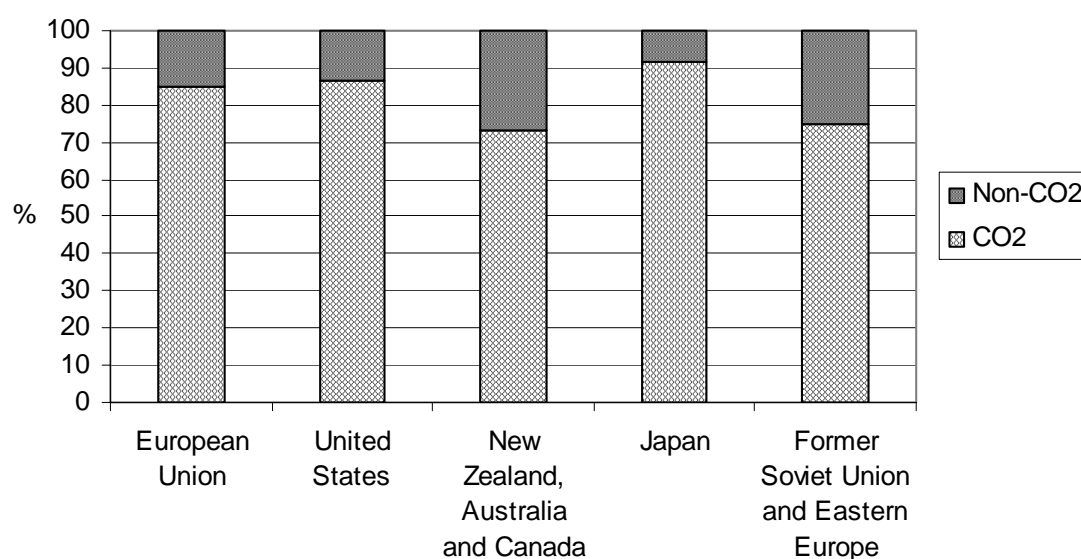
The next section gives an overview of sinks and abatement of non-CO₂ gases, and this provides the background for our analysis of a multi-gas control strategy. Section 3 then introduces the EDGE model and outlines the extensions necessary for multi-gas analysis. Section 4 defines the policy scenarios and section 5 discusses the numerical results. Section 6 presents the sensitivity analyses and the last section summarizes the main findings and discusses natural extensions of the analysis.

2. Economic analysis of multi-gas abatement and sinks

Most of the existing economic analyses of the Kyoto Protocol focus exclusively on abatement of energy related CO₂ emissions. This has been a natural first step given the wide availability of energy data and the long experience with energy modelling, for example for planning purposes. Furthermore, this approach covers the quantitatively most important of the six greenhouse gases included in the Kyoto Protocol (illustrated in Figure 1).

The following sections present the first steps towards incorporating sinks and non-CO₂ emissions. Specifically, we provide an overview of the main sources of emissions of non-CO₂ gases, the abatement requirements, and the most important abatement options. We also discuss issues related to CO₂ sinks, including the modelling challenges the sinks involve.

Figure 1. Greenhouse gas emissions (excluding sinks), 2010.



Emissions of non-CO₂ greenhouse gases

The greenhouse gases covered by the Kyoto Protocol are listed in Table 1 along with the main sources of emissions. The agricultural sector accounts for many of the emissions of CH₄ and N₂O, but waste (for example landfills) and energy supply (for example coal mining) also contribute significantly. HFCs, PFCs and SF₆ are also known both as the industrial greenhouse gases because of their origin, and as the HGWG gases because of their high global warming potentials.

Table 1. Main emission sources for greenhouse gases.

Greenhouse gas	Global Warming Potential ^a	Main emissions sources
CO ₂	1	Combustion of fossil fuels (coal, oil, and gas)
CH ₄	21	Livestock, rice, natural gas, waste and coal
N ₂ O	310	Agricultural soils, fertiliser, livestock, industrial production
HFCs ^b	140-11700	Air conditioning and foam blowing
PFCs ^b	6200-9200	Aluminium and semiconductors
SF ₆	23900	Magnesium, semiconductors and electrical switchgear.

^a 100 year GWP.

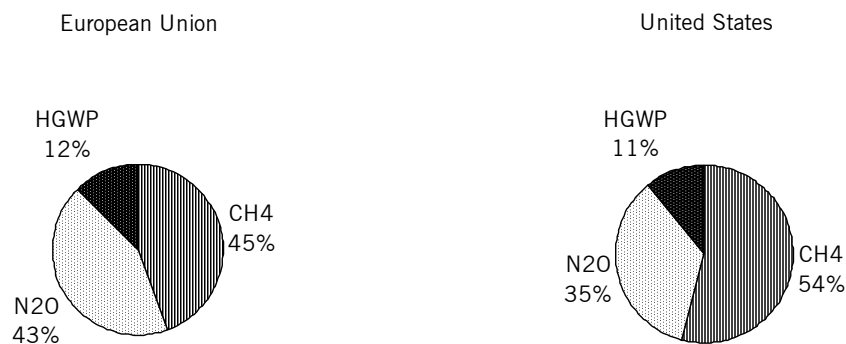
^b Includes several different gases.

The gases have different impacts on the climate as well as different lifetimes in the atmosphere, and they are therefore not directly comparable on a tonne-for-tonne basis. Since the limits for emissions in the Kyoto Protocol apply to aggregate emissions of the six greenhouse gases, we need a method to establish equivalency in terms of climate effects in order to compare reductions in emissions of the different gases.

We follow the Kyoto Protocol and use 100-years global warming potentials to convert all emissions into carbon equivalents (CE). This method supposedly establishes equivalency in terms of climate effects over a time horizon of 100 years, but it has been subject to a number of criticisms.² In particular, the choice of a 100 year horizon is arbitrary, as a shorter (longer) horizon would imply higher (lower) global warming potentials for the shorter lived gases (for example CH₄).

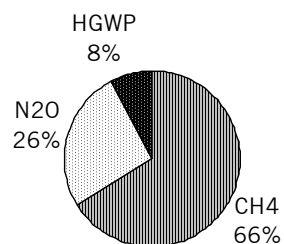
The quantitative importance of each gas varies by country, but in most countries CH₄ and N₂O emissions account for most of the non-CO₂ emissions (Figure 2). The three industry gases, HFCs, PFCs, and SF₆, currently have little importance, except in Japan, but their high global warming potentials imply that even small changes in emissions may have large climate effects.

Figure 2. Distribution of non-CO₂ emissions, 2010.

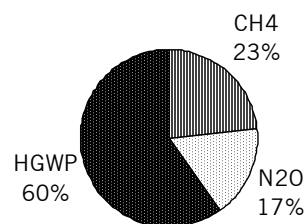


² See Reilly *et al.* [1999] and Manne and Richels [2000] for economic analyses of alternative methods.

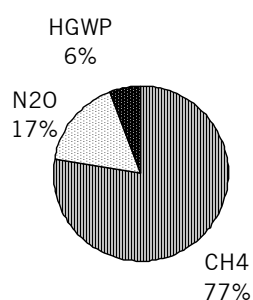
New Zealand, Australia and Canada



Japan

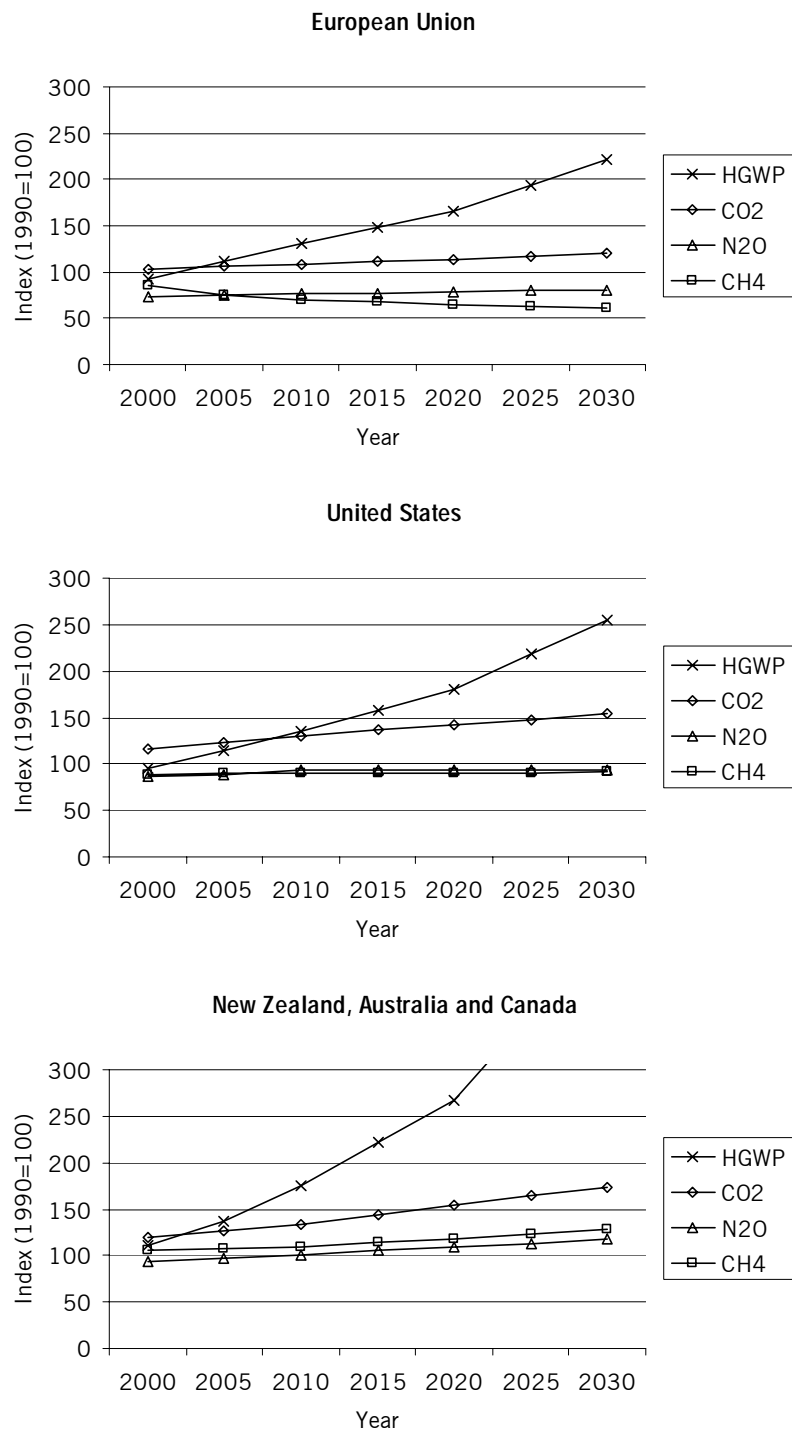


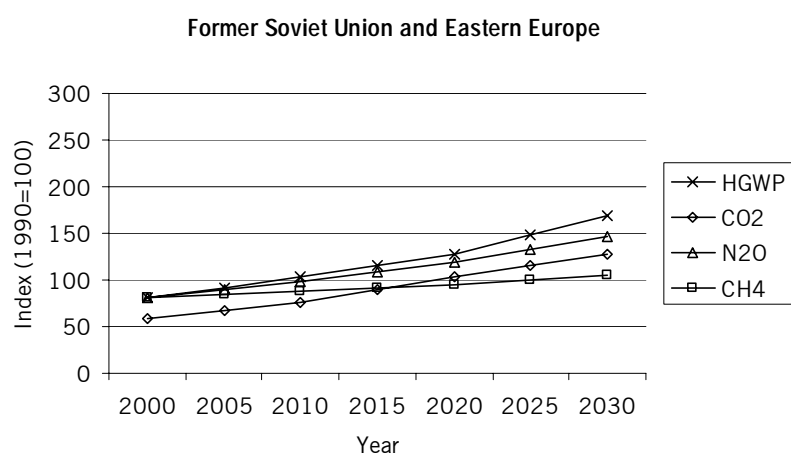
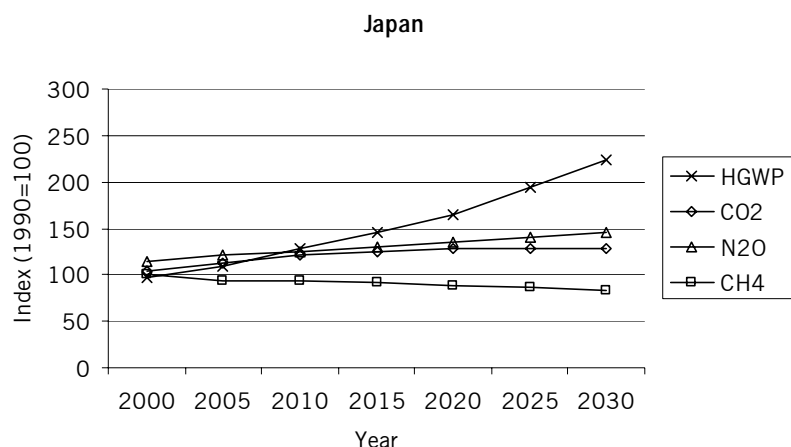
Former Soviet Union and Eastern Europe



In most countries, economic growth is the key driver for CO₂ emissions. Expectations about future economic growth imply that energy outlooks typically expect CO₂ emissions in 2010 to exceed 1990 emissions by 10-30% in most Western Annex B countries (see Figure 3). In several countries undergoing transition to a market economy, the Kyoto commitments are expected to exceed emissions in 2008-2012. This difference, also known as Hot Air, can then be traded with other Annex B countries along with other “real” emissions reductions.

Figure 3. Baseline emissions of greenhouse gases





The international energy outlooks are typically based on global models of energy demand and supply.³ This ensures some consistency in the outlooks across countries, for example with respect to international energy markets and methods for emissions accounting.

International outlooks with similar consistency are not available for non-CO₂ greenhouse gas emissions. We have therefore compiled a database with baseline non-CO₂ emissions based on the Annex B countries' *individual* communications to the UNFCCC.⁴ The communications are not necessarily mutually consistent and in many cases, they furthermore include the anticipated effects of *proposed* policies. This makes it hard to identify a relevant baseline, i.e., the expected future emissions with no changes in *current* policies.

We therefore caution a too literal interpretation of the baseline emissions of non-CO₂ gases in Figure 3. The weak growth in most of the non-CO₂ emissions are consistent with Burniaux [2000], who also uses UNFCCC data to construct baseline emissions paths, but

³ See for example European Commission [1999] and Energy Information Administration [1999].

⁴ See the appendix for further details on the data sources and the methods we employ.

different from Reilly *et al.* [2000], who report significant increases in most regions' emissions (also in Eastern Europe and the Former Soviet Union).⁵

Economic growth is one of the key drivers for the emissions increases in Reilly *et al.* [2000]. In our sensitivity analysis reported below, we adopt a similar assumption to illustrate the sensitivity with respect to the choice of baseline.

Abatement of emissions of non-CO₂ greenhouse gases

The key to lower emissions of CO₂ is reduced combustion of fossil fuels. In contrast, lower activity (use) is only one option with respect to emissions of non-CO₂ gases. For example, emissions of CH₄ from landfills can be combusted and provide energy, and the emissions of the HWP industrial greenhouse gases can be recovered and recycled.

There typically exists a range of alternative abatement technologies for each source of non-CO₂ emissions, and a quickly growing literature analyses the potential emissions reductions and the associated costs and benefits. The studies typically summarize their results in a list, which shows estimates of costs for different levels of abatement. These estimates are effectively points on marginal abatement cost curves, which order the options for abating emissions from lowest cost to highest cost.

Using these points as inputs, we estimate continuous functional forms to incorporate the marginal abatement cost curves in the model. For CH₄ and HWP, the functional form is

$$P = a + \frac{b}{Max - X}$$

where P is the marginal abatement costs in 95\$/tCE, a , b , and Max are parameters and X is the percentage reduction in the country's emissions. Max can be interpreted as the maximum potential reduction. AEA [1998] and EPA [1999] list data for CH₄ for the European Union and the United States, respectively, and the data for the HWP is listed in Harnisch and Hendriks [2000] for the European Union and EPA [2000] for the United States.

For N₂O, we use estimates from Burniaux [2000] based on

$$X = Max - Max * e^{c*P}$$

In this case, c and Max are parameters and P and X are as above. Table 2 summarizes the estimation results.

⁵ The baseline data reported in Manne and Richels [2000] do not make comparisons possible.

Table 2. Analyses of potential reductions in non-CO₂ emissions

Region	CH ₄	N ₂ O ^a	HGWP
European Union	$a = -104.25$ $b = 32.206$ $Max = 0.43$	$c = -0.01$ $Max = 0.26$	$a = -50.203$ $b = 37.859$ $Max = 0.816$
United States	$a = -20.674$ $b = 5.035$ $Max = 0.4435$	$c = -0.01$ $Max = 0.26$	$a = -6.7101$ $b = 3.1205$ $Max = 0.6522$

^a Estimation results from Burniaux [2000].

All the studies of CH₄ and N₂O abatement report “free” reductions, i.e., reductions with zero or negative costs. In the European Union, the “free” reductions amount to 40 MtCO₂ in 2010 or around 6% of total non-CO₂ emissions. In the United States, the corresponding figures are 139 MtCO₂ and 13%.

As noted above, the UNFCCC baselines often include the anticipated effects of *proposed* abatement policies. To minimize double counting of reductions, we therefore include the “free” reductions in the baseline in our policy analysis. This is an important assumption; the amount of “free” reductions is substantial and we illustrate the consequences in our sensitivity analysis reported below.

We have only found studies of the costs of non-CO₂ abatement for the European Union and the United States. We therefore make the simplifying assumption that all other regions have marginal abatement cost curves similar to the curves for the European Union. That is, the same percentage reduction in emissions has the same marginal costs in all Annex B countries, except the United States.

Figure 4 and Figure 5 compare marginal abatement costs across gases and across regions. We constructed the figures by first reducing CO₂ emissions in each region in steps of 1%-points from 1% to 20%.

Figure 4 shows that Japan and the European Union has the highest marginal abatement costs for CO₂ emissions, and that the Former Soviet Union and Eastern Europe has the lowest.

We then used the marginal abatement costs for CO₂ to calculate reductions in non-CO₂ emissions using our estimated marginal abatement cost curves. Figure 4 summarizes the costs all non-CO₂ gases and the Figure shows that the non-CO₂ gases offer a significant amount low costs abatement options.

Figure 5 finally shows the marginal abatement costs curves for the individual non-CO₂ gases. CH₄ dominates the abatement opportunities in the regions including the United States, New Zealand, Australia, Canada, the Former Soviet Union and Eastern Europe. The HGWPs dominate in Japan, following the large share of HGWPs in total non-CO₂ emissions, and in the European Union, the three types of gases offer an equal amount of abatement options.

Figure 4. Marginal abatement costs

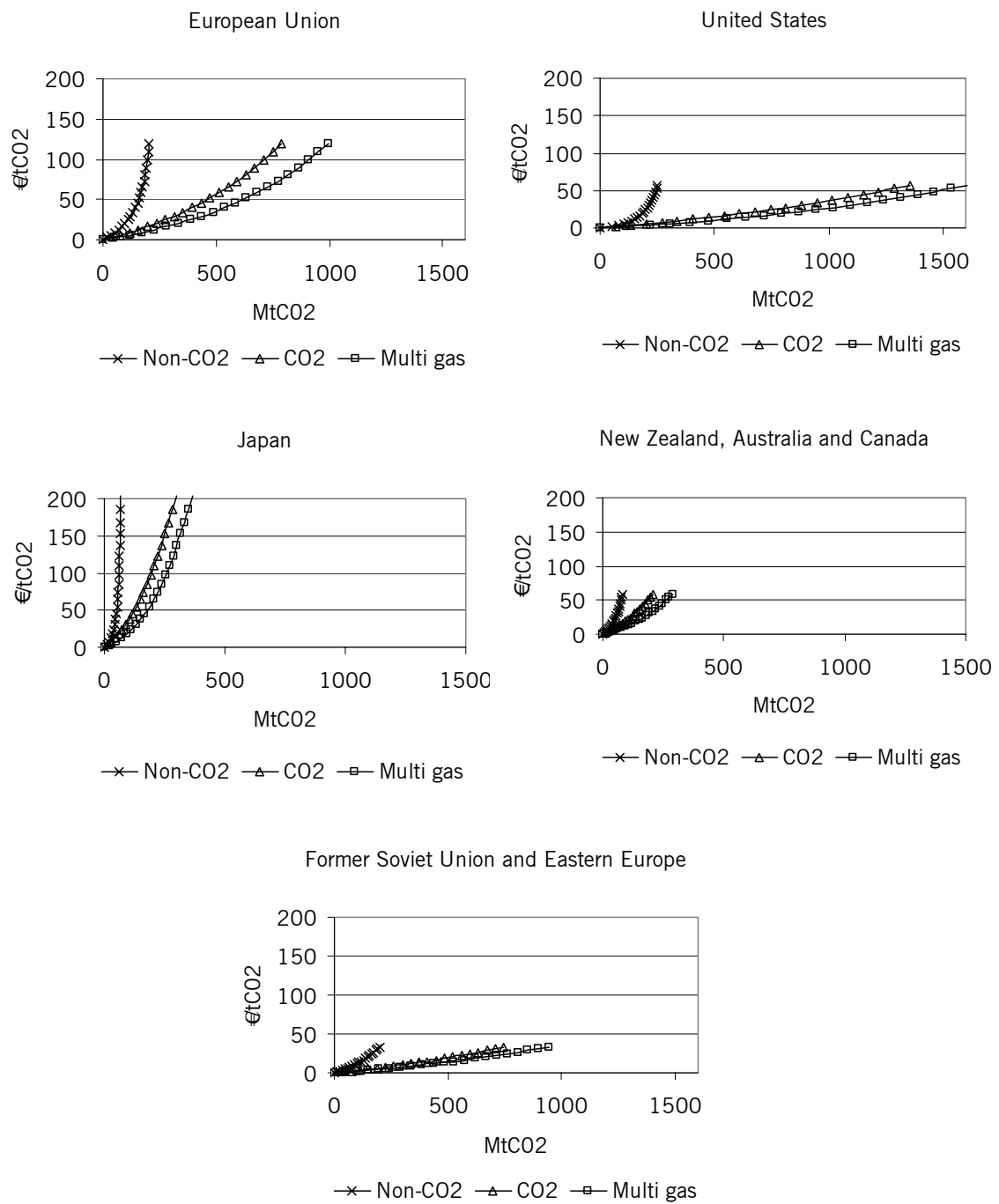
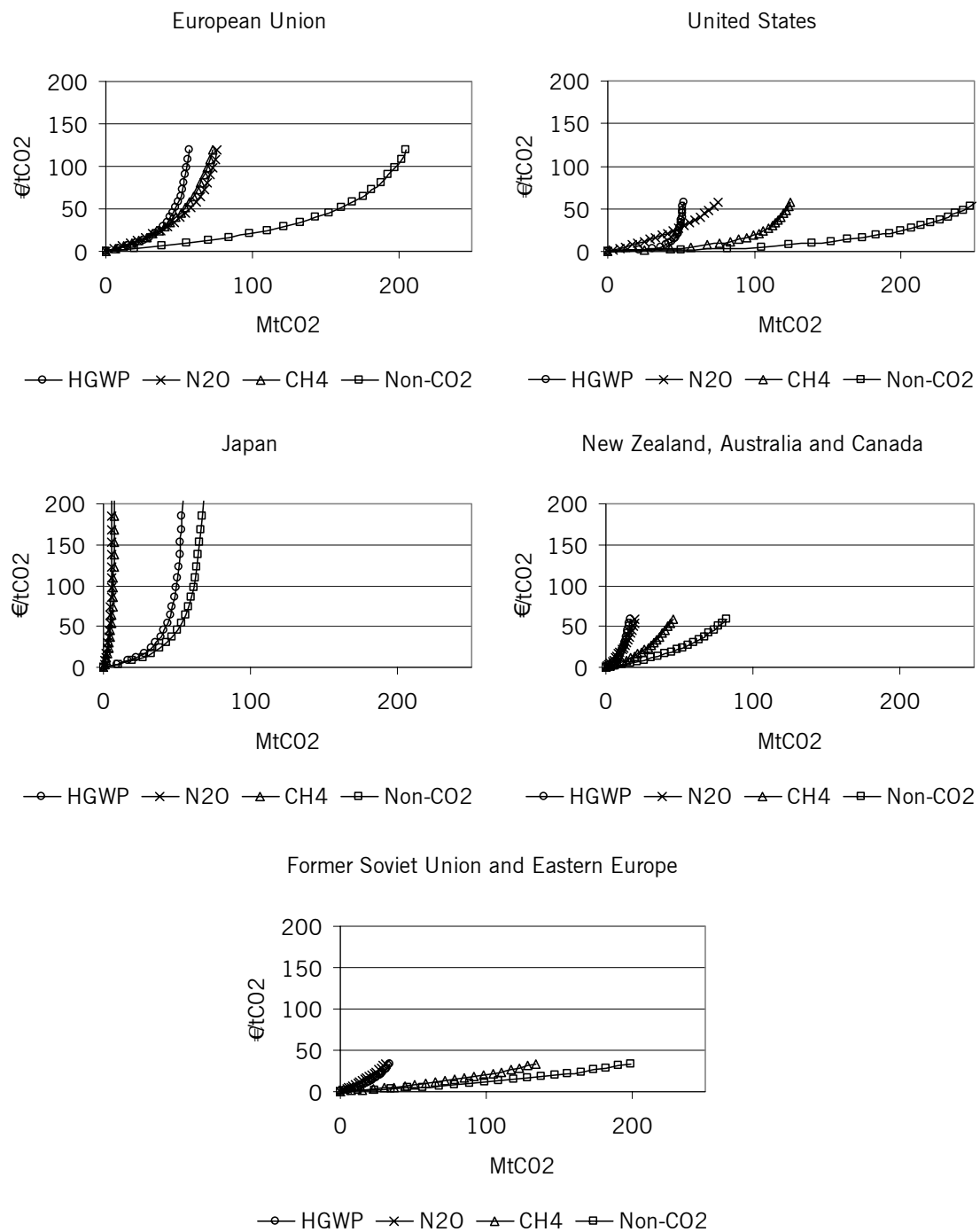


Figure 5. Marginal abatement costs for non-CO₂ gases



Sinks

The Kyoto Protocol allows net removals of greenhouse gases from land-use and forestry activities (hereafter referred to as sinks) to be counted towards the emissions limits. Several problems complicate the economic analysis of sinks.

First, it has been particularly difficult to reach agreement on the exact definitions of sinks as witnessed by the COP6 negotiations in November 2000. For example, what constitutes land management (including forest management) and how should the uncertainties related to emissions accounting be handled?

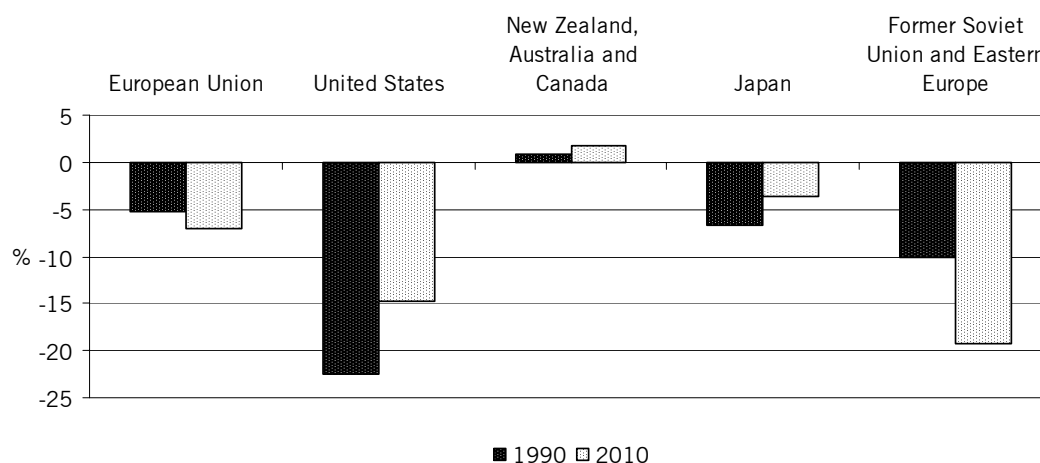
Second, we know very little about the costs of sinks projects. For example, what are the marginal costs per ton of removed CO₂ of converting agricultural land to a forest?

Finally, the removal of CO₂ by most forestry activities occurs over long periods and therefore requires discounting of both net removals of CO₂ and net revenues. To illustrate, plantation of a periodically harvested forest involves a cycle of both removal of CO₂ through the growth of the trees, the forest floor and soil, and release of CO₂ through material decay, harvesting, processing and manufacturing. Furthermore, the economics of forest plantation also depend on the opportunity costs of growing agricultural products and the value of harvested trees in a distant future.⁶

As a first step towards incorporating sinks, we therefore only incorporate baseline CO₂ removals and emissions from land use change and forestry using the Annex B countries' communications to the UNFCCC. We ignore any additional sinks projects.

Figure 6 illustrates the importance of sinks. Australia and the United Kingdom both have net emissions from sinks in 1990, but in all other countries, sinks reduce total emissions. Sinks are both absolutely and relatively most important in the United States, but sinks also make a large difference in Eastern Europe and the Former Soviet Union.

Figure 6. Sinks (share of total emissions including sinks).



⁶ Stavins [1999] discusses these points and develops a methodological framework for estimating the marginal costs of CO₂ removal from land use, but his calculations are only illustrative.

3. The EDGE model

To analyse the economics of a multi-gas strategy towards the Kyoto commitments, we extend the EDGE model to incorporate removal of CO₂ via sinks and abatement of the five non-CO₂ gases. The model is an extension of Jensen *et al.* [2000a], which analyses the consequences of ceilings on international trade with emissions rights.

In the following, we outline the extensions necessary for multi-gas analysis. We refer the interested reader to Jensen *et al.* [2000a] for a non-technical summary of the model, and Jensen *et al.* [2000b] for a technical summary of the model.

Modelling greenhouse gas abatement

Abatement of CO₂ emissions effectively reduces to lower use of fossil fuels. Specifically, abatement may happen in the model through the following types of substitution: between the individual fossil fuels, between fossil fuels and non-fossil goods and services, and between non-fossil goods and services.

We model CO₂ abatement via a scheme for tradable emissions rights. All combustion of fossil fuels requires emissions rights according to the embodied CO₂ in the fuel. The government in each region sets the emissions limit, and firms and households can trade emissions rights on a perfectly competitive market.

In addition to lower use, abatement of non-CO₂ emissions also include options to recover gases, for example use recovered CH₄ from landfills to provide energy, and options to recycle gases. Including non-CO₂ abatement also raises the issue of interaction between abatement of the different gases. For example, lower use of coal may not only reduce CO₂ emissions but also reduce CH₄ emissions via lower mining activity.

Following Reilly *et al.* [2000] we ignore the interaction effect and focus on options for lower use, recovery and recycling. This allows us to employ directly our estimated marginal abatement cost curves and let the emissions be tradable on the market for CO₂ emissions.

4. Scenarios

All our scenarios share a number of common features. First, all countries and regions in the model have cost-effective national emissions trading. No transactions costs apply to any trade with emissions, and all markets for emissions rights are perfectly competitive.

Second, the scenarios reach the Kyoto emissions limits and imply the same absolute reduction in carbon-equivalent emissions (the same climate change effect). In other words, the scenarios provide the same public good, and we can therefore compare the scenarios without evaluating the costs and benefits of climate change.

Third, all emissions rights in a given country, corresponding to the country's Kyoto commitment, are grandfathered to the representative agent.⁷ We therefore ignore any revenue recycling effects, for example if the government auctions the emissions rights and uses the revenue to reduce distortionary labour income taxes.⁸

Fourth, we assume Kyoto-forever. That is, the Kyoto commitments also apply in all commitment periods after 2012. This is important even if we are only interested in the results for 2008-2012, as the decisions of forward-looking agents in 2008-2012 also depend on the policies after 2012. The assumption is a convenient, but arbitrary point of departure, and we appreciate that the concentrations of greenhouse gases in the atmosphere will grow considerably under this assumption.

Fifth, we assume unlimited trade with emissions trading among the Annex B countries, including unlimited trade with hot air. We do not consider transfers of emissions via the Clean Development Mechanism.

Finally, we calibrate autonomous energy efficiency improvements and other technological changes to match the changes in baseline emissions and GDP. These changes are exogenous in the policy scenarios.⁹

Policy scenarios

We use acronyms to label the scenarios to facilitate the presentation of the results. The scenario **SingleGas** assumes control of CO₂ emissions only and no abatement of the non-CO₂ gases. This scenario corresponds to the least cost strategy across all sources of CO₂ emissions to reach the Kyoto emissions limits.

Policy makers can alternatively adopt a multi-gas strategy, which implies control of all emissions. We label this scenario **MultiGas**, and this scenario corresponds to the least cost strategy across all sources of emissions of all six greenhouse gases to reach the Kyoto emissions limits.

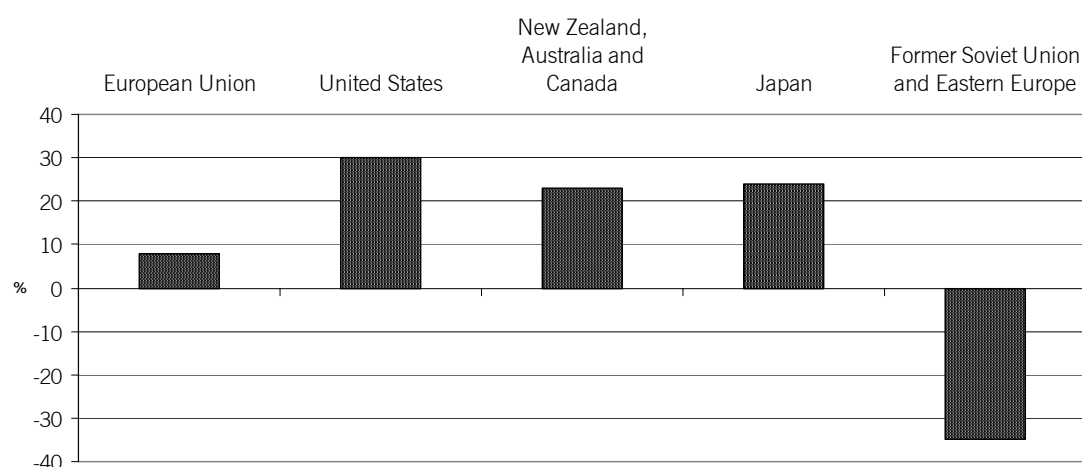
Both the scenarios **SingleGas** and **MultiGas** reach the same multi-gas target for aggregate carbon-equivalent emissions of all gases and both scenario include the same change in sinks. Figure 7 shows the percentage reduction requirements from the baseline emissions in 2010 necessary to reach the emissions limits in the Kyoto Protocol. Weak growth in baseline emissions implies a relatively low reduction requirement for the European Union. The emissions limits exceed the baseline emissions in the Former Soviet Union and Eastern Europe, and this region therefore has excess emissions (Hot Air).

⁷ See Jensen and Rasmussen [2000] for an analysis of alternative allocation rules and their distributive effects.

⁸ Goulder [1995] provides an introduction to the "Double Dividend" literature.

⁹ See Goulder and Schneider [1999] and Goulder and Mathai [2000] for analyses of technological change induced by climate policies.

Figure 7. Required reduction in emissions, 2010



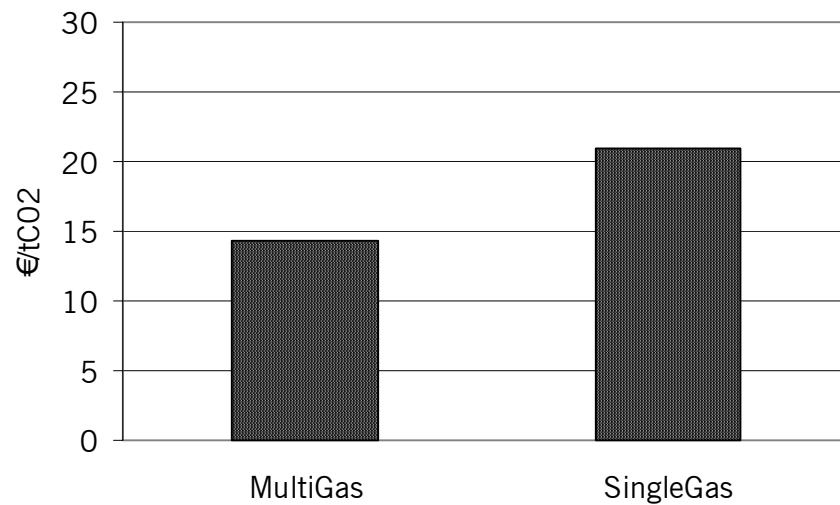
5. Results

The next sections present the numerical results from the analysis of the scenarios in the EDGE model. In all scenarios, we report marginal abatement costs, welfare costs, domestic action, and we furthermore decompose domestic action into CO₂ and non-CO₂ abatement. All economic results are reported in €2000. Our database is denominated in US\$1995, and we assume that 1 US\$1995 = 1.30 €1995, and that inflation implies that 1 €1995 = 1.11 €2000. Thus, 1 US\$1995 = 1.44 €2000.

Economic results

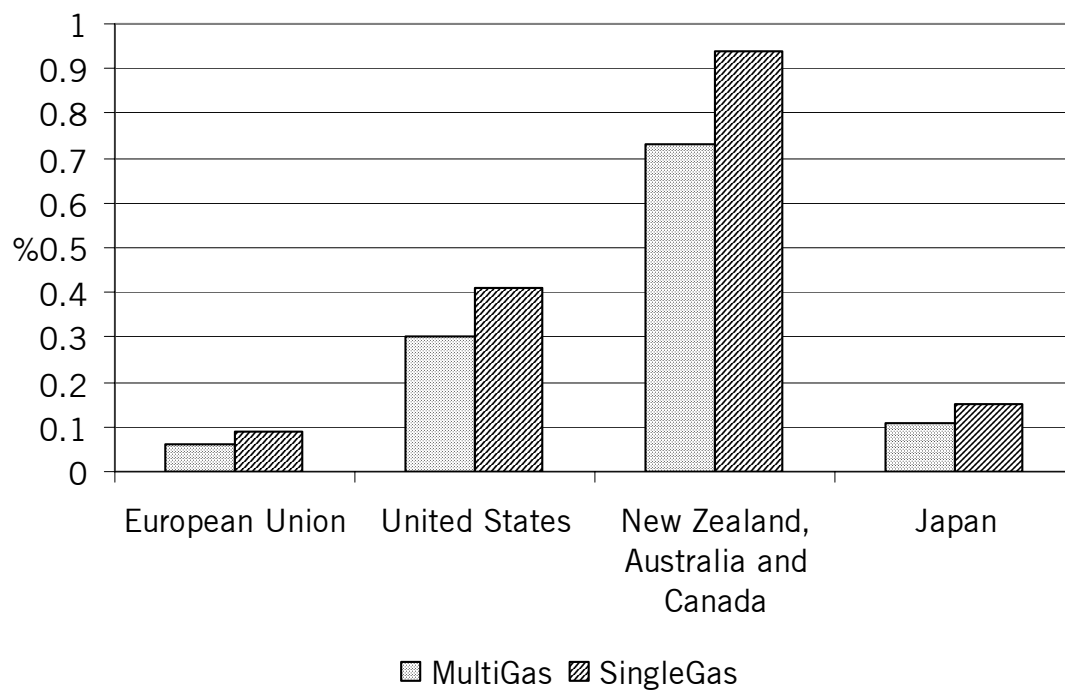
The marginal abatement costs in Figure 8 summarizes the economic impacts of the scenarios. A multi-gas control strategy lowers costs from 21 €/tCO₂ to 14 €/tCO₂ (or around 30%) when compared with a single-gas (CO₂) control strategy. Intuitively, non-CO₂ emissions offer many low cost opportunities, which can replace some of the high cost CO₂ abatement options.

Figure 8. Marginal abatement costs, 2010



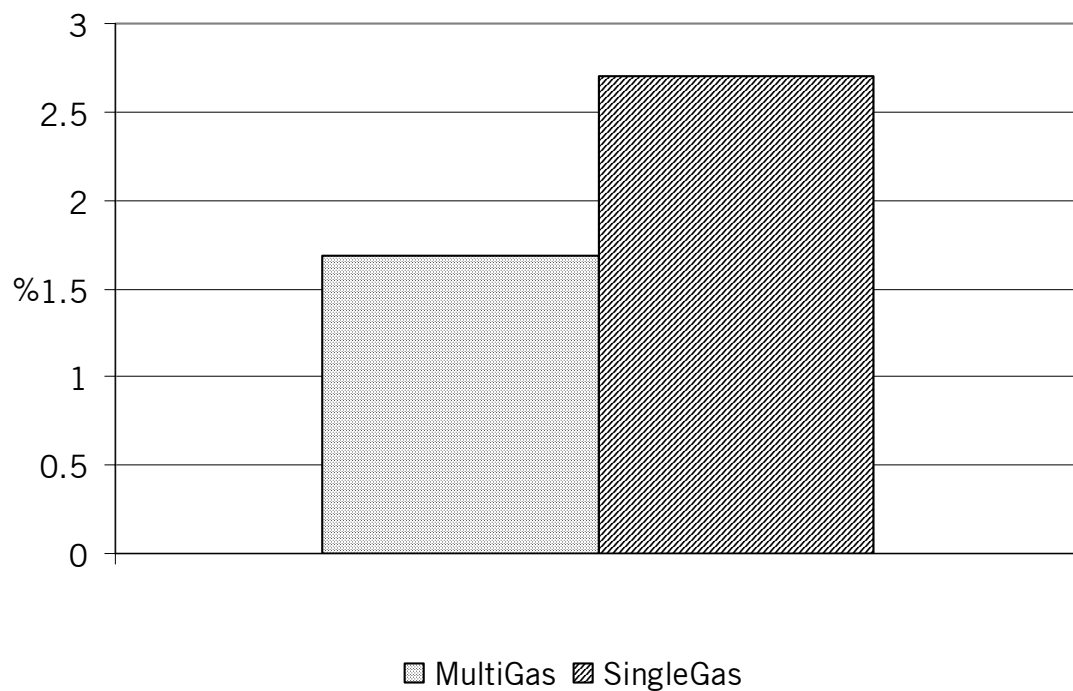
The reduction in marginal abatement costs reduces the welfare costs of the Kyoto Protocol in all Western Annex B countries (see Figure 9). The reductions in costs vary between 20% and 35%.

Figure 9. Welfare costs of the Kyoto Protocol



Exports of emissions, including Hot Air, are a major source of income for the Former Soviet Union and Eastern Europe. The reduction in the marginal abatement costs therefore reduces this region's welfare gain by almost 40% (see Figure 10).

Figure 10. Welfare gain in the Former Soviet Union and Eastern Europe

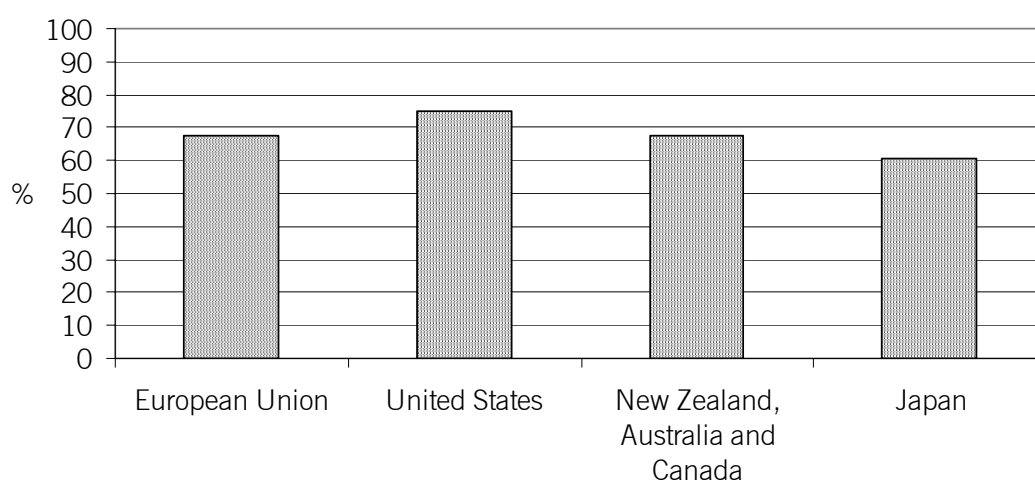


Environmental results

Abatement of CO₂ emissions will account for between 60% and 75% of the abatement in a multi-gas control strategy (see Figure 11). The large share is intuitive given CO₂'s large share in total emissions. Nevertheless, in all regions, the share is smaller than the share of CO₂ emissions in total emissions as it is cost-effective to abate a relatively higher percentage of the non-CO₂ emissions.

The distribution of the reductions in non-CO₂ emissions follows the marginal abatement cost curves in Figure 5. That is, CH₄, N₂O, and the HGWP roughly account for one-third of total non-CO₂ abatement in the European Union, and in all other regions, except Japan, CH₄, also account for the majority of the reductions.

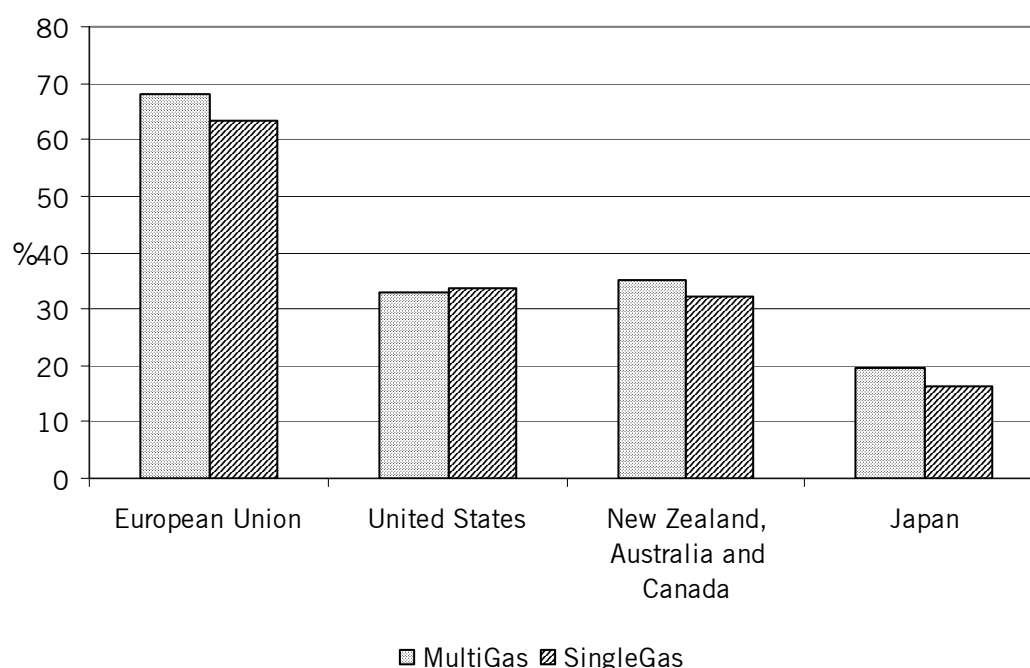
Figure 11. Share of CO₂ abatement in total domestic abatement, 2010



Finally, we report results for domestic action.¹⁰ A multi-gas strategy increases domestic action slightly in most regions; lower marginal abatement costs increases imports of emissions rights and therefore lower domestic action, but more low cost abatement options increase domestic action and dominate the effect of cheaper emissions imports (see Figure 12). Domestic action decreases slightly in the United States, where the effects of cheaper emissions imports dominate.

¹⁰ A set of current and prospective European Union member states underlined their concern for domestic action by proposing guidelines with concrete ceilings on emissions trading in 1999 (see Submission [1999]). See Ellerman and Wing [2000] and Jensen *et al.* [2000a] for analyses of the proposal.

Figure 12. Domestic action, 2010



6. Sensitivity analysis

How sensitive are the results to the assumptions we have made to extend the EDGE model to include sinks and non-CO₂ emissions? We address this question by analysing a second set of scenarios, which partly has been motivated by some of the uncertainties surrounding the limited data on sinks and non-CO₂ emissions.

Scenarios

First, we define the scenario **OnlyCO₂**, which assumes control of CO₂ emissions only and ignores both sinks and non-CO₂ emissions in setting the limits for emissions. This scenario shows the effects of all of the extensions of the model, and it also allows us to compare the EDGE model with most of the existing literature

The scenario **Growth** assumes that non-CO₂ emissions grow with the same percentage as CO₂ emissions in each region. This scenario illustrates the consequences of the generally optimistic baselines for future non-CO₂ emissions reported by the Annex B governments to the UNFCCC.

The scenario **NoRegrets** differs from the **MultiGas** scenario by including the “free” non-CO₂ abatement options in the analysis. That is, these options will be used as a response to the Kyoto requirements.

Finally, we define the scenario **FixedSinks**, which includes sinks in 1990 in setting the target (similar to the other scenarios) but ignores any subsequent removals or emissions of CO₂ from land use change and forestry. In other words, this scenario illustrates the importance of the changes in sinks embodied in the baselines.

Table 3 summarizes the scenarios in terms of emissions and Figure 13 shows the corresponding reduction requirements. The scenarios **MultiGas**, **SingleGas**, and **NoRegrets** imply the same baseline emissions and reduction requirements by definition, as they only differ by the available abatement options. Table 3 also shows that the scenario **OnlyCO₂** does not provide the same environmental improvement as the other scenarios as it ignores sinks and non-CO₂ emissions.

Table 3. Scenario emissions (MtCO₂)

Region	Year	MultiGas SingleGas NoRegrets	OnlyCO ₂	Growth	FixedSinks
European Union	1990	4338	3641	4338	4338
	2010	4352	3945	4642	4433
	Kyoto	4000	3359	4000	4000
United States	1990	5170	5196	5170	5170
	2010	6838	6776	7245	6692
	Kyoto	4811	4833	4811	4811
New Zealand, Australia and Canada	1990	1118	766	1118	1118
	2010	1434	1030	1514	1415
	Kyoto	1107	759	1107	1107
Japan	1990	1261	1232	1261	1261
	2010	1562	1485	1566	1533
	Kyoto	1184	1159	1184	1184
Former Soviet Union and Eastern Europe	1990	5727	4928	5727	5727
	2010	4158	3725	3967	4393
	Kyoto	5621	4836	5621	5621

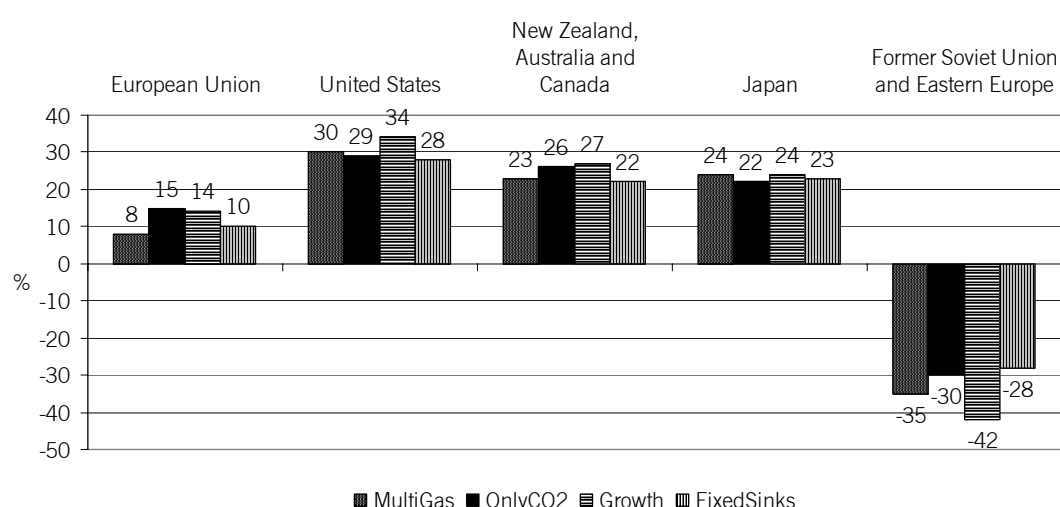
Two factors help explain the comparison with most of the existing literature (scenario **MultiGas** versus scenario **OnlyCO₂**). First, baseline emissions of non-CO₂ gases grow slower than CO₂ emissions in all regions, except in Eastern Europe and the Former Soviet Union. The effect is particularly strong in the European Union, where the exclusion of the five non-CO₂ emissions implies a strong increase in the percentage reduction requirement. Second, emissions from sinks in the United States and Japan dominate the baseline decrease in non-CO₂ emissions and the reduction requirements therefore increase in these regions.

Alternatively, if the expected decreases in baseline non-CO₂ emissions fail to materialize (as in the scenario **Growth**), the reduction requirements increase significantly in most

Western regions. In particular, the reduction requirement in the European Union almost doubles if non-CO₂ emissions grow at the same yearly rate as CO₂ emissions. In addition, the amount of hot air in Eastern Europe and the Former Soviet Union increases significantly.

Finally, Figure 13 also shows that the increases in the reduction requirements in the scenario **FixedSinks** show that the changes in baseline sinks imply a net removal in the European Union, Eastern Europe and the Former Soviet Union, and vice-versa for the other regions.

Figure 13. Emissions reduction requirements, 2010



Economic results

The scenario **OnlyCO₂** implies marginal abatement costs of 28 €/tCO₂ or 71 \$1995/tCE. (see Figure 14). This compares well with the results of the multi-model evaluation of the Kyoto Protocol in Weyant [1999]. The median carbon tax for Annex B trading is around 70 \$1990/tCE and five out of the thirteen models included report carbon taxes in the range 50-80 \$1990/tCE.¹¹ The scenario also suggests that the narrow focus on CO₂, both with respect to abatement options and in setting the target, leads to a significant overestimate (almost 100%) of the costs of the Kyoto Protocol.

Comparing the same scenarios, Reilly *et al.* [1999] show narrow focus on CO₂ leads to an overestimate of the marginal abatement costs between 8% in Eastern Europe and 153% in some of the OECD countries. Assuming Annex B emissions trading and ignoring the

¹¹ Pp. xxxi-xxxii in Weyant [1999].

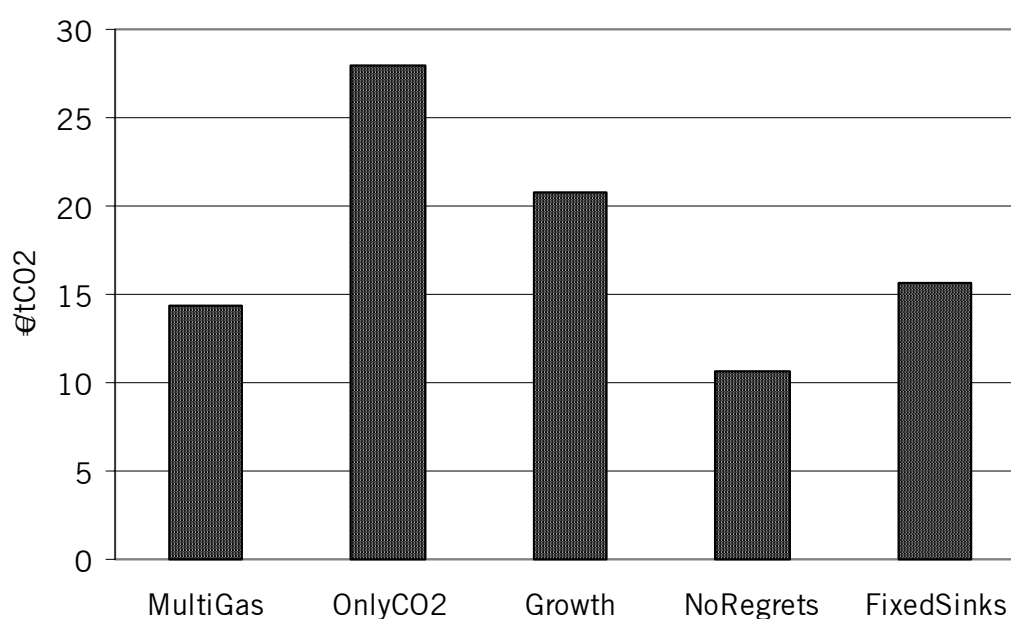
HGWPs, Burniaux [2000] and Manne and Richels [2000] show that the marginal abatement costs increases by around 50% and 100%, respectively.

The weak growth in the non-CO₂ baseline emissions, particularly in the European Union, reduces the reduction requirements significantly. If these baseline reductions fail to materialize and non-CO₂ emissions grow in line with CO₂ emissions, the scenario **Growth** shows that the marginal abatement costs increase almost 50%.

In contrast, marginal abatement costs decrease more than 25% if we include the “free” reductions in the analysis as part of the abatement options for new policies (scenario **NoRegrets**). Effectively, the “free” reductions shift the marginal abatement curves horizontally, and the same reduction requirements therefore imply lower costs.

Finally, the scenario **FixedSinks** illustrates the effects of eliminating the baseline changes in sinks. Specifically, all the previous scenarios, except the scenario **OnlyCO₂**, included a total net removal of 110 MtCO₂, or around 7% of the total emissions Annex B emissions reductions in 2010. In the scenario **FixedSinks**, we exclude this baseline effect and the marginal abatement costs therefore increases, as expected.

Figure 14. Marginal abatement costs, 2010



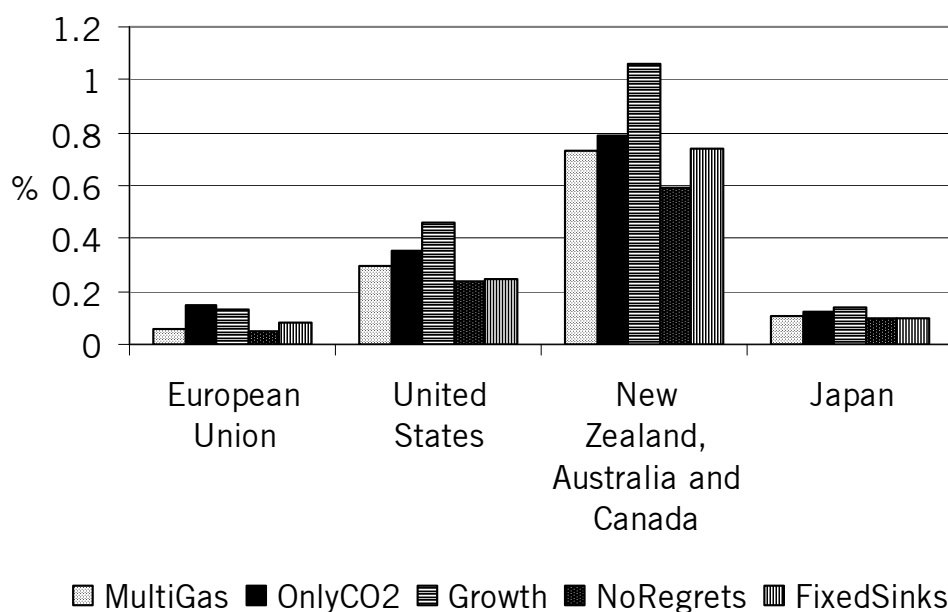
The changes in the marginal abatement costs and the reduction requirements help explain the changes in the welfare costs (Figure 15). In all regions, a narrow focus on CO₂ (scenario **OnlyCO₂**) leads to an overestimate of the costs of the Kyoto Protocol.

Stronger growth in the non-CO₂ baseline emissions increases the reduction requirements (scenario **Growth**). As expected, this increases the welfare costs in all regions. The Figure also shows that if non-CO₂ baseline emissions grow in line with CO₂ baseline emissions, then the costs of a multi-gas strategy may actually exceed the cost estimates focussing on CO₂ only (compare scenarios **MultiGas** and **OnlyCO₂**).

Our reference baseline for non-CO₂ emissions includes the effects of proposed policies, and we therefore include the “free” non-CO₂ abatement options in the baseline to minimize double counting of reductions. If we instead include the “free” reductions in the policy analysis (scenario **NoRegrets**), costs decrease in all regions as expected.

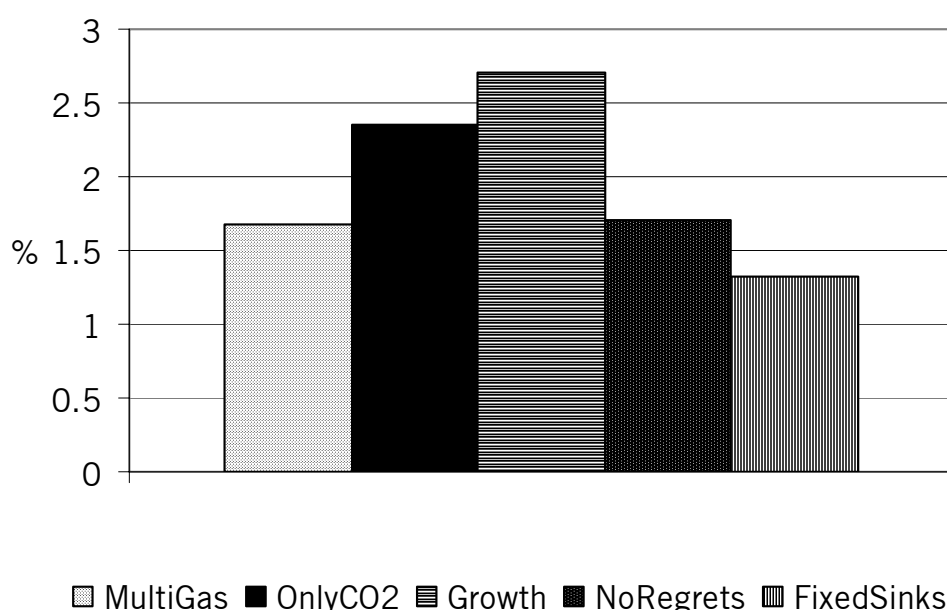
Finally, if sinks in 2010 equal sinks in 1990 (scenario **FixedSinks**), marginal abatement costs increases, but the reduction requirements decrease in all regions, except in the European Union. The changes in marginal abatement costs and in the reduction requirements unambiguously increase welfare costs in the European Union, but works in opposite directions in the other regions.

Figure 15. Welfare costs of the Kyoto Protocol



A multi-gas strategy reduces the gains to countries in the Former Soviet Union and Eastern Europe (Figure 16). A narrow focus on CO₂ (scenario **OnlyCO₂**) increases both the marginal abatement costs and the revenues from emissions exports.

Figure 16. Welfare gain in the Former Soviet Union and Eastern Europe



Stronger growth in the non-CO₂ baseline emissions (scenario **Growth**) leads to similar effects: higher marginal abatement costs and higher revenues from emissions exports, and both effects improve welfare. The opposite happens if we instead include the “free” reductions in the policy analysis (scenario **NoRegrets**). Finally, the scenario **FixedSinks** implies a welfare loss, if the net removal emissions in the baseline do not materialize.

Environmental results

Figure 17 shows that the CO₂ abatement share decreases in both the scenarios **Growth** and **NoRegrets**. Intuitively, both scenarios imply a larger abatement potential for non-CO₂ gases (because of higher baseline non-CO₂ emissions and “free” abatement options, respectively). The marginal abatement cost curves for non-CO₂ emissions are steeper than the curves for CO₂ emissions, and as the marginal abatement costs increases in the scenario **FixedSinks**, the share of CO₂ abatement increases.

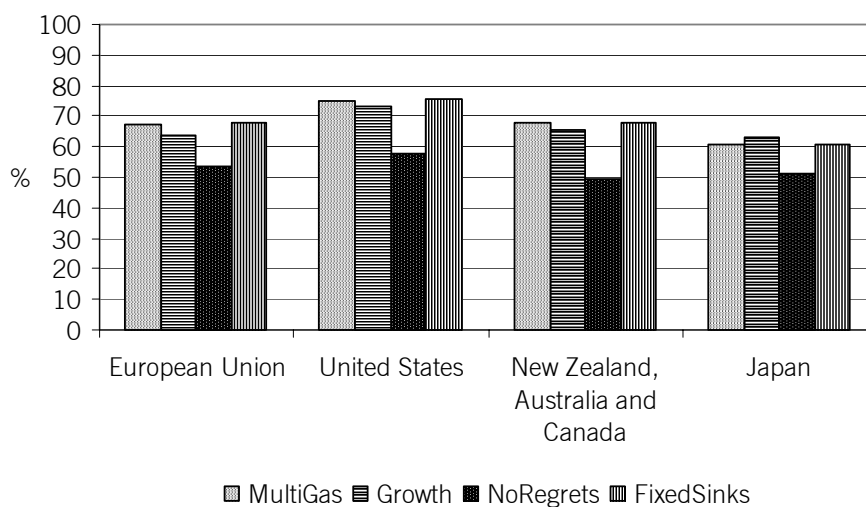


Figure 17. Share of CO₂ abatement in total domestic abatement, 2010

The narrow focus on CO₂ increases domestic action, except in the European Union (see scenario **OnlyCO₂** in Figure 18). Three factors drive this share. First, more low cost domestic abatement options increase domestic action. Second, domestic action increases as the marginal abatement costs increases (imports of emissions become more expensive). Third, domestic action decreases with the reduction requirement. The effect of higher marginal abatement dominates in all regions, except in the European Union, where the reduction requirements inflates emissions imports so much, that domestic action decreases.

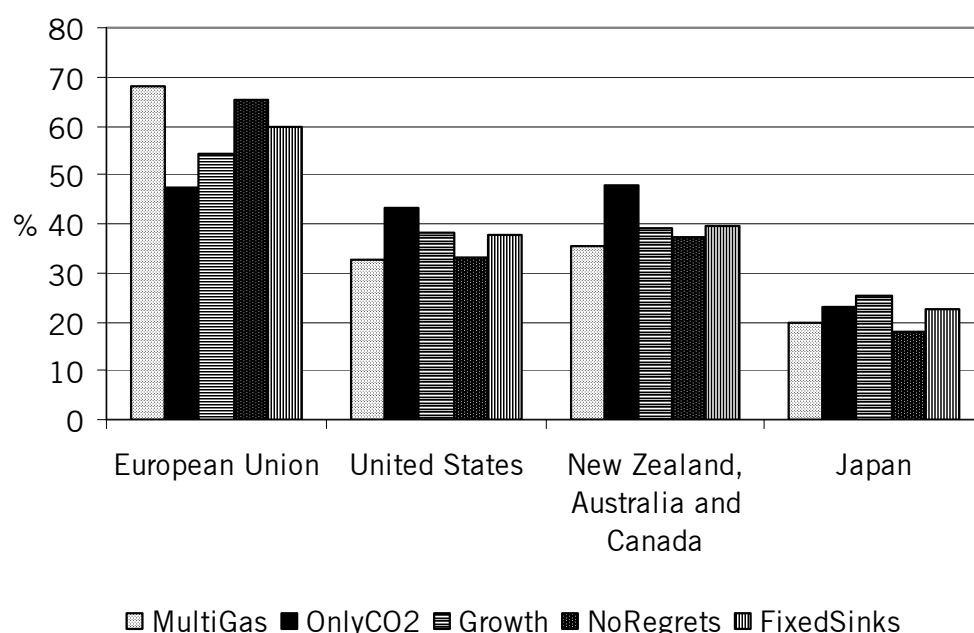
Ellerman and Wing [2000] also analyse the scenario **OnlyCO₂**. They report domestic action in the range 38% to 47% in all Western Annex B regions.

Stronger growth in the baseline non-CO₂ emissions (the scenario **Growth**) increases the abatement requirements and therefore the overall marginal abatement costs. The abatement requirement increases considerably in the European Union, and this reduces domestic action more than the increase following higher marginal abatement costs. In the other regions, the net effect is opposite: domestic action increases.

Marginal abatement costs decreases significantly, if we include the “free” reductions in the abatement options (the scenario **NoRegrets**). Most of the “free” reductions are available in the United States, which explains why domestic action increases in the United States. In the European Union and in Japan, the lower marginal abatement costs make imports of emissions rights more attractive, and domestic action therefore decreases.

Finally, the scenario **FixedSinks** illustrates the effects of the baseline changes in sinks: net removal in the European Union and emissions in the other regions. Marginal abatement costs change little, so if sinks in 2010 equal sinks in 1990, domestic action decreases in the European Union, but increases elsewhere.

Figure 18. Domestic action, 2010



7. Concluding remarks

The narrow focus on CO₂ in most economic analyses of the Kyoto Protocol captures the effects of abatement of the single-most important greenhouse gas. Our analysis shows, however, that policy makers may reduce costs significantly by exploiting the multi-gas flexibility in the Protocol. Specifically, the multi-gas flexibility implies more low costs abatement options and reductions in the abatement requirements. These effects may also increase domestic action, which together with costs, are some of the key issues in the policy debate.

We emphasize the preliminary nature of our results as many issues related to sinks and non-CO₂ abatement warrants more work. First, we only have studies of the marginal abatement costs of the non-CO₂ emissions in the European Union and the United States, and together these countries account for more than 50% of total Annex B emissions of non-CO₂. For the other Annex B regions, we use the marginal abatement cost curves for the European Union, but it would be useful to get estimates for these regions, particularly Eastern Europe and the Former Soviet Union, which together accounts for around 30% of total Annex B emissions.

Second, we developed our own baseline for non-CO₂ emissions based on the Annex B countries' communications to the UNFCCC. It is generally hard to identify consistent and

relevant baselines in these data, so more and better emissions data could substantially improve the analysis.

Finally, additional sinks projects could be incorporated through a sector, which uses scarce land resources and receives emissions credit depending on the characteristics of the activities it undertakes (for example conversion of agricultural land to forests). Sales of the credits from this sector would then add to the regular sales revenues and thus provide an incentive to use the technologies with the highest potential for emissions removal. This approach would also capture the effects of changes in land rents and in product prices, but again, more analyses are needed, as we know little about the costs and benefits of additional sinks projects.

8. References

- AEA, Options to Reduce Methane Emissions, Report for DGXI, November 1998.
- Burniaux, J.-M., "A Multi-Gas Assessment of the Kyoto Protocol," OECD Economics Department Working Paper No. 270, 2000.
- Conference of the Parties, "Kyoto Protocol To The United Nations Framework Convention On Climate Change," 1997.
- Ellerman, D. and Wing, I., "Supplementarity: An Invitation to Monopsony?" *Energy Journal* 21(4), 2000, pp. 29-59.
- Energy Information Administration, *International Energy Outlook 1999* (Washington D.C., U.S. Department of Energy, 1999)
- EPA, "U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions," United States Environmental Protection Agency, 1999.
- EPA, "Estimates of U.S. Emissions of High-Potential Warming Gases and the Costs of Reductions," United States Environmental Protection Agency, 2000.
- European Commission, *European Union Energy Outlook to 2020* (Luxembourg, Office for Official Publications of the European Communities, 1999).
- Goulder, L., "Environmental taxation and the double dividend: A readers guide," *International Tax and Public Finance* 2, 1995, pp. 157-183.
- Goulder, Lawrence, og Mathai, Koshy, "Optimal CO₂ Abatement in the Presence of Induced Technological Change," *Journal of Environmental Economics and Management* 39, 1-38, 2000.
- Goulder, Lawrence og Schneider, Stephen, "Induced technological change and the attractiveness of CO₂-abatement policies," *Resource and Energy Economics* 21, 211-253, 1999.
- Harnisch, J. and Hendriks, C., "Economic Evaluation of Emission Reductions of HFCs, PFCs and SF₆ in Europe", Report to the European Commission (DG-Environment), 2000

- Hendriks, C.; de Jager, D. and Blok, K., "Emission Reduction Potential and Costs for Methane and Nitrous Oxide in the EU-15", Report to the European Commission (DGXI), 1998.
- Jensen, J.; Nielsen, C. and Rutherford, T., "The economic effects of the European ceilings proposal", Working Paper, Copenhagen Economics, 2000a.
- Jensen, J.; Nielsen, C. and Rutherford, T., "Technical documentation of the EDGE model", Working Paper, Copenhagen Economics, 2000b.
- Jensen, J. and Rasmussen, T., "Allocation of CO₂ Emissions Permits: A General Equilibrium Analysis of Policy Instruments," Journal of Environmental Economics and Management 0, 2000, pp. 111-136.
- Manne, A. and Richels, R., "A Multi-Gas Approach to Climate Policy – with and without GWPs," Stanford University Working Paper, 2000.
- Reilly, J.; Prinn, R.; Harnisch, J.; Fitzmaurice, J.; Jacoby, H.; Kicklighter, D.; Melillo, J.; Stone, P.; Sokolov, A. and Wang, C., "Multi-gas Assessment of the Kyoto Protocol," Nature 401, 1999, pp. 549-555.
- Stavins, R., "The Costs of Carbon Sequestration: A Revealed-Preference Approach," American Economic Review 89 (4), September 1999
- Submission by Germany on Behalf of the European Community, its Member States, and Croatia, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic and Slovenia on Emissions Trading (Art. 17 KP); Principles, Modalities, Rules, and Guidelines for the Mechanisms Under Articles 6, 12, and 17 of the Kyoto Protocol, Note by the Secretariat, Addendum (FCCC/SB/1999/MISC.3/Add.3). Page 19-24.
- UNFCCC, Second compilation and synthesis of second national communications, Doc.: FCCP/CP/1998/11/Add.2, COP-4, 5 October 1998. Available at
<http://www.unfccc.de/resource/docs/cop4/11a02.pdf>
- UNFCCC, Report on national GHG inventory data from Annex I Parties for 1990 to 1998, Doc.: FCCC/SBI/2000/11, 5. September 2000. Available at
<http://www.unfccc.de/resource/docs/2000/sbi/11.pdf>
- Weyant, J. (ed.), "The Costs of the Kyoto Protocol: a Multi-Model Evaluation," The Energy Journal, Special Issue, 1999.
- World Bank, World Development Indicators 2000, World Bank, 2000. Available at
<http://www.worldbank.org>

9. Appendix: Database for sinks and non-CO₂ gases

Our model analysis requires data for historic and projected emissions of the six greenhouse gases covered by the Kyoto protocol. For CO₂, we combine consistent base year energy data from the International Energy Agency and carbon emissions coefficients to calculate historic CO₂ emissions. We derive projected CO₂ emissions based on model calculations reported in European Commission [1999].

Similar information is not available for sinks and non-CO₂ greenhouse gas emissions. We have therefore compiled a database with baseline sinks and non-CO₂ emissions based on the Annex B countries' communications to the UNFCCC.¹² The data sources include UNFCCC [1998], UNFCCC [2000], and World Bank [2000].¹³

Neither the data for historic nor projected emissions are complete. For historic emissions, we therefore make two assumptions: First, if only data for 1990 or 1995 is available, emissions in the two years are identical. Second, if no data for a given country is available, emissions equal GDP times the ratio of emissions to GDP in the EDGE region where the country belongs.

The data with projected emissions typically include data points for the years 1990, 2000, 2005, 2010 and 2020. To get data for 2030, we assume that the percentage growth from 2020 to 2030 equal the percentage growth in the period 2010-2020. Within the decades (2015 and 2025), we assume that emissions grow linearly. We can then compute emissions indices (1990=1) for each country and after aggregation also for each of the 45 GTAP regions and for each of eight regions in the model.

For countries without projected emissions, we use a three-step procedure. First, use the relevant GTAP index, if available. Second, if the relevant GTAP index is not available, use the index from the relevant model region. Third, if neither of the previous indices is available, use the index for global emissions.

Finally, we recalculate the emissions indices for the model regions based on the complete set of emissions projections.

¹² Note that the communications are not necessarily mutually consistent and in some cases, they furthermore include the anticipated effects of proposed policies. This makes it hard to identify a relevant baseline, i.e., the expected future emissions with no changes in current policies.

¹³ Very little data are available from the UNFCCC on developing countries (see <http://ghg.unfccc.int>). Alternative data sources include ALGAS and UNEP studies.

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

To order any of these papers, please fill out the form at the end of the list.

CLIM	1.2000	<i>Claudia KEMFERT</i> : <u>The Impacts of Emissions Trading on World Economies. Contemplation of baseline emissions paths and a ceiling on emissions trading</u>
CLIM	2.2000	<i>Pascal FAVARD</i> : <u>Does Productive Capital Affect the Order of Resource Exploitation?</u>
CLIM	3.2000	<i>Robert T. DEACON</i> (xxxix): <u>The Political Economy of Environment-Development Relationships: A Preliminary Framework</u>
SUST	4.2000	<i>Piet RIETVELD and Roberto ROSON</i> : <u>Joint Costs in Network Services: the Two-way Problem in the Case of Unbalanced Transport Markets</u>
CLIM	5.2000	<i>Robert S. PINDYCK</i> (xxxix): <u>Irreversibilities and the Timing of Environmental Policy</u>
MGMT	6.2000	<i>Domenico SINISCALCO, Stefania BORGHINI, Marcella FANTINI and Federica RANGHIERI</i> (xl): <u>The Response of Companies to Information-Based Environmental Policies</u>
SUST	7.2000	<i>Guy D. GARROD, Riccardo SCARPA and Ken G. WILLIS</i> : <u>Estimating the Benefits of Traffic Calming on Through Routes: A Choice Experiment Approach</u>
CLIM	8.2000	<i>ZhongXiang ZHANG</i> : <u>Estimating the Size of the Potential Market for the Kyoto Flexibility Mechanisms</u>
VOL	9.2000	<i>Jean-Christophe PEREAU and Tarik TAZDAIT</i> (xli): <u>Partial and Global Cooperation with Unilateral Commitment in the Presence of Global Environmental Problems</u>
KNOW	10.2000	<i>Giacomo CALZOLARI and Giovanni IMMORDINO</i> : <u>Hormone Beefs, Chloridric Chicken and International Trade: Can Scientific Uncertainty be an Informational Barrier to Trade?</u>
CLIM	11.2000	<i>Laura MARSILIANI and Thomas I. RENSTRÖM</i> (xxxvi): <u>Imperfect Competition, Labour Market Distortions, and the Double Dividend Hypothesis</u>
KNOW	12.2000	<i>Patrizia BUSSOLI</i> : <u>An Empirical Analysis of Technological Convergence Process and RIVs in Europe at the Firm Level</u>
KNOW	13.2000	<i>Luigi BENFRATELLO and Alessandro SEMBENELLI</i> : <u>Research Joint Ventures and Firm Level Performance</u>
KNOW	14.2000	<i>Nicholas S. VONORTAS</i> : <u>US Policy towards Research Joint Ventures</u>
ETA	15.2000	<i>Y.H. FARZIN</i> : <u>The Effects of Emissions Standards on Industry in the Short Run and Long Run</u>
ETA	16.2000	<i>Francis BLOCH and Stéphane ROTTIER</i> (xli): <u>Agenda Control in Coalition Formation</u>
CLIM	17.2000	<i>Giovanni IMMORDINO</i> : <u>Looking for a Guide to Protect the Environment: the Development of the Precautionary Principle</u>
CLIM	18.2000	<i>Hans W. GOTTINGER</i> : <u>Negotiation and Optimality in an Economic Model of Global Climate Change</u>
VOL	19.2000	<i>Paola MILIZIA and Marialuisa TAMBORRA</i> : <u>Juridical Framework of Voluntary Agreements in Italy and Policy Relevance at the Local Level</u>
CLIM	20.2000	<i>Richard S.J. TOL, Wietze LISE and Bob van der ZWAAN</i> (xli): <u>Technology Diffusion and the Stability of Climate Coalitions</u>
CLIM	21.2000	<i>Pietro TEATINI and Giuseppe GAMBOLATI</i> (xlii): <u>The Impact of Climate Change, Sea-Storm Events and Land Subsidence in the Adriatic</u>
CLIM	22.2000	<i>Emiliano RAMIERI</i> (xlii): <u>An Overview of the Vulnerability of Venice to the Impacts of Climate Change and Sea Level Rise</u>
PRIV	23.2000	<i>Bernardo BORTOLOTTI, Marcella FANTINI and Carlo SCARPA</i> : <u>Why do Governments Sell Privatised Companies Abroad?</u>
ETA	24.2000	<i>Carlo CARRARO and Gilbert E. METCALF</i> : <u>Behavioral and Distributional Effects of Environmental Policy: Introduction</u>
ETA	25.2000	<i>Santiago J. RUBIO and Juana AZNAR</i> : <u>Sustainable Growth and Environmental Policies</u>
KNOW	26.2000	<i>Francesca RECANATINI and Randi RYTERMAN</i> : <u>Disorganisation or Self-Organisation?</u>
KNOW	27.2000	<i>Giorgio BARBA NAVARETTI and David TARR</i> : <u>International Knowledge Flows and Economic Performance. An Introductory Survey of the Evidence</u>
SUST	28.2000	<i>Francesca CODA CANATI</i> : <u>Secondary Raw Materials Market Creation: Waste Stock Exchange</u>
KNOW	29.2000	<i>Giorgio BRUNELLO and Simona COMI</i> : <u>Education and Earnings Growth. Evidence from 11 European Countries</u>
CLIM	30.2000	<i>Michael GRUBB</i> : <u>The Kyoto Protocol: an Economic Appraisal</u>
CLIM	31.2000	<i>Gérard MONDELLO and Mabel TIDBALL</i> (xxxix): <u>Environmental Liability and Technology Choice: A Duopolistic Analysis</u>

KNOW	32.2000	Alberto PETRUCCI and Edmund PHELPS: <u>Capital Subsidies Versus Labour Subsidies: A Trade-Off between Capital and Employment?</u>
VOL	33.2000	Petr ŠAUER, Antonín DVOŘÁK and Petr FIALA: <u>Negotiation between Authority and Polluters – Model for Support of Decision Making in Environmental Policy: Principles and Experimental Case Test</u>
SUST	34.2000	Riccardo SCARPA, George W. HUTCHINSON and Sue M. CHILTON: <u>Reliability of Benefit Value Transfers from Contingent Valuation Data with Forest-Specific Attributes</u>
CLIM	35.2000	Allen PERRY (xlii): <u>Impact of Climate Change on Tourism in the Mediterranean: Adaptive Responses</u>
CLIM	36.2000	Laura MARSILIANI and T.I. RENGSTRÖM (xxxvi): <u>Inequality, Environmental Protection and Growth</u>
CLIM	37.2000	Massimiliano MONTINI (xlii): <u>Italian Policies and Measures to Respond to Climate Change</u>
CLIM	38.2000	Horst STERR, Richard KLEIN and Stefan REESE (xlii): <u>Climate Change and Coastal Zones. An Overview of the State-of-the-Art on Regional and Local Vulnerability Assessment</u>
CLIM	39.2000	Tullio SCOVAZZI (xlii): <u>Ideas Behind the New or Updated Mediterranean Legal Instruments</u>
CLIM	40.2000	Dimitrios GEORGAS (xlii): <u>Assessment of Climatic Change Impacts on Coastal Zones in the Mediterranean. UNEP's Vulnerability Assessments Methodology and Evidence from Case Studies</u>
SUST	41.2000	Herath M. GUNATILAKE and Ujjayant CHAKRAVORTY: <u>Forest Resource Extraction by Local Communities: A Comparative Dynamic Analysis</u>
PRIV	42.2000	Giancarlo SPAGNOLO: <u>Optimal Leniency Programs</u>
CLIM	43.2000	Paolo BUONANNO, Carlo CARRARO, Efrem CASTELNUOVO and Marzio GALEOTTI: <u>Emission Trading Restrictions with Endogenous Technological Change</u>
CLIM	44.2000	Alan S. MANNE and Richard G. RICHEL: <u>A Multi-Gas Approach to Climate Policy – with and without GWPs</u>
WAT	45.2000	Ujjayant CHAKRAVORTY and Chieko UMETSU: <u>Basinwide Water Management: A Spatial Model</u>
CLIM	46.2000	Don FULLERTON, Inkee HONG and Gilbert E. METCALF (xl): <u>A Tax on Output of the Polluting Industry is not a Tax on Pollution: The Importance of Hitting the Target</u>
PRIV	47.2000	Axel GAUTIER and Dimitri PAOLINI: <u>Delegation and Information Revelation</u>
ETA	48.2000	Andreas PAPANDREOU: <u>Externality, Convexity and Institutions</u>
ETA	49.2000	Cesare DOSI and Michele MORETTO: <u>The Timing of Adoption of Cleaner Technologies: Private Costs and Public Incentives</u>
ETA	50.2000	Michele MORETTO and Roberto TAMBORINI: <u>Liquidity: What can a “Hausbank” do that Other Lenders Cannot Do?</u>
PRIV	51.2000	Michele MORETTO and Paola VALBONESI: <u>Option to Revoke and Regulation of Local Utilities</u>
PRIV	52.2000	Giancarlo SPAGNOLO: <u>Self-Defeating Antitrust Laws</u>
PRIV	53.2000	William L. MEGGINSON and Maria K. BOUTCHKOVA: <u>The Impact of Privatisation on Capital Market Development and Individual Share Ownership</u>
KNOW	54.2000	Giorgio BARBA NAVARETTI, Marzio GALEOTTI and Andrea MATTOZZI: <u>Moving Skills from Hands to Heads: Import of Technology and Export Performance</u>
ETA	55.2000	Elisabetta STRAZZERA, Riccardo SCARPA, Pinuccia CALIA, Guy GARROD and Ken WILLIS: <u>Modelling Zero Bids in Contingent Valuation Surveys</u>
CLIM	56.2000	Paola CONCONI: <u>Can Green Lobbies Replace a World Environmental Organisation?</u>
VOL	57.2000	Paola CONCONI and Carlo PERRONI (xli) : <u>Issue Linkage and Issue Tie-in in Multilateral Negotiations</u>
ETA	58.2000	Fernando JARAMILLO, Hubert KEMPF and Fabien MOIZEAU (xli): <u>Conspicuous Consumption, Social Status and Clubs</u>
SUST	59.2000	Gianni CICIA and Riccardo SCARPA: <u>Willingness to Pay for Rural Landscape Preservation: A Case Study in Mediterranean Agriculture</u>
CLIM	60.2000	Josef JANSSEN: <u>Will Joint Implementation Survive International Emissions Trading? Distinguishing the Kyoto Mechanisms</u>
CLIM	61.2000	Carlo CARRARO: <u>Costs, Structure and Equity of International Regimes for Climate Change Mitigation</u>
KNOW	62.2000	Alberto BUCCI: <u>On Scale Effects, Market Power and Growth when Human and Technological Capital are Complements</u>
KNOW	63.2000	Alberto BUCCI and H.C. SAGLAM: <u>Growth Maximising Patent Lifetime</u>
WAT	64.2000	Michele MORETTO and Paolo ROSATO: <u>The Value of Licences for Recreational Resources Use</u>
WAT	65.2000	Edi DEFRANCESCO and Paolo ROSATO: <u>Recreation Management in Venice Lagoon</u>
KNOW	66.2000	Carlo DELL'ARINGA and Claudio LUCIFORA: <u>Inside the Black Box: Labour Market Institutions, Wage Formation and Unemployment in Italy</u>
CLIM	67.2000	Erkki KOSKELA, Markku OLLIKAINEN and Mikko PUHAKKA: <u>Renewable Resources in an Overlapping Generations Economy without Capital</u>
CLIM	68.2000	A. Lans BOVENBERG and Lawrence H. GOULDER (xl): <u>Neutralising the Adverse Industry Impacts of CO2 Abatement Policies: What Does it Cost?</u>
KNOW	69.2000	Ioanna KASTELLI: <u>Science and Technology Policy in Greece. Policy Initiatives for R&D Cooperation</u>
CLIM	70.2000	Katrin MILLOCK: <u>Contracts for Clean Development – The Role of Technology Transfers</u>
VOL	71.2000	Alberto CAVALIERE and Fabio FRONTOSO SILVESTRI (xliii): <u>Voluntary Agreements as Information Sharing Devices: Competition and Welfare Effects</u>

VOL	72.2000	Na Li DAWSON and Kathleen SEGERSON (xliii): <u>Voluntary Agreements with Industries: Participation Incentives with Industry-wide Targets</u>
VOL	73.2000	Patricia M. BAILEY (xliii): <u>The Application of Competition Law and Policy to Environmental Agreements in an Oligopolistic Market</u>
VOL	74.2000	Joanna POYAGO-THEOTOKY (xliii): <u>Voluntary Approaches and the Organisation of Environmental R&D</u>
VOL	75.2000	Scott C. MATULICH, Murat SEVER and Fred INABA (xliii): <u>Cooperative Bargaining to Internalise Open Access Externalities: Implications of the American Fisheries Act</u>
VOL	76.2000	Allen BLACKMAN and James BOYD (xliii): <u>Tailored Regulation: Will Voluntary Site-Specific Environmental Performance Standards Improve Welfare?</u>
VOL	77.2000	Vincenzo DENICOLA' (xliii): <u>A Signaling Model of Environmental Overcompliance</u>
VOL	78.2000	Markus A. LEHMANN (xliii): <u>Voluntary Environmental Agreements and Competition Policy. The Case of Germany's Private System for Packaging Waste Recycling</u>
VOL	79.2000	Hans H.B. VEDDER (xliii): <u>Voluntary Agreements and Competition Law</u>
VOL	80.2000	Thomas P. LYON and John W. MAXWELL (xliii): <u>Self-Regulation, Taxation and Public Voluntary Environmental Agreements</u>
VOL	81.2000	Paola MANZINI and Marco MARIOTTI (xliii): <u>A Bargaining Model of Voluntary Environmental Agreements</u>
VOL	82.2000	Alain NADAI and Benoit MOREL (xliii): <u>Product Ecolabelling, Competition and the Environment</u>
CLIM	83.2000	Simone BORGHESI: <u>Income Inequality and the Environmental Kuznets Curve</u>
KNOW	84.2000	Giorgio BRUNELLO and Massimo GIANNINI: <u>Stratified or Comprehensive? The Economic Efficiency of School Design</u>
KNOW	85.2000	Giorgio BRUNELLO, Simona COMI and Claudio LUCIFORA: <u>The College Wage Gap in 10 European Countries: Evidence from Two Cohorts?</u>
ETA	86.2000	Michael FINUS: <u>Game Theory and International Environmental Co-operation: A Survey with an Application to the Kyoto-Protocol</u>
CLIM	87.2000	Clare GOODESS, Jean PALUTIKOF and Maureen AGNEW (xlii): <u>Climate Change Scenarios for the Mediterranean: A Basis for Regional Impact Assessment</u>
CLIM	88.2000	Ian COXHEAD: <u>Tax Reform and the Environment in Developing Economies: Is a Double Dividend Possible?</u>
SUST	89.2000	Peter BARTELMUS and André VESPER (xliv): <u>Green Accounting and Material Flow Analysis. Alternatives or Complements?</u>
SUST	90.2000	Mark DE HAAN and Steven J. KEUNING (xliv): <u>The NAMEA as Validation Instrument for Environmental Macroeconomics</u>
SUST	91.2000	Jochen JESINGHAUS (xliv): <u>On the Art of Aggregating Apples & Oranges</u>
SUST	92.2000	Jan KOLAR (xliv): <u>Land Cover Accounting in the Czech Republic</u>
SUST	93.2000	Anil MARKANDYA, Alistair HUNT and Pamela MASON (xliv): <u>Valuing Damages for Green Accounting Purposes: The GARP II Approach</u>
SUST	94.2000	Anil MARKANDYA, Pamela MASON and Marialuisa TAMBORRA (xliv): <u>Green National Accounting: Synthesising and Extending the Welfare Based and Sustainability-standard Based Approaches</u>
SUST	95.2000	Martin O'CONNOR (xliv): <u>Towards a Typology of "Environmentally-Adjusted" National Sustainability Indicators: Key Concepts and Policy Application</u>
SUST	96.2000	Anton STEURER (xliv): <u>Towards an Environmental Accounting Framework for the EU</u>
SUST	97.2000	Cesare COSTANTINO, Federico FALCITELLI and Angelica TUDINI (xliv): <u>New Developments in Environmental Accounting at Istat</u>
CLIM	98.2000	Stefan BAYER and Claudia KEMFERT: <u>Reaching National Kyoto-Targets in Germany by Maintaining a Sustainable Development</u>
CLIM	99.2000	ZhongXiang ZHANG: <u>An Assessment of the EU Proposal for Ceilings on the Use of Kyoto Flexibility Mechanisms</u>
KNOW	100.2000	Maria Rosa BATTAGGION and Patrizia BUSSOLI: <u>Italian Policy towards Cooperation in R&D</u>
KNOW	101.2000	Giorgio BARBA NAVARETTI, Patrizia BUSSOLI, Georg VON GRAEVENITZ and David ULPH: <u>Information Sharing, Research Coordination and Membership of Research Joint Ventures</u>
WAT	102.2000	Cesare DOSI and William K. EASTER: <u>Water Scarcity: Institutional Change, Water Markets and Privatisation</u>
WAT	103.2000	Cesare DOSI and Naomi ZEITOUNI: <u>Controlling Groundwater Pollution from Agricultural Nonpoint Sources: An Overview of Policy Instruments</u>
KNOW	104.2000	Alberto PETRUCCI: <u>On Debt Neutrality in the Savers-Spenders Theory of Fiscal Policy</u>
SUST	105.2000	Roberto ROSON and Stefano SORIANI: <u>Intermodality and the Changing Role of Nodes in Transport Networks</u>
CLIM	106.2000	Alain BOUSQUET and Pascal FAVARD: <u>Does S. Kuznets' Belief Question the Environmental Kuznets Curves?</u>
CLIM	107.2000	Ottavio JANNI: <u>EU Biodiversity Conservation in Tropical Countries</u>

VOL	108.2000	<i>Katrin MILLOCK and François SALANIE: <u>Collective Environmental Agreements: An Analysis of the Problems of Free-Riding and Collusion</u></i>
VOL	109.2000	<i>Katrin MILLOCK: <u>The Combined Use of Taxation and Voluntary Agreements for Energy Policy</u></i>
VOL	110.2000	<i>Markus A. LEHMANN: <u>The Impact of Voluntary Environmental Agreements on Firms' Incentives for Technology Adoption</u></i>
SUST	1.2001	<i>Inge MAYERES and Stef PROOST: <u>Should Diesel Cars in Europe be Discouraged?</u></i>
SUST	2.2001	<i>Paola DORIA and Davide PETTENELLA: <u>The Decision Making Process in Defining and Protecting Critical Natural Capital</u></i>
CLIM	3.2001	<i>Alberto PENCH: <u>Green Tax Reforms in a Computable General Equilibrium Model for Italy</u></i>
CLIM	4.2001	<i>Maurizio BUSSOLO and Dino PINELLI: <u>Green Taxes: Environment, Employment and Growth</u></i>
CLIM	5.2001	<i>Marco STAMPINI: <u>Tax Reforms and Environmental Policies for Italy</u></i>
ETA	6.2001	<i>Walid OUESLATI: <u>Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital</u></i>
CLIM	7.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI: <u>Kyoto Commitment and Emission Trading: a European Union Perspective</u></i>
MGMT	8.2001	<i>Brian SLACK (xlv): <u>Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy</u></i>
VOL	9.2001	<i>Giulia PESARO: <u>Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors</u></i>
VOL	10.2001	<i>Cathrine HAGEM: <u>Climate Policy, Asymmetric Information and Firm Survival</u></i>
ETA	11.2001	<i>Sergio CURRARINI and Marco MARINI: <u>A Sequential Approach to the Characteristic Function and the Core in Games with Externalities</u></i>
ETA	12.2001	<i>Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS: <u>Inflation and Welfare in an OLG Economy with a Privately Provided Public Good</u></i>
KNOW	13.2001	<i>Paolo SURICO: <u>Globalisation and Trade: A "New Economic Geography" Perspective</u></i>
ETA	14.2001	<i>Valentina BOSETTI and Vincenzina MESSINA: <u>Quasi Option Value and Irreversible Choices</u></i>
CLIM	15.2001	<i>Guy ENGELN (xlii): <u>Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making</u></i>
SUST	16.2001	<i>Julie Catherine SORS: <u>Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches</u></i>
SUST	17.2001	<i>Julie Catherine SORS: <u>Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools</u></i>
CLIM	18.2001	<i>Johan ALBRECHT and Niko GOBBIN: <u>Schumpeter and the Rise of Modern Environmentalism</u></i>
VOL	19.2001	<i>Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO (xlili): <u>Participation Incentives and the Design of Voluntary Agreements</u></i>
ETA	20.2001	<i>Paola ROTA: <u>Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs</u></i>
ETA	21.2001	<i>Paola ROTA: <u>Empirical Representation of Firms' Employment Decisions by an (S,s) Rule</u></i>
ETA	22.2001	<i>Paola ROTA: <u>What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes</u></i>
PRIV	23.2001	<i>Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD: <u>Optimal Privatisation Design and Financial Markets</u></i>
KNOW	24.2001	<i>Giorgio BRUNELLO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI: <u>Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy</u></i>
ETA	25.2001	<i>Klaus CONRAD: <u>Locational Competition under Environmental Regulation when Input Prices and Productivity Differ</u></i>
PRIV	26.2001	<i>Bernardo BORTOLOTTI, Juliet D'SOUZA, Marcella FANTINI and William L. MEGGINSON: <u>Sources of Performance Improvement in Privatised Firms: A Clinical Study of the Global Telecommunications Industry</u></i>
CLIM	27.2001	<i>Frédéric BROCHIER and Emiliano RAMIERI: <u>Climate Change Impacts on the Mediterranean Coastal Zones</u></i>
ETA	28.2001	<i>Nunzio CAPPUCCIO and Michele MORETTO: <u>Comments on the Investment-Uncertainty Relationship in a Real Option Model</u></i>
KNOW	29.2001	<i>Giorgio BRUNELLO: <u>Absolute Risk Aversion and the Returns to Education</u></i>
CLIM	30.2001	<i>ZhongXiang ZHANG: <u>Meeting the Kyoto Targets: The Importance of Developing Country Participation</u></i>
ETA	31.2001	<i>Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN: <u>An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control</u></i>
MGMT Coalition	32.2001	<i>Roberta SALOMONE and Giulia GALLUCCIO: <u>Environmental Issues and Financial Reporting Trends</u></i>
Theory Network	33.2001	<i>Shlomo WEBER and Hans WIESMETH: <u>From Autarky to Free Trade: The Impact on Environment</u></i>
ETA	34.2001	<i>Margarita GENIUS and Elisabetta STRAZZERA: <u>Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods</u></i>

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

CLIM	67.2001	Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI (l): <u>Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence</u>
CLIM	68.2001	Alexey VIKHLYAEV (xlviii): <u>The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context</u>
NRM	69.2001	Gary D. LIBECAP and Zeynep K. HANSEN (li): <u>U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s</u>
NRM	70.2001	Lee J. ALSTON, Gary D. LIBECAP and Bernardo MUELLER (li): <u>Land Reform Policies, The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon</u>
CLIM	71.2001	Claudia KEMFERT: <u>Economy-Energy-Climate Interaction – The Model WIAGEM -</u>
SUST	72.2001	Paulo A.L.D. NUNES and Yohanes E. RIYANTO: <u>Policy Instruments for Creating Markets for Biodiversity: Certification and Ecolabeling</u>
SUST	73.2001	Paulo A.L.D. NUNES and Erik SCHOKKAERT (lii): <u>Warm Glow and Embedding in Contingent Valuation</u>
SUST	74.2001	Paulo A.L.D. NUNES, Jeroen C.J.M. van den BERGH and Peter NIJKAMP (lii): <u>Ecological-Economic Analysis and Valuation of Biodiversity</u>
VOL	75.2001	Johan EYCKMANS and Henry TULKENS (li): <u>Simulating Coalitionally Stable Burden Sharing Agreements for the Climate Change Problem</u>
PRIV	76.2001	Axel GAUTIER and Florian HEIDER: <u>What Do Internal Capital Markets Do? Redistribution vs. Incentives</u>
PRIV	77.2001	Bernardo BORTOLOTTI, Marcella FANTINI and Domenico SINISCALCO: <u>Privatisation around the World: New Evidence from Panel Data</u>
ETA	78.2001	Toke S. AIDT and Jayasri DUTTA (li): <u>Transitional Politics. Emerging Incentive-based Instruments in Environmental Regulation</u>
ETA	79.2001	Alberto PETRUCCI: <u>Consumption Taxation and Endogenous Growth in a Model with New Generations</u>
ETA	80.2001	Pierre LASSERRE and Antoine SOUBEYRAN (li): <u>A Ricardian Model of the Tragedy of the Commons</u>
ETA	81.2001	Pierre COURTOIS, Jean Christophe PÉREAU and Tarik TAZDAÏT: <u>An Evolutionary Approach to the Climate Change Negotiation Game</u>
NRM	82.2001	Christophe BONTEMPS, Stéphane COUTURE and Pascal FAVARD: <u>Is the Irrigation Water Demand Really Convex?</u>
NRM	83.2001	Unai PASCUAL and Edward BARBIER: <u>A Model of Optimal Labour and Soil Use with Shifting Cultivation</u>
CLIM	84.2001	Jesper JENSEN and Martin Hvidt THELLE: <u>What are the Gains from a Multi-Gas Strategy?</u>

(xxxvi) This paper was presented at the Second EFIEA Policy Workshop on “Integrating Climate Policies in the European Environment. Costs and Opportunities”, organised by the Fondazione Eni Enrico Mattei on behalf of the European Forum on Integrated Environmental Assessment, Milan, March 4-6, 1999

(xxxvii) This paper was presented at the Fourth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei, CORE of Louvain-la-Neuve and GREQAM of Marseille, Aix-en-Provence, January 8-9, 1999

(xxxviii) This paper was presented at the International Conference on “Trade and Competition in the WTO and Beyond” organised by the Fondazione Eni Enrico Mattei and the Department of International Studies of the University of Padua, Venice, December 4-5, 1998

(xxxix) This paper was presented at the 3rd Toulouse Conference on Environment and Resource Economics, organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE on “Environment, Energy Uses and Climate Change”, Toulouse, June 14-16, 1999

(xl) This paper was presented at the conference on “Distributional and Behavioral Effects of Environmental Policy” jointly organised by the National Bureau of Economic Research and Fondazione Eni Enrico Mattei, Milan, June 11-12, 1999

(xli) This paper was presented at the Fifth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CODE, Universitat Autònoma de Barcelona, Barcelona January 21-22, 2000

(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 the Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

2000 SERIES

MGMT	<i>Corporate Sustainable Management</i> (Editor: Andrea Marsanich)
CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
PRIV	<i>Privatisation, Antitrust, Regulation</i> (Editor: Bernardo Bortolotti)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Dino Pinelli)
WAT	<i>Water and Natural Resources Management</i> (Editor: Carlo Giupponi)
SUST	<i>Sustainability Indicators and Impact Assessment</i> (Editor: Marialuisa Tamborra)
VOL	<i>Task Force on Voluntary Agreements</i> (Editor: Rinaldo Brau)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)

2001 SERIES

MGMT	<i>Corporate Sustainable Management</i> (Editor: Andrea Marsanich)
CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
PRIV	<i>Privatisation, Antitrust, Regulation</i> (Editor: Bernardo Bortolotti)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Dino Pinelli)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
SUST	<i>Sustainability Indicators and Environmental Evaluation</i> (Editor: Marialuisa Tamborra)
VOL	<i>Voluntary and International Agreements</i> (Editor: Carlo Carraro)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)

SUBSCRIPTION TO "NOTE DI LAVORO"

Starting from January 1998 Fondazione Eni Enrico Mattei issues a Periodic E-mail "Note di Lavoro" Bulletin listing the titles and the abstracts of its most recent Working Papers.

All the "Note di Lavoro" listed in the Bulletin are available on the Internet and are downloadable from Feem's web site "www.feem.it".

If you wish to receive hard copies you may choose from the payment options listed in the following table (minimum order: 10 papers)*.

*Orders for individual papers should clearly indicate the "Nota di Lavoro" number and can therefore be issued for published papers only.

All orders must be sent by fax to:

"Publications Office" - Fondazione Eni Enrico Mattei: Fax +39+2+52036946

PAYMENT OPTIONS

How many papers?	What's the price?	How to pay?
10 or more*	US\$ 4.00 each ITL 7,000 each	By Credit card or Bank transfer
Annual subscription (approx. 100 papers/year)	US\$ 250.00 ITL 425,000	By Credit card or Bank transfer

***Please fill out the Working Paper Subscription Form indicating your preferences (Periodic E-mail "Note di Lavoro" Bulletin, Annual subscription, Order for individual papers - minimum 10*)!**

✂.....

WORKING PAPER SUBSCRIPTION FORM

Name: _____

Affiliation(if applicable): _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

I wish to: _____ Amount due: _____

☐ receive the Periodic E-mail Working Papers Bulletin

☐ place a full annual subscription for 2001 (US\$ 250.00/ITL 425,000) _____

☐ order no.....individual papers (minimum 10 papers at US\$ 4.00/ITL 7,000 each)* _____

Total _____

I will pay by:

☐ VISA ☐ American Express Card No. _____ Expiration Date: _____

Signature: _____

Bank transfer in US\$ (or Italian Lire in Italy) to Fondazione Eni Enrico Mattei - account no. 39341-56 -

SWIFT ARTIITM2 - ABI 03512 - CAB 01614 - Credito Artigiano - Corso Magenta 59, 20123 Milano, Italy.

Copy of the bank transfer should be faxed along with the order.

Please return this duly completed form to:

"Publications Office" - Fondazione Eni Enrico Mattei - Corso Magenta, 63 - 20123 Milano, Italy