Onderzoeksproject HL/DD/04 :

Internationale Economische Orde : Opportuniteiten en Beperkingen voor een Belgische milieufiscaliteit

BIJLAGEN

Onderdeel van het programma "Hefbomen voor een beleid gericht op duurzame ontwikkeling"

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Bijlagen

Bijlage I : Programma van de conferentie 'Instruments for Climate Policy : Limited versus Unlimited Flexibility?'

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Bijlage I : Programma van de conferentie 'Instruments for Climate Policy : Limited versus Unlimited Flexibility?'

Het programma van de conferentie is eveneens terug te vinden op :
http://fetew.rug.ac.be/ceem/nl/climpolprog.htm

Doel van de conferentie :
Deze conferentie kadert in de presentatie van de onderzoeksresultaten aan de buitenwereld. Verder bood de conferentie de kans om mensen uit verschillende socio-economische groepen aan het woord te laten. Zo waren er in de eerste plaats academici die hun eigen onderzoek m.b.t. het klimaatbeleid toelichtten. Verder waren er ook mensen uit het bedrijfsleven vertegenwoordigd. Tot slot kwamen ook een aantal mensen aan het woord die nauw verbonden zijn met het beleid.

Programma van de conferentie 'Instruments for Climate Policy: Limited versus Unlimited Flexibility?'

Thursday, October 19th

9.00 - 9.30 Registration
Room 'Refter'
9.30 Welcome address
Marc De Clercq, Ghent University
Chair: Marc De Clercq, Ghent University
9.45 The EU perspective on climate policy instruments and strategies
Peter Zapfel (European Commission, DG Environment)
10.15 The US perspective on climate policy instruments and strategies
David Gardiner, Executive Director, White House Climate Change Task Force, US Government,Washington
10.45 Questions and discussion
11.00 Break
Chair: Bart Ameels, Ghent University
11.15 Emission trading - from the virtual to the real? The EURELECTRIC energy and emission trading simulation (GETS)
John Scowcroft, Eurelectric, Brussels
11.45 Which strategies are available when you are a known large emitter of GHG in a competitive environment?
Jean-Claude Steffens, Electrabel (Head of European & Institutional Affairs), Brussels
12.15 Emission trading and large energy consumers
Jan-Peter Huges, ENERG8
12.45 Questions
13.00 Lunch
Chair: André Suck, Ghent University
14.15 Diverging business strategies towards climate change. A USA-Europe comparison for four major sectors of industry
Frans van der Woerd, Kathy de Wit, Ans Kolk, David L. Levy - IVM, Institute for Environmental Studies, Vrije Universiteit Amsterdam, Amsterdam (The Netherlands)
14.45 Implementing the Kyoto Mechanisms: Potential contributions by banks and insurance companies
Jozef Janssen – Institute for Economy and the Environment (IWOe-HSG), University of St. Gallen (Switzerland)
15.15 Questions
15.30 Break
15.45 A theoretical and empirical analysis of the reasons for the EU to propose a ceiling on the use of Kyoto mechanisms
Edwin Woerdman - University of Groningen (RuG), Faculty of Law, Groningen (The Netherlands)
16.15 On the optimal timing of reductions of CO_2 emissions. A survey of the debate on 'when flexibility'
Henri L.F. de Groot - CPB (Netherlands Bureau of Economic Policy Analysis) and Vrije Universiteit Amsterdam, Amsterdam (The Netherlands)
16.45 Questions
17.00 End of first day
19.30 Dinner

Friday, October 20th

Het Pand, Room 'Refter'
Chair: Igor Struyf, Ghent University
9.30 A multi-gas approach to climate policy
Richard Richels – EPRI, Palo Alto, California (USA)
10.00 Questions
10.15 Break
10.30 Parallel sessions IA and IB
IA Room 'Refter' - Limited Flexibility
Chair: Khalil Helioui - CIRED-CNRS, Nogent-sur-Marne (France)
10.30 The supplementary condition: a device to reconcile the precautionary and the flexibility principles?
Khalil Helioui – CIRED-CNRS, Nogent-sur-Marne (France)
11.00 Potential limits imposed by the multinational trading system in implementing flexibility mechanisms
Joy Aeree Kim – Climatic Research Unit, University of East Anglia (England)
11.30 Efficiency and equity in the EU Bubble Agreement
Johan Eyckmans and Jan Cornillie - Katholieke Universiteit Leuven (CES-ETM), Leuven (Belgium)
12.00 Questions
12.15 Lunch
IB Room 'Louis XVI' - Clean Development Mechanism & Joint Implementation
Chair: Jyoti P. Painuly - UNEP Collaborating Centre on Energy and Environment, RISO National Laboratory, Roskilde (Denmark)
10.30 The Clean Development Mechanism: potential, promise and limitations
Jyoti P. Painuly – UNEP Collaborating Centre on Energy and Environment, RISO National Laboratory, Roskilde (Denmark)
11.00 Can portfolio diversification reduce the risks of the Kyoto mechanisms? Evidence from the Swedish AIJ Programme
Urs Springer – Institute for Economy and the Environment, University of St. Gallen (Switzerland)
11.30 Carbon taxes and Joint Implementation: an applied CGE analysis for Germany and India
Andreas Löschel, Christoph Boehringer, Klaus Conrad - ZEW, Centre for European Economic Research, Environmental and Research Economics, Mannheim (Germany); Mannheim University (Germany)
12.00 Questions
12.15 Lunch
13.45 Parallel session IIA and IIB
IIA Room 'Refter' - Voluntary Agreements and emission trading
Chair: Rory Sullivan, University of London
13.45 Voluntary approaches for climate policy: lessons learned from the Australian greenhouse challenge
Rory Sullivan and Robin Ormerod - University of London; Pacific Air and Environment (Australia)
14.15 Voluntary agreements - an effective tool for enhancing organisational learning and improving climate policy-making
Stephan Ramesohl and Kora Kristof - Wuppertal Institute for Climate, Environment, Energy, Wuppertal (Germany)
14.45 Questions
15.00 Break
15.15 The political economy of international emissions trading scheme choice: empirical evidence
Jan-Tjeerd Boom and Gert Tinggaard Svendsen, University of Groningen, Faculty of Law, Groningen (The Netherlands)
15.45 Economic efficiency of cross-sectoral emission trading of CO_2 emission in the European Union
Pantelis Capros, Leonidas Mantzos, Matti Vainio and Peter Zapfel - National Technical University of Athens (Greece); European Commission, DG Environment, Brussels
16.15 Industry-level emission trading in the EU under the Kyoto Protocol
Christoph Böhringer - ZEW, Centre for European Economic Research, Environmental and

Resource Economics, Mannheim (Germany)
16.45 Questions

II.B. Room 'Louis XVI' – Efficiency and social contracts

Chair: Michael Finus, Institute of Economic Theory, Hagen (Germany)

13.45 Quotas may beat taxes in a global emission game
Alfred Endres and Michael Finus - Institute of Economic Theory, Hagen (Germany)
14.15 Climate politics and international institutions: supporters of global ecological cooperation
Banu Bayramoglu-Lise, IVM, Amsterdam
14.45 Questions
15.00 Break
15.15 Negotiating climate change as a social situation
Wietze Lise, Bob van der Zwaan and Richard Tol - IVM, Institute of Economic Studies, Vrije Universiteit Amsterdam; Stanford University (USA); Carnegie Mellon University, Pittsburgh (USA) and Hamburg University (Germany)
15.45 Questions
End of this session - Session in Refter continues

Room 'Refter'

17.00 Closing of the conference
Marc De Clercq – Ghent University
17.15 Reception

Bijlage II : Lijst van publicaties die het resultaat zijn van het onderzoeksproject

De papers die opgenomen zijn in de onderstaande lijst zijn terug te vinden in Bijlage III van het onderzoeksproject.

- Albrecht, J. en De Clercq, M., 1998, Milieu en competitiviteit, Energie & Milieu 14(3), mei/juni 1998, pp. 143-146.

- Albrecht, J. en François, D., 2001, Voluntary Agreements with Emission Trading Options in Climate Policy, European Environment, Vol.11(4), pp.185-196.

- Albrecht, J., 1998, Environmental Consumer Subsidies and Potential Reductions of CO_2 Emissions, paper gepresenteerd op de conferentie “Greening the Budget” van het Institut für Wirtschaftsforschung, te München (11 en 12 mei 1998).

- Albrecht, J., 1998, Environmental Policy and the Inward Investment Position of US “Dirty” Industries, Intereconomics Vol 33(4), July/august 1998, pp. 186-194.

- Albrecht, J., 1998, Environmental Regulation, Comparative Advantage and the Porter Hypothesis, Note di Lavore 59.98 op de website op de website van de Fondazione Eni Enrico Mattei (www.feem.it).

- Albrecht, J., 1998, Green policies – from ecotaxes to extended producer responsibility : an institutional search for policy autonomy from the EU and WTO frameworks, in bundel DWTC workshop dd. 22 september 1998.

- Albrecht, J., 1999, Environmental Agreements and Sectoral Performance : Cases of the CFC Phase-out and the US Toxic Release Inventory, CAVA Working Paper n° 89/11/11.

- Albrecht, J., 1999, Making CO_2 Emission Trading More Effective : Integrating Cross-sectoral Energy Efficiency Opportunities, Note di Lavoro 47.99 op de website van de Fondazione Eni Enrico Mattei (www.feem.it) en opgenomen in: Carraro C. (ed.), Efficiency and Equity of Climate Change Policy (Kluwer, London), 156-177

- Albrecht, J., 1999, Policy Instruments and Incentives for Environmental R&D: A Market-Driven Approach, Note di Lavoro 17.99 op de website van de Fondazione Eni Enrico Mattei (www.feem.it).

- Albrecht, J., 2000, Environmental policy and new technologies : to create or to scrap ?

- Albrecht, J., 2000, The diffusion of cleaner vehicles in CO_2 emission trading designs, Transportation Research Part D5, 385-401.

Bijlage III : Gedetailleerde onderzoeksresultaten

In deze Bijlage zijn de verschillende publicaties van het onderzoeksproject terug te vinden. Ze zijn zo geordend dat ze aansluiten bij de structuur van het eindverslag.

Bijlage III – A :

Environmental Regulation, Comparative Advantage and the Porter Hypothesis
Johan Albrecht (1998)

Note di Lavoro 59.98, deze paper is gepubliceerd op de website van de Fondazione Eni Enrico Mattei.

Deze paper hoort bij deel A.1 : De belangrijkste bevindingen van ons onderzoek naar de relatie tussen milieudoelstellingen en de internationale competitiviteit.

Bijlage III – B :

Environmental Policy and the Inward Investment Position of US "Dirty" Industries
Johan Albrecht (1998)

Gepubliceerd in Intereconomics Vol 33(4), July/august 1998, pp. 186-194.

Deze paper hoort bij deel A.1 : De belangrijkste bevindingen van ons onderzoek naar de relatie tussen milieudoelstellingen en de internationale competitiviteit.

Bijlage III – C :

Milieu en Competitiviteit
Johan Albrecht en Marc De Clercq (1998)

Gepubliceerd in Energie & Milieu 14(3), mei/juni 1998, pp. 143-146.

Deze paper hoort bij deel A.1 : De belangrijkste bevindingen van ons onderzoek naar de relatie tussen milieudoelstellingen en de internationale competitiviteit.

Bijlage III – D :

Environmental Agreements and Sectoral Performance : Cases of the CFC Phase-out and the US Toxic Release Inventory
Johan Albrecht (1999)

CAVA Working Paper n° 89/11/11.

Deze paper hoort bij deel A.1 : De belangrijkste bevindingen van ons onderzoek naar de relatie tussen milieudoelstellingen en de internationale competitiviteit.

Bijlage III – E :

Green policies – from ecotaxes to extended producer responsibility : an institutional search for policy autonomy from the EU and WTO frameworks
Johan Albrecht (1998)

Deze tekst hoort bij deel A.2 : Analyse van de Internationale Economische Orde.

Bijlage III – F :

Environmental Consumer Subsidies and Potential Reductions of CO_2 Emissions
Johan Albrecht (1998)

Deze paper werd gepresenteerd op conferentie “Greening the Budget” van het Institut für Wirtschaftsforschung, te München (11 en 12 mei 1998).

Deze paper hoort bij deel B.2.2 : Beleidsondersteunende maatregelen en concrete voorstellen inzake het technologisch beleid.

Bijlage III – G :

Policy Instruments and Incentives for Environmental R&D: A Market-Driven Approach
Johan Albrecht (1999)

Note di Lavoro 17.99, deze paper is gepubliceerd op de website van de Fondazione Eni Enrico Mattei.

Deze paper hoort bij deel B.2.2 : Beleidsondersteunende maatregelen en concrete voorstellen inzake het technologisch beleid.

Bijlage III – H :

Environmental policy and new technologies : to create or to scrap ?
Johan Albrecht (2000)

Deze paper hoort bij deel B.2.2 : Beleidsondersteunende maatregelen en concrete voorstellen inzake het technologisch beleid.

Bijlage III – I :

Making CO_2 Emission Trading More Effective : Integrating Cross-sectoral Energy Efficiency Opportunities
Johan Albrecht (1999)

Note di Lavoro 47.99, deze paper is gepubliceerd op de website van de Fondazione Eni Enrico Mattei en in: Carraro C. (ed.), Efficiency and Equity of Climate Change Policy (Kluwer, London), 156-177

Een herwerkte versie van deze paper werd eveneens gepubliceerd :
Albrecht, J., 2000, The diffusion of cleaner vehicles in CO_2 emission trading designs, Transportation Research Part D5, 385-401.

Deze paper hoort bij deel B.2.2 : Beleidsondersteunende maatregelen en concrete voorstellen inzake het technologisch beleid.

Bijlage III – J :

Voluntary Agreements with Emission Trading Options in Climate Policy
Johan Albrecht en Delphine François (2001)

Gepubliceerd in European Environment, Vol.11(4), pp.185-196.

Deze paper hoort bij deel B.2.2 : Beleidsondersteunende maatregelen en concrete voorstellen inzake het technologisch beleid.

Environmental Regulation, Comparative Advantage and the Porter Hypothesis

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JEL Classification :F14, F21; L52, O32, Q28

Keywords : Environmental regulation; Industrial flight; Comparative advantage ; Export diversification ; Porter hypothesis

Short Abstract :
Empirical surveys find no significant impact of environmental regulation and environmental costs on international competitiveness. In the literature, we can find three hypotheses on the impact of environmental regulation. For the industrial-flight and pollution-haven hypothesis, there is no clear empirical evidence. We show that this is a logical consequence of the principle of comparative advantage. Another explanation can be that developed countries have very diversified exports and most surveys do not link regulation to specific products. We therefore investigate the link between export diversification and two measures of labor productivity. The Porter hypothesis - the third or revisionist hypothesis in our overview - states that environmental regulation can lead to improved competitiveness. Many authors only find 'anecdotal' evidence for this hypothesis but we show that when regulation is linked to specific products, there is clear evidence for the Porter hypothesis. In our model, we work with international CFC-regulation (chlorofluorocarbons) and the export performance of CFC-using industries like refrigerators, freezers and air conditioning machines. A final section does focus on the tradition of cartelization that has been typical in many of the old - and 'dirty' - industries.

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I want to thank Koen Schoors (University of Ghent) and Tom Verbeke (FWO Vlaanderen, University of Ghent) for their useful comments.

Non-technical Abstract
Empirical surveys find no significant impact of environmental regulation and environmental costs on international competitiveness. This is rather surprising because considerations on competitiveness strongly influence many national and international environmental agreements and measures. In the literature, we can find three hypotheses on the impact of environmental regulation. For the industrial-flight and pollution-haven hypothesis, there is no clear empirical evidence. We show that this is a logical consequence of the principle of comparative advantage. This principle is used to illustrate that for each product that a country exports, the impact of environmental costs will be different. Since these products all have different comparative advantages, some will loose their advantage as a result of new regulation while other products will be able to maintain their advantage. As a consequence, a country will never loose an important part of its exports as a result of an increase in regulatory costs.

This could however be the case for countries that have very concentrated trade flows and are as such vulnerable for product-specific regulations. Another explanation can be that developed countries have very diversified exports and most surveys on environmental regulation and competitiveness do not link regulation to specific products. Most surveys work with total exports or with sectoral exports. Again, this is not the best approach since sectors like the chemical industry make hundreds or even thousands - depending on the level of analysis - of products that are on a different way vulnerable for changes in environmental regulation.

In a next section, we investigate the link between export diversification and two measures of labor productivity. Other variables in our analysis are income pro capita and the inward FDI-stock. We find that productivity explains diversification of exports. We can conclude that the most productive countries have the most means to cope with costly regulation while they are the least vulnerable for new regulation. The weak impact of regulation on competitiveness can be explained in part by this finding.

The Porter hypothesis - the third or revisionist hypothesis in our overview - states that environmental regulation can lead to improved competitiveness : efficient regulations may actually stimulate innovation, efficiency gains, industrial growth and competitiveness. Many authors only find ‘anecdotal’ evidence for this hypothesis but we show that when regulation is linked to specific products - the best approach for estimating the direct impact of regulation -, there is clear evidence for the Porter hypothesis. In our model, we work with international CFC-regulation (chlorofluorocarbons) and the export performance of CFC-using industries like refrigerators, freezers and air conditioning machines. Since all industrial nations signed the Montreal Protocol on Substances that Deplete the Ozone Layer, they all had to impose regulation in line with the agreed CFC-phase-out schedules. We find that the two countries with the most pro-active CFC-policy (the US and Denmark) experienced better export growth for their CFC-using industries than countries that reacted later and with less convincing instruments.

In a final section, we focus on the tradition of cartelization that has been typical in many of the old - and ‘dirty’ - industries in our analysis. Due to their market power, these industries had the capability to influence the regulatory process. Drastic actions that strongly harmed competitiveness are as such very scarce..

1.Introduction

Since the 1960s, the institutionalisation of environmental issues gained momemtum and developed into a World Environmental Regime. Compared to international trade policy, this environmental framework is of very recent date and as such subject to constant changes. This ‘green’ regime has however its origins in the late nineteenth century when the first international environmental associations and environmental treaties saw light. After World War II, environmental intergovernmental organizations were established and the first national environmental ministries date from the early 1970s (Meyer, 1997). Since then, environmental regulation developed into a complex and diversified body that affected all layers of society. In terms of financial impacts, pollution abatement and control expenditures in most industrialized countries increased on average to some 2-3% of GDP (Kalt, 1988).

In an era of globalization, measured by increasing transnational trade and investments, it is not surprising that industrial leaders and policy makers are very sensitive to a possible deterioration of national competitiveness as a consequence of environmental regulation that is relatively more stringent compared to other nations. The argument of competitiveness has not only been used to oppose national and supranational environmental legislation (like the US Clean Air Act or the proposed European CO_2-tax), it also strongly influenced negotiations on global issues like stratospheric ozone, acid rain and climate change. The 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change has clearly been shaped by considerations on possible losses of competitiveness vis-à-vis developing countries that would not incur similar greenhouse abatement expenditures.

Is competitiveness a political issue because of an accellerating globalization or is there clear evidence of a negative impact of environmental regulation on national or regional economic performance? This needs further research because if undesirable impacts of stricter regulation are recognized in advance, environmental policies can be redesigned to reduce them to acceptable levels.

In the next sections, we will present the hypotheses on the impacts of environmental regulation. After an overview of the empirical findings, we will focus on the essence of comparative advantage and add aspects of product differentiation and of export diversification. Our findings will be used to shape the optimal framework for an empirical test of the Porter hypothesis for the sectors that are directly influenced by specific environmental regulation or agreements.

We conclude with some considerations on the nature of competition among major ‘dirty’ industries.

2.The hypotheses on environment and competitivity

From an impressive body of surveys (more than hundred (Jaffe, 1995)) on the link between environmental regulation and competitiveness, we can extract three hypotheses :

- the *industrial-flight* hypothesis : environmental regulation would push an increasing number of industries out of the advanced industrial countries ;
- the *pollution-haven* hypothesis : less-developed countries would use lenient environmental regulations to attract multinational industries ;
- the *Porter* hypothesis : efficient regulation may stimulate innovation, productivity and competitivity.

The first two hypotheses were formulated and investigated by Leonard (1988). He concluded that there is 'no reason to believe that the major trend in international comparative advantage - the gradual shift of many heavy industries such as steel from the most industrialized to rapidly industrializing countries - is being significantly heightened by stringent environmental regulations in the most advanced countries (p.231).'
Recent data on foreign direct investment showed however that this gradual shift of many heavy industries may have reversed during the 1990s. This has been documented by Bhagwati (1997) and when we classify industries to their environmental impact (dirty, clean and medium industries, as measured by pollution abatement expenditures as a percentage of output), we found that the inward foreign direct investment-position in the US of the group of 9 'dirty' industries grew by 67.1% over the period 1991-1995 , while the cumulative growth for the medium group (9 other industries) was only 7.2% and the 'clean' group even lost foreign investments in the US. This is a remarkable result because output and gross fixed capital formation evolved similarly for the three groups of industries. A possible explanation is the large difference in investments in Research and Development (R&D). We found that the 'dirty' group (with the exclusion of primary metal industries) increased its investments in R&D by 45% over the period 1988-1992, while on average the clean industries slightly reduced their R&D-expenditures. Table 1 summarises the results.

Table 1 - Changes in FDI, capital formation and R&D in the US

Group of Industries Variable	Dirty	Medium	Clean	P-value (Anova)
Growth (%) of inward FDI-position	+67.1	+7.2	-8.2	0.0036
Growth of (Inw-Outw)FDI-balance	+267	-53.5	-104.8	0.1029
Growth in Gross Fixed Cap. Form.	-0.9	+3.4	+3.0	0.566
Growth in Research&Development	+45.4		-0.7	0.0288

Source : Albrecht, 1998

There are also indications from business practices that limit the relevance of the pollution-haven hypothesis. With the increase in global environmental scrutiny, environmental performance becomes increasingly transparent. In some countries, firms include (worldwide) environmental liabilities in their annual reports. Securities and Exchange Commission rules

in the United States, for example, dictate that companies clearly must state potential environmental liabilities.
In the aftermath of the Bhophal disaster at a Union Carbide subsidiary in India, a growing number of American chemical plants have made it company policy to apply the same rules and environmental standards worldwide (Cairncross, 1992). Dunning (1993, p.539) refers to a German study which demonstrated that 90% of the firms surveyed claimed to use the same environmental techniques in developing countries as in West- Germany. If this principle would be adopted in national legislations or in supranational agreements, some environmental incentives to move to less stringent countries might be eliminated.
Some industrializing countries and their business associations explicitly demand the use of clean production technologies in investment projects of multinationals. The Thailand Leadership Initiave solicited commitment of multinational companies to halt their use of ozone-depleting substances and the Vietnam Pledge by more than forty multinational companies from seven countries was to invest only in modern, environmentally acceptable technology in their Vietnam projects (Fujimoto, 1997)

3.How have the three hypotheses been tested?

We gave already some indications on the (limited) validity of the pollution-haven hypothesis for the US. Broader overviews can be obtained from Rausher (1997), Jaffe (1995), Markandya (1994) and The World Bank (1992, edited by Patrick Low).
The World Bank (p.13) draws a number of tentative general conclusions from the analysed surveys :

- dirty industries have expanded faster in developing countries than the average rate for all industries but this pattern can merely reflect growth or industrial migration as well ;
- pollution abatement and control expenditures by firms do not appear to have a significant effect on competitiveness in most industries which suggests that national differences in environmental regulations have not been a major explanatory factor in the changing international pattern of location of dirty industries ;
- pollution intensity per capita appears to fall as income rises (the green Kuznets-curve) ;
- the effects of growth and trade liberalization on environmental quality are ambiguous ;
- fast-growing economies with liberal trade policies have experienced less pollution-intensive growth than closed economies, and
- firms seem to have good reason not to transfer dirtier technologies to lower income countries when they invest in these countries.

Markandya (1994) answers the related question ‘is free trade compatible with sustainable development’ with a (slightly) qualified ‘yes’. Most conflicts between environmental and trade concerns can be resolved by the choice of appropriate instruments in global trade frameworks like the World Trade Organization (WTO).

In their analysis of the maquiladora programme, Grossman and Krueger (1992) find that pollution abatement costs were not a significant determinant of US-Mexican trade. Jaffe (1995) concludes that there is relatively little evidence to support any of the three hypotheses. He states that the literature on the Porter hypothesis remains one 'with a high ratio of speculation and anecdote to systematic evidence (p.157).'

Some possible explanations for the weak empirical link are also given : limited ability to measure the relative stringency of environmental regulations, the relatively small cost of complying with environmental regulation, relatively small differences between regulations in the US and in the other western industrial democracies and the fact that multinationals should be reluctant to build less-than-state-of-the-art plants in foreign countries.

Similar conclusions are presented by Rauscher (1997). He also stresses two important problems intrinsic to the input-output or Leontief approach that is used in many surveys. First, most analyses are only bivariate and neglect as such many other factors. Secondly, pollution abatement data are only considered for the country under consideration but not for its trading partners. This is a practice that not only depends on the problems with comparing national regulations, but also on the limited information on the enforcement of regulations in many countries with a less explicit environmental profile. There is also the fact that many environmental investments have a 'once-and-for-all' character, especially when industries opt for end-of-pipe clean-up investments (UNIDO, 1990). When regulators impose stricter standards, industries make an adapting investment. This means that the environmental expenditures are relatively high in the first years after the new regulations. As a result, when cost profiles or export performances of industries are compared, the period of analysis is crucial when different countries have different periods of regulatory implementation. And this problem is probably too complicated to be captured with lead- and lag-variables in empirical surveys.

Rauscher also mentions the survey of Rowland and Feiock (1991) that concludes that environmental regulation affected investment decisions of the chemical industry in the United States. The relationship is non-linear : there should be a threshold value of pollution-abatement expenditures below which dislocation effects of changes in environmental policy cannot be observed.

A general remark on these (and most of the other) surveys is that environmental costs are rarely directly linked to specific products. Most authors work with 'dirty' industries like steel, chemicals and paper. This approach reduces environmental costs to a part of general overheads (like administration). We think it is better to link environmental costs to specific products like detailed chemical subsectors or specific steel or paper products. In a later test of the Porter hypothesis, this product-specific link will generate good results.

A crucial survey (cited in Jaffe), for its methodology and interpretation by other authors, has been made by Kalt (1988). Kalt gives an overview of the environmental regulatory costs and calculates these for 78 SIC-industries making use of input-output tables. Starting from a Heckscher-Ohlin-Leamer framework, Kalt explains the variation in net export performance for 1977 by using as independent variables pollution abatement costs, capital, R&D, human capital and unskilled labor. Without a correction for heteroscedasticity, the environmental variable (pollution abatement) was only significant for manufacturing and not for all input-output industries. With the heteroscedasticity correction, pollution abatement proved only to be significant for manufacturing without chemicals. The coefficient was negative as expected. The other significant variables were R&D and human capital. Rather surprisingly, the sign of human capital was negative. Kalt concludes that environmental regulations had in 1977 a clear negative impact on US trade performance.

Most authors that review the survey of Kalt do not come to the same conclusions. They do not focus on the year 1977 of which Kalt clearly states that, at that time, the fraction of the resources in the US devoted to abatement were ‘at the upper end of the distribution’ of private sector investments in pollution control in 10 industrialized countries. This suggests however that if the same analysis was made 5 or 10 years later, the results could be different.

Jaffe (1995) states that ‘it is troubling however, that the magnitude and significance of the effect [of the environmental variable] was increased even further when the chemical industry was excluded from the sample, because this is an industry with relatively high environmental compliance costs (p.143).’ If the impact of pollution abatement would be significant for all industries (what it almost is with a t-statistic of -1.93), most authors would probably agree with Kalt. And this is a recurrent objective of most of the empirical surveys : there should be a clear link between environmental regulation and the (export) performance of *all* ‘dirty’ industries. In our opinion, this is not a good test.

Since the starting point of many of these surveys is an interpretation of the H-O-framework, why are the results not interpreted according to the fundamentals of the principle of comparative advantage? If a country performs worst in all industries (for reasons of extremely high environmental costs), it will still have a comparative advantage in some of those industries while other activities might be taken over by countries with less stringent regulations.

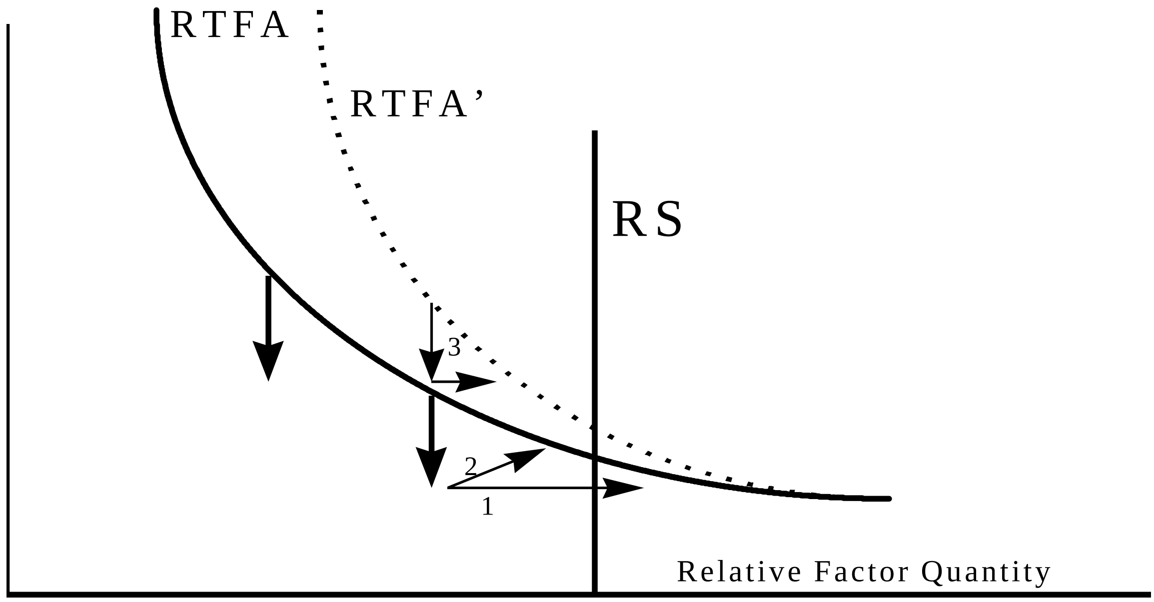
The findings of Kalt could be interpreted as a clear comparative advantage of the US in chemicals compared to the other industries that have to face environmental expenditures. Similarly, if there is clear evidence of a relocation of wood furniture firms from California to Mexico, or from Germany to Poland, this should not be considered as a ‘too specific’ case, not suitable for generalizations. Wood furniture is clearly one of the industries in which the comparative advantage is lost to countries that offer a mixture of cost advantages of which environmental costs are a part of. That other sectors do not migrate is not a counterargument but an expected logical consequence of the H-O-framework. In a next section, we will discuss the weight of a sector like wood furniture in total trade performance.

4.Comparative advantage and environmental costs

The main conclusion of the Heckscher-Ohlin model (and extensions like Leamer, Vanek) is that countries export commodities that are relatively intensive in the relatively abundant factor

in exchange for imports of commodities that are relatively intensive in the relatively scarce factor. There are however many empirical surveys that do not confirm this conclusion.
This depends to a large extent on the assumptions that are crucial in shaping the H-O conclusions. Authors like Staiger (1988) find evidence of misspecifications of the H-O-V model and conclude that endowments affect trade in important ways not captured by the H-O-V relationship.
For the introduction of some specific aspects of environmental regulation in the framework of comparative advantage, we opted to start with the Ricardian presentation as in Krugman and Obstfeld (1994). Figure 1 enables us to compare the industrial-flight hypothesis with the sweatshop labor argument that is used to seek protection from foreign low-wage competition. It seems to be obvious that 'green' protectionists use very similar arguments.
Figure 1 shows a ranking of *n* products according to their relative home productivity advantage.
The products with the highest relative advantages are located in the upper left part of the relative total factor advantage (RTFA). As we include not only labor but also capital and nature, we do not use the term relative labor advantage but relative total factor advantage. RTFA presents a derived world demand for the products of Home.

Figure 1 - Comparative advantage and environmental costs



The supply of Home is determined by the relative prices of the factors used in the production. In this Ricardian world, prices depend on factor availabiliy. The relative supply (RS) of

factors determines whether a product with a relative productivity advantage can be sold on the world markets at a competitive price or not.
Suppose an environmental regulation is imposed. Pollution abatement is the result of labor and capital, production factors that are not available anymore for the production of manufactures. If we assume the abatement to be expensive - Porter (1995) suggests that abatement efforts can increase efficiency and hence outweight expenditures - , environmental regulation will lead to a reduction in RTFA.
For each ‘dirty’ product, the lower RTFA can be presented by an arrow. We indicated only two of those products in figure 1 but there can be many more. Depending on the initial level of RTFA, only for the product for which the new RTFA falls under the intersection with RS, Home will loose its comparative advantage to Foreign. This is case 1 in the figure. The other product or industry (like chemicals in the survey of Kalt) will maintain its comparative advantage after the implementation of the regulation.
If we introduce a second period in the analysis and include the fact that environmental investments are high for specific periods of first implementation (like the late 1970s for the US), it can be that total environmental costs will fall back in the next period. This is situation 2 in figure 1. The recovery of RTFA might compensate the initial loss of the product to Foreign.
In this case, the relocation will depend on information on the duration of the RTFA-loss, the possibility to absorb these costs and the cost of relocation.

Another possibility is presented by situation 3 in figure 1. Productivity advantages are always measured by differences in factor productivity for identical products. This is a hypothesis that is problematic in analyses that cover longer periods. Product changes are typical for most sectors. Each year, new types of manufactured products, chemicals, paper or glass are introduced.
When product lifecycles run shorter and non-price competition gains importance, product-upgrading and positive differentiation can compensate for increasing costs. This is typical for electronics and chemicals, especially in rich economies that value product differentiation. The high R&D-intensity of these sectors can indicate that product characteristics are very important to maintain and improve market share. Since R&D is still largely concentrated in the industrialized countries, the compensation of regulatory costs by product improvements and upgradings can be a partial explanation for the weak empirical link between environmental regulation and export performance.
The dotted line RTFA’ in figure 1 shows the new relative demand after a general upgrading as a result of succesful product differentiation and continuous investments in R&D in Home. Evidently, not all products share the same relative upgrading. We assumed that the specific product in our example could maintain its relative position.
If after such a shift from RTFA to RTFA’ an environmental regulation is imposed (case 3), a fall in RTFA’ will not result in a shift of the comparative advantage in Foreign like it did in the first case. Continuous upgradings can compensate for frequent and expensive regulatory

changes.

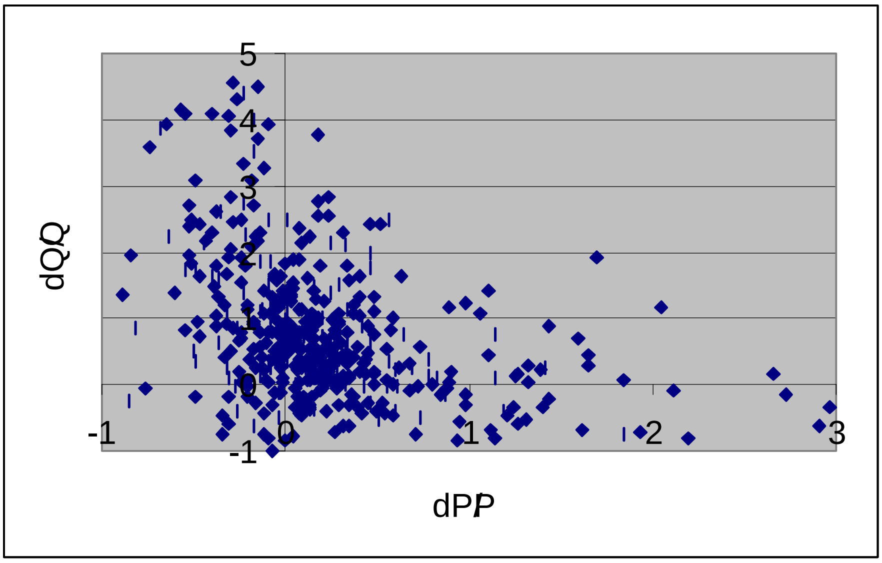
In figure 1, we worked with downward arrows to illustrate the introduction of environmental costs. Similar results could be obtained when shifting RS to the right : pollution abatement extracts factors from the pool of available resources for production.

These three aspects of environmental costs illustrate that it is far from easy to integrate all these considerations in a conclusive empirical test.

We looked at the relevance of the last case (i.e. differentiation) for chemicals. Quality improvements can be reflected in price developments. If increasing prices result in export growth, or in very small export losses, this can indicate product upgradings. Another explanation can be that foreign producer prices increased even more than the domestic producer prices. We analysed relative price and quantity changes of US chemical exports for the period 1989-1995. At the 5-digit level, the OECD International Trade by Commodities Statistics includes data for more than 400 chemical products. Since the chemical industry has the highest pollution abatement expenditures, stricter environmental regulations could increase producer prices and influence international competitivity. We see in figure 2 that three-fourth of US chemical products showed increased exports (1995-export quantities compared to 1989-quantities). Notice that the number 1 on both axes represent an increase of 100% over this short period of six years.

For 40% of the chemical products, export prices decreased and this led to increased exports (negative elasticity). But for the chemical products with increased export prices, we see the same positive development of exports. For 82 chemical products, prices increased by more than 50% and only for 24 of these products, export quantities were below the 1989-level. The correlation between relative price change (dP/P) and relative quantity change (dQ/Q), the average price elasticity, was negative but very small (-0.19903). Price increases had only a very limited negative impact on exports. The combination of higher prices and higher exports can be an indication of the positive valuation of product characteristics (improvements and upgradings).

Figure 2 - Relative changes in export prices and quantities for US chemicals and related products, 1989-1995



But if we assume that some industries like wood furniture migrate to or grow faster in developing countries, the fundamental question remains : is this the result from a pattern of growth in developing countries or is it the result of differences in environmental regulation?
The first scenario could be the result of a pattern of global convergence in industrial activity.
Empirical research can not confirm a trend of global convergence. Verspagen (1995) concludes in his historical overview on convergence of national pro capita incomes that there is no global trend. In the post-war period, convergence only took place in the OECD countries.
More related to our analysis of comparative advantage, Bernard and Jones (1996) find for 14 OECD countries during 1970-1987 that manufacturing (including the dirty industries) shows little or no evidence of convergence in labor or multifactor productivity, even after the introduction of a new measure of multifactor productivity.
For other sectors, especially services, they found strong evidence in favor of convergence.
When we compare OECD countries to developing countries, the differences are expected to be more pronounced. As a general indicator of convergence or divergence, we can use indices of export diversification. Does export diversification follow the same pattern in OECD and developing countries or not? In the a section, we will link this index to labor productivity.

5.Diversification of exports

Most surveys cited in section 3 analyse exports of chemicals, paper, iron and steel and some manufactured goods. We already suggested that analyses at the level of the product should be preferred. Only a few surveys make use of sectoral classifications at the 2-digit level. Using the OECD International Trade by Commodities Statistics ITCS/SITC, Revision 3, this level of detail (2-digit) results in trade-data for 72 products or sectors. At the 3-digit level, the OECD ITCS includes trade data for 312 products, at the 4-digit level 1170 products are defined and the 5-digit level includes data for 2831 products. The chemical industry should be the most dirty industry. But what part of the chemical industry is dirty and are there clean chemical subsectors? At the 4-digit level of analysis we have already 141 chemical products, at the 5-digit level even 443.

Some manufactured goods are also considered as dirty. But, as an example, wood furniture is only one of the 249 products at the 4-digit level, and one (with subclassifications) of the 804 products at the 5-digit level.

We can conclude that surveys at the 1 or 2-digit level can only generate rather crude approximations of what is the impact of environmental regulations on 'dirty' industries.

A second conclusion is that the loss of a significant part of the wood furniture industry is very bad news for the concerned workers and firms but for the record of national export performance, it will not have a dramatic impact. If the US or Germany would loose over a period of 20 years their comparative advantage for some 20 to 30 chemical subsectors, is this a problem if over the same period 40 new subsectors have been created and developed, or if for some 15 other subsectors the comparative advantage was regained? Recoveries of lost exports are not exceptional ; the product 'sulphides : polysulphides' (ITCS 52315) was imported in the US since 1978 and it entered US exports only in 1989 ($ 12.8 mill.).

UNCTAD calculates an index of export diversification at the three-digit SITC, Revision 2. This index is based on 239 products and is Hirschmann-normalized to calculate values ranking from 0 (perfect diversification, no concentration) to 1 (complete concentration, no diversification), according to the formula :

$$H_j = \frac{\left(\sum_{i=1}^{239}\left(\frac{x_i}{X}\right)^2\right)^{\frac{1}{2}} - \sqrt{1/239}}{1-\sqrt{1/239}}$$

where j is the country index, x_i the value of exports of commodity i and X is total exports of country j.

If we compare indices of diversification for 1980 and 1994, table 2 shows that there is a striking difference between developed and developing countries. The right colum calculates the relative improvement in terms of more diversification (here a reduction in H_j).

Table 2 - Export diversification/concentration of some selected countries, 1980-1994

Country	1980	1994	% change
Canada	0.513	0.410	+20
Japan	0.546	0.417	+22
Germany	0.386	0.270	+30
United States	0.428	0.272	+36.5
United Kingdom	0.333	0.223	+33
France	0.345	0.267	+23
Nigeria	0.771	0.903	-17
Venezuela	0.710	0.767	-8
Malaysia	0.640	0.521	+19
Mexico	0.523	0.397	+24

Source : UNCTAD, 1997, Handbook of International Trade and Development Statistics 1995, p.203

From the 25 rich countries in the UNCTAD-classification, only Norway and Ireland developed a more concentrated export pattern over the period of analysis. From the 105 other countries, only 54 could reduce their export concentration and most improvements were rather modest (like Paraguay: from 0.884 to 0.879). Only the recent industrialising countries like Mexico, Singapore, Malaysia and Korea showed improvements comparable to developed countries.

6.Explaining export diversification

The slow improvement - if we assume there is an improvement - of the export concentration of developing countries is clearly linked to the ability to build up a comparative advantage in new products. Developed countries can use this ability to overcome the negative impacts of pollution abatement expenditures and other regulatory costs. The fundamental determinant of comparative advantage is labor or total factor productivity.

We therefore want to explain the variation in export diversification in 1994 for developed and developing countries by introducing labor productivity as one of the independent variables. Another variable in the analysis is the impact of foreign direct investments (FDI) in the host country because we assume that a high inward stock of foreign capital should improve export diversification. Data on inward investment stocks in 1994 were taken from UNCTAD.

As export diversification is clearly linked to consumer preferences, there should be a significant influence of the average national income. Data on GDP pro capita (1994) were also derived from UNCTAD.

For the data on labor productivity, we followed the Cobb-Douglas approach by Hall and Jones (1997). The main problem with Cobb-Douglas production functions (see formula 6.1) that are used to make comparisons of productivity across many countries, is that the parameter mostly differs. As a result, entering identical inputs will then produce different output, mostly for reasons of different technological infrastructures. Therefore, we need to find a measure to capture different technological capabilities across countries.

Hall and Jones introduce in the production function the amount of human capital-augmented labor (H_i) and a 'basic' labour-augmenting measure of productivity (A_i).

$$Y_i = K_i^{a} (A_i H_i)^{1-a}$$

Output Y_i in country i is then produced according to
where K_i denotes the stock of physical capital.

The value of the human capital-augmented labor is depending on the years of schooling for each country.

Hall and Jones rewrite the production function in terms of output per worker (y_i =Y/L), with L_i as homogeneous labor ;

$$y_i = \left(\frac{K_i}{Y_i}\right)^{\frac{a}{1-a}} \frac{H_i}{L_i} A_i$$

The decomposition is written in terms of the capital-output ratio rather than the capital-labor ratio.

A value of $\forall$ = 1/3 is used which is broadly consistent with national income accounts.

Table 3 presents the results for some countries of the decomposition. Labor productivity and all the contributing factors are expressed as ratios to US values to make comparisons more meaningful.

The presentation offers the advantage that differences in total productivity can be explained by differences in inputs. Italian workers work with less 'human capital skills' and this explains why their total labor productivity is lower than in the US. The Italian 'basis' labor productivity is however higher.

The low Japanese productivity might be a surprise. Probably this is due to the low productivity of services in Japan that is known for its high ratio of employees to clients in the lower levels of the distribution chain.

For 107 countries we found data for all the variables. In the regressions, reported in table 4, the dependent variable was calculated as 1 minus the UNCTAD-value of export diversification. A high (new) value means a high level of export diversification. This makes it more comfortable in the later interpretations of the signs in the OLS estimates.

Table 3 - Productivity calculations : ratios to US values

Country	Y/L	$(K/Y)^{\alpha/(1-\alpha)}$	H/L	A
United States	1.000	1.000	1.000	1.000
Canada	0.941	1.002	0.908	1.034
Italy	0.834	1.063	0.650	1.207
Germany	0.818	1.118	0.802	0.912
France	0.818	1.091	0.666	1.126
Singapore	0.606	1.031	0.545	1.078
Japan	0.587	1.119	0.797	0.658
Mexico	0.433	0.868	0.538	0.926
India	0.086	0.709	0.454	0.267
Kenya	0.056	0.747	0.457	0.165
Average, 133 countries	0.289 (st.dev. 0.265)	0.854 (st.dev. 0.241)	0.564 (st.dev. 0.163)	0.502 (st.dev. 0.320)

Source : Hall and Jones, 1997, p.28

Since data were available for total and 'basic' labour productivity (Y/L and A), we opted to work with two sets of variables. In the first regression (1), we used the Y/L-values as labour-productivity, while A-values were taken for the second regression (2).

We included in the analysis also a dummy to capture the dependency of some countries on oil and minerals. Typical oil countries have a limited export diversification but relatively high average incomes and concentrated foreign investments in resource extraction. We gave a value 1 to coutries for which the export of fuels and minerals accounted for more than 25% of their exports. Data were taken from UNCTAD.
The dummy is not just another indication of export concentration because even some developed countries are relatively specialized in the exports of natural resources. In the Australian exports, fuels accounted for 19.1% and ores and metals for 17.3% in 1995. For Norway, the two percentages are 47.3% and 8.7%. For Saudi Arabia, fuels account still for 90% of total exports.
The correlation between the dummy and the other variables in the analyses was low (between - 0.00036 and -0.14855). A much higher threshold for the dummy (like oil and minerals account for 75% of exports) would of course result in a high correlation between the dummy and export diversification. The results are presented in table 4. None of the models showed indications of heteroscedasticity (Goldfeld-Quandt test and White's general heteroscedasticity test).

Table 4 - OLS estimates for export diversification (107 countries)
(t-statistics in parentheses, 5%-level of significance)

Variable	(1) *OLS with Basic Labor Productivity (A)*	(2) *OLS with Total Labor Productivity (Y/L)*
Constant	-0.2262	-0.0754
	(-4.391)	(-2.381)
LN(GDP pro capita)	0.0213	
	(2.173)	
Labor productivity	0.1279	0.2840
	(2.416)	(6.201)
LN(Inward FDI-stock)	0.0412	0.0399
	(8.333)	(8.400)
Dummy (fuels & minerals)	-0.1094	-0.1097
	(-5.139)	(-5.322)
Adjusted R^2	0.7454	0.7593
F-value	78.591	112.507
Sign.F	2.77E-30	2.25E-32
Number of observations	107	107

In the second regression, the variable LN(GDP pro capita) was excluded because this resulted in a clear case of multicollinearity. In a first estimate of the regression, we found contrary to our expectations, that the coefficient of LN(GDP pro capita) was not significant (t-statistic : -0.2225) and the sign was negative. The very high correlation (0.886) between Y/L and LN(GDP pro capita) was responsible for this result. In regression (1) the basic labor productivity A clearly did not capture the same income-effect (in terms of available human and non-human capital). The correlation with LN(GDP pro capita) is not disturbing. The sign of the coefficient of LN(GDP pro capita) in (1) is positive and the t-statistic is good.
From the results it is clear that labour productivity (both total and 'basic') is a crucial factor in explaining export diversification. Using Y/L gave the best results. The high labor productivity in developed countries will as such guarantee high levels of exports for long periods of time. Total productivity is clearly linked to the level of income and this can explain why rich countries do not face *en masse* migrations of major industries. The results also show that inward FDI can help to improve export diversification. As expected, the sign of the dummy is negative.

7.The Porter Hypothesis

In the previous section, we illustrated that the diversified export patterns of developed countries are only to a very limited extent vulnerable for the negative impacts of

environmental regulation. This conclusion was in fact the expected result of the great differences in labour productivity and the interpretation of the Heckscher-Ohlin model.
Many authors do not consider the H-O-conclusions and link the not finding of a clear negative impact to the hypothesis articulated by Porter (1990,1995) : efficient regulations may actually stimulate innovation, efficiency gains, industrial growth and competitiveness. This is as such not an appropriate test of the latter hypothesis.
This positive effect of environmental regulation can be expected for the industries that directly benefit from stricter regulations like manufacturers of filters and purification equipment or importers of low-sulphur-content-coal. But also for firms in the steel, paper and chemical industry, there is clear case-evidence of reduced total costs as a result of investments in cleaner production methods (UNIDO, UNEP). For these firms, environmental regulation might bring a 'free lunch'.
There are however no surveys that present a general test of the Porter hypothesis for specific sectors or products. Some indications in favour of the Porter hypothesis for the US are offered by Stephen Meyer (1992). He finds that US States with strict environmental laws do not demonstrate poorer economic performance compared to less stringent US States. Jaffe (1995) suggests however that the conclusions of Meyer could indicate spurious correlation : the strongest nations can easily invest in environmental protection while other nations have other priorities. But this remark is of equal importance for any test because if the most competitive nations have the most effective and the most expensive environmental policy, can we ever expect to find clear evidence for the industrial-flight or pollution-haven hypothesis? Organisations like the International Institute for Management Development (IMD) present every year a ranking of national competitiveness that is frequently cited in the financial press. As could be expected, the countries with the clearest environmental profile are on top of this ranking.
The conclusions from the previous sections on the hypotheses of industrial flight and delocalisation are also valid for a test of the Porter hypothesis. Export gains or losses will only be relevant for some specific industries and it is important to work with national environmental regulations that are comparable. The regulations have to be installed and implemented at the same moment, for the same period of time and with similar environmental objectives. Other important considerations should be given to enforceability of the regulations and possible exceptions for specific firms or sectors.
All this conditions make it very difficult to find a general test-case for any of the three hypothesis. In our opinion, the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol), with subsequent amendments, could be an ideal test-case for the hypotheses.

7.1. The Montreal Protocol and policy responses

In 1974, the worldwide scientific community accepted the Rowland-Molina hypothesis that the thin layer of stratospheric ozone could be depleted by emissions of chlorine. After the announcement in 1985 of the existence of a ‘hole’ in the atmospheric ozone layer near the South Pole, worldwide concerns were almost immediately followed by clear actions by the international environmental community. The 1985 Vienna Convention for the Protection of the Ozone Layer was followed by the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol imposed concrete obligations to reduce production and use of chlorine-based ozone-depleting substances (ODSs), with a grace period for developing countries. The most important ODSs are chlorofluorocarbons (CFCs), bromofluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide and hydrochlorofluorocarbons (HCFCs).

Since 1987, new substances have been added and phase-out commitments have been seriously strenghtened. Export and import of controlled substances to non-parties were prohibited. A multilateral fund to support phase-outs in developing countries has been established.

Ten years after the signing, 162 countries did ratify the Montreal Protocol. Most developed countries ratified in 1988, countries like Argentina, Chile, Brazil and Poland followed in 1990 and the latest ratifications were made by Senegal in 1993 and Morocco in 1995 (UNEP, 1998). All new supplies of ODSs, except HCFCs and methyl bromide, were phased out by developed countries starting January 1, 1996. The respective phase-out deadlines for the latter are 2030 and 2010.

The ratification of the Montreal Protocol ensures that all developed countries face the same technological substitution costs at the same time and this is one of the conditions for an optimal test of any hypothesis on the impact of environmental regulation on specific sectors.

The phasing-out of CFCs had significant consequences for the producing chemicals firms and all the industries that use CFCs. Du Pont (US) was the worldwide leading firm in the production of CFCs with a global market share around 20%, followed by Elf-Atochem, Allied-Signal, ICI, Solvay, Hoechst, Ausimont, Daikin and some other firms. Du Pont played a crucial role in the implementation of the Montreal Protocol (Haas, 1992).

Already in 1979, the firm developed an in-house state-of-the-art atmospheric computer model to evaluate the potential problems associated with CFC emissions. This investment ensured the ability to evaluate the most recent scientific findings and to develop a pro-active strategic policy. In 1988 alone, DuPont spent more than $30 million for process development, market research, applications testing, and small-lot production of CFC substitutes (Haas, p.214) and shortly after the release of the Ozone Trends Panel report in March 1988, the company announced to completely phase out the production of CFCs before the end of the century (see appendix A for the actual position of DuPont). And of equal importance, DuPont would assist its customers in converting to chemical substitutes. The most important substitute for DuPont was HCFCs for which the company gained important patents already in the early 1980s (Howes, 1997). This proved the long-term view of Du Pont because it clearly did not opt to enjoy the higher profits on CFCs that would follow due to the enforced scarcity of chlorofluorocarbons. Since the sales by DuPont of CFCs totalled $600 million in 1987, The New York Times headed «Why DuPont Gave Up $600 Million».

By its announcement, DuPont accelerated the projected phase-out what resulted in less time

for its competitors to find the needed CFC-substitutes. It also increased the attractiveness of the substitutes (mainly HCFCs) that DuPont could present to its customers. The unilateral measures attributed also to the public image of the firm that was the target of several environmental pressure group actions around that time.
The impact of DuPont as the most important market-player is also visible in the American implementation of the Montreal Protocol. As a consequence of the Protocol, the US enacted mandatory controls on CFCs. In order to stimulate substitutions, the Congress passed an excise tax on certain ozone-depleting chemicals sold or used by the manufacturer, producer or importer (Westin,1997). The amount of the tax is determined by multiplying a base tax amount (that is every year increased) by an 'ozone-depleting factor' that reflects the potential ozone depletion of the chemical. This US Tax on Ozone Depleting Chemicals increased prices of CFCs significantly. HCFCs are excluded from the tax, despite their limited but clear ozone-depleting potential. Westin states that this is 'a questionable decision (p.36)'. DuPont, as a producer of HCFCs, clearly will not regret this exception.
In this perspective, it is interesting to note that the unlimited use of HCFCs is also strongly defended by the Air-Conditioning and Refrigeration Institute (ARI, Virginia). The members of ARI manufacture 90% of US production of refrigerators and air conditioning equipment. The ARI strongly opposed Congress proposals to establish an excise tax on HCFC, either on a per-pound basis or weighted according to ozone depletion potential. And after the European Union proposed, at the end of 1997, an accelerated phase-out of HCFCs by 2015, the ARI was one of the most active groups against this proposal. According to ARI (1998), the European proposal could disturb the transition by equipment owners away from the more environmentally-damaging CFCs. Besides, in 1996 the US consumption of HCFC was at 82% of the allowable cap amount.

Of course, the impact of industry on politics is not limited to the United States. In France, the Industry Ministry defended strongly the benefits of Elf-Atochem that tried to delay any substitution. Unlike DuPont, Atochem did not have substitutes that could be marketed in a very short period. The French environmental minister even denied in 1987 any definitive link between CFCs and ozone depletion (Haas, p.210). Similar practices are noticed in the Soviet Union, Japan and the United Kingdom.
In 1997, the Montreal Protocol is called by the World Bank (1997) 'the major bright spot in global environmental efforts'. Actual progress is being undermined by excessive CFC-production of lower quality in Russia and black market smuggling. Not every country has an effective enforcement programme to limit these practices (see appendix B for enforcement actions by the US Environmental Protection Agency). The World Bank, in collaboration with production factories and the Russian government, has developed a plan to eliminate all production of CFCs in Russia by the year 2000.

7.2. Export performance of CFC-using industries

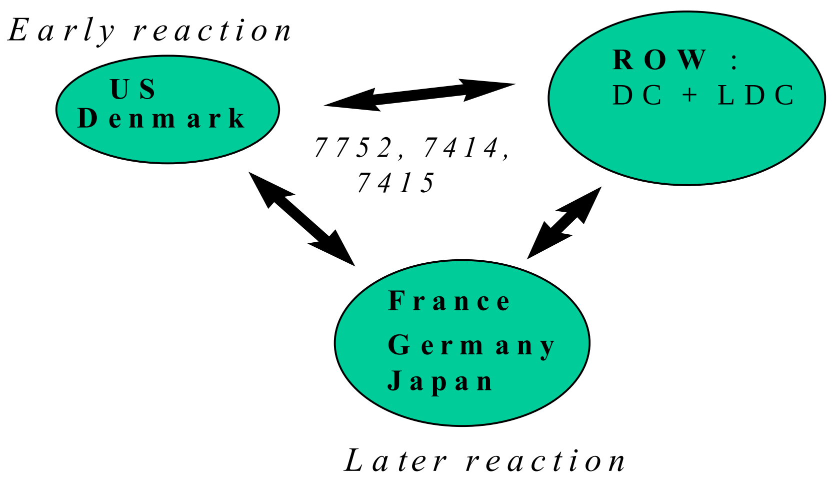
The substitution of CFCs provided an opportunity for firms that invested first in substituting R&D and could influence the political priorities and framework that followed the Montreal Protocol. Ozone policies can provide as such a competitive advantage for the early adaptors. One could see this as an illustration of the Porter hypothesis.
But assuming this pro-active strategy paid well for DuPont, did CFC-using industries also benefit from US policies? Otherwise, if only one industry or firm did benefit and other industries had to pay an 'expensive lunch', this is not at all a confirmation of the Porter hypothesis.
CFCs are mainly used for the production of refrigerators, air conditioning equipment, fire extinguishers, foams, aerosols and solvents (used to clean many types of electronic equipment like computers).
Manufacturers of refrigerating equipment will face the highest substitution costs, followed by the manufacturers of (mainly mobile) air conditioning equipment. In the US, these two sectors form a seventeen billion dollar industry which employs more than 136000 men and women (ARI, 1997).
Since this will be the case for all the industrial countries, we will investigate whether the active national ozone-policies of some countries did improve the competitivity of their main CFC-using manufacturers. If this should be the case, we have a product-specific confirmation of the Porter hypothesis.

According to Haas (1992, p.206), the US position during the Montreal negotiations was supported by Canada, Denmark, Finland, the Netherlands, New Zealand, Norway and Sweden. Most countries of the EC-12, led by Britain and France, favoured only a production cap to minimize the costs to their CFC producers. In the analysis, we therefore take the US and Denmark as the countries that favoured a pro-active strategy. Like the US, Denmark has also a tax on CFC and halon, a statutory order gradually banning the use of ODSs for specific purposes and a development programme to support non-ODS technology (Danish EPA, 1995).
We selected France, Germany and Japan as the countries that were more hesitating about the phase-out of CFCs. For France, we referred already to Elf-Atochem, while the Japanese feared especially the ban of CFC-solvents in their computer industry. The five selected countries represent a significant part of world trade in the related sectors.
Since the protocol went into force on 1 January 1988, we will analyse changes in bilateral trade flows of these five countries to their major trade partners. These trade partners differ of course for each country but it is important to note that they contain also countries like Canada, Sweden, Norway, Finland, the Netherlands and New Zealand that also favoured an early phase-out policy. The other developed countries (Italy, Switzerland, Belgium, Spain, ...) are also included in the analysis next to a number of developing countries like Morocco and Algeria (trade partners of France), Mexico, Brazil, Ecuador and Venezuela (trade partners of

the US).
We analysed trade flows for the three most important sectors that use of CFCs : household type refrigerators and food freezers (SITC-code 7752), refrigerators and refrigerating equipment, except households (SITC 7414) and air conditioning machines, self-contained and parts (SITC 7415). The industrial refrigerators are used in meat industries, cold storage warehouses, transport refrigeration, vending machines and retail food refrigeration.
We used OECD-data (Rev.3) for the period 1989-1995 (not all data for 1996 were available at the moment of the analysis). Only when trade exceeded a minimum level of $50000, the bilateral flows were included in the data sample.

Figure 3 illustrates the model with three poles ; US & Denmark vs. France & Germany & Japan vs. Rest of the World (ROW). The numbers inside the arrows (bilateral trade) indicate the SITC-codes of the concerned industries.

Figure 3 - Presentation of the model



The dependent variable in the analysis was the change in bilateral exports (Export-value in 1995/Export-value in 1989) for the country of origin. The independent variables, next to a constant term, were change in bilateral imports (that the country of origin imported from the country that bought its exports : dM =M1995/M1989), the relative change in bilateral exchange rate (from 1988 to 1994, as an index calculated using IMF International Financial Statistics : dER) and a dummy (Early-d) that expressed the early reaction and pro-active stance of the US and Denmark. For exports originating in these two countries, we gave the value 1 to the dummy. For the exports from France, Germany and Japan, the value for the dummy was 0.
Bilateral trade data have the advantage that they enable it to include changes in the bilateral exchange rate in the analysis. Furthermore, if we link the bilateral change in exports to the

bilateral change in imports, we find a bilateral rate of export-import-substitution. Since the CFC-substitution costs are high, we might expects possible substitutions of trade flows between different countries.
Since we work with very specific sectors, no other sectoral production data (like labour productivity and wage rates) were available for the many countries in the analysis. Compared to the use of absolute trade flows (like in gravity models), the explained variation in the sectoral growth rates of bilateral exports is rather good.
Table 5 summarizes the results for the three sectors, the total refrigerator sector (7752+7414) and the three sectors combined (7752+7414+7415).

Table 5 - OLS estimates for bilateral export growth (1989-1995) of three CFC-using industries (SITC-codes : 7752, 7414, 7415)
(t-statistics in parentheses, 5%-level of significance)
(7752 : household refrigerators and freezers - 7414 : industrial refrigeration - 7415 : air conditioning)

SITC-Sectors Variable	7752	7414	7415	7752+7414	7752+7414+7415
Constant	-0.9547	0.1994	1.3316	-0.4707	0.2637
	(-1.403)	(0.722)	(2.910)	(-1.308)	(0.889)
dM	0.0612	-0.0185	0.1952	0.0542	0.0834
	(2.177)	(-0.590)	(5.592)	(2.739)	(4.687)
dER	0.8978	0.4154	-0.1452	0.6492	0.3776
	(2.634)	(2.767)	(-0.606)	(3.475)	(2.425)
Early-dummy	2.5081	0.6887	-0.5022	1.6013	0.8087
	(3.991)	(2.787)	(-1.291)	(5.033)	(3.105)
Adjusted R^2	0.1865	0.1047	0.2510	0.1480	0.0880
F-value	8.8745	5.8345	14.2940	14.2097	12.1952
Sign.F	2.8E-05	0.0009	5.47E-08	1.63E-08	1.32E-07
Number of observations	104	125	120	229	349

The dummy that captures the early reaction of the US and Denmark is clearly significant in all sectors, except for the air conditioning equipment for which the sign of the dummy is even negative. This can be explained by the fact that the category of air conditioners in the SITC is rather general and also includes systems that are less depending on CFCs. For these installations, ozone policies have only an indirect effect. The results would differ if the SITC offered specific data on mobile air conditionings (like the types used in cars).
The significance and positive sign of the dummy in the other calculations proves that the two countries with a relatively active CFC-policy and relatively high CFC substitution costs could improve their competitiveness and hence export performance.
The benefits of the analysis at the product level are clear. Working with the totals of the three sectors (the column at the right in table 5) suggests that also for air conditioning equipment,

the strategy of early reaction in the two countries did stimulate exports. But this conclusion is only valid for the refrigerating sectors. And it is obvious that without export data for refrigerators (at the 4-digit level: 7752), working with household type equipment (SITC-code 775) or electrical machinery (SITC-code 77), would not enable to test the impact of CFC-policies.
Similarly, surveys concluding that the competitiveness of 'dirty' industries is not influenced by environmental regulation, can come to this 'weak' conclusion by compensating at the aggregated sectoral level the benefits of the regulations for specific products by the losses for other products.

If DuPont and the most important CFC-using industries (7752 and 7414) in the US can benefit from the environmental regulatory settings after the Montreal Protocol, this can be considered as a valid illustration of the Porter Hypothesis. In our analysis, the same conclusion can be linked to the Danish CFC-policies what ensures that this Ozone-Porter case is not depending on specific American market conditions. This is also a reason why we opted to include Denmark and not Canada because in that case, the conclusions could be specific for North-America.

Data at the most detailed level also show that the pro-active CFC-policy gave better export results in sector 7752 than in sector 7414. The difference in the coefficient of the dummy is substantial. Other differences between household and industrial refrigerators are the signs and coefficients of the constant and the change in imports. Only for industrial refrigerators, the growth of bilateral imports had a negative, but not significant, impact on export growth. The market for household refrigerators was clearly in full expansion. For the air conditioning equipment, the change in bilateral exchange rate was not significant for export growth. For the four other regressions in table 5, changes in exchange rates proved to have a significant impact. Of course, the five countries in the analyse experienced very different exchange rate evolutions.

8. Dirty industries and competition

Not finding a clear negative impact of environmental regulation on international competitiveness of dirty industries may be linked to the specific kind of competition that is typical for industries like chemicals, steel, cement, paper and electrotechnical products.

8.1. Cartelization

Before World War II, governments and firms used international cartels or regulation mechanisms in many of these sectors. The international chemical industry had a very clear cartel structure. Worldwide cartel agreements existed for potash, dyestuff, nitrogenious fertilizers, chlorine, explosives and soda,.... There were even chemical cartels that focussed on technological processes. Some chemical firms like the German IG Farben during the interwar period also participated in cartels that grouped other industrial branches (like the important customers of their products). In some countries like Italy and the Netherlands during the 1930s, governments were so strongly in favour of cartels that they passed laws under which outsiders were compelled to become cartel-members (Schröter, 1997). It was also common practice to help the establishment of cartels on timber, pulp and paper by diplomacy. Other important industries with cartel structures were steel, oil, mining, the aluminium industry and cement.

According to Schröter (1997), it took at least 20 years after 1945 to reach a decent standard of decartelisation and the problems of international cartelisation are by no means gone. Even during the 1990s, numerous important competition cases were brought to the European and American courts.

The international aspects of competition policy become very important as a result of worldwide globalisation. Like environmental policy, competition policy is rather ‘recent’ and this can limit the validity of the assumption of free competition that is frequently used in trade models and empirical analyses. If industries like steel and chemicals are targeted by strict environmental policy, there is always the possibility that they can use their power on international markets to offset possible negative impacts on their competitiveness. This can happen by means of guiding voluntary Gentlemen’s Agreements that ensure that many firms make similar adaptations at the same time. If the most powerful market players adopt this policy, they can convince smaller firms to follow their lead.

The important growth in environmental (and other fields of) regulation can also be linked to market power by making use of concepts like ‘regulatory capture’ and ‘rent seeking’ (Peltzman, 1976). Like all regulating agencies, the environmental policy makers can become object of capture by interest groups, including producers, consumers and the environmental lobby. The producer group is probably best endowed with resources to influence environmental policies. As such, there is a chance that the regulation is in line with the interests of the regulated industries. The potential impact on competitiveness will be limited.

The related hypothesis on rent-seeking states that most monopolies and oligopolies are created or stimulated by government regulation. The European steel industry is a clear example of an industry that is shaped by many agreements and regulations. Also here, the impact of new environmental regulation on competitiveness will not be dramatic.

In historical overviews of chemical cartels, we find of course corporations like DuPont. In the technological race for the best CFC-substitute, one of the the main competitor of DuPont is ICI from the United Kingdom (Howes, 1997). The collaboration between these two giants was however very intensive during the interwar period with their 1929 Patent and Processes Agreement (Schröter, 1997). The ending of their collaborative links in 1952, as a result of antitrust rulings, was the start of massive foreign investments by DuPont in Europe and by ICI in the United States (Jones,1996). Decartelization was the start of multinational strategies and massive foreign direct investment.

In 1995, DuPont and ICI are among the hundred greatest transnational corporations. Table 6 gives an overview of the most important chemical companies. Pharmaceutical companies are not included. All these companies do already exist for many decades and did build up over time a transnational network. Their foreign assets are more important than their assets in the country of origin. If the Polish and Russian subsidiaries of German chemical firms apply the same environmental procedures and principles as in their home country, they can contribute to diminishing environmental problems in the host country. Multinational corporations clearly have the potential to diffuse clean tecnologies and procedures.

Table 6 - Ranking of chemical transnational corporations by foreign assets, 1995 (billions of US dollars)

Corporation	Country	Position in top 100	Foreign assests	Total assets	Foreign sales	Total sales
Bayer AG	Germany	11	28.1	31.3	19.7	31.1
Hoechst	Germany	24	21.9	36.7	13.4	36.3
DuPont	US	28	17.8	37.3	20.6	42.2
BASF AG	Germany	29	17.6	29.3	23.5	32.3
Rhone-Poulenc	France	33	16.1	27.6	12.4	17.0
Ciba-Geigy AG	Switzerl.	38	14.9	26.5	7.5	17.5
Dow Chemical	US	44	13.5	23.6	11.2	20.2
Johnson&Johnson	US	73	8.2	17.9	9.7	18.8
Solvay AG	Belgium	74	8.1	8.9	8.8	9.3
BHP	Australia	77	7.8	21.8	4.4	12.7
ICI	UK	97	6.1	14.7	9.5	15.9

Source : UNCTAD, World Investment Report 1997, p.29

The products of these corporations are capital-intensive and this can be an important market barrier. Loss of competitiveness is also linked to the entrance of new competitors on the market. But in the European steel industry that has already excess capacity and administered production levels, environmental regulation will never increase costs to a level that invites new entrances. There just isn’t a market to enter.
We already mentioned the importance of product differentiation. High capital costs make it difficult for new-comers to find a profitable niche in the market. Since most R&D takes place in the leading corporations, most differentiations will also be situated within these firms.
Before WWII, cartels ensured market power and now the high capital base and international

networks can be used to exert market power. In most industries, cartels are an element of industrial history but even now the European steel industry is still partly cartelized and there are also many examples of industries that are stimulated by governments to work together in the field of R&D, just like in the cartels for technologies and processes. These specific aspects of competition provide a practical experience of collaboration and negotiating with competitors and government representatives. These are capacities that can be used to influence the regulatory business framework. On this aspect, powerful companies with a long tradition have advantages to new firms in more competitive markets.

8.2. AFEAS and PAFT

In Europe and in the US, international corporations still work together on many environmental Research & Development projects. For specific programmes like the cleaning up of hazardous waste sites, corporations even work together with environmental agencies. As an example, Monsanto's recent Lasagna™ process was developed by Monsanto in collaboration with DuPont, General Electric, the US Environmental Protection Agency and the Department of Energy.

In the field of finding alternatives for CFCs, 17 of the world's chemical companies joined together to form the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS) and the Programme for Alternative Fluorocarbon Toxicity Testing (PAFT).

These two programmes were set up to provide research on the potential effects of CFC-alternatives on the environment and on human health - through international cooperation with independent scientists, with government research programmes, and among the companies. The proposed alernatives were hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs).

The member companies of PAFT and AFEAS are : AlliedSignal, DuPont, Elf-Atochem, LaRoche, Akzo, Solvay, Ausimont, ICI, Rhône-Poulenc, Hoechst, Asahi Glass, Central Glass, Daikin Industries, SICNG, Showa Denko and Hankook Shinwha.

By close cooperation and by combining their resources, the AFEAS and PAFT companies believe that the usual period of time for environmental and toxicity testing of new chemicals has been substantially reduced.

AFEAS started in 1988 and total funding for the period 1988-1995 was ten million U.S. dollars. For PAFT, the participating companies have contributed at least 21 million U.S. dollars, while the costs for in-house studies are probably of similar magnitude (AFEAS, 1996).

This collaboration might limit the impact of CFC-substitution policies on the competitiveness of the participating firms.

9.Conclusions

Policy makers and industrial leaders use the argument of competitiveness in various environmental debates. Contrary to what most expect, only weak or anecdotal empirical evidence can be collected from the numerous surveys on the impact of environmental regulation. One explanations is that the used methodology is not optimal. Therefore, we did focus on the principle of comparative advantage that should be correctly interpreted. We concluded that most empirical tests were just too strict : not all industries can suffer significant export losses as a consequence of stringent environmental regulation.

If sectoral losses can be found, these losses have to be related to total trade flows of a nation. It is obvious that the loss of some industries is not dramatic for countries with a very diversified trade pattern. Maximal diversification is some insurance against dramatic export losses. We found that rich countries with a high labour productivity have this diversified export pattern what explains why the most competitive nations only suffer marginal losses from stricter environmental regulation.

Measuring diversification of exports requires information at the most detailed level. At the level of the final products, the impact of environmental regulation will be most direct. Therefore, we tested the impact of ozone-policies for the products that use ozone-depleting substances like chlorofluorocarobons. From the overview on the Montreal Protocol and on the strategic policies of firms and governments, we concluded that this framework could be a relevant test for the Porter hypothesis that links environmental regulation to innovations and improved competitiveness.

For most authors, the attractiveness of the Porter hypothesis might be due to the not finding of a clear negative impact of environmental regulation on international competitivity. But this non-negative impact of regulation should not be considered as a 'free lunch'. Efficiency gains are not generated at random but are the results of continuous efforts and adaptations. The best performing industries can be the first to deal efficiently with new environmental restrictions. Our findings suggest that a pro-active strategy before and after the Montreal Protocol generated clear benefits. We conclude therefore that at the level of the final products, there is more than anecdotal evidence supporting the Porter hypothesis.

In a final section, we did focus on the specific balance of power that characterised many 'dirty' industries. Many of these industries were cartelized in the past and this can explain why increasing environmental cost did not result in significant changes in market structures. Related to the policies after the Montreal Protocol, we find that the major chemical companies closely collaborated in finding and testing CFC-substitutes. The collaboration clearly enabled the fast introduction of HCFCs and HFCs, a very needed outcome, but also can influence competition between the 17 participating firms and other, non-participating firms.

Appendix A : Du Pont on CFCs and Substitutes (as of April, 1998)

The Issue:

Leading atmospheric scientists have determined that a number of man-made compounds deplete the ozone layer. Chief among these are the long-lived chlorofluorocarbons, or CFCs. These gases exist on average for 100 years, working their way up to the stratosphere, where they break down from exposure to ultraviolet rays and subsequently destroy ozone.
CFCs were first manufactured in 1931 as safer substitutes for ammonia and sulfur dioxide, the toxic refrigerants then in use, because they were very low in toxicity, nonflammable, stable and extremely energy efficient. Their use was heralded in the refrigeration industry and applications were soon found in thousands of products -- automobile air conditioners, all home refrigerators and freezers, water coolers and fountains, aerosol sprays, asthma inhalers and cleaning for electronic circuit boards, among others.

The international Montreal Protocol treaty was enacted in Sept. 1987 and initially called for a 50 percent phase down in CFC production in developed countries by 1998. In 1988 the NASA Ozone Trends Panel provided the first scientific consensus that CFCs were linked to ozone depletion. Since then, new science has prompted a more urgent response and the world's developed countries ended CFC production for sale by Jan. 1, 1996.

DuPont Position:

Within 10 days of the NASA Ozone Trends Panel report in March 1988, DuPont became the first company to announce a complete phaseout of CFC production. In 1991, DuPont shut down the world's oldest and largest CFC facility and introduced the first in its line of low or non-ozone-depleting alternatives. Today the company has ceased CFC production at all facilities
around the world except in Brazil, where the government has requested continued production as
allowable to developing countries under the Montreal Protocol.

DuPont has five families of alternatives commercially available. Most of these are hydrofluorocarbons (HFCs) that do not harm the ozone layer. The company also manufactures a few hydrochlorofluorocarbons (HCFCs), but only those with the lowest ozone depletion
potential -- 95 to 98 percent improvements over CFCs and easy to retrofit into the billions of pieces of existing equipment currently operating with CFCs globally.

Appendix B : EPA Enforcement Actions under the regulation on ozone-depleting substances

The US Environmental Protection Agency (EPA) has issued several regulations under Title VI of the Clean Air Act designed to protect the ozone layer and to provide for a smooth transition away from the ozone-depleting substances. EPA is also charged with enforcing these regulations. Some information is featured about enforcement actions, ranging from civil fines to criminal prosecutions. No information is presented here about ongoing investigations.
From a long list, we selected the following cases:

January 26, 1998: EPA Cites U.S. Mint For Clean Air Act Violations

The U.S. Environmental Protection Agency announced that it has cited the U. S. Treasury for Clean Air Act violations at the United States Mint in Philadelphia. In the administrative complaint issued January 23, 1998, EPA charges the Mint violated regulations governing the emission of chromium compounds and chlorofluorocarbons (CFCs). EPA alleged that the coin-making site violated testing, monitoring, and operation and maintenance requirements for chromium electroplating since January 1997. The October 23 inspection also uncovered violations of Clean Air Act regulations on the repair and servicing of equipment containing CFC-based refrigerants. Specifically, EPA alleged that Mint employees serviced air conditioners and water coolers without using required CFC recovery and recycling equipment and that the Mint used an uncertified technician. The complaint also alleged that the Mint failed to evacuate CFCs to required levels before servicing refrigerant containing equipment.
EPA seeks a $129,400 penalty for these violations.

January 21, 1998: Philadelphia Scrap Metal Company to Pay $30,000 For CFC Violations

The U.S. Environmental Protection Agency announced that S.D. Richman Sons Inc., a Philadelphia scrap metal company, will pay a $30,000 penalty for violating regulations on the disposal of equipment containing chloroflorocarbons (CFCs).

September 12, 1997: California Men Charged For Installing HC-12a®

Two men who allegedly installed a flammable refrigerant known as "HC-12a®" in the air conditioners of motor vehicles have been indicted in one of the first criminal cases of its kind.

September 12, 1997: Issuing False Technician Certifications Leads to Guilty Plea

Charles Warren Joseph of Houston, Texas admitted to participating in a scheme that resulted in approximately 100 false chloroflurocarbon (CFC) technician certificates being issued between June 1994 and November 1995. His co-conspirator, Herman Brodzenski of Canton, Ohio, pleaded guilty to charges on June 19.

September 5, 1997: President of Refrigeration U.S.A. Corp. Jailed and Fined $375,000

Roland Wood, President of Refrigeration U.S.A. of Hallandale, Fla., pled guilty for his role in a CFC smuggling operation. Also see the related story below about Refrigeration U.S.A.
On Aug. 29, Roland Wood of North Miami Beach, Fla., was sentenced to serve 37 months in prison and three years supervised release and was ordered to pay a $375,000 fine by the U.S. District Court for the Southern District of Florida in Miami. As part of his guilty plea, Wood will forfeit over $13 million in assets including: property in Miami valued in excess of $1.5 million; 11,200 thirty-pound cylinders of chloroflurocarbon gas worth over $6.7 million; almost $5 million in illegal proceeds held in European Banks; an apartment in London valued at $395,000 and stock in a local bank worth over $80,000. Wood, President of Refrigeration U.S.A. of Hallandale, Fla., previously pleaded guilty to illegally diverting 4,000 tons of ozone-depleting CFC refrigerants into commerce in the United States. The case was investigated by EPA's Criminal Investigation Division, the U.S. Customs Service and the Internal Revenue Service.

August 29 , 1997: Refrigeration U.S.A. Corp. Fined $37 million

Refrigeration U.S.A. previously pleaded guilty to 129 felony counts, and employees previously pleaded guilty to conspiracy to violate the Clean Air Act in connection with a scheme to divert 4,000 tons of CFCs into commerce in the United States.

CFC Smuggling - 1995

United States v. Adi Dara Dubash and Homi Patel (S.D. FL): Adi Dara Dubash was sentenced on July 24, 1995, after pleading guilty to smuggling 8,400 cylinders of the ozone depleting refrigerant gas dichlorodifluoromethane (known as "CFC-12") into the United States in violation of the Clean Air Act. He was sentenced to 22 months of imprisonment, 3 years of probation and a $6,000 fine.

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Environmental Policy and the Inward Investment Position of US 'Dirty' Industries.

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1. Introduction

It has become increasingly apparent that there is a widespread political and public concern with environmental issues. The environmental effects of economic activity tend to be very diverse and vary between sectors and locations.

Local policies aimed at specific sectors lead to pollution abatement and control expenditures (PAC) that can vary significantly between countries for reasons of differences in natural endowments and assimilative capacities, types of pollution (from very toxic and carcinogenic pollution versus levels of acceptable noise pollution or landscape distortion), the structure of industry and services, evolutions of political priorities and policy models, attitudes of consumers and pressure groups, possible policy implementation limitations, effective enforceability of regulation, applicability of environmental and economic instruments and so on.

Differences in environmental costs might influence the relative prices of natural assets. This has consequences for industries that are nature-intensive.

We may assume that environmental control costs encourage reduced specialization in the production of pollution-intensive outputs in countries with stringent environmental regulations while countries with lax environmental regulation can build up a comparative advantage in these industries.

Since chemical industries, micro-electronics, pulp and paper, oil refining, iron and steel, and many other so-called 'dirty' industries are responsible for a very important share in national value added and employment, any new measure that increases environmental

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(and other) costs, faces a strong opposition from groups advocating that the implementation of stiffer measures will reduce the competitiveness of the targeted industries, what could lead to the forced migration of these industries (industrial flight).
This competitivity issue has been studied by many authors. Complex theoretical models suggest that competitiveness could be at stake depending on many parameters but surprisingly, there has been very little empirical support, nor when changes in trade flows have been studied, nor in surveys on the migration (industrial flight hypothesis) or attraction (pollution haven hypothesis) of pollution-intensive industries.
In her often cited[1] survey of the existing literature ('Trade and Environment: A Survey of the Literature') Judith M.Dean concludes that the many empirical surveys on diverse competitiveness-related hypotheses show no evidence to support them. She adds as a partial explanation that there may be room for better estimates of actual environmental control costs incurred by firms, and for estimates by industry of actual losses in output due to these costs.
A recent survey of the literature is made by Michael Rauscher[2] and gave comparable results. Specific surveys for the US were made by Jaffe[3] en Kalt[4].
Most surveys – starting with Arthur Andersen & Co. in 1979, followed by Worldbank, UNCTAD and many authors - estimate environmental costs around 1 to 3% of GDP for industrial countries. These rather low figures are based on sectoral studies for chemicals, metals, paper,... But when we consider the social and environmental cost of only the transport sector, the OECD gives an estimate of 5% of GDP[5]. The inclusion of health aspects and costs could clearly result in higher figures.
Patrick Low and Alexander Yeats[6] make use of a RCA (revealed comparative advantage)

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[1] World Bank Policy Research Working Paper 966 (1992) or see World Bank Discussion Papers 159 (1992), International Trade and the Environment, pp.15-28

[2] Rauscher M. (1997), International Trade, Factor Movements, and the Environment.

[3] Jaffe, Adam B. et al. (1995), Environmental Regulation and the Competitiveness of the United States Manufacturing : What Does the Evidence Tell Us, Journal of Economic Literature 33 (1), pp.132-163

[4] Kalt, Joseph P. (1985), The Impact of Domestic Regulatory on International Competitiveness, Harvard Institute of Economic Research, Discussion Paper No.1411

[5] European Commission (1997), Statements on Sustainable Development, p.17

[6] Patrick Low (ed) (1992), 'Do dirty industries migrate?', World Bank Paper 159, International Trade and the Environment, pp.89-103

analysis that enables them to conlude that dirty industries account for a growing share of exports of some developing countries together with an overall world wide reduction of dirty exports. Of course, many other factors could be responsible for this shift over a period of 20 years. They also suggest that production and FDI-data would enable a better analysis.

James A.Tobey[7] in his analysis of world trade makes use of the Walter and Ugelow index of the degree of stringency of environmental policy . This index ranges from tolerant (index value 1) to strict (index value 7). The environmental policy of only three countries (the US, Sweden and Japan) is considered as strict. Finland, Norway and Singapore follow closely. Including a dummy based on this index in his analysis on net exports of certain commodities yielded no signifant results. Although Tobey concludes that the empirical effects of domestic policies are not significant, he remarks that trade surveys are in many cases biased by trade barriers that are difficult to deal with at the empirical level.

If we can assume that the US have a very strict environmental policy and data on production and FDI-flows offer an alternative for analysis that excludes problems with trade data (trade barriers, strongly differing 'openess to trade'-ratio's,...), a sectoral analysis of these FDI-flows could give us valuable insights in the possible consequences of strict environmental policies on industrial location patterns.

2. Foreign Direct Investments (FDI) and dirty industries

We want to analyse to what extent recent FDI-patterns in and outside the US could be influenced by the strict environmental policy that is maintained. We do not want to explain investment patterns by means of a multivariate analysis including variables like market size, factor prices, corporate taxes ans tax holidays, government grants, rates of return on foreign investments, and transportation costs. For this kind of analysis, Tobey illustrates that differences in environmental regulation are not easily quantifiable.

The US has been chosen because of the data-availability : FDI , production, gross fixed capital formation and R&D are provided on a sectoral base.

Data sets were taken from Survey of Current Business, the UNIDO Industrial Statistics Database (3 digit SITC) and the World Bank Discussion Papers 159 (International Trade

[7] Tobey, James A. (1990), The Effects of Domestic Environmental Policies on Patterns of World Trade : An Empirical Test, Kyklos, vol.43, no.2, pp.191-209

and Environment).

3. The assumptions on location patterns of dirty industries

Following standard theory, environmental regulation will lead to pollution abatement expenditures that increase input and output price. In competitive markets, increasing production prices will lead to diminishing profits if international competitors do not have to internalize to the same extent the cost-increasing externalities.

Depending on profit margins and the possibilities of reducing pollution by new technologies and new product designs, some sectors or firms will face too high additional environmental costs when standards are increased. In very competitive global markets this can force them to relocate their production facilities in regions with less environmental constraints, due to different assimilative capabilities or the lack of enforceable environmental regulation.

Of course, this possible relocation will hardly ever take place immediatelly after the implementation of a new environmental measure. The firm can make some 'easy' end-of-pipe abatement investments that at the end do not fulfill legal requirements. In other cases, standards included in the legislation could change after some years and pose from that moment a serious problem.

We therefore assume that the impact of many new environmental measures during the 1980's becomes visible during the early 1990's or still did not take place.

Why not compare the diffusion of environmental legislation and its enforceability to the diffusion of information technology (IT) or other major innovations or breakthroughs like electricity? The real impact of IT and electricity was delayed by decades. According to some observers[8], the real IT-shock still has to take place.

In the next sections, we study inward and outward US FDI-flows during the early 1990's and analyse the impact of strict environmental regulation : do dirty industries leave the US and do the US attract clean industries?

To complete the picture, it is interesting to note that Bartik[9] and Levinson[10] examined

[8] The Economist (1996), Survey of the World Economy (1-8), New technology and globalisation are changing the world.

[9] Bartik, Timothy (1988), The Effects of Environmental Regulation on Business Location in the United States,

business location decisions in the US and found that government environmental expenditures had small but insignificant effects on these intra-US investment flows. In a subsequent analysis, Bartik detected a significant negative impact of state-level environmental regulations on the start-up rate of small businesses.

4. The identification of dirty industries

Following Patrick Low[11] there is no standard definition of dirty industries but they are commonly identified as those sectors with the highest level of pollution abatement and control expenditures. As such, dirty industries tend to be concentrated in relatively few but all important sectors like chemicals, cement, pulp and paper, certain wood industries, petroleum refining, and ferrous and nonferrous metal industries. Table 3 lists the industries with highest relative abatement efforts in 1988. These data are in the following paragraphs used to divide industrial sectors in three groups : dirty, medium (in terms of pollution intensity) and clean industries.

Due to non-availability of 3-digit data for FDI, the division based on broader categories (2-digit) slightly differs from what would be concluded from the 3-digit data. This is however a very relative problem since the data in table 3 are were compiled from a probability sample and are subject to sampling variations.

A concluding remark could be that firms with high PAC expenditures could reduce almost all environmental impacts of their products while firms that only need to do some modest investments could still postpone the necessary efforts and are as such more dirty compared to firms with the greater potential for pollution.

<u>Table 1 Pollution abatement expenditures as a percentage of output by US industry, 1988</u>

SIC	Industry	PAC/output	share in total industry output

Growth Change 19(3), pp.22-44

[10] Levinson, Arik (1992), Envinronmental Regulations and Manufacturers's Location Choices : Evidence from the Census of Manufacturers, New York, Columbia University

[11] WorldBank (1992), ibid. p.106

324	Cement, hydraulic	3.17 %	0.17 %
261	Pulp mills	2.42	0.20
245	Wood buildings/mobile homes	2.39	0.26
333	Primary nonferrous metals	2.35	0.62
281	Industrial inorganic chemic.	2.21	0.86
286	Industrial organic chemicals	2.13	2.34
263	Paperboard mills	2.08	0.63
262	Paper mills	1.97	1.31
287	Agricultural chemicals	1.94	0.63
332	Iron and steel foundries	1.83	0.47
291	Petroleum refining	1.62	4.63
331	Blast furnace/basic steel	1.39	2.50
329	Misc.nonmetallic mineral pr.	1.28	0.43
347	Metal services nes	1.18	O.36

...

Source: Worldbank, International Trade and the Environment, p.113

5. Changes in the US inward FDI-position (1991-1995)

The US Bureau of Economic Analysis[12] offers data on foreign direct investments in the US by industry. The investment position is presented on a historical cost basis. Following our assumption that in the medium or long term, dirty industries could locate in countries with less stringent environmental regulation than in the US, we wonder whether the foreign direct investments in US dirty industries are falling behind, face a zero-growth, or are growing at a slower rate than 'non-dirty' industries.

The period of analysis is rather short in order to eliminate possible structural industrial changes. We tested however for a period of eight years what resulted in similar results. The test consisted of a simple comparison of growth rates. We defined three categories - dirty, clean and medium (not dirty but not clean) industries -, mainly based on pollution expenditures. For each category we selected 9 sectors. A few sectors with exceptional

[12] Survey of Current Business (1995), Foreign Direct Investment in the United States (Mahnaz Fahim-Nader and William J.Zeile), May 1995, pp.57-81

growth rates of the inward FDI-position were elimimated. A (dirty) industry like 'Lumber, wood, furniture, and fixtures' realized a remarkable increase in its FDI-position : from US$ 465 million in 1991 to US$ 2667 million in 1995 (+ 473 % !). We did not include this industry in our analysis, although this sector is often cited as one of the migrating industries from states like California to Mexico as a result of differences in environmental regulations in the NAFTA.

This leads us to the following nine dirty industries :

- Petroleum refining without extraction
- Industrial chemicals and synthetics
- Drugs
- Soap, cleaner and toilet goods
- Other chemicals
- Paper and allied products
- Misc. plastic products
- Nonmetallic minerals, except fuels
- Metal mining

In 1995 these sectors accounted together for an inward FDI-position in the US of US$ 96607 million, which is 45 % of the total manufacturing inward FDI-position and 17% of the total US inward FDI-position (with the inclusion of services, real estate,..).
The inward FDI-position in the US increased by 33.6 % for all industries over the period 1991-1995. For manufacturing, the increase was almost identical, + 33.8%.
These figures can be compared with the average increase in the dirty, medium and clean group.
All growth figures that will follow represent cumulative growth over the five year period 1991-1995 and are calculated on data found in Survey of Current Business.
This analysis leads to a remarkable and unexpected result. The average increase for the dirty group was + 67.1%, the increase for the medium group only + 7.2% and the clean industries saw a reduction of their inward FDI-position with - 8.2%.
The best performers in the dirty group were : drugs (+ 188%), paper and allied products (+ 117%) and metal mining (+ 84%). The lowest growth rate was found for industrial chemicals and synthetics (+ 13%). Remember that we excluded 'Lumber, wood, furniture, and

fixtures' out of the dirty sample.

In the medium group, general industrial machinery preformed best (+ 68%). Negative growth was found for metal cans, forgings, stampings (- 29%), computer and office equipment (- 37%), refrigeration and service industrial machines (- 37%) and rubber products (- 9%).

In the clean group medical instruments (+ 57%) and other food and kindred products (+ 33%) performed very good, the other sectors showed sharp reductions in their FDI-position.

A simple comparison of averages needs to be complemented with an analysis of variance over the three groups. The ANOVA (table 4) showed a very good F-value (alfa = 5%, df = 26, P = 0.0036). Also the comparison between dirty and medium -without the clean group- proved very significantly (df = 17, P = 0.0182).

<u>Table 2 Summary of ANOVA : growth rate in inward FDI-position</u>

Groups	Count	Sum	Average	Variance
Dirty	9	603.9	67.1029	3262.461
Medium	9	65.2	7.2456	1400.329
Clean	9	-73.8	-8.2082	1295.093

Souce of Variation	SS	df	MS	F	P-value	F crit
Between groups	28480	2	14240	7.17	0.003619	3.4028
Within groups	47663	24	1985			
Total	76143					

These good ANOVA-results are strongly confirmed by a Kruskal-Wallis test - one-way analysis of variance by ranks - where the growth rates over the three groups are ranked from 1 to 27. We then found a Kruskal-Wallis H statistic that is very close to the chi-square distribution with 3 - 1 degrees of freedom because every sample size is at least 5. The calculated H = 8.141093 exceeds the critical value of H = 5.991 at the .05 level and even exceeds the critical value of H = 7.824 at the .02 level.

If the United States attract far more dirty industries than industries from the medium and clean group, the strict environmental policy does not seem to be an investment barrier and as such no restriction on US competitivity.

An analysis through FDI-positions is a registration of preferences of international investors that have the necessary home country-expertise and experience and could as such be better than an analysis based on distorted trade figures where we have to include a lot of other explaining variables like labour cost differences, changes in exchange rates, government support, regional trage agreements, etc..

FDI lead to local production (same factor renumeration and legal constraints as domestic firms), in direct and fair competition with existing domestic producers.

Of course, it could be possible that dirty industries grow faster in the US than clean industries. This could then be already a partial explanation for the impressive growth rate of inward FDI in dirty industries.

However, data from Survey of Current Business and UNIDO Industrial Statistics (3-digit) showed no significant difference in growth rates of output and gross fixed capital formation for dirty and clean industries. To the contrary, UNIDO-data showed that the output growth rate of dirty industries is somewhat smaller than the growth rate of other industries (+ 14% compared to + 18%). The ANOVA showed no significant difference in output growth rate. This makes our FDI-findings even more interesting.

UNIDO-data on Gross Fixed Capital Formation (GFCF) for the 22 manufacturing sectors showed that the capital formation over the period 1989-1993 decreased for the dirty industries (with the exclusion of petroleum industries) on average with - 0.9% while the other (clean and 'medium') industries had a modest increase of + 3.2%. The difference proved not to be significant (df = 21, F = 0.34, P = 0.566). This result is in line with the findings resulting from the output data.

6. The US outward FDI-position

In the previous section, we found that the US attracted more dirty manufacturing industries than not-dirty industries, while these sectors showed a slightly decreasing national capital formation.

To complete the picture, we need to analyse the US outward FDI-position because it could be that dirty industries leave the US to a greater extent than that they are attracted by the US. Some dirty FDI will always take place for reasons of scale of the home market and transaction costs.

We should also remember that our sectors could consist of some specific subsectors (4-digit level) that do not fit in our a priori categorization of dirty, medium and clean. Even within the chemical industry, differences in toxicity and environmental impact are very great between benzene, lead, sodium sulphate, acetone, amonium nitrate solutions, ethylene, and so on...

To link inward with outward FDI-data, we calculated sectoral (inward minus outward) FDI-balances for 1991 and 1995. For most industries, this balance was negative because total US outward FDI are larger than total US inward FDI. An increase of the inwardsurplus (or reduction of the deficit) proved the attrativeness of the industry.

For our analysis, we eliminated in each group one sector that showed a very high growth rate due to an initial very small deficit or surplus.

Again, we found the best results for the dirty industries. Only this group could seriously improve its (inward - outward) balance and is an important (net) host of FDI. Dirty industries are not at all en masse leaving the US. The contrary is true. We find in table 5 that the high variance within the groups - what could be expected from working with changes in balances - resulted however in a P-value of 0.1029.

Table 3 Summary of ANOVA : growth rate in (inward -outward) FDI balance

Groups	Count	Sum	Average	Variance
Dirty	8	2136	267	296338
Medium	8	-428	-53.5	4868.6
Clean	8	-839	-104.8	38866.7

Source of variation	SS	df	MS	F	P-value	Fcrit
Between groups	64975	2	324867	2.539	0.1029	3.46679
Within groups	2686905	21	127948			
Total	3336640					

To reduce the variance within the three groups, we express the 1991-1995 change in (inward minus outward) balance as a percentage of the initial inward FDI-position. This gives us net inflow of capital as a percentage of existing position.

For metal mining, as an example, the inwardsurplus increased with 38% from 1991 to 1995. This increase (US$ 828 million) represented 15.59% of total inward FDI in 1991 ($US 5312 million).

Comparing these percentages for the three groups gave good results, as shown in table 4. Again, only dirty industries could improve their balanced position, while medium and clean industries saw more capital flow out of the US than flow in. In this case, the P-value

is good.
A Kruskal-Wallis test gave the same results.

Table 4 Summary of ANOVA : (inward - outward) balance over 1991-1995 change as percentage of initial inward FDI-position

Groups	Count	Sum	Average	Variance
Dirty	8	28.5	3.5	1699.4
Medium	8	-55.4	-6.9	1695.5
Clean	8	-506.3	-63.2	3646.6

Source of variation	SS	df	MS	F	P-value	Fcrit
Between groups	20691	2	10345.5	4.407	0.02522	3.46679
Within groups	49290.4	21	2347.1			
Total	69981.5	23				

7. Possible explanations

The attraction of the US for dirty industries comes as a surprise. It should however be noted that foreign-owned US manufacturing establishments differ from US-owned establishments. A survey of the establishments from the six major investing countries in the US (Canada, France, Germany, Japan, the Netherlands, and the United Kingdom) showed that these foreign establishments tend to be much larger, pay higher wages, and be more productive than the US-owned establishments[13]. These differences vary of course by country of owner and by industry but we can conclude that a higher productivity makes it possible to adapt easier to changing regulatory and environmental challenges. A pollution abatement cost of only 2 percentage of value added is not dramatic for adaptive and flexible firms with a sound profitability basis.
These major investing countries have also increased their environmental standards but comparable sectoral pollution abatement data are not available so we cannot include them in the empirical analysis for the US.
Entrepreneurial efficiency is linked to advantages resulting from environmental regulation

[13] Survey of Current Business (1996), Differences in Foreign-Owned US Manufacturing Establishments by Country of Owner, March 1996, pp.43-60

by the Porter hypothesis. An efficient regulation that reduces uncertainty, creates maximum opportunity for innovation and fosters continuous improvements can results in clear advantages over non-regulated firms and regions[14].

An illustration of the Porter hypothesis can be found in the fact that the most competitive environmental industries are found in countries with stringent environmental regulations. According to Rolf-Ulrich Sprenger[15] from IFO (Munich), one of the major reasons for Germany's success in exports of environmental goods and technology is that exacting national policies on environmental protection created an early domestic demand, which ultimately gave a technological edge over its competitors.

If we link this with the estimates from MITI, Miller and Moore[16] that in the first half of the 21st century 40% of global economic output will be from environment- or energy-linked products and technologies, the development of efficient regulation will be a crucial factor. The choice of instruments that stimulate innovations and improvements will be important. Performance standards, pollution charges, information disclosure and subsidies for environmental R&D are expected to perform better than standards, emissions trading and voluntary agreements.

We will focus on environmental R&D expenditures and try to distinguish dirty from clean industries. We can assume that firms with high R&D expenditures make these efforts for specific reasons like the development of new products and new designs but also for modifications and improvements of the production process.

An important part of the new technologies can be seen as clean technologies, just because environmental considerations are integrated in the R&D objectives. It is obvious that clean technologies offer an important cost-decreasing opportunity in industries with high pollution abatement costs.

The link between global R&D expenditures and cost savings by means of clean technologies is of course complicated and depending on many factors. Investing in new technologies is always a risky and costly engagement for several years during which new

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[14] Porter and Van der Linden (1995), Toward a New Conception of the Environment-Competitiveness Relationship, Journal of Economic Perspectives

[15] Rolf-Ulrich Sprenger (1996), Environmental Policy and International Competitiveness : the Case of Germany, IFO Paper, p.32

[16] Miller and Moore (1994), Strengths and Limitation of Governmental Support for Environmental Technology in Japan, Industrial and Environmental Crisis Quaterly

oppurtunities can rise. Many entrepreneurs could therefore opt to wait and invest when the clean technologies improve overall efficiency.

These 'economics of waiting' are not the only limiting factor in the diffusion of clean technologies. Not all firms are aware of the latest technological innovations and possibilities, nor have the means to conduct own R&D. In many cases, their interaction with the economic environment is limited to a fixed number of other entreprises, federations, suppliers, customers, government agencies, banks, lawyers, etc. In order to be aware of recent scientific and technological developments, they should find a network that can provide them recent information. And even when firms are aware of latest technological possibilities, their followed technological trajectories in the past can make it impossible or very expensive to install new technologies.

Another limitation for the introduction of clean technologies could be a limited willingness to innovate. This willingness to innovate can strongly differ among industries. Determinants can be : past experiences with innovations, long-term perspective of the actual capital structure, uncertain appropriability of new technologies or licenses, legal or regulatory uncertainty that necessitates investors to wait, difficult to estimate investment risks, general uncertainty, conjectural market problems, ...

However, we can suppose that large scale firms with high productivity (and hence profitability) that take the risk to invest in a competitive economy with a strict regulatory framework, have the necessary means and entrepreneurial spirit to undertake the needed research and development.

7.1 Some selected cases on cleaner technologies and lower costs

The following benefits of introducing clean technologies through process modifications have been identified in most surveys on the subject by UNEP[17] :

(a) Savings in raw material and energy ;

(b) Decreased waste management costs ;

(c) Improved product quality ;

(d) Enhanced productivity ;

(e) Decreased down-time ;

[17] D.Huisingh (1989), 'Cleaner technologies through process modifications, material substitutions and ecologically based ethical values', in UNEP Industry and Environment, pp.4-8

(f) Reduced worker health risks and environmental hazards ;

(g) Decreased long-term liability for clean-up of waste-materials that might otherwise have been buried ;

(h) Improved image for the company ;

The authors of the UNIDO Global Report 1990/1991, Industry and Development, state that the numerous case-studies at the plant level do suggest that the pollution-prevention investment in clean technologies can lower production costs and at the same time reduce emissions. Of course, this conclusion cannot not be generalized across industries and countries. We present a case from the metal industry and one from the paper industry..
In environmental literature on the opportunities and limitations of BATNEEC (Best Available Technology Not Entailing Excessive Costs) and BPEO (Best Practicable Environmental Option), cases like Ciba-Ceigny illustrate improvements to the following technologies with environmental impact resulting from general R&D programmes.
The list of improvements is long : chemical and biological effluent treatment, biodegradation of special wastes, wet air oxidation of non-biodegradable wastes, incineration of wastes, biofiltration for waste air purification/deodorization, off-gas purification by absorption, catalytic oxidation, incineration, flue-gas purification, immobilization and stabilization of slags and ashes, site remediation, groundwater decontamination, ecotoxicology, environmental trace analysis, biospheric monitoring and noise abatement[18].

7.2 Do R&D expenditures distinguish dirty from clean and medium industries?

Case studies suggest that R&D can lead to clean and cost-saving technologies. Of course, data on R&D-expenditures do not distinguish between product or process-oriented R&D, neither between clean or not-clean technologies.
The R&D part of total pollution abatement expenditures seems to be non-constant and can depend on regulatory requirements or cost-reducing opportunities. Unfortunately, we have no sectoral data on environmental R&D.
We then studied the sectoral expenditures for total R&D (also other R&D than for PA). The Bureau of Economic Analysis[19] presents data for most manufacturing sectors (2-digit level).

[18] Hutchinson and Hutchinson (1997), Environmental Business Management, p.267

[19] Survey of Current Business (1994), A Satellite Account for Research and Development, pp.37-71

Data on R&D expenditures performed outside the US by US companies and foreign subsidiaries were also available.
When we concentrate on the 5-year period 1988-1992, we analyse the growth in R&D expenditures for the group of dirty and the group of clean industries. The period of analysis partly preceeds and overlaps the period of the inward and outward investment analysis.
It is not surprising that capital-intensive industries have the highest R&D expenditures. In 1992, US$ 16835 million was spent by the chemical (and allied products) industry, US$ 15303 million by 'industrial machinery and equipment', US$ 13634 million by 'electronic and electric equipment', and so on.
Nentjes and Wiersma[20] observed already during the 1980s that the most active sectors in environmental-related industrial R&D are machinery, chemicals, petroleum and motor vehicles. The relation between green R&D and general R&D seems to be obvious.
The growth rate of R&D expenditures over the 1988-1992 period was calculated for the group of dirty and clean industries.
The difference was great. On average R&D expenditures in the US by dirty industries (that were already impressive) increased by 29%, while on average the clean industries reduced R&D expenditures by -1%. The variance within the groups is however too great (F = 3.05663, P-value = 0.11854, F crit = 5.31764).
A very significant result was obtained by excluding primary metal industries from the group of dirty industries (R&D opportunities are less available for primary industries) and by including R&D performed outside the US by US companies and the foreign subsidiaries. We can assume that R&D is managed on a transnational basis. We found that the dirty industries invested very strong in R&D : on average + 45.4% for the period 1988-1992! The clean industries reduced R&D expenditures by - 0.7 %. The difference proved to be very significant : P-value = 0.02828.

8. The same story for the EU?

We wonder whether our findings for the US also hold for the situation in Europe.
A simple comparison between the US and EU makes no sense. The EU consists of 15

[20] Nentjes, Andries and Doede, Wiersma (1987), Innovation and Pollution Control, International Journal of Social Economics, Vol.15, pp.51-71

relatively small countries that experienced specific interactions due to the gradual integration into the EEC/EU. Since the EU increased step by step, investment patterns among EU and non-EU European countries changed significantly for non-endogenous reasons.

Baldwin, Forslid and Haaland[21] analysed investment creation and diversion in Europe with special focus on the consequences of EU membership for the former EFTA-countries. They calibrated EU-integration effects for 15 sectors (with monopolistic competition) with steady-state capital stock and found that the process of trade cost reduction and integrated market prices (market fragmentation, the procompetitive mechanism and scale effects) will lead to an overall increase of 1.8 % for the EU-capital base. The sectors with the highest increases in production and investment (FDI-included) were chemicals, food products, rubber and plastic products, transport equipment, electrical goods, agricultural and industrial machines. These sectors make intensive use of capital and nature.

It is clear that inward FDI in EU-countries are influenced by integration scenario's. We should be aware of this when we analyse FDI-patterns in Europe.

Eurostat[22] offers electronic data on direct investments flows in the EU for the period 1984-1993. The data were however not detailed enough to include them into the empirical analysis for the US.

We analysed inward investment flows for chemicals and machinery. Data were available for Germany, Denmark, Spain, France, the UK and Italy. Two sources for the inward FDI-flows were also given : intra-EU (Germany invests in Spain,..) and extra-EU (Japan invests in Belgium).

Table 5   Inward EU-FDI in mill.ECU in selected sectors, 1984-1993

	EU	Germany	Denmark	Spain	France	UK	Italy
Chemicals							
Intra-EU	12080	-1071	-14	1596	1536	2025	1181
Extra-EU	5263	-803	413	1193	1226	2512	1726
Total	17343	-1874	399	2789	2762	4537	2907

[21] Richard E. Baldwin, Rikard Forslid and Jan I.Haaland (1996), Investment Creation and Diversion in Europe, The World Economy, Vol.19, No.6, pp.635-659

[22] Eurostat (1996), Statistical Office of the European Communities, FDI European Union Direct Investment 1984-1993, Theme 2, Series D, Luxembourg

% of total	100	-10.8	2.3	16.1	15.9	26.2	16.8
% of intra	100	-8.9	-0.1	13.2	12.7	16.8	9.8
% of extra	100	-15.6	7.8	22.7	23.3	47.7	32.8
Machinery							
Intra-EU	3106	99	98	202	449	1241	-20
Extra-EU	1677	-115	100	230	763	953	-33
Total	4783	-16	198	432	1212	2194	-53
% of total	100	-0.3	4.1	9.0	25.3	45.9	-1.1
% of intra	100	3.2	3.2	6.5	14.5	40.0	-0.6
% of extra	100	-6.9	6.0	13.7	45.5	56.8	-2.0

Source : Eurostat, FDI EU 1984-1993, Luxemburg, 1996,

Table 5 shows that Germany has on balance a strong negative FDI-inflow, while the UK seems to be the most attractive country for chemicals and machinery. In many cases, the most attractive countries receive most of their FDI from non-EU countries. This could be the result of an integration effect (or investment creation or diversion), or could just be the consequence of historical patterns (the UK chemical industry has been strongly developed long before EU membership).

The negative figures for Germany could be surprisingly but flow figures cannot be compared with the initial capital base that is largest in Germany.

Data on FDI-position for the EU-12 would enable a comparison with the US but also here integration effects would be very distortive. Table 9 shows also that differences between countries are very great, what could be expected for capital intensive sectors where size of the home market determines to a large extent the possibilities to exploit economies of scale.

For this - and other reasons - a comparison with the US is very difficult.

9. Conclusions

Dirty industries were identified by means of expenditures for pollution abatement and control (PAC). These abatement costs increased slowly over time but from American data we find that they hardly ever exceeded the frequently used 2%-barrier of US GDP. This percentage however has a limited relevance because costs should not be compared with value added. For some industrial countries, the total agricultural sector delivers 2% of national GDP but one cannot say that expeditures on PAC and agriculture are of equal importance...

Expressed as share in total firms costs or investments, high abatement efforts could be a competitive disadvantage faced by countries with a high level of environmental awareness.

For most observers, the US adapts a strict environmental policy for already many years. This policy increases environmental costs and we wondered to what extent the investment position of American 'dirty' industries could be harmed.

We found that the inward foreign direct investment position for the group of dirty industries increased by 67.1% over the period 1991-1995, while the groups of medium (in between dirty and clean) and clean industries saw a status-quo or even deterioration of their inward FDI-position.

We can conclude that the strict environmental policy did not harm the attractiveness of the US for investments in dirty industries. This conclusion holds when we include outward investments in our analysis. We also found that the impressive growth in inward FDI is not the mere expression of a general increase in the capital base of these industries. UNIDO-data showed that the gross fixed capital formation in dirty industries is increasing at a slower rate than in the group of clean industries.

For these contra-intuitive results, diverse explanations are possible.

Any investment is the result of a complex multi-criteria decision process of which many criteria are hardly to capture in figures. It could be that investors opted for the US because they think that the high standards will not change for the coming years or decade. Other less strict countries could lose part of their investment attraction because of regulatory uncertainty.

Another explanation could be found in analysing expenditures on research and development. We found that the group of dirty industries is the most intensively investing in R&D. These efforts do not only result in new products and new processes but also in reaching regulatory compliance. Why not follow Michael Porter and assume that the strict environmental policy in the US stimulated R&D and entrepreneurial dynamism in order to cope with it. These efforts could lead over time to a 'first mover advantage' that will become more important in the future.

Based on investment data, we therefore conclude that a strict environmental policy does not necesarily harm national competitivity. Of course, this will not be guaranteed for each country but the US case could be inspiring for governments that want to integrate environmental priorities in the business environment.

Milieu en Competitiviteit

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Summary – The relationship between environmental policy and international competitivity has been surveyd by many researchers. The empirical results from testing the hypotheses on industrial flight and delocalisation are however not conclusive what lead to the 'revisionist' Porter-hypothesis: efficient environmental regulation can spur innovation, product quality and hence competitivity. But also the latter hypothesis still needs to be confirmed by more than indicative evidence.
The authors conclude that the impact of environmental policy and the stringency of application are hardly comparabale among different countries, due to different priorities, natural endowments and policy frameworks. It is however clear that the best performing economies can overcome these environemtal costs and maintain their competitive advantage.

De relatie tussen het milieubeleid en internationale competitiviteit staat reeds geruime tijd in de belangstelling. De materie is evenwel zeer divers, complex en permanent onderhevig aan belangrijke veranderingen. Een thema dat we hierbij steeds terugvinden is de koppeling van internationale competitiviteit aan milieukosten. Een denkkader ter interpretatie van de link milieu-competitiviteit is dan ook gewenst.

1. Bezorgdheid om de concurrentiepositie

Van zodra een land of regio een beleid voor een specifiek milieuprobleem uitstippelde, weerklonk er van diverse fronten bezorgdheid om de internationale concurrentiepositie. Competitieve sectoren zoals de chemische nijverheid besteden reeds aanzienlijke budgetten aan milieuzorg en willen dan ook verdere druk op hun financiële positie voorkomen. Uit case-studies, gebaseerd op de registratie van milieukosten door het Environmental Protection Agency (EPA) in de VS, blijkt dat voor verscheidene chemische produkten de milieukost bijna 20% uitmaakt van de totale produktiekost (DeSimone en Popoff, p.27). Dit zijn natuurlijk uitersten maar ook de oliesector en sectoren als ijzer, staal en paper dragen reeds aanzienlijke milieukosten.
Het zijn niet alleen deze sectoren die hun bezorgdheid uiten omtrent competitiviteit. Competitiviteit is voor elke natie en sector belangrijk, ook voor ontwikkelingslanden.
Enkele specifieke voorbeelden in onderstaand kader typeren de problematiek.
We mogen evenwel stellen dat competitiviteit steeds een cruciaal element is, ook bij de meest 'ruime' milieu-onderhandelingen. De Kyoto-top in december 1997 illustreerde dit andermaal. Artikel 3 van het Kyoto Protocol (FCCC/CP/1997/L.7/Add.1) stelt een algemene minimumreductie van broeikas-

gassen van 5% tegenover het niveau van 1990 voorop voor de periode tussen 2008 en 2012 (per land gespecifieerd in Annex B).

Deze onverhoopte resultaten werden bijna gekelderd door de discussie tussen de VS en China over mechanismes van verhandelbare emissierechten en inspanningen van ontwikkelingslanden in het algemeen. De ontwikkelingslanden speelden immers een actieve rol tijdens de top : ze willen hun competitiviteit immers ook veilig stellen.

Het Amerikaanse standpunt bevatte immers de dwingende eis dat ontwikkelingslanden ook 'aanzienlijke' inspanningen zouden leveren. Clinton volgde hierbij de op 25 juli 1997 gestemde resolutie in de Amerikaanse Senaat (Environmental News Network). De eis van de Senaat is duidelijk ingegeven door de vrees voor competitiviteitsverliezen. De gedwongen conversie van de relatief 'steenkoolintensieve' Amerkaanse economie zou als gevolg van het Protocol immers zeer veel gaan kosten, althans dit beweren de critici en lobbies.

Milieumaatregelen en bezwaren van de industrie

De Amerikaanse Clean Air Act Amendements van 1970 met o.a. strenge normen voor zwaveldioxide, koolstofmonoxide, ozon, lood, roetdeeltjes... werden voor de Amerikaanse industrie het doelwit van een juridisch steekspel met de overheid en de milieubewegingen dat bijna twintig jaar duurde (Booth, p.104). Deze Amendements waren zeer omstreden omdat men de verplichtingen die eruit voortvloeiden als zeer duur inschatte. Deze vrees bleek evenwel ongegrond.

Na de milieuconferentie van Rio in 1992 opteerde de Europese Unie in mei 1992 voor het installeren van een CO_2-tax om aldus het inefficiënt verbranden van fossiele brandstoffen te beïnvloeden.
Voor de energie-intensieve sectoren waren vrijstellingen voorzien van 25 tot 90% van de tax (maximaal $10/barrel). Een cruciale voorwaarde was wel dat de competitiviteit met de andere OESO-landen niet in het gedrang kwam (Howes e.a., p.135). Japan wou een analoge heffing installeren maar de VS weigerden. Uiteindelijk werd de Europese CO_2-tax eerst sterk afgezwakt in maart 1995 - onder druk van de energie-intensieve sectoren en kritiek van DGVII (Energie) en DGIII (Industrie) - , vervolgens in maart 1996 definitief afgevoerd om redenen van internationale competitiviteit.
Begin 1997 kwam er dan een nieuw Europees initiatief ; de Energy Product Tax (COM(97)30). Alle energiedragers (dus ook gas, kerosene,...) zouden onderworpen worden aan hogere minimumaccijnzen en deze verhoging zou zelfs gedeeltelijk gelden voor de energie-intensieve sectoren die in dit voorstel geen volledige vrijstellingen krijgen. Een uniforme toepassing voor alle sectoren kan evenwel andermaal niet om redenen van internationale competitiviteit.

In 1997 werden de resultaten geanalyseerd van 10 jaar Montreal Protocol. 162 landen hebben deze Conventie intussen getekend en sinds 1996 is de produktie van de belangrijkste substanties die de ozonlaag aantasten verboden. Dit heeft gevolgen gehad voor de producenten van koelkasten, airconditionings, sprays, solventen, enz...
In een detailstudie -in opdracht van de Canadese regering- wordt de wereldwijde conversiekost voor deze sectoren over de periode 1987-2060 door Canada Environment geschat op ongeveer 6000 miljard BEF (230 bill CAN$). Ongeveer 40% dient gedragen door de producenten van koelkasten, diepvriezers en airconditioners die niet meer gebruik kunnen maken van CFKs. We kunnen dan ook stellen dat de industrie terecht vreesde voor de gedwongen kostenverhoging.
Deze 'ozon-case' heeft nog andere interessante aspecten. De ontwikkelingen na het Montréal Protocol indiceren een zgn. 'first mover advantage' voor het Amerikaanse Du Pont, een belangrijke marktspeler. Reeds 10 jaar voor Montréal verbood het Amerikaanse EPA het 'niet-essentieel gebruik' van CFKs. Du Pont investeerde dan reeds massaal in substituerende R&D (vooral HCFKs) en kondigde een vrijwillige versnelde ban van CFKs aan (Howes e.a., p.32 en 34). Europese en Japanse concurrenten deden dit pas 10 jaar later en Du Pont heeft nu reeds waardevolle patenten en uitstekende vooruitzichten dankzij deze

2. Milieu en competitiviteit : empirisch onderzoek

Wanneer de Europese CO_2-tax afgevoerd werd en als we zien hoe stroef en langzaam bepaalde landen maatregelen van diverse Conventies implementeren, hoe bevochten de consensus in Kyoto was en hoe heftig lobbiegroepen zich hebben gekant tegen ogenschijnlijk neutrale maatregelen zoals bijvoorbeeld de Europese labels voor energiezuinige produkten, dan verwachten we duidelijke empirische verbanden tussen milieu- en energiekosten en de internationale competitiviteit.

Het tegendeel is echter waar. De eerste (internationale) onderzoeken naar de link tussen milieu en competitiviteit dateren van begin jaren ‘80 en komen steeds tot dezelfde conclusie : milieuzorg schaadt de competitiviteit niet. De meeste studies behandelen vooral de impact van ‘command and control’ wetgeving. Een goed overzicht vindt men in de bekende overzichtsstudie van Judith M.Dean uit 1992. Het niet kunnen ondersteunen van de hypotheses van competitiviteitsverlies en het delocaliseren van vervuilende sectoren naar landen met een minder streng milieubeleid, kan volgens Dean te wijten zijn aan de gebrekkige berekening van milieukosten door bedrijven.
Een recent overzicht met vergelijkbare conclusies vinden we bij Michael Rauscher.
Specifiek voor de VS zijn er studies van Jaffe, Grossman en Krueger (analyse maquiladora-programma met Mexico) en Kalt. Hierbij worden Input/Output-analyses gebruikt wat een vollediger beeld geeft. De resultaten kunnen geen duidelijk negatief verband aantonen. Er zijn wel beperkte indicaties.
Voor het Verenigd Koninkrijk is er de recente studie van Smith en een Nederlandstalig overzicht vinden we bij Komen en Folmer. Ook zij concluderen dat bedrijven blijkbaar niet vluchten voor een streng milieubeleid.
Indicaties voor het tegendeel (strengere milieubescherming en betere exportprestaties) vinden we o.a. in enkele overzichtsstudies van de Europese Commissie (EC, p.146) en bij David Pearce.
Enkele studies verdienen extra aandacht. Patrick Low van de Wereldbank maakt gebruik van indices van comparatief voordeel (RCA : revealed comparative advantage) om aan te tonen dat over een periode van 20 jaar het terugvallend aandeel van de vervuilende sectoren in de wereldhandel gepaard gaat met een toenemend aandeel van ontwikkelingslanden in deze specifieke handelsstromen. Dit kan een indicatie zijn van een delocalisatie van vervuilende sectoren naar regio’s met minder milieureglementering. Het kan evenwel ook gewoonweg het gevolg zijn van industriële ontwikkeling binnen deze regio’s of van het inspelen op loonkostverschillen.

Sterk vergelijkbare resultaten vinden we in een UNCTAD-studie voor de periode 1981-1991. Hierin wordt nagegaan in welke mate sectoren met een hoge milieukost - in termen van uitgaven ter bestrijding van de milieuverontreiniging (pollution abatement cost)- hun aandeel kunnen uitbreiden in intra-OESO handelsstromen. Vervolgens wordt voor dezelfde periode gekeken naar de regio's die hun aandeel in deze exporten van vervuilende produkten kunnen uitbreiden. Uit de resultaten, gepresenteerd in 'competitiveness matrices', blijkt dat vooral ontwikkelingslanden hun aandeel hebben kunnen uitbreiden in deze sectoren die als groep voor de OESO van minder belang geworden zijn.
Een andere bekende studie is deze van James A.Tobey. Hij gebruikt een index van milieustrengheid, samengesteld door Walter en Ugelow, om landen een ranking te geven van 1 (zeer tolerant) tot 7 (zeer streng). Drie landen halen de hoogste score : de VS, Zweden en Japan. Drie landen halen de op één na hoogste score : Finland, Noorwegen en Singapore. De empirische analyse toont echter aan dat de index van milieustrengheid niet significant bijdraagt tot het verklaren van de exportstromen. Tobey ziet in marktbarrières een verklaring voor de 'tegenvallende' resultaten. Een oplossing kan zijn het werken met investeringsgevens in plaats van met exportgegevens.
Tenslotte dienen we te onderstrepen dat bijna al deze geciteerde studies competitviteit meten door gebruik te maken van handelsstromen. Wanneer we evenwel studies analyseren die de impact bestuderen van milieumaatregelen op de nationale werkgelegenheid, dan is de conclusie veelal dat de verminderde werkgelegenheid in de vervuilende sectoren meer dan gecompenseerd wordt de sterke groei van de nieuwe milieusectoren (EC, COM(95)396). Deze zouden in Europa goed zijn voor minimum 1,6 miljoen banen (hoofdzakelijk afvalwaterzuivering en afvalverwijdering). Deze economische activiteit vinden we maar in zeer beperkte mate terug in de handelsstromen wat indiceert dat handelscijfers alleen onvoldoende informatie bevatten om sluitende conclusies te trekken.

3. Een index voor milieustrengheid

Er is maar één studie die een significant verband vindt tussen een streng milieubeleid en uitvoerprestaties. Deze studie van Cees Van Beers en Jeroen van den Bergh lijkt sterk op de studie van Tobey. Ze onderzoeken bilaterale handel tussen OESO-landen en maken ook gebruik van een maatstaf voor striktheid van milieubeleid. De ranking als gevolg van deze index is evenwel het zwakke element in deze studie. Deze is zeker voor discussie vatbaar. Oostenrijk zou het strengste milieubeleid hebben binnen de OESO, gevolgd door Nederland, Duitsland, Denemarken, Japan, Zweden, Zwitserland, Canada, enzovoort. Het meest lakse milieubeleid wordt toegeschreven aan de VS, Spanje, Finland, Noorwegen, Portugal, Griekenland en Italië. Daarnaast is er nog een tweede ranking (de 'enge' indicator), uitsluitend gebaseerd op verandering in het energiegebruik tussen 1981 en 1991 en op het niveau van energiegebruik in 1980. Hierbij staat zelfs België in het koppeleton en bengelen zoals verwacht Australië, Canada en de Scandinavische landen onderaan. Ook de VS 'scoort' slecht.

Deze ranking is bijna het spiegelbeeld van deze van Tobey en de resultaten zijn dan ook verschillend. De auteurs stellen dat, gebruik makend van deze enge indicator, de hypothese dat een streng milieubeleid een negatieve invloed uitoefent op exporten niet kan worden verworpen.
De relevantie van deze resultaten is aanvechtbaar. Een index van milieustrengheid per land blijft in een grote mate arbitrair. Deze index laten afhangen van de toename van het energiegebruik is zeer eenzijdig.
De ideale ranking bestaat natuurlijk niet. Rijke landen treden als eerste in de fase van vergevorderde industriële verontreiniging en moeten dan ook als eerste maatregelen uitwerken. De eerste wet ter beperking van toxische emissies - de Engelse Alkali Act uit 1863 - kwam er omdat de regio rond het Engelse Widnes als eerste de alkali-industrie zag ontwikkelen rond het midden van de vorige eeuw (Gottlieb, p.210). Het is dan ook vrij logisch dat landen als de VS, Canada en Duitsland op vele domeinen een aanzienlijke voorsprong hebben op landen met een eerder middelmatig milieuprofiel zoals België. Dit is moeilijk in cijfers uit te drukken.

4. De analyse op het niveau van landen en de Porter-hypothese

Na het overzicht van de empirische studies, dienen we twee fundamentele vragen te stellen : bestaat er competitie tussen landen en wat is daarbij de rol van milieuzorg?
De eerste vraag is het uitgangspunt van *The Competitive Advantage of Nations* van Michael Porter. Volgens hem zijn het immers bedrijven die met elkaar concurreren en is de rol van de overheid vooral ondersteunend. Het overheid dient een ruim kader te creëren en te bestendigen waarbinnen bedrijven kunnen evolueren tot kwalitatieve marktspelers. De cruciale variabelen hiertoe zijn vooral arbeidsproduktiviteit, kwaliteit en relatieve kostprijs van de productiefactoren, het wetgevend kader en investeringen in onderwijs, R&D en infrastructuur. Milieuregulering is een deel van het wetgevende kader en dient dus ook efficiënt en effectief geconcipieerd te zijn.
Binnen deze context is het belangrijk dat de traditionele handelsbelemmeringen zoals tarieven en quota langzaam maar zeker volledig uitdoven waardoor de liberalisatie-inspanningen verschuiven naar verschillen in produktstandaarden en de wetgevende omgeving. De mogelijke barrières als gevolg van een strikt milieubeleid worden dus belangrijker omdat de traditionele beperkingen weggewerkt worden.
In later werk stellen Porter en van der Linden dat de hypothese van de nadelige impact van milieureglementering op de competitiviteit moet vervangen worden door deze waarbij efficiënte wetgeving resulteert in duidelijke voordelen voor de gereguleerde sectoren. Dit is de Porter-hypothese die in het begin van de jaren ‘90 in enkele papers uitgewerkt werd. Het voorbeeld van de pro-actieve strategie van Du Pont kan als een illustratie van deze hypothese gezien worden. Enkele cases zijn natuurlijk

geen afdoen bewijs want er zijn natuurlijk ook tegenvoorbeelden aan te halen (zie hiervoor Walley and Whitehead).

Het testen van de hypothese veronderstelt dat het onderscheid kan gemaakt worden tussen efficiënte en niet-efficiënte wetgeving. Dit is niet eenvoudig en zeer moeilijk te kwantificeren.

De meeste auteurs geven dan ook alleen maar indicaties ter ondersteuning van de Porter-hypothese. Zo gaat Meyer (1993) na of de Amerikaanse Staten met de strengste milieunormen hierdoor in hun economische ontwikkeling geremd worden. Het tegendeel blijkt waar te zijn. Een logische verklaring hiervoor is dat vooral staten met goede economische vooruitzichten kunnen investeren in milieuzorg. Analoog stelt Rolf-Ulrich Sprenger van IFO (München) dat het internationale succes van de Duitse eco-business te wijten is aan de strenge Duitse wetgeving, die voorliep op de meeste omliggende landen en daardoor als eerste een duidelijke binnenlandse vraag naar milieu-technologie en -consultancy in het leven riep. Ook de Europese Commissie heeft reeds herhaaldelijk benadrukt dat de Duitse exportcompetitiviteit zeker niet geschaad is geweest door de strenge milieuwetgeving. Deze vaststelling geldt ook voor de Verenigde Staten (Wereldbank).

Een meer algemene ‘indicatie’ is gewenst en we kunnen deze vinden in een analyse van investeringsgegevens. Investeerders beoordelen immers de globale aantrekkelijkheid van een land of regio. Investeringsgegevens zijn echter niet voor alle landen beschikbaar. We beperken ons tot de VS waarvoor het US Bureau of Economic Analysis (in Survey of Current Business) per sector de inkomende investeringsstromen publiceert. Ons baserend op kosten ter voorkoming of opruiming van vervuiling per sector, vormen we 3 groepen die elk bestaande uit 9 Amerikaanse sectoren : dirty, clean en medium (tussengroep) industries.

We hebben niet de bedoeling om een globale verklaring van de Amerikaanse inkomende investeringsstromen te geven : we vertrekken van het standpunt dat de VS reeds lang een beleid hebben dat de milieu-impact van de meest vervuilende sectoren wil beperken (en daar in slaagt ook), en aldus kan de aantrekkelijkheid van deze sectoren voor buitenlandse investeerders een goede indicatie zijn van de link tussen milieubeleid en competitiviteit.

Als de vervuilende sectoren (dirty groep) massaal wegtrekken uit de VS, dan is er wellicht een negatief verband. Wanneer deze meest vervuilende sectoren evenzeer buitenlands kapitaal als de andere groepen aantrekken, is het verband neutraal. Wanneer ze beter presteren dan de medium en ‘propere’ groep, dan lijkt de Porter-hypothese ook op macro-niveau relevant te zijn.

De resultaten zijn onverwacht sterk. Over de periode 1991-1995 namen de inkomende buitenlandse investeringen met 33.8% toe voor de globale Amerikaanse industrie, maar voor de groep van de meest vervuilende sectoren was de toename echter veel groter : +67.1%. De tussengroep kende een toename van 7.2% en voor de minst milieubelastende sectoren verminderden de buitenlandse investeringen met 8.2%. Een variantie-analyse over deze drie groepen toonde aan dat deze verschillen significant waren (P-waarde van 0.003619). Een Kruskal-Wallis test bevestigde deze resultaten.

Dit onverwachte resultaat is niet het gevolg van een sterke binnenlandse toename van de kapitaalbasis van de vervuilende sectoren. UNIDO-data toonden aan dat de vervuilende sectoren over dezelfde periode zelfs een kleinere binnenlandse groei van de kapitaalbasis kenden vergeleken met de andere sectoren. De sterk gereguleerde Amerikaanse sectoren zijn dus blijkbaar zeer aantrekkelijk voor buitenlandse investeerders. In dezelfde studie (Albrecht,Working Paper UGent),vonden we tevens dat de ‘dirty ‘ groep significant meer investeerde in R&D dan de andere sectoren. Dit is eigenlijk het tweede luik van de Porter-hypothese : voorsprong door continue innovatie.

Natuurlijk zijn we er ons van bewust dat deze resultaten op zich niet volstaan om de Porter-hypothese al dan niet te verwerpen. Hiertoe is een analyse van investeringsstromen en van het milieubeleid in meerdere landen nodig. Sterk verschillende nationale doelstelllingen en omstandigheden beperken evenwel de vergelijkbaarheid tussen landen.

Bij deze analyses die gebruik maken van milieukosten, dienen we tevens steeds voor ogen te houden dat milieuregulering in vele gevallen een éénmalige investering vraagt die dan het normale patroon van andere kapitaalgoederen volgt (onderhoud, bediening van de installatie, vervanging en reparaties). Vele sectoren hebben dus maar gedurende enkele jaren sterk verhoogde milieukosten. Eens de aanpassingen zijn gebeurd, dalen de kosten (ook door verbeterde milieu-efficiëntie). Dit is een algemene vaststelling (UNIDO) en blijkt bijvoorbeeld ook voor België uit de conjunctuurenquêtes van de NBB.

Op lange termijn wordt efficiënte milieuzorg een belangrijke pijler van de Amerikaanse en Europese competitiviteit. De meest acute milieuproblemen doen zich momenteel voor in Azië, Oost-Europa en bepaalde gebieden in Latijns-Amerika en Afrika (UNEP). Eens daar het gemiddelde welvaartsniveau gestegen zal zijn tot het niveau waar meer rijkdom meer milieuzorg betekent, zullen deze regio’s sterk gaan investeren in deze eco-sectoren waarin het rijke Westen tegen dan een comparatief voordeel opgebouwd zal hebben. Aldus ontstaan elders markten wanneer bij ons milieuzorg algemeen verspreid zal zijn.

5. Besluit

De relatie milieu-competitiviteit is een permanent element in politieke discussies maar is moeilijk empirisch te ondersteunen. Milieukosten zijn niet marginaal maar wel tijds- en situatiegebonden. Weinig landen acteren tevens op hetzelfde niveau van milieuzorg en vergelijkingen zijn dan ook moeilijk te maken, laat staan te kwantificeren. De Porter-hypothese (als alternatief voor de hypothese van de negatieve impact van milieukosten op de competitiviteit) kan anderzijds wel steunen op enkele indicaties maar ook hier is een veralgemening voorbarig.

Bij al de studies moeten we steeds de vraag stellen wat we eigenlijk meten. Indien de belangrijkste economieën sterk blijven presteren ondanks aanzienlijke milieukosten, is de conclusie dan dat milieukosten niet belangrijk zijn of dat de meest efficiënte economieën deze beperkte tijdelijke handicap kunnen overwinnen en in bepaalde gevallen zelfs kunnen ombuigen tot een troef op langere termijn? De tweede visie lijkt ons juister.

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Environmental Agreements and Sectoral Performance: Cases of the CFC Phase-out and the US Toxic Release Inventory

Johan Albrecht

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CAVA is the European Research Network on Voluntary Approaches for Environmental Protection. It aims at achieving synergies between researchers and providing an efficient interface to policy makers. CAVA is steered by University College Dublin (Ireland), University of Gent (Belgium), Fondazione ENI Enrico Mattei (Italy), Öko-Institut (Germany), AKF (Denmark) and CERNA at the Ecole des Mines de Paris (France, Coordinator). The Network is funded by DGXII of the European Commission. For more information about the CAVA Network please go to:

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A b s t r a c t

Voluntary approaches are considered as a relatively new instrument for specific environmental policies. It is still too early to present a general evaluation of the instrument and we therefore present two cases of successful realization of environmental objectives for which voluntary approaches proved valuable. Industry took up its responsibility in voluntarily phasing out the production and use of CFCs and in reducing toxic releases in the US. There are however clear differences. In the case of CFCs, the complementarity of pro-active national strategies for the CFC-using industries proved to result in comparative advantages for the US and Denmark.

In the second case, our analysis showed that some US industries could reduce toxic emissions at a low cost. But probably this was not the most important motive to invest in pollution reduction. The availability of emission data in the US makes it possible to identify the biggest polluters and suggest the link between pollution and health problems in the surroundings of the facility. We can assume that pollution reduction was an option to avoid costs of liabilities in the future.

In the two cases, there was a clear regulatory threat that could contribute to the success of the agreements with industry. We should also mention that the targets in both EAs were not determined by industry.

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1. Introduction

It is obvious that in many environmental debates, the role of industry is of crucial importance. Industry has a clear information advantage over regulators and pressure groups and has probably the best competencies to develop the new technologies and structures that will be needed to tackle complex environmental problems. As a consequence, the position and goodwill of industry can contribute strongly to the environmental effectiveness of possible solutions and policies. When industry accepts this ‘shared responsibility’, Environmental Agreements (EAs) - or Voluntary Agreements (VAs) - can bring about very effective measures, even in advance of detailed legislation. There are however limitations to the ‘problem-solving’ potential of EAs and in COM(96)561, we read that EAs ‘are not a panacea and need to be applied in a mix of policy instruments, i.e. as a supplement to legislation and environmental taxes.’

The intention of the European Commission not to operate EAs in isolation from other policy instruments, is not always shared by all industrial federations. CEFIC, the European Chemical Industry Council, clearly links the continuation of its Voluntary Energy Efficiency Program (VEEP) - that will further improve energy efficiency of the chemical industry by an additional 20% over the years 1990-2005 - with the proviso that no new taxes are levied on energy (CEFIC, 1998).
Industry is clearly in favour of EAs because this instrument would allow flexibility to adjust environmental investments to the medium term capital investments. Compared to tax and quantity instruments, voluntary approaches are probably much less costly. Another advantage is the limited administrative cost for industry as well as for government agencies. We will therefore investigate, in two distinct cases, whether this potential cost-effectiveness of the instrument did lead to a negative or positive impact on sectoral performance, measured by changes in bilateral export flows and in abatement costs. We will also consider briefly the environmental effectiveness of the two EAs.
In the first case, we investigate the impact of the limitations of the use of chlorofluorocarbons (CFCs) on the export performance of the most important CFC-using industries. The Montreal Protocol is one of the most significant ‘global’ voluntary agreements that has ever been implemented. The implementation of this international agreement was to a large extent depending on voluntary initiatives. We work out a product-specific test of the Porter hypothesis that links environmental legislation to innovations and productivity and will analyse whether countries and sectors with a pro-active CFC-strategy and management did overcome the imposed limitations and could establish a competitive advantage.
In the second case, we will calculate the marginal costs of pollution abatement for the industries that could strongly reduce their total emissions under the Toxic Release Inventory (TRI) of the US

Environmental Protection Agency (EPA). We will show that many efforts by industry were the consequence of the TRI's subprogram Voluntary 33/50. We also analyse the significant differences resulting from defining industries as 'dirty' by making use of emission data or by using pollution abatement and control expenditures.

In the final section, we present our conclusion. Without having the intention to generalize, we argue that selective and monitored use of EAs can result in impressive environmental records next to competitive advantages.

2. The Montreal Protocol and the phase-out of CFCs

2.1 The history of the Protocol

In 1974, the world-wide scientific community accepted the Rowland-Molina hypothesis that the thin layer of stratospheric ozone could be depleted by emissions of chlorine. After the announcement in 1985 of the existence of a 'hole' in the atmospheric ozone layer near the South Pole, world-wide concerns were almost immediately followed by clear actions by the international environmental community. The 1985 Vienna Convention for the Protection of the Ozone Layer was followed by the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol imposed concrete obligations to reduce production and use of chlorine-based ozone-depleting substances (ODSs), with a grace period for developing countries. The most important ODSs are chlorofluorocarbons (CFCs), bromofluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide and hydrochlorofluorocarbons (HCFCs).

Since 1987, new substances have been added and phase-out commitments have been seriously strengthened. Export and import of controlled substances to non-parties were prohibited. A multilateral fund to support phase-outs in developing countries has been established. Ten years after the signing, 162 countries did ratify the Montreal Protocol. Most developed countries ratified already in 1988. Countries like Argentina, Chile, Brazil and Poland followed in 1990 and the latest ratifications were made by Senegal in 1993 and Morocco in 1995 (UNEP, 1998).

In Europe, the first Council resolution on the issue dates from October 1988. In this resolution, we find explicitly the term 'voluntary agreement': 'The Commission invites, in co-operation with the Member States, to initiate discussions on *voluntary agreements* at the Community level with all the industries concerned, wherever feasible to substitute chlorofluorocarbons and halons in products (Official Journal, 1988).' The production caps in the Montreal Protocol introduced also the first experience in Europe with the 'grandfathering principle' when allocating quotas for the market of

HCFCs to nine European chemical manufacturers and importers (Lorenz-Meyer, 1998). The first allocation in 1996 was very difficult to agree because the HCFC business is highly competitive and past production data needed to be handled in confidentiality.

It is also clear that initiatives at the level of the Member States are of equal importance. A country like Denmark elaborated a comprehensive national CFC-policy while other Member States were rather passive.

All new supplies of ODSs, except HCFCs and methyl bromide, were phased out by developed countries starting January 1, 1996. The respective phase-out deadlines for the latter are 2030 and 2010. We do not consider the grace period for developing countries as an important source of free riding. Since CFCs were banned in developed countries, the CFC-market for free riders was limited to developing countries.

The ratification of the Montreal Protocol ensures that all developed countries face the same technological substitution costs at the same time and this is one of the conditions for an optimal test of any hypothesis on the impact of environmental regulation on specific sectoral performance (Albrecht, 1998).

2.2 The role of the chemical industry

The chemical industry has been an active stakeholder in the scientific debate on ozone and related problems. Since 1976, the chemical industry has voluntarily reported the production and sales of fluorocarbons through a survey compiled by an independent accountant (Grant Thornton LLP). The purpose of the survey was to provide the scientific community with data on the atmospheric release of CFCs and the alternative fluorocarbons (AFEAS, 1997). Another purpose of this industry initiative was to provide the own researchers with good information.

The phasing-out of CFCs had significant consequences for the producing chemicals firms and all the industries that use CFCs. Du Pont (US) was the worldwide leading firm in the production of CFCs with a global market share around 20%, followed by Elf-Atochem, Allied-Signal, ICI, Solvay, Hoechst, Ausimont, Daikin and some other firms. Du Pont played a crucial role in the implementation of the Montreal Protocol (Haas, 1992).

Already in 1979, the firm developed an in-house state-of-the-art atmospheric computer model to evaluate the potential problems associated with CFC emissions. This investment ensured the ability to evaluate the most recent scientific findings and to develop a pro-active strategic policy. In 1988 alone, DuPont spent more than $30 million for process development, market research, applications testing, and small-lot production of CFC substitutes (Haas, 1992) and shortly after the release of the Ozone Trends Panel report in March 1988, the company announced to completely phase out the production of CFCs before the end of the century[1]. And of equal importance, DuPont would assist its customers in converting to chemical substitutes. The most important substitute for DuPont was HCFCs for which the company gained important patents already in the early 1980s (Howes, 1997). This proved the long-term view of DuPont because it clearly did not opt to enjoy the higher profits on CFCs that would follow due to the enforced scarcity of chlorofluorocarbons. Since the sales by DuPont of CFCs totalled $600 million in 1987, The New York Times headed “Why DuPont Gave Up $600 Million”.

By its announcement, DuPont accelerated the projected phase-out what resulted in less time for its competitors to find the needed CFC-substitutes. It also increased the attractiveness of the substitutes (mainly HCFCs) that DuPont could already present to its customers. DuPont created a gigantic retrofit market on which it could sell the relatively expensive HCFCs to replace old CFCs. The unilateral measures attributed also to the public image of the firm that was the target of several environmental pressure group actions around that time.

The impact of DuPont as the most important market-player is also visible in the implementation of the Montreal Protocol by the US. As a consequence of the Protocol, the US enacted mandatory controls on CFCs. In order to stimulate substitutions, the Congress passed an excise tax on certain ozone-depleting chemicals sold or used by the manufacturer, producer or importer (Westin,1997). The amount of the tax is determined by multiplying a base tax amount (that is every year increased) by an ‘ozone-depleting factor’ that reflects the potential ozone depletion of the chemical. This US Tax on Ozone Depleting Chemicals increased prices of CFCs significantly. HCFCs are excluded from the tax, despite their limited but clear ozone-depleting potential. Westin (1997) states that this is ‘a questionable decision’. DuPont, as a producer of HCFCs, clearly will not regret this exception. In this perspective, it is interesting to note that the unlimited use of HCFCs is also strongly defended by the Air-Conditioning and Refrigeration Institute (ARI, Virginia). The members of ARI manufacture 90% of US production of refrigerators and air conditioning equipment. The ARI strongly opposed Congress proposals to establish an excise tax on HCFC, either on a per-pound basis or weighted according to ozone depletion potential. And after the European Union proposed at the end of 1997 an accelerated phase-out of HCFCs by 2015, the ARI was one of the most active groups against this proposal. According to ARI (1998), the European proposal could disturb the transition by equipment owners away from the more environmentally-damaging CFCs. Besides, in

[1] Currently, DuPont still produces CFCs in countries like Brazil because the company was *asked* by the Brazilian government to continue the production. The first multinationals that completed the phase-out of CFCs were Hoechst and Solvay. These two firms decided also in 1988 to stop production and with the closing down of the Solvay CFC unit in Torrelavaga (Spain), Solvay completed the phase-out in May 1994 (personal communication from Pierre Coërs [Solvay Communication Manager Environment & Safety], April 10, 1998). Hoechst stopped producing CFCs in April 1994, even in countries like Brazil that were allowed to continue producing CFCs until 2010 (Hoechst, 1996).

1996 the US consumption of HCFC was at 82% of the allowable cap amount.
Of course, the impact of industry on politics is not limited to the United States. In France, the Industry Ministry defended strongly the benefits of Elf-Atochem that tried to delay any substitution. Unlike DuPont, Atochem did not have substitutes that could be marketed in a very short period. The French environmental minister even denied in 1987 any definitive link between CFCs and ozone depletion (Haas, 1992). Similar practices are noticed in the Soviet Union, Japan and the United Kingdom.

2.3 On the environmental effectiveness

In 1997, the Montreal Protocol is called by the World Bank (1997) 'the major bright spot in global environmental efforts'. At the latest Ozone Day (September 16, 1998), the chairman of the Global Environmental Facility, Mohamed T. El-Ashry, opened his speech by confirming that the concentration of some of the ozone-related chemicals in the atmosphere started to decline (GEF, 1998). Considering the long presence of CFCs in the atmosphere (CFC-11 : 75 year / CFC-12 : 111 year / CFC-114 : 185 year / CFC-115 : 380 year /...(TNO, 1989)), this decline in concentrations came earlier than in the most optimistic simulations. These trends are confirmed by data from AFEAS (1998), the organization that collects and calculates the annual ODP weighted CFC production. There are however still some problems. Actual progress in developed countries is being undermined by excessive CFC production of lower quality in Russia and China and black market smuggling. Not every country has an effective enforcement program to limit these practices. The World Bank, in collaboration with production factories and the Russian government, has developed a plan to eliminate all production of CFCs in Russia by the year 2000.
Some authors have a different opinion on the environmental effectiveness of the Montreal Protocol. Murdoch and Sandler (1997) analyse emission data for 61 countries and conclude that there is only a very limited environmental impact of the Montreal Protocol. An opposite conclusion is reached by Swanson and Mason (1998). They conclude that in absence of the Protocol, production and emissions of CFCs would have increased by a factor of five over the next fifty years.

2.4 Export performance of CFC-using industries

The substitution of CFCs provided an opportunity for firms that invested first in CFC-substituting R&D and were able to influence the political priorities and framework that resulted from the Montreal Protocol. Ozone policies can provide as such a competitive advantage for the early adapters. One could see this as an illustration of the Porter hypothesis ; effective regulation can trigger innovation and productivity (Porter and van der Linde, 1995) .

But assuming this pro-active strategy paid well for DuPont, did CFC-using industries also benefit from US policies? Otherwise, if only one industry or firm did benefit and other industries had to pay an 'expensive lunch', this is not at all a confirmation of the Porter hypothesis.

CFCs are mainly used for the production of refrigerators, air conditioning equipment, fire extinguishers, foams, aerosols and solvents (used to clean many types of electronic components and processes). Manufacturers of refrigerating equipment will face the highest substitution costs, followed by the manufacturers of (mainly mobile) air conditioning equipment. In the US, these two sectors form a seventeen billion dollar industry which employs more than 136000 men and women (ARI, 1997).

Since this substitution will take place in all the industrial countries, we will investigate whether the active national ozone-policies of some countries did improve the competitivity of their main CFC-using manufacturers. If this should be the case, we have a product-specific confirmation of the Porter hypothesis.

According to Haas (1992), the US position during the Montreal negotiations was supported by Canada, Denmark, Finland, the Netherlands, New Zealand, Norway and Sweden. Most countries of the EC-12, led by Britain and France, favoured only a production cap to minimize the costs to their CFC producers and users. In the analysis, we therefore take the US and Denmark as the countries that favoured a pro-active strategy. Like the US, Denmark has also a tax on CFC and halon with a border tax adjustment, a statutory order gradually banning the use of ODSs for specific purposes and a development program to support non-ODS technology (Danish EPA, 1995).

We selected France, Germany and Japan as the countries that were more hesitating about the phase-out of CFCs. For France, we referred already to Elf-Atochem, while the Japanese feared especially the ban of CFC-solvents in their computer industry. The five selected countries all have a manufacturing industry with similar technological capabilities and an excellent reputation. They represent a significant part of world trade in the related sectors.

Since the Protocol went into force on 1 January 1988, we will analyse changes in bilateral trade flows since 1989 of these five countries to their major trade partners. These trade partners differ of course for each country but it is important to note that they contain countries like Canada, Sweden, Norway, Finland, the Netherlands and New Zealand that also favoured an early phase-out policy. The other developed countries (Italy, Switzerland, Belgium, Spain, ...) are also included in the analysis next to a number of developing countries like Morocco and Algeria (trade partners of France), Mexico, Brazil, Ecuador and Venezuela (trade partners of the US).

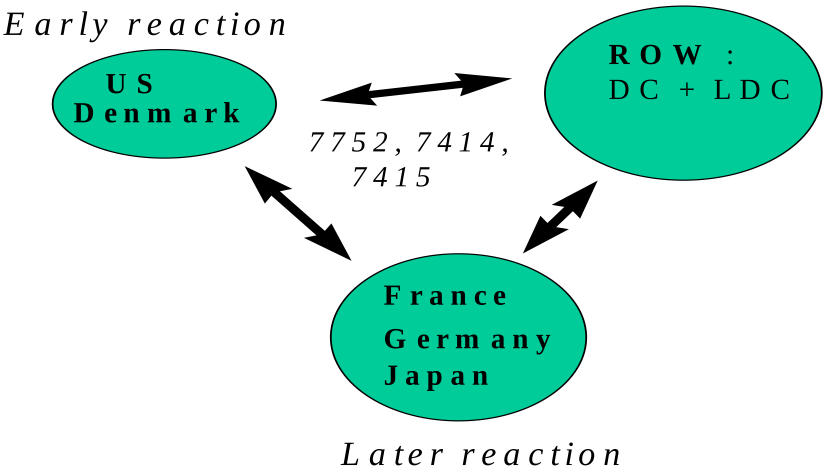
We analysed trade flows for the three most important sectors that make use of CFCs : household type refrigerators and food freezers (SITC-code 7752), refrigerators and refrigerating equipment, except households (SITC 7414), and air conditioning machines, self-contained and parts (SITC 7415). The industrial refrigerators are used in meat industries, cold storage warehouses, transport refrigeration, vending machines and retail food refrigeration.

We used OECD-data (Rev.3) for the period 1989-1995 (not all data for 1996 were available at the moment of the analysis). Only when trade exceeded a minimum level of $50000, the bilateral trade flows were included in the data sample.

Figure 1 illustrates the model with three poles; [US & Denmark] vs. [France & Germany & Japan] vs. [Rest of the World (ROW : developed and developing countries)]. The numbers inside the arrows (bilateral trade) indicate the SITC-codes of the concerned industries.

The dependent variable in the analysis was the change in bilateral exports (Export-value in 1995/Export-value in 1989) for the country of origin. The independent variables, next to a constant term, were change in bilateral imports (that the country of origin imported from the country that bought its exports: *dM* =M1995/M1989), the relative change in bilateral exchange rate (from 1988 to 1994, as an index calculated using IMF International Financial Statistics : *dER*) and a dummy (*Early-d*) that expressed the early reaction and pro-active stance of the US and Denmark. For exports originating in these two countries, we gave the value 1 to the dummy. For the exports from France, Germany and Japan, the value for the dummy was 0.

Figure 1 - Presentation of the model



Bilateral trade data have the advantage that they enable it to include changes in the bilateral exchange rate in the analysis. Furthermore, if we link the bilateral change in exports to the bilateral change in imports, we find a bilateral rate of export-import-substitution. Since the CFC-substitution costs are high, we might expect possible substitutions of trade flows between different countries. Due to their more complex production processes, it was estimated that the substitutes for CFCs would be two to five times as expensive (Kemp, 1995). In addition, the production of HCFCs and HFCs is very capital intensive and economies of scale play an important role.

Since we work with very specific sectors, no other sectoral production data (like labour productivity and wage rates) were available for the many countries in the analysis. Compared to the use of absolute trade flows (like in gravity models), the explained variation in the sectoral growth rates of bilateral exports is lower but still rather good.

Table 1 summarizes the results for the three separated sectors, the total refrigerator sector (7752+7414) and the three sectors combined (7752+7414+7415).

Table 1 - OLS estimates for bilateral export growth (1989-1995) of three CFC-using industries (SITC-codes : 7752, 7414, 7415)

(t-statistics in parentheses, 5%-level of significance)

(7752 : household refrigerators and freezers - 7414 : industrial refrigeration - 7415 : air conditioning)

SITC-Sectors Variable	7752	7414	7415	7752+7414	7752+7414+7415
Constant	-0.9547 (-1.403)	0.1994 (0.722)	1.3316 (2.910)	-0.4707 (-1.308)	0.2637 (0.889)
dM	0.0612 (2.177)	-0.0185 (-0.590)	0.1952 (5.592)	0.0542 (2.739)	0.0834 (4.687)
dER	0.8978 (2.634)	0.4154 (2.767)	-0.1452 (-0.606)	0.6492 (3.475)	0.3776 (2.425)
Early-dummy	2.5081 (3.991)	0.6887 (2.787)	-0.5022 (-1.291)	1.6013 (5.033)	0.8087 (3.105)
Adjusted R^2	0.1865	0.1047	0.2510	0.1480	0.0880
F-value Sign.F	8.8745 2.8E-05	5.8345 0.0009	14.2940 5.47E-08	14.2097 1.63E-08	12.1952 1.32E-07
Number of observations	104	125	120	229	349

The dummy that captures the early reaction of the US and Denmark is clearly significant in all sectors, except for the air conditioning equipment for which the sign of the dummy is even negative. This can be explained by the fact that the category of air conditioners in the SITC is rather general and also includes systems that are less depending on CFCs. For these installations, ozone policies have only an indirect effect. The results would differ if the SITC offered specific data on mobile air conditionings (like the types used in cars).

The significance and positive sign of the dummy in the other calculations proves that the two countries with a relatively active CFC-policy and relatively high CFC substitution costs could improve their competitiveness and export performance.

The benefits of this analysis at the product level are clear. Working with the totals of the three sectors (the column at the right in table 1) suggests that also for air conditioning equipment, the strategy of early reaction in the two countries did stimulate exports. But this conclusion is only valid for the refrigerating sectors. And it is obvious that without export data for refrigerators (at the 4-digit level: 7752), working with household type equipment (SITC-code 775) or electrical machinery (SITC-code 77), would not enable to test the impact of CFC-policies.

2.5 Conclusions of the analysis

If DuPont and the most important CFC-using industries (7752 and 7414) in the US can benefit from the environmental regulatory settings after the Montreal Protocol, this can be considered as a valid illustration of the Porter hypothesis. In our analysis, the same conclusion can be linked to the Danish CFC-policies what ensures that this ‘Ozone-Porter case’ is not depending on specific American market conditions. This is also a reason why we opted to include Denmark in the analysis and not Canada because in the latter case, the conclusions could be specific for North America.

Data at the most detailed level also show that the pro-active CFC-policy gave better export results in sector 7752 than in sector 7414. The difference in the coefficient of the dummy is substantial. Other differences between household and industrial refrigerators are the signs and coefficients of the constant and the change in imports. Only for industrial refrigerators, the growth of bilateral imports had a negative, but not significant, impact on export growth. The market for household refrigerators was clearly in full expansion.

For the air conditioning equipment, the change in bilateral exchange rate was not significant for export growth. For the four other regressions in table 1, changes in exchange rates proved to have a significant impact. Of course, the five countries in the analyse experienced very different exchange rate evolutions.

3. The case of the Toxic Release Inventory

In the literature we find the weak impact of environmental regulations on international competitiveness. Many explanations are possible but an important one could be that stricter environmental regulation is not necessarily a very expensive regulation for industry.

We therefore tried to calculate some sectoral marginal abatement costs for a period of six years. We opted for the United States because it is one of the few countries that measures in detail all toxic releases since 1987 and also collects sectoral pollution abatement costs. Only recently, other countries started with similar registration systems for releases and transfers of chemicals. The international term for these systems is Pollutant Release and Transfer Registers (PRTRs). There presently are six nations with PRTR[2] systems : Canada, France, Netherlands, Norway, the United Kingdom and the United States. Many more nations are in various stages of establishing a system: Australia, Czech Republic, Denmark, the European Union, Finland, Japan, Mexico, Sweden and Switzerland (EPA, 1997).

For the US, average abatement costs for air pollution have been calculated by Hartman, Wheeler and Singh (1994). They used the U.S. Department of Commerce's annual 20000-plant random survey of pollution abatement costs and expenditures (PACE). For 37 sectors, the average abatement costs in $US (1993) per tonne were calculated for seven air pollutant categories: suspended particulate matter, sulfur dioxide, nitrogen oxides and carbon monoxide, hydrocarbons, lead, hazardous (toxic) emissions and other emissions. They concluded that maximum/minimum ratios are frequently near ten, and occasionally near hundred : abatement costs can vary from $10 to $ 46000 per tonne. Another conclusion from their empirical analysis was that scale economies may apply to some abatement processes. If this would be the case, declining marginal abatement costs could be a possible outcome of our analysis.

To calculate marginal abatement costs, we first had to select the 'dirty' industries. Two options were available: working with the Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI), a publicly available database that contains specific toxic chemical release and transfer information from manufacturing facilities, or with data on Pollution Abatement and Control Expenditures (PAC or PACE, in US Department of Commerce, Bureau of Economic Analysis, Bureau of the Census and Survey of Current Business). Since expenditures on pollution abatement equipment have as main objective to reduce (toxic and other) emissions, we might assume that industries with the highest emissions have also high abatement expenditures. In most of the empirical surveys on the impact of environmental regulation on competitiveness, authors only work with data on PAC. It would therefore be interesting to calculate the correlation between rankings based on PAC and ranking based on TRI. Furthermore, industries are measured at the aggregated sectoral level so it is possible that an analysis at the plant level gives another picture.

We therefore made in table 2 a ranking of US industries for 1995, using data on total sectoral toxic releases (TTR), total sectoral toxic releases and transfers (TTR+T), total releases per facility (TR/F), pollution abatement capital costs (PACc), pollution abatement capital costs per facility (PACc/F), total pollution abatement costs (PAC) and total abatement cost per facility (PAC/F). Spearman's rank-order coefficient were added. Unfortunately, similar analyses for other countries were not possible for reasons of data-availability.

[2] As a follow-up to the UNCED, the OECD was asked in 1993 by Member countries and UN organisations to prepare a guidance manual for use by governments considering establishing a PRTR. The OECD envisaged complementarity with industry programmes like ISO 14000 and Responsible Care.

At the sectoral level, the rankings for total toxic releases (TTR) and pollution abatement costs (PAC) show chemicals, primary metals and paper as the most 'dirty' industries. For many other sectors, the differences for the two rankings are significant. Measured by PAC, plastics only rank 15th while this sector ranked fifth in terms of toxic releases. The sector of petroleum products was in 1995 the second sector in terms of PAC, while it was ninth for TTR. The stone, clay and glass industry closes the ranking for PAC but is 11th in terms of TTR.

At the facility level, the paper industry has the 'dirtiest' plants followed by the average plants in the chemical and primary metals industries. The average plant of the primary metal industry is however ranked 8th when it comes to PAC per facility.

The rank-order coefficients show that the correlation between the rankings for TTR and PAC is only 0.585. When we include transfers in TTR, the correlation is 0.575. Since in most empirical surveys on the impact of environmental regulation, the industries in the sample are selected using PAC, this means that the results do not necessary capture developments of 'dirty' industries in terms of toxic emissions. Using PAC in empirical surveys gives information on dirty industries that clearly invest to reduce their toxic emissions.

At the plant level, the differences are somewhat smaller. The correlation between TTR/F and PAC/F is 0.650.

The rank-order coefficient between PACc and PACc/F (0.853) is higher than the coefficient between PAC and PAC/F (0.771), and much higher than the coefficient between TTR and TTR/F (0.535). This suggests that pollution abatement efforts are more equally spread among the facilities in a sector compared to toxic emissions. Of course, the number of reporting facilities is different for the sectors in this analysis.

Table 2 - Ranking of US 'dirty' industries (1995) and Spearman's coefficients

Industry	TTR	TR+T	TR/F	PACc	PACc/F	PAC	PAC/F
Chemicals	1	1	2	1	5	1	4
Primary Metals.	2	2	3	7	8	5	8
Paper	3	3	1	4	2	3	2
Multiples	4	4	6	6	6	7	6
Plastics	5	5	10	16	18	15	18
Transport.Equipm.	6	6	7	3	4	6	5
Food	7	7	16	8	10	8	10
Fabricated Metals	8	8	19	13	19	10	19
Petroleum Products	9	9	4	2	1	2	1

Industry	TTR	TR+T	TR/F	PACc	PACc/F	PAC	PAC/F
Furniture	10	12	8	15	15	16	20
Stone/Clay/ Glass	11	11	11	11	9	21	17
Printing	12	14	5	5	3	4	3
Lumber	13	13	15	14	13	17	16
Electrical Equipm.	14	10	20	12	14	12	13
Machinery	15	15	21	10	12	14	15
Textiles	16	16	14	19	17	18	9
Meas.&Photogr.Eq	17	17	12	17	7	13	7
Miscellaneous	18	18	17	18	21	20	21
Leather	19	19	18	21	16	19	11
Tobacco	20	20	9	9	11	9	12
Apparel	21	21	13	20	20	11	14
Spearman's rank-order coeff.	TTR -	984	605	692	516	585	366
		TR+T -	535	681	490	575	358
			TR/F -	658	715	676	650
				PACc -	853	832	667
					PACc/F -	722	846
						PAC -	771

(TTR: total toxic releases - TR+T: total toxic releases and transfers - TR/F: total releases per facility - PACc: pollution abatement costs (only capital) - PACc/F: pollution abatement costs (only capital) per facility - PAC: pollution abatement costs (capital and operational costs) - PAC/F: pollution abatement costs (capital and operational costs) per facility

3.1 'Core' chemicals for year-to-year comparisons

The EPA Toxic Release Inventory program is a dynamic one. Since its inception over 10 years ago, the program has seen many changes aimed at improving the relevance of the database and the public's access to information. This last objective was a consequence of the 1986 Community Right-to-Know Act that forced US companies to report their releases of toxic chemicals. This disclosure law - arduously lobbied against by many corporations - facilitated the imposition of regulation on toxic releases. Information was the start and an important part of the regulation (Konar and Cohen, 1997).

The first TRI program included the releases of some 320 toxics. Many of these substances were already targeted by the 1970 Clean Air Act but during the first twenty years the EPA managed to publish regulations on precisely nine substances. The other 311 remained uncontrolled (Easterbrook, 1995). The disclosure of releases facilitated further regulations.

From the 1987 TRI report, one of the major conclusions was that, although the list included more than 300 chemicals, the top 25 chemicals accounted for about 94 per cent of 1987 total releases and transfers. Sodium sulphate alone represented 54 per cent of all releases (UNIDO, 1990). It was also no surprise that apart from emitting the greatest amount of total chemicals among the industry groups, the chemical industry generated also the greatest variety of chemicals. By contrast, some light industry groups, like food products, beverages and leather products, seem to generate a far narrower range of chemicals than other industry groups.

On November 30, 1994, EPA added 286 chemicals and chemical categories to the TRI. This expansion of the chemical list nearly doubled the number of chemicals on the TRI, bringing the total number of chemicals to 647 (EPA, 1997).

It is obvious that not all chemicals have the same impact on the environment. Therefore EPA established the Voluntary 33/50 Program in 1991. This program was EPA's first voluntary initiative aimed at reducing the releases and transfers of the most dangerous toxic chemicals. From the list of TRI chemicals, EPA selected 17 chemicals for the program (benzene, carbon tetrachloride, chloroform, 1,1,1-trichloroethane, toluene, xylenes, mercury, lead, ...). The name is derived from the program's two goals: a 33% reduction by 1992 and a 50% reduction by 1995. The baseline year was 1988. The program was a success. In 1995, releases and transfers were reduced by 55.6% (EPA, 1997). According to EPA, the 33/50 program paved the way for successful reductions of the other TRI chemicals. It was the start of a concerted industrial effort.

It is interesting to mention here that at the same time, a similar program was established in Indonesia. The PROKASIH program, beginning in 1989, is a voluntary program designed to clean up Indonesia's heavy polluted waterways. Firms were encouraged to sign letters of commitment to cut emissions by specific percentages. After two years, over one thousand firms signed such letters and started to invest in abatement measures (O'Connor, 1994). As a consequence of this program, a colour-coded rating system for 'grading' facilities' environmental performance was introduced into the Indonesian PROPER program in the mid-1990s. The in-compliance category is subdivided into blue, green, and gold ratings, and the out-of-compliance into red and black ratings, all depending on the relative environmental performance of the firm. This idea would not have attracted that much attention if the ratings were not made public (Afsah and Vincent, 1997). This was possible by the principle of community participation in environmental management in the 1982 Environmental Law. Making the rating public was intended to provide reputational incentives for better environmental performance.

In June 1995, the Indonesian Minister of Environment publicly awarded green ratings to 5 facilities and the media gave heavy coverage to the awards. The Minister also disclosed the distribution of the ratings for, but not the identities of, the remaining 182 facilities. Surprisingly, already 36 percent of the facilities received a blue or green rating, despite the prevailing weakness of enforcement. By September 1996, non-compliant plants accounted for 47 percent of the total. This was a significant improvement over a short period.

This case illustrates the potential of capital and information markets with reputational incentives.

For the US, Khanna and Damon (1998) examine the motivations for participation in the Voluntary 33/50 Program and the impact on the toxic releases and economic performance in the US chemical industry. They found that the benefits due to public recognition and the potentially avoided costs of liabilities and compliance under mandatory environmental regulation provide strong incentives for participation. Other conclusions were that the participants also reduced strongly their other releases and that the negative impact of the Program on the current return on investment was small but significant. Its impact on the expected long run profitability of firms was positive and statistically significant. Similar findings were presented by Arora and Cason (1995).

The 33/50 Program is not the only specific program in the TRI. Another category is the OSHA Carcinogen Releases. 164 chemicals were designated as carcinogens based on criteria set forth in the Occupational Safety and Health Administration’s Hazard Communication Standards. Some of these chemicals, such as benzene or asbestos, are known to cause cancer in humans. Others are suspected to cause cancer in humans because they have been shown to cause cancer in laboratory animals (EPA, 1997)

When analysing the impact of the TRI Program, we should also consider the lowering of the thresholds for reporting to the TRI. Since 1989, a facility must report to the TRI if it manufactures or processes more than 25000 pounds or otherwise uses more than 10000 pounds of any listed chemical during the calendar year. The manufacturing and process thresholds began at 75000 pounds for 1987 and dropped to 50000 pounds for 1988. These threshold changes clearly have impacted the TRI data between 1988 and 1989, but would not affect data after 1989.

For our analysis, year-to-year comparisons must be based on a consistent set of chemicals to assure that changes in total releases and transfers do not simply reflect the addition, deletion, or change in definition of reportable chemicals from one year to another. EPA recognises this problem and therefore included in the TRI a list with the releases of ‘core’ chemicals. These chemicals were already in the first 1987 TRI and remained in the list until now. The definition of the chemical also remained unchanged. In our analysis, we worked with this ‘core’ list.

From 1988 to 1995, total releases of core chemicals decreased by 1.35 billion pounds, a 45.6% decline. Table 3 compares the TRI data for 1988 and 1995.

For the US, we want to link sectoral data on chemical releases to sectoral data on pollution abatement expenditures. We will work with core chemicals to enable year-to-comparisons.
Table 4 gives an overview of the sectoral core emissions as a percentage of total emissions. It is clear that in many industries, the releases of core chemicals account now for only a very small part of total emissions. Since the core chemicals were among the most targeted chemicals in 1987, this trend illustrates that current emissions with less core chemicals are probably relatively less detrimental for the environment and human health.

Table 3 - Comparison of TRI releases* (in pounds), 1988-1995

Releases	1987	1995	% change
Total air emissions	2 176 711 749	1 172 650 647	-461
Fugitive air	679 933 826	302 209 786	-556
Point source air	1 496 777 923	870 440 861	-419
Surface water	164 466 515	35 794 255	-782
Underground injection	161 939 132	136 751 624	-156
Releases to land	459 231 827	265 251 632	-422
TOTAL	2 962 349 223	1 610 448 158	-456

Source: EPA, 1995 TRI Public Data Release, p.118 / * note: only 'core' chemicals

Not every industry could reduce its releases of core chemicals by the same percentage as the food, tobacco or stone, clay and glass industry. This does not mean that these industries are the pollution abaters *par excellence* because the toxic releases differ strongly among industries and the technical possibilities to reduce releases are not everywhere the same. Another possibility is that the first TRI did focus strongly on industries like chemicals, primary metals and paper so that cleaner industries like food and tobacco were no priority at the time.

3.2 Marginal abatement cost

In the further analysis, we will work with the 16 industries for which core releases in 1995 still account for at least 60% per cent of total releases in 1995. For these industries, we calculated for each year the reduction in core releases (in pounds). These reductions are the result of pollution abatement efforts.

Table 4 - Emissions of 'core' chemicals (in pounds) by US industry, 1988-1995

SIC	Industry	Core Rel.,1988	Core Rel.,1995	Total Rel.,1995	Core/Total,1995
20	Food	7288468	5281131	86012864	6%
21	Tobacco	341927	95226	1747616	5%
22	Textiles	34153528	14990080	17765609	84%
23	Apparel	922129	1232144	1259182	98%
24	Lumber	31049580	29497347	31289208	94%
25	Furniture	61362570	40711615	40961204	99%
26	Paper	201458920	176175802	233225214	76%
27	Printing	60694291	31375373	31625355	99%
28	Chemicals	979850322	492004551	787752210	62%
29	Petroleum	67649305	40189664	59943433	67%
30	Plastics	146534545	100928021	112218977	90%
31	Leather	11927916	2649261	3069489	86%
32	Stone, clay, glass	23923302	12647514	36042468	35%
33	Primary metals	471663856	291696854	331199802	88%
34	Fabricated metals	130536711	78244699	82585482	95%
35	Machinery	59463237	19293375	23159469	83%
36	Electric. equipm.	115408046	23444714	30488646	77%
37	Transportat.eqm.	188629628	104852457	110017733	95%
38	Meas.&phot.eqm.	47209809	12201793	16866015	72%

Source: EPA, 1995 TRI Public Data Release, p.28

But since most industries experienced an important expansion over the period 1988-1995, most reductions of releases are achieved while output and the number of facilities increased. Therefore, we corrected sectoral reductions of releases for output growth by means of quantity indices for GDP by industry (1992=100), taken from the Survey of Current Business (Nov.1997, Vol.77, Number 11).

For each sector, we then collected total pollution abatement costs (capital costs and operational costs). Data were taken from the US Bureau of the Census and Survey of Current Business. These abatement costs were made to reduce all releases; the 'core' releases and the more recent chemicals in the TRI.

By dividing for each year and for each sector the pollution abatement expenditures by the reductions of releases (in pounds), we find the average abatement cost per reduced pound of toxic releases per year. These calculations include operational costs that are for a significant part the result of past investments in pollution abatement equipment. New reductions are probably the result of new investments and new operational efforts. We therefore calculate the annual marginal abatement costs per pound reduced releases as:

d(PAC)/d(core releases) = d(PAC)/Reductions.

The results for 8 industries are presented in figure 2. Contrary to the standard assumption used in many models and in most textbooks, we found that the marginal abatement costs for reducing toxic releases by industry in the United States were not increasing for these industries. For the other industries, marginal costs were relatively stable.

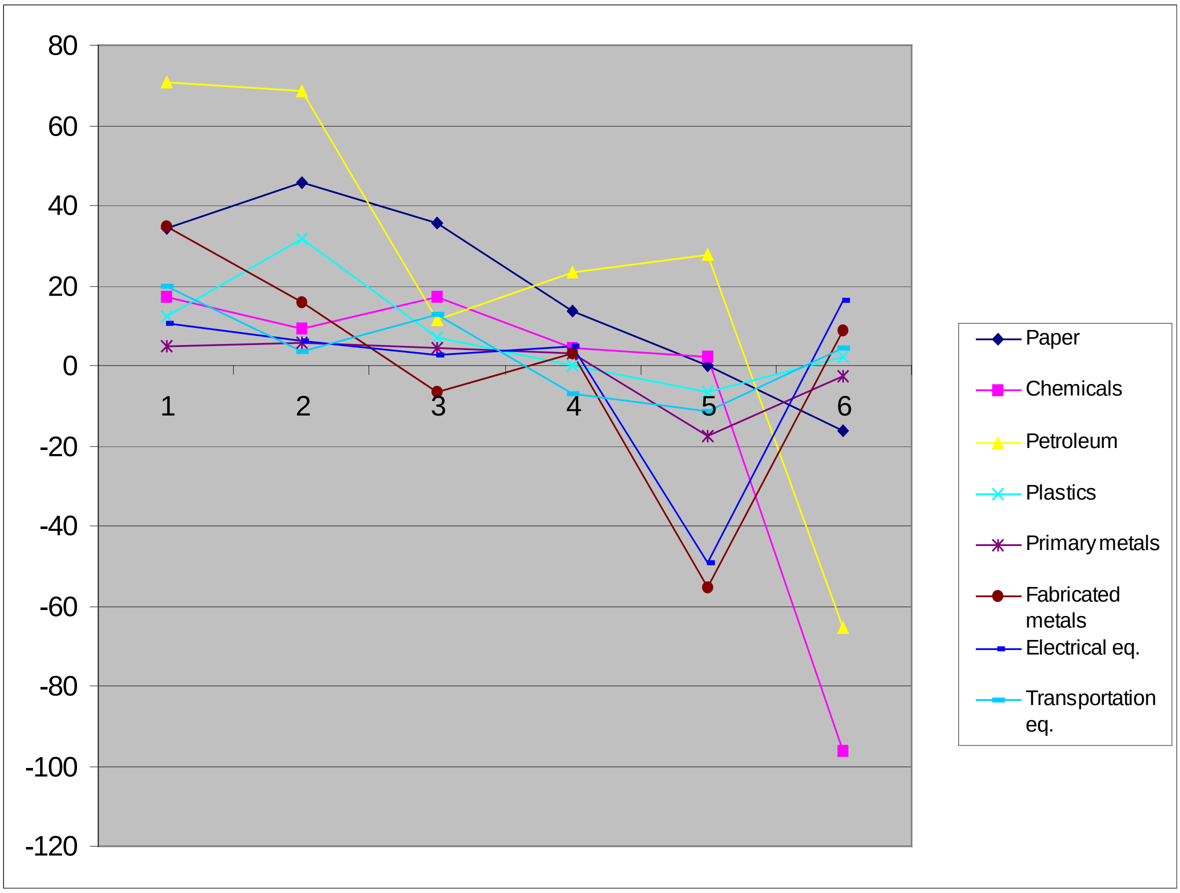
While marginal abatement costs (MAC) per reduced pound of releases were positive for most sectors for the period 1988-1991, we found for 1992 negative marginal abatement costs for industries like plastics, primary metals, fabricated metals, electrical and transportation equipment. In 1993, also the chemical and petroleum industry showed negative marginal abatement cost for reducing core releases. These negative values for MAC indicate a reduction of releases while for the same period the investments and operational costs for pollution abatement are also reduced. Again, since the used abatement costs were also made to reduce other than core releases, the actual costs of reducing core releases are even lower.

These results are of course depending on data for a limited number of industries. The validity of the results depends on confirmations by other surveys and business cases (see section 3.3). We already mentioned that table 3 showed a reduction by 45.6% for total TRI releases for the period 1988-1995 and this is of course an average reduction. The most efficient firms with the best environmental programmes did perform much better.

We also want to emphasize that figure 2 is a registration of abatement costs for a limited period. Since the scoreboard of reduced emissions is already impressive for the first years of the Toxic Release Inventory, opportunities for reductions for the coming ten to twenty years might shift to other, less toxic areas like organic compounds, smog, dust, soot, ...

In a next section, we will analyse some developments of toxic releases at the plant level. We will show that the reductions in releases for the last ten years are very impressive. We will also give some examples of companies that could reduce emissions and abatement expenditures, what results in negative marginal abatement costs.

Figure 2 - Marginal Abatement Cost ($) for reducing toxic releases (pound) by US industry (1988-1993)



3.3 Reductions of releases by selected companies

3.3.1 BASF Antwerp

BASF Antwerp is an important subsidiary of the BASF Group. In its environmental report for 1996, we found data on production, emissions and environmental expenditures. The most important conclusion is that the total absolute environmental impact of BASF Antwerp was reduced from 17 698 tons in 1985 to 10 048 tons in 1996, a reduction of 43.3%. For the same period, production increased from 3 595 mln tons to 9 027 mln tons, an increase by 151%. Corrected for this increase in output, the relative environmental impact decreased form 4.92 kg per produced ton in 1985 to 1.11 kg per produced ton in 1996, a reduction of 77.5%.

We used data on environmental costs (operational costs and investments) to calculate the marginal abatement costs of reduced emissions for the last years. Firstly, we corrected the absolute emissions for the increase in production. We found that emissions were reduced by 1547 ton in 1994, by 1115 ton in 1995 and by 395 ton in 1996. The positive reductions developed in a period during which

BASF Antwerp first reduced its environmental costs in 1994 - compared to 1993 - and but then clearly increased its environmental expenditures.

As a result of this reduction in environmental costs in 1994, we found for that year a negative marginal abatement cost of -617 970 BEF per reduced ton emissions. For 1995 and 1996, we found respectively 771 000 BEF and 1 572 000 BEF per reduced ton emissions.

Also of interest, the environmental charges and taxed paid by BASF Antwerp increased from 133.6 mln BEF in 1993 to 204.3 mln BEF in 1996, an increase by 52.9% while emissions where strongly reduced (BASF, 1997a).

For the BASF Group world-wide, we found some other illustrations of excellent environmental performances:

- Chattanooga, USA: 70% reduction of styrene in offgas wastewater ;
- Ludwigshaven, Germany: 90% reduction of atmospheric emissions of nitrous oxide;
- Schwarzheide, Germany: 50% reduction of the nitrogen load in wastewater ;
- Seal Sands, UK: 95% reduction of VOC and CO emissions.

The operational costs for the BASF Group's environmental protection facilities amounted to DM 1 621 million in 1996. In the same period, DM 233 million was spent on capital expenditures for environmental protection. Research into eco-friendly products and processes again required a high level of financing. In the last 5 years, BASF has invested world-wide DM 1.85 billion in environmental protection facilities (BASF, 1997b).

3.3.2 Solvay

Solvay's unified and verified emissions reporting system SERF (Solvay Environmental Release File) covers the emissions of the 94 Solvay plants across 17 countries. In the last consolidation in 1997, figures from 1988 to 1996 were given. While production increased by 17%, the weighted index of air emissions was reduced by 42%. For volatile organic compounds (VOCs), the reduction was 54%, and emissions of heavy metals and sulfur dioxide were both reduced world-wide by 37%.

For the same period, the weighted index for water emissions has fallen by 77%. The reduction of 'priority substances (excl. heavy metals)' was even 91%.

Concerning waste, the quantity of waste classified as hazardous disposed of away from the production site has dropped by 46% since 1988. The chlorinated organic residue internal 'full-recovery' progamme was successfully implemented with a recovery rate of 100% (Solvay, 1997).

3.3.3 ICI

In its 1997 Safety, Health and Environment Performance Report, ICI states that the company remains close to the goal of total compliance with local regulations and emissions consents, wherever ICI operates. For air emissions, the compliance rate in 1997 was 99.5%, for water emissions it was 99.1%.

ICI developed an own scientific method to measure optimally the environmental impact of its activities. Even for the short period from 1995 to 1997, the improvements on specific fields are impressive:

- acidity to air and water, down 42% ;
- hazardous air emissions, down 37% ;
- aquatic oxygen demand, down 31% ;
- aquatic ecotoxicity, down 28% ;
- ozone depletion, down 31% ;
- photochemical ozone creation, down 23% (ICI, 1997).

These reductions prove that even in the late 1990s, firms can still further reduce already low levels of emissions.

4. Conclusions

We presented two cases of successful realization of environmental objectives. Industry took up its responsibility in voluntarily phasing out the production and use of CFCs and in reducing toxic releases in the US. There are however clear differences. In the case of CFCs, the complementarity of pro-active national strategies for the CFC-using industries proved to result in comparative advantages for the US and Denmark. It is understandable that these countries favour a strict implication of the Montreal Protocol.

In the second case, our analysis showed that many industries could reduce emissions at a low cost. But probably this was not the motive to invest in pollution reduction. Pollution data are available for everybody in the US[3] (and to a limited extent also in Indonesia) and this is in sharp contrast to many European countries. This availability of data makes it possible to identify the biggest polluters and suggest the link between pollution and health problems in the surroundings of the facility. We can assume that pollution reduction was an option to avoid costs of liabilities in the future. The implementation of a system like TRI could therefore result in different reduction patterns in other countries.

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[3] On the EPA Internetsite (<http://www.epa.gov>), it is possible to make a search for the release of each TRI-chemical for each company that has to report to the Environmental Protection Agency.

In the two cases, there was a clear threat that could contribute to the success of the agreements with industry. The Montreal Protocol did foresee trade sanctions in case of non-compliance and in the TRI-case, future liabilities could turn out to be more expensive than investments in pollution control. We should also mention that the targets in both EAs were not determined by industry but by governments at international conventions or by government agencies.

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Onderzoeksproject HL/DD/004

Internationale Economische Orde : Opportuniteiten en Beperkingen voor een Belgische Milieufiscaliteit

(olv. Prof.Dr.M.De Clercq)

Tekst bij

Deel A. Analyse van de internationale economische orde ; laat deze een kleine, open economie voldoende beleidsautonomie om een gerichte milieu-fiscaliteit uit te bouwen?

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Green Policies -
from ecotaxes to extended producer responsibility :
an institutional search for policy autonomy starting from the EU and WTO frameworks

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Content

Introduction

Regarding national policy autonomy, the increasing number of regional and international agreements is expected to influence national policies. This impact can range from trade policy to other important aspects of economic and industrial policy. For the Member States of the European Union - still the most succesful example of international political integration - , one could therefore expect a framework that clearly distincts national powers from supranational powers. This expectation might be one of the consequences of the recent subsidiarity debate and the discussions on the many possible meanings of this concept. Another factor is the ever widening range of domains and competences that the European Union is working on (Eur-Op News, 1997). For the future, new European policies are expected.
At this moment, it still remains an open question whether the European Union can establish an industrial, economic, fiscal, environmental, monetary, transport and social policy - see the renewed Article 2 - or that these competences will remain a strictly national occupation? In our overview of the European Union (EU), we will focus on environmental and commercial policy.

National policy autonomy is much more than the result of a division of powers. Autonomy is an evidence like national sovereignty. Next to specific limitations following international agreements (like the Montreal Protocol or CITES), all national states will always have the unlimited power to develop a specific policy that targets very national ambitions. But when the introduction and the application of these national policies can have consequences for other countries that are not in line with the principles underwritten in supranational agreements (like GATT/WTO, EU, NAFTA, CITES, Montreal Protocol,...), these national policies can be challenged for reasons of de jure or de facto discrimination. As a consequence, violation of international agreements - that have been signed and ratified voluntarily by the country - can result in clear limitations of policy autonomy.

We will work on the interactions between environmental, economic and trade policy. Environmental policy should have the aim to conserve and protect natural endowments and has many different aspects and possible applications, depending on specific situations and needs. Trade policies are introduced to stimulate free and fair trade to improve economic efficiency of transactions and wealth-creating processes. In many cases, the practice of trade policy is directed at removing existing and possible trade barriers, mostly linked to specific national regulation.

We will not discuss the validity of trade theories that feed most trade agreements, but we will focus on the possible trade impact of environmental policies. The word 'impact' could sound negative or detrimental in terms of environmental hindrance for wealth-creating trade flows. But the establishment of free or common markets for goods and the protection of the environment do not necessary contradict each other per se.

Trade is an instrument for the optimal allocation of production resources. The protection of the environment, particularly in terms of the concept of ‘sustainable development’, aims at the maintenance of an ecological equilibrium in the interest of a balanced long-term growth in terms of consumption and production. Environmental policy works at the preservation of natural production factors for future generations and can be a necessary condition for future allocation patterns. As such, the two policies can similar objectives..

As already suggested, an environmental policy can introduce measures that could discriminate foreign exporters. Examples of such measures are the designs of green taxes, take-back obligations for all producers, specific prohibitions for certain products (some of them based on the conditions of production), recycling content obligations, green labels, green subsidies for domestic firms, voluntary agreements between industries and other involved parties, technical standards and testing procedures that are more difficult for foreign exporters,...

Depending on the environmental objectives and the specifications of these instruments, the environmental protection can create a trade barrier and this practice could then eventually be challenged by foreign competitors. As a result, national environmental policies could be stopped or strongly modified.

These scenarios with conficting trade and green interests are problematic because they might slow down some of the urgently needed environmental protection programmes. Therefore, policy makers should work out green programme specifications that make complaints and litigations from possibly discriminated parties ‘hardly impossible’.

A transparent environmental policy with clearly formulated ambitions and instruments, with a consultation round for trade partners and related international organisations (EU, WTO), with clear provisions for harmed trade partners (especially from less developed regions) and of course with de jure and de facto neutrality, has a very good change of becoming internationally accepted and even supported by complementary initiatives in other countries.

National policies should as such not be undercut by international agreements but should foresee possible interactions and consequences and beware possible litigations. Therefore we will study the international economic order that should shape these national policy frameworks. We will try to make a global analysis that is more than the aggregate of some specific cases because market conditions and environmental needs change over time, as well as their perception by citizens and public authorities.

Globalisation is a process ; so are environmental concerns and priorities and the efforts to find an appropriate equilibrium between market needs and the environment.

Why using market-based instruments in green policies?

Like recent medical practice illustrates more and more, for very complex diseases the best therapies use cocktails of medicines instead of just one antidotum. Environmental problems are very complex and diverse and cannot be treated by a standardised approach. Each approach has to be very specific and take care with local conditions. Considerations on costs are also shaping green policies. Inflexible command-and-control regulations are considered as more costly compared to flexible market-based instruments (Hanley, 1997). This latter category of instruments will therefore gain importance especially since designing new policies seems to be closely linked with considerations on international competitiveness (WTO, 1997).

Environmental policies in the late 1990s therefore use a multitude of instruments - environmental regulation next to market-based instruments - that are very flexible and case-depending.

The use of economic instruments is however still a recent trend in environmental policy making. They have the clear advantage that they make it possible to confront producers and consumers with the (external) consequences of their production and consumption behaviour. Correct price signals can motivate producers to alter their production processes and adapt to new priorities. Entrepeneurial dynamism and goodwill are crucial in the struggle against environmental deterioration because for most (but not all) problems there is at the moment a technological solution that just needs some improvements to be applicable, affordable and diffused on a large scale.

With a government that limits its policy to prohibitions (traditional command-and-control approach), without economic instruments that involve the dynamics of the business community, many possible solutions may not be elaborated. Similarly, the forced imposition of one specific technology - even when it is the best available at the moment - will reduce the attractivity of further R&D in this area. Fixed regulation also risks significant pressure group influence that is motivated by static analyses mainly in the field of international competitiveness and the doubts on the instigating role played by smaller countries.

We should also keep in mind that environmental problems stem from failures within economies and economic transactions. If transactions on markets for goods, services and factors create the problem, market-based measures can be a part of the solution.

In the coming sections, we investigate the installation of a programme of green taxes. Since these programmes make use of many related instruments like labels or take-back obligations, they can provide us a general view on interactions between green policies and trade objectives. Member States can work out autonomously these programmes, but in accordance to existing European prescriptions.

Internalization

Environmental programmes that make use of economic instruments have the aim of internalising the full environmental cost of a product into the product's shelf price. This internalisation should take place not only during the manufacturing process when natural inputs are used or when certain emissions take place, but also at the end of the life-cycle. Costs born by the municipality and other authorities that take care of post-consumption waste disposal, should become part of the price paid at the point of retail and should not be covered by local taxes (COM(97)9).

Introducing take-back obligations for producers might be a strategy that assures full cost pricing at the retail point. Another strategy might be the introduction of green taxes on waste disposals or on products that have a significant environmental impact.

A combination of both strategies - completed with other instruments - can be found in policies that use green taxes and provide exemptions when producers alter their behaviour into the preferable environmental direction, for instance by organising a take-back programme for the total sector. These taxes are currently used in Belgium.

As a result, producers will have to manage a new set of business issues. The design, type and weight of the packaging and the recyclability of all the materials used will become very important and can influence manufacturing and design. On the short term, producers will face additional costs. Therefore, resistance has to be anticipated by law-makers. On a longer term, a new competitive dynamic has to be initiated by manufacturers. Price-cost structures and market positions will change. New competitive advantages can be the result of small but fast design adaptions or efficient take-back initiaves.

Local business and national government can and will work together in many of these new environmental areas. For many issues, like packaging waste, the supranational level is of equal importance. The European Union (EU) for instance has recently passed a Packaging directive, requiring take-back throughout most of the Union by 2001 (Eur-Op Info, 1997).

The mechanisms used in the many countries differ to a great extent in scope and application, but when it comes to post-consumption initiatives like take-back and waste programmes, we can find some clear points of correspondence.

Firstly, no programme explicitly discriminates against imports.

Secondly, participation in private (take-back) systems is voluntary and not obligatory.

Thirdy and of crucial importance, most of the decisions directly affecting producers are made by a private or semi-private collection organisation and not by the government (Krämer, 1997). If this private organisation acts as a monopoly or has great market power, motivated by scale economies in the collection and treatment of waste, then private decisions can take the force of national law. Potential trade barriers resulting from the practices of these private organizations are as such not the result of specific government action. The question is then whether governments are still responsible and who should be litigated by potentially discriminated trade partners (in EU or WTO Courts).

These legal implications and the success of environmental programmes and strategies depend on international policies and programmes at the European and GATT/WTO-level. We will start with a survey of these two international agreements and look for the balance between environmental protection and objectives like free trade, the common market and undistorted competition.

Part I European Union

From the Treaty of Rome in 1957, the European Community, part of the European Union, has as its most important objective the establishment of a common market for its Member States. Therefore, any possible restriction on free trade and undistorted competition has been or will be removed.

The objective of the Community has been clearly reformulated by the Single European Act (SEA), the Maastricht Treaty, the Amsterdam Summit (June 1997),... and consists now of more than the establishment of the common market.
Since Amsterdam, the new Article 2 reads :
'The Community shall have as its task, by establishing a common market and an economic and monetary union and by implementing common policies or activities referred to in Articles 3 and 3a, to promote throughout the Community a harmonious, balanced and sustainable development of economic acitivities, a high level of employment and of social protection, equality between men and women, sustainable and non inflationary growth, a high degree of competitiveness and convergence of economic performance, a high level of protection and improvement of the quality of the environment, the raising of the standard of living and quality of life, and economic and social cohesion and solidarity among Member States (CONF/ 4002/97, CAB, EN4).'
This Article refers to the new Article 3d in the Treaty that reads (and deletes the last sentence of Article 130r(2)):
'Environmental protection requirements must be integrated into the definition and implementation of Community policies and activities referred to in Article 3, in particular with a view to promoting sustainable development'.

It is striking how many times we find the word 'sustainable' in the two Articles, next to a great number of other ambitions like EMU and employment policies. The Community has clear ambitions to improve the environmental situation in Europe. The future will learn us whether these ambitions are more than intentions on paper.

When we look at the European budget, there seem to be clear opportunities to channel money to the new objectives of Article 2.
Considering the accounts for 1997, the Common Agricultural Policy costed 41.1 billion Ecu what accounted for 46.5% of the total of 88.2 billion Ecu. If we add fishery policy and agricultural actions in the structural policy and in the intern and extern actions of the Community, this percentage adds up to

52.5% of the total budget. This is in very sharp contrast to the importance of the agricultural sector in the European economy.
Structural policies attracted 35.6% of total means, external policy 6.3%, the administration 3.1%, reserves 1.3% ... (EC, Algemeen Verslag over de werkzaamheden van de Europese Unie 1997, p.397 ev).
It should not be a surprise that 'Environment' received only 0.132 billion Ecu, a modest 0.15% of the total budget. If we relate this to the most conservative estimates on actual and expected environmental employment in the EU - at least 1% of the total European labour force is directly or indirectly working in the area of environmental conservation -, more funding in the environmental area could be a interesting element of employment policies (EU, Werkgelegenheid in Europa, 1995).
Other priorities like industry, trans-European networks, internal market, information technologies,... also received unsignificant amounts.
As a conclusion we might state that a reallocation of the Community budget could make certain policy objectives - like the integration of environmental protection - possible, at least when it comes to the financing of these objectives.

But the ‘integration of environmental protection’ should not be compared to designing environmental policies in existing free trade frameworks. Environmental policies always had to be integrated in other policies and we will present an overview in the coming sections.
Integration means here that when designing other policies, all key policy initiatives should integrate concern for the environment. This means that instruments like environmental impact assessments will become crucial determinants in investment issues for transport policies, industry and commerce. At the recent Cardiff Summit, it was decided that Member States had to identify a set of environmental priority actions and foresee effective mechanisms for monitoring their implementation (Eur-Op Info, 2/1998 + COM(98)333 fin). In a following phase, these environmental priorities will be included in other policies. As a consequence, only new European policies will in the future integrate environmental concerns, assuming that the integration will be a success. But trade and competition policy are, next to energy policy, the most crucial policy sets that can interact with environmental protection. And can we expect significant changes in European trade policy? Could trade policy be reshaped by environmental considerations? Notwithstanding the question whether this would be a desirable development, there is only a very small chance because free trade and undistorted competition are also the fundamentals of the world trade system institutionalised into the GATT/ WTO.

Critical 'EU-watchers' have serious doubts when it comes to the integration of environmental considerations in other European policies. Environmental policies are by nature already closely intertwined with other policy objectives (transport, health, stocks of natural assests,...) and this limits the

possibility for 'stand alone' policy making and autonomy.
Integration already existed in one direction : adopting environmental policies and instruments to other policies. In the next section, we will study the degree of success of this integration. Future actions will focus on the other direction : adopting other policies to environmental policies.
The focus on integration in European environmental policy has an interesting potential but we still have to ask the question whether existing environmental policies have been successful. And this does not seem to be the case on all domains (see the Dobris Assessment (EEA, 1995) for an overview).
We would like to stress a few related points of which some were also suggested by Ricardo Petrella during a conference on the Community's Environmental Policy in Brussels (October 17th, 1997) where he talked about the modest realizations of actual and future European environmental policies.

Among the problems for European environmental policies we find :

- too many ambitions : any policy framework includes a number of choices and excludes many other options. Article 2 takes together a harmonious, sustainable development, a high degree of competitiveness and convergence of economic performance with a high level of economic protection; all elements of a green diamond.
This convergence of objectives will depend on the workable interpretation of the concepts and on various time-scenarios. What is a high degree of competitiveness compared to the actual economic situation in the Union? Some countries are clearly first-class world competitors and finance through the European financial canals poorer Member States. This situation can change but next to the fact that the financing Member States discuss their net-contribution to the Union, do we have to develop different environmental ambitions for the different countries? After all, national environmental priorities do vary. But this could result in different prices for environmental inputs and can one internal market for the EU be based on different allocation and price schemes? Is this a probleme or is it the mere consequence of differences in comparative advantages?
Suppose one specific European country wants to go much further in environmental protection or conservation, making use of fiscal instruments like higher excise duties on mineral oils. Is it acceptable that this country could be stopped by the unanimity rules on fiscal affairs, or not? Especially in the EU, environmental ambitions also need to deal with political decision procedures next to all the other considerations.
This unanimity rule also influences the convergence of environmental objectives in the EU to a very significant extent. A good illustration is the European CO_2 - and other greenhouse gases - reduction proposal of -15% for the European bubble in 2010, presented at the Climate Conference in Kyoto (Dec.1997). Next to the proposed reduction of greenhous gas emissions for the EU bubble, national reduction targets ranged from -25% (Denmark, Germany) to +40% (Portugal). As could be expected,

this was a proposal that received a lot of criticism from developing countries.

So we had a ‘reduction’ proposal for the EU but in fact only a few countries were demanded to invest in emission reduction. We can then interpret it as a partial proposal. But was it a bad proposal for the environment because many countries could delay any investment in energy savings and emission reductions, or was it a proposal that optimally made use of great potentials for reductions in specific countries? If it were the case that in the countries with highest proposed reductions the costs were much lower than in other countries, the proposal was not bad at all. It then just made use of market and cost opportunities.

But if we then analyse the growth of gross inland energy consumption in 1995 (Eurostat Energy Balance Sheets 1994-1995), we find an average growth of 3.6% for the EU. The growth was highest in Denmark (+13.8%), Sweden (+12.6%), Finland (+10.3%), Belgium (+6%) and the UK (5.6%) while Portugal (-3.6%), Spain (-3.8%) and Italy (-0.7%) saw a decline (Eurostat, 1997). The obvious link between energy demand and CO_2-emissions make the European consensus not that convincing.

Unfortunately, extreme unemployment rates in Southern Member States and the right to 'develop' the same energy-consuming pattern like the more prosperous states - a right closely linked to their veto - makes the focus on competitiveness necessary. This can delay the design and the implementation of EU environmental policies even if some important countries want to go much further. As a result of the European integration, the ‘European competitiveness’ becomes a common good that influences the design of other policies...

Furthermore we don't think the EU can develop now policies that will only be implemented when market conditions or employment situations in some countries improve. For implementing the Kyoto Protocol that foresees a first evaluation already in 2005, significant actions are needed now. But again, it shows to be problematic to work out actions for the EU as a whole. Policies need to be kind of tailor-made because otherwise countries like Spain refuse collaboration. Even if we foresee transitional periods (like for the “Auto-Oil programme”, DGXI Press Releases, 1998) and support by the Cohesion Fund, it will be hard to develop now effective policies that will be applied by these countries a few years later than in other countries.

So what we have is a strongly criticised proposal - it is de facto only a partial proposal - that makes it now necessary to develop measures that are also accepted by the countries that refused to engage into the initial proposal. If only 10 or 12 of the EU Member States were involved at some EU-10 or EU-12 proposal for Kyoto, it was now possible to develop measures that only needed the support of these motivated countries.

In the near future, a gradual implementation procedure with a core-group of Member States that takes the lead, might be considered as a valuable alternative. The possible enlargement of the Union will sharpen this problem.

To conclude, it is clear that the EU faces many problems when implementing environmental measures.

These limitations should encourage Member States to develop themselves new national programmes. Waiting for European solutions could take too much time. It is therefore illustrative that since the Rio Conference (1992) many Member States work already many years on regulations concerning fuel efficiency for cars. Substantial measures are not yet taken because almost every country sees this as a typical European competence and just waits for 'instructions from Brussels'.
After all, the European Commission states clearly that "the Member States have the major responsibility for meeting the Kyoto reduction target. The EU, as a signatory of and future party ot the Protocol, along with the Member States, has the responsibility to ensure that Member States' actions are consistent with the Treaty and that their obligations are met under the Protocol (EU, 1998)."

- ambitious programmes by important Member States with specific environmental priorities will be needed in the future. There might be some consequences of these practices. Petrella (1997) states that national initiatives could be seen as some kind of re-nationalisation as a result of the subsidiarity principle and of various structures and procedures that provide extended powers to Member States. He also claims that once Member States (MS) have installed own programmes and laws, their participation in future European projects might be uncertain and limited. Powerful Member States could as such influence the EU policy development. The institutionalised excape routes in the new Article 100a (see further) are a striking example.
We agree that some Member States can strongly influence EU environmental policy development. This can result in some rent-seeking behaviour if 'green funding' is scarce. But if some nations take the lead, this has the clear advantage of diffusing environmental priorities, new instruments, scientific information and experiences. Weighted against the problems associated with developing measures at the EU level, specific problems could be best dealt with by the MS. This is not a tendency against the European integration process but the consequence of the need for an effective strategy.

- <u>eco-technocracy</u> : actual and future environmental problems can only rarely be tackled by available end-of-pipe solutions. Many problems are complex and need very specific regulations that makes it difficult to develop generic policies. Policy makers are in most cases depending on information provided by polluters. In most countries, environmental inspections are scarce so even enforcement policies depend on the quality of provided information. There are many types of waste and many possible treatments that are hardly comparable in terms of environmental impact. Just stating that the 'polluter must pay' is not enough. We will later discuss the problems associated with the introduction of environmental principles in environmental policy. Economic operators can use the complexity of the problems and can use their advantage in terms of information to delay progress.
The more ambitions that European policies have to fulfill - making use of more and more principles that might possibly conflict in their application - the greater the change that involved parties can stop the pace

by introducing complaints that result in time-consuming cases for the Court and secondary law that further complicates the situation. For example, a simple instrument like an ecotax has to include a multitude of considerations and even then, future developments in the common market can make it inapplicable due to conflicting interests.

- implementation problems : it should be no surprise that regulations are in many cases translated with great delay into national legislation. Some MS even never start with the implementation of certain directives. At the end of 1995, 133 environmental directives were applicable. Denmark and the Netherlands had notified measures for 131 of them, Germany and Ireland had measures for 127 directives, France had measures for 126 directives... Three countries had measures for less than 115 directives : Finland (114), Italy (113) and Belgium (111) (Micosi, 1996).
These differences in delay depend mainly on capabilities and experience but also to a large extent on goodwill. The growing number of Member States increases the average delays and linguistic problems (not every Member State translates and interprets 'polluter pays' and 'sustainable development' the same way).
Next to the dependence on national goodwill, it is striking that the legal affairs department of the Commission that should supervise correct and adequate implementation is deprived from sufficient human and non-human resources to function properly. Without an effective implementation, ambitious policies and principles will not work (Rhiannon Williams, 1997).

- stakeholders' interests : the Commission consults many involved parties before a policy will be designed. This is a condition for a later succesful implementation but it risks to introduce non-transparent and non-democratic policy mechanisms. The European Parliament should control the process of policy-making instead of giving opinions on implementation issues once the policy in introduced. Another problem is that the Commission might spend too much time in consultation rounds and faces evolutions like growing concern on competitivity and employment, institutionel effects of future enlargements, influence by stakeholders and eco-technocracy.

- the importance of European competitivity needs no further explanation. The European Union has to create a great common market to provide equal market-opportunities for European-based firms compared to their American and Asian competitors. Market-integration is the principal priority of the European Commission. A competitive market will make any environmental barrier to trade or competition very problematic. This focus on free trade and undistorted competition makes it difficult to introduce economic, social, industrial or fiscal policies on a European scale. These policies can induce financial transfers that can disturb competition. Even structural funds for poor regions have to be carefully allocated in order not to disturb competition. If there is no perspective for a European economic, social or industrial policy - without valuing the need for these policies - , can we really expect that an environmental policy can be introduced in this market-doctrine? Here I would like to come back to Petrella who cited Helmut Kohl (October 1997): 'In the actual global context, there are simply no possibilities to introduce a European common economic policy. It seems that the only available alternative is the introduction of national policies of competitivity.' Every country has to solve its own problems, there is no European solution and the common market cannot be disturbed by national regulations and measures..

The future of common environmental policies at the EU level is as such rather uncertain. National initiatives like green instrument programmes are needed.

It is of course easy to state that European environmental policies might not be that effective. This impression can be the consequence of the ambitions and expectations that are always higher and more complicated (like in the new Article 2). This make criticism rather easy. One should however look at environmental data to judge (see the Dobris Assessment). Then we might conclude that the objective of the common market clearly created growth but at the same time many environmental problems still need a solution.

The Commission is aware of many of these problems and has the merits to foresee reviews on the Fifth Environmental Action Programme (5EAP, see later). The European Environment Agency contributed in 1995 to this review with a report (Report for the review of the Fifth Environmental Action Programme) edited by Keimpe Wieringa (EEA, 1995).

The main conclusion is that the Union is making some progress in reducing certain pressures on the environment but this progress is not enough to improve the general quality of the environment and to ensure a sustainable development. Accelerated policies are necessary and current actions will not lead to full integration of environmental considerations into economic sectors. Transport appears to be a key sector on which to focus future policy.

In the beginning of this section, we started with the new Article 2 that stated that environmental considerations need to be integrated in all policies. This new Article seems to be inspired by the review of the 5EAP. But if a succesful integration in new policies will become possible, many environmental problems will remain like we have already stated. The commom market will limit the potential application of environmental instruments and the focus on European competitiveness will limit the European environmental policy to a policy of integration in other policies.

On July 11th 1997, the Commission issued a press release stating 'Commission renews its environment commitments'. The press release included various elements ; measures are environmental appraisals of proposals by Directorates-General at an early stage in their development, sectoral policy statements by each DG on the environment, reporting on integration and implementation of measures, green stars in Commissions work programmes when a detailed assessment of environmental consequences is required, environmental integration correspondents in each DG, a general 'greening' of the budget, green housekeeping in the Commission and training programmes on environmental appraisal and integration (Klatte, 1997).

This nice list gives measures that are rather internal - and that can be very valuable as such - but do not go to the core of the problem : how to consolidate environmental protection with the common market doctrine in times when international competititvity needs to be ensured?

Therefore, we first need to look at interactions between environmental protection in the EU and the ambitions or consequences of the common market.

The Common market and an integration policy

Resulting from the formulation of the common market ambition, a European integration policy was envisaged as the next phase. Too much regulatory and institutional differences (organisation of commerce and finance, labour conditions, border controls) between countries could act as trade barriers and create market fragmentation. A free market with undistorted competition was the final objective.

When regulatory differences exist and especially if they are intended by governments, the term regulatory competition is used. Different academic disciplines study this competition between market and social structure paradigms (Mc Cahery, 1996). Game theoretists worked out competitive processes involving strategical behaviour between different groups of players. This regulatory diversity has some clear advantages. In the global economy, it enables firms and citizens to make a choice (on consumption and production issues) among different national and regional systems. If people, goods and capital are highly mobile, they will value the best regulatory system and eventually relocate. Therefore, jurisdictions with ‘costly’ regulations may find businesses pressing to reduce their regulatory burden, when faced with competitors on third markets or with imports from less burdened regimes. Of course, ‘costly’ might mean ‘correct’ so many analyses depend on how to define the exact external cost. Higher external costs are the result of different natural endowments among countries and justify as such higher prices for natural factors. Reducing ‘correct’ environmental costs as a result of business pressures means a reduction in national wealth because the natural inputs are undervalued at the benefit of mainly foreign consumers (Bhagwati, 1997). This can create iterative processes of regulatory adaptations. In the worst case scenario, we can expect a general downsizing of environmental regulation. So if market forces make it impossible to (fully) capture externalities, the environmental damage could outweight all integration benefits. A realistic harmonization of environmental policies could therefore be a better approach to reduce differences in national regulation.

This integration can be reached by the creation of Community policies in certain areas, by the formulation of non-binding Communitiy communications, or can be stimulated by the approximation of national laws to the extent required for the establishment of the common market. By Article 100 of the Treaty, the Council can on a proposal from the Commission, issue directives for the approximation of laws, regulations or administrative provisions that Member States made as a result of an initial Council directive, at least if they affect the establishment or functioning of the Common Market (Lenaerts, 1995). This mechanism should have stimulated integration and harmonization but this practice was limited by some exception clauses and the unanimity rule (now replaced by qualified majority voting, QMV) that blocked many proposals in the Council or exluded some 'try-outs' by the Commission.
Authors like Pelkmans (1995) go even further and state that, 'when approximation did result in EC legislation, a degree of regulatory failure crept in because approximation was invariably interpreted as detailed and rigid harmonisation'.
Coming back to the exceptions, if a Member State deems it necessary to apply national provisions on grounds of major needs referred to in Article 36 (see further), or relating to the protection of the environment, it shall notify the Commission of these provisions.
This possibility is since the Amsterdam Summit in June 1997 clearly formulated in the fourth paragraph of Article 100a. The fifth paragraph of the same Article goes even further : '...(if) a Member State deems it necessary to introduce national provisions based on new scientific evidence...on grounds of a problem specific to that Member State arising after the adoption of the harmonization measure, it shall notify the Commission of the envisaged provisions as well as the grounds for introducing them (CONF/4002/97, CAB, EN71).' The Commission shall within six months approve or reject the national provisions. This period can be extended with another period of six months.
The final paragraph (ibid) states that harmonization measures shall, in appropriate cases, include a safeguard clause authorizing the Member States to take for reasons referred to in Article 36, provisional measures subject to a Community control procedure. The new Article 100a therefore foresees enough escape clauses for environmental priorities that would be endangered by harmonization and further integration.

Community policies, guidelines or harmonization?

To balance environmental objectives and the elimination of trade-hindering regulatory differences in Community policies, two approaches are possible.
The first is that the Community should establish basic principles (like non-discrimination) concerning the

application of national environmental measures, eventually with possible exceptions.
The second approach is the harmonization of environmental standards. Under the Single European Act, the existing set of competences was complemented by an explicit power to introduce a comprehensive environmental policy at Community level, but recently this approach came under growing criticism. The principle of subsidiarity and the actual competition among regulatory systems express a strong desire to limit the harmonization measures taken by the Community to those absolutely necessary (Ziegler, 1997). There are also strong environmental arguments because some Member States want to go further in their environmental protection compared to the protection that was envisaged by the Commission.

The Community showed a tendency to the first approach based on guidelines which allow for the application of domestic environmental measures and instruments at the national and regional level, without of course jeopardising the establishment of the common market.

GREEN TAX PROGRAMMES IN THE EU

Many European countries recently applied new environmental instruments or consider their future application. The environmental purpose is always rather obvious but many authors expressed their concerns when it comes to possible trade restrictive consequences.
In a growing number of cases, taxes on products - ecotaxes - are installed. They do not replace existing taxes on emissions, energy or water use. These ecotaxes can be conditional and mostly make part of a larger policy framework that also includes take-back programmes (maybe enabled by voluntary agreements between private firms or between public authorities and firms), recycling objectives or shifts towards greener technologies. Of course, also countries that have no green taxes (and do not want to install them in the near future) can have a take-back programme or a 'green technology' policy. For these countries the analysis of the ecotaxes, the main instrument in our survey, can be interesting because of possible future Community initiatives in other, related fields.

We want to answer the question which national ecotax programmes are compatible with the European Union Treaty, and which, by contrast, breach the rules of the Single Market? In an attempt to clarify this situation, the European Commission presented a communication on January 29th, 1997, setting out guidelines for Member States on their margin for manoeuvre in this field.
In the absence of relevant Community law (the second approach), national, regional and local entities are entitled to take necessary actions provided they do not jeopardize the Community legal order and, in particular, the establishment of the Common Market.

It is clear that the abuse of environmental measures for reasons of protectionism and deliberate trade distortions has to be avoided through the strict application of the Community principles. Nevertheless, the compatibility of domestic environmental measures with the basic freedoms and competition rules governing the common market and Community law in general must be interpreted in the light of the established principles of Community environmental policy and in view of the achievement of a high level of environmental protection.

Any domestic measure, this means not only green taxes and regulation that extends producer responsibility but also prohibitions, product standards and procedures, systems of permits, technological requirements,... should therefore consider the following basic principles :

-> no arbitrary discrimination and protectionism should be created
-> distortive actions and trade barriers are incompatible with the Commom Market
-> justified limitations on the free movement of goods are however allowed under specific conditions
-> domestic environmental objectives and evaluations should be clear and Member States should be granted sufficient discretion to elaborate an own national policy
-> reasonabless and necessity are essential for each measure
-> proportionality : the establishment of a balance between gains from trade and domestic environmental measures under the proportionality test.

Of course, these principles are based on a complete elaboration and are in many cases conditional with specific exceptions.
When it comes to green taxes, we have to study the recent communication by the European Commission : *"Environmental Taxes and Charges in the Single Market"* (COM(97)9)

1. Introduction

First of all, one should remember that the European Union, in its Fifth Environmental Action Programme and its 1996 review, clearly called for the exploration of new environmental policy instruments. Environmental taxes and charges form part of the range of environmental instruments and can be an appropriate way of implementing the 'polluter pays principle' (PPP) that was already adopted in the First Environmental Action Programme in 1973. This principle, in 1972 adopted by the OECD and by the EU, declares that the creators of environmental externalities, and they alone, ought to bear the costs of remediation. The potential of the PPP is impressive because if each trading countries adopted the Principle seriously, there would be no need for border tax adjustments ; every commercially traded item

would bear its full environmental price (Westin, 1997). The PPP is however only a statement of policy and the WTO did not yet consider it as a serious factor when evaluating trade disputes. Therefore, the PPP should have a complete legal elaboration.
In the EU, the ‘polluter pays principle’ is also introduced explicitly in Article 130r(2). Its legal consequences are still not that clear as it is much more an economic instrument which lacks legal force. According to authors like Krämer and Ziegler (p.127), the main problem with the PPP is that at the moment 'pollution' exists only if legal standards for limiting emissions have not been respected, i.e. if they are exceeded without permission.. If there are no standards in force, emissions into air, water, soil, and under the ground are lawful and therefore free of charge.

Currently, the polluter pays principle is also used in evaluating state aid. The PPP states that polluters and not taxpayers should pay for the recovery or prevention of pollution. Government subsidies to compensate for environmental investments therefore conflict with the PPP and are not legal, although some exceptions will be discussed later.

Green taxes are here taxes on products, in fact on the consumption of the product. Ecotaxes are not taxes on emissions. We do not need as such additional legal standards that enable legal force. It could be however that waste or emissions during the production process are partly responsible for the taxation of the product.
The tax is not a value added tax (VAT). The reason for the taxation is not the creation or transaction of a product with an economic value in the economy, but is more a consequence of the contrary. The production, consumption and post-consumption phase of the product (plastics, tires, batteries, oils, pesticides,...) create environmental problems that should be strongly limited. The green tax or ecotax is mostly expressed as a fixed amount (and not as a percentage) that should be payed in addition when the consumer buys the product, e.g. an ecotax of 10 Ecu for a car tire, 0.05 Ecu for a battery, 0.2 Ecu for a plastic bottle,...
Where it was appropriate in the harmonization approach, Community-wide rules have already been adopted to enable such green taxes for some energy products to be applied within the framework of the single market (e.g. excise duties for the taxation of mineral oils). Energy is an input of crucial importance for the European economy. Since the recent climate conferences, energy policy is closely linked to environmental objectives like reducing greenhouse gas emissions. Therefore, an energy tax can now be a green tax - especially if the tax is linked to a measure of the global warming potential (GWP) of the energy use - but we do not consider it as an ecotax on products.
For products, other than energy, the guideline approach should be best. In line with the principle of subsidiarity, an increasing number of national and regional initiatives in the form of taxes and charges are being taken to deal with local environmental problems, which often are more efficiently dealt with at the

local level.
Therefore the Commission deems it important to clarify the legal framework applicable for Member States wishing to introduce environmental taxes and charges. The framework is defined by the Treaty, secondary EC legislation, the jurisprudence of the Court of Justice, as well as the decisions and legal steps the Commission has taken to put this legal framework into practice.

2. Definition and legal context of market-based instruments

One likely feature for a levy or tax to be considered as environmental would be that the taxable base of the levy has a clear negative effect on the environment. In this case, environmental protection means the reduction of the taxable base by the application of instruments, here market-based instruments.
We should however remark that the Community institutions have never given a comprehensive explication of the term 'protection of the environment'. The Court has decided each case on its merits. This lack of a clear definition - a recurrent problem in European policies (see later the definition of waste) - can be crucial when it comes to the evaluation of certain policies that are aimed at problems that are not only found within the national territory. This is essential for green taxes because that tax will also be applied for imported products that are produced abroad.

Taxing Processes and Production Methods (PPMs)

If the environmental problem in the taxing country is caused in a post-consumption phase like the recovery of waste, we do not see a problem for motivating the environmental necessity of the tax. But when an ecotax is installed to internalize production externalities and this tax will also be applied on imports, the reason to tax the product deals with production aspects in the exporting countries. This brings us a case where a Member State taxes a process or production method (PPM) in another country. If there is then a clear case of transboundary pollution, the ‘polluter pays principle’ can be used to motivate this decision. In theory, the tax on PPMs is an application of 'the correction at source' principle. If there is no transboundary pollution, can extraterritorial environmental measures be accepted ? Is it acceptable that national policies and instruments of a EU Member State are directed at the protection of the ozone layer or the tropical forests in Latin-America? For these cases, we have to consider specific agreements (Montréal, Rio,...) but there are many other potential PPMs. An example could be an import ban on paper bleached with chlorine.
The European Union follows the WTO rules on PPMs. In COM(96)54 final it is stated that ‘quantitative import and export prohibitions or restrictions related to PPMs, imposed on products whose characteristics do not cause themselves environmental harm, are inconsistent with GATT/WTO rules... WTO Members cannot unilaterally ban or restrict the import of products because of the environmental

effects of processes and production methods (PPMs) used in the exporting (producing) country.' But in the case of environmental harm to a neighbouring state, this may be counteracted by the argument that States also have an obligation under Principle 2 of the Rio Declaration 'to ensure that activities within their jurisdiction do not cause damage to the environment of other States or areas beyond the limits of national jurisdiction.' The correct application of this principle would render PPMs unnecessary. The EU underwrites these statements but emphasises that this last category of PPMs should be based on rigorous scientific evidence, be proportional to the objectives sought and implemented in a transparent manner. They should also be considered as last resort measures, once attempts to find other bilateral and multilateral solution have been exhausted. In later sections, we will further elaborate PPMs.

Environmental effects

Any measure should be proportional to the environmental effects of it. This rule does not imply that difference in environmental requirements should be problematic. Already in the 1972 OECD Guiding Principles, valid reasons for different environmental requirements were formulated (OECD/GD(97)137). However, the OECD went on to state that where valid reasons for differences do not exist, 'government should seek harmonisation of environmental policies.'

In general, it is up to the Member State (MS) to show the estimated environmental effect of the levy, if that would be needed in assessing its compatibility with Community law (COM(97)9). The ecotax is a measure that can in principle be installed for the realization of any environmental objective that is related to the consumption of goods and services. Like for all measures, the European Court has established that a national measure has to be reasonable for the pursuit of the objective. As a consequence, it is possible that the Court refers to the capacity of a measure to achieve the attempted objective.

For products with a very low elasticity, the price signal created by the ecotax could be insignificant so the levy needs accompanying measures to realize a specific environmental objective. This explains why some existing ecotaxes are relatively high compared to the initial product price. Only then the price signal will be obvious.

Working with elasticity always is problematic because it remains a rather theoretical principle that requires excellent data to calculate. Even then, the calculated value is only valid for a specific moment in time with a specific price and market situation. But here we can state that even low elasticities could influence enterprise profits so the ecotax could stimulate producers to alter their behavior. This can also be realization of the environmental objective.

But as far as the suitability of domestic measures is concerned, the Court has repeatedly held that Member States should have a relatively wide discretion in the choice of the appropriate measures and that the test applied by the Court is aimed mainly at eliminating obviously inappropriate measures. The Court will assess whether there is an obvious and reasonable link between the measure used and the objective pursued (Ziegler, 1996). This will happen by making use of clear declarations and informations, without an analysis in detail of each aspect. The Court will ask the elimination of domestic measures if they seem predominantly to be adopted for other reasons.

Next to the general principles of the common market (like no arbitrary discrimination, no distortive actions and trade barriers,...), the specific design of the measure and the environmental objective, there are many Articles in Community legislation that need further consideration..
In the communication (COM(97)9), the basic legal context surrounding environmental levies is given by the following Articles :

- custom duties levied on intra-Community trade, or charges having equivalent effect (Articles 9-12) ;
- quantitative restrictions on importations and exportations of goods between the Member States, or measures having equivalent effect (Art.30-36) ;
- provisions on transport policy, that are less favourable in their effect on carriers of other Member States (Art.76) ;
- state aid creating distortions of competition affecting intra-community trade (Art.92-93) ;
- internal taxation discrimination against products of other Member States or otherwise protecting national production (Article 95) and legislation concerning excise duties and other forms of indirect taxation based on Article 99 ;
- Article 130r stating the objectives of Community environmental policy.

These articles are directly applicable for the consideration of environmental taxes. If we add to this list Article 85 that defines fair competition between undertakings (no cartels and restrictive practices) and Article 86 (abuse of a dominant position), we have the most relevant Articles that currently deal with the broad category of market-based instruments.

3. Guidelines

3.0 Environmental objective

The environmental objective of any measure and levy is crucial. The communication states that, generally spoken, any environmental policy should deal with three principles : prevention, the polluter pays and precaution. Furthermore, it is stated that environmental protection requirements must be integrated into the definition and implementation of other policies (following Article 130r), into the Fifth Environmental

Action Program and into international agreements to which the European Community has acceded (COM(97)9).

This last element can be very important because it is used by authors like Krämer (Ziegler, 1996) to state that Member States have the permission to protect the environment in another Member State because they are explicitly allowed to protect global commons such as the ozone layer, endangered species or stability of the global climate. We already referred to the Rio Declaration and also in this context, some Principles can offer a guideline. Principle 15 of the Rio Declaration states that ‘in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (OECD/ GD(97) 137).’ These Principles have however no legal power and can only be used as ‘good arguments’ in defending specific environmental measures. The WTO will not tolerate trade barriers that result from the application of one of the Rio Principles if other WTO Members suffer from these restrictions. Like already stated, matters differ when there is clear transboundary pollution. In this case, Principle 2 demands that activities within the jurisdiction of one country do not cause damage to the environment in other states. This Principle gives the right to the affected countries to ask for a regulation that stops the source of the pollution in the other country. Ideally, direct control or regulation of the PPMs may be achieved through regional co-operation among the countries concerned.

For our survey, the possible acceptance of extra-domestic environmental objectives and protection might be important when it comes to imports targeted by an ecotax. There remains of course a great difference between an objective and practical measures and we should however be aware that any measure for environmental protection (ozone layer, fauna and flora, domestic issues,...) should be in accordance with European law. If a Member State or the Commission wants to protect the ozone layer, the Montreal Protocol can not be used to depart from EC law (see later MEAs) if the EU or the Member States did not sign and ratify it.

We have to start with the Community constituting a 'legal order' that produces direct effects when its provisions are 'unconditional and sufficiently precise'. (EC Law, 1995).

An interesting example - unpublished proceedings, reported by L.Krämer (Ziegler, 1996) - of an 'alternative scenario' is the German import prohibition that the Commission accepted on products made from corralum rubrum, a species of coral occuring in the Mediterranean Sea which is not protected under Community rules or Italian law, although its existence is threatened. This measures was in clear contradiction with the Treaty, and in particular with Article 30, but the Commission allowed this extra-domestic protection under Article 36 (justification clause for national restrictions). So the unconditional application of EC law has been achieved by considering the case as a valid exception. It is also important to note that Germany invoked Article 15 of Regulation 3626/82 implementing the CITES convention which allows for more stringent domestic measures for the species regulated in this regulation. It allows inter alia the adoption of more stringent domestic measures for the conservation of an endangered species in the country of origin.

This example might be followed for some other extra-domestic cases. As a general rule, the adoption of unilateral measures with important effects on Member is not compatible with the Treaty and in particular with Article 5. Therefore, we can suggest that the environmental interests of the Community as a whole or any environmental problem with trans-border effects should be tackled at Community level. This is also in line with the subsidiarity principle.

3.1 Customs duties, quantitative restrictions, charges and measures having equivalent effect

Custom duties on exports or imports do not exist between Member States. The crossing of a frontier can not be a reason for the imposition of any pecuniary charge, however small and whatever its designation and mode of application. Articles 9 and 12 EC provide for 'the prohibition between member states of custom duties and of all charges having equivalent effect' (COM(97)9). Charges that are applied without distinction to national and foreign producers and that will be refunded in the from of subsidies, are considered as parafiscal charges and fall under Article 12, if the subsidies are used for the realization of environmental objectives. Furthermore, such refunds of charges may raise problems under the subsidies provisions in the Treaty (Article 92).
The external aspect of Article 9 is the common external tariff at the European Union borders. The provision has direct effect.

If a levy like an ecotax falls only on foreign products, it may be regarded as equivalent to a custom duty. In this case, the tax is nothing more than a pecuniary charge levied only because products cross a frontier. This ‘ecotax’ would then have the effect of a customs duty. However, if such a levy is part of a general system of taxation of products, according to objective criteria without regard to the origin of the products, it will be examined on the basis of non-discriminatory taxation (Art.95)
A taxation system that exempts a large portion of national production, like the Belgian ecotax law that foresees many exceptions on the general principle of taxation - the Belgian tax is an incentive tax - , may still be regarded as a charge having an effect equivalent to a customs duty. Exceptions for exports - like exports are not ecotaxed but imports are - are frequently used in ecotax designs but they risk not to internalize completely production externalities. For the inclusion of consumption externalities, the destination principle is implicitly applied.

In this context, the Court has made it clear that it may also be necessary to take into account the appropriation of the revenue from the levy. A levy applying to products of other Member States and domestic products according to the same criteria can therefore constitute a charge having an effect equivalent to customs duties if the revenue is used to fully compensate domestic producers of the taxed products. However, using the revenue to support the consumers of the taxed products would not fall in this category, but would have to be judged according to state aid law (COM(97)9).

The Commission includes in the legal context of its communication the Articles 30 and 36 (the Article that foresees exceptions) but does not work them out in detail, probably because the communication only deals with environmental levies and not with general green policy frameworks. Tariffs or customs are by nature not considered as quantitative restrictions like quota. But an ecotax policy can include many conditions and prescriptions of which some fall under the latter category, like take-back programs. In order to make this analysis applicable to general policy packages, we include the two mentioned Articles in this overview.

Article 30 is striking for its brevity : Quantitative restrictions on imports and all measures having equivalent effect shall, without prejudice to the following provisions, be prohibited between Member States (ECLaw, 1995). Trade restrictions like quota are more prejudicial to free trade than tariffs or customs because they impose an absolute ban on trade beyond the stipulated ceilings of imports, rather than rendering importations more expensive.

Article 34 applies a similarly worded prohibition to quantitative restrictions on exports. This Article can become relevant in situations where national authorities want to limit exports of certain wastes to ensure the profitability of local recycling plants or regenerating industries. Often, measures of this kind are justified by the authorities with the need to eliminate circumvention opportunity for domestic recycling and process regulations.

The application of Article 30 as an instrument for the removal of a wide range of hindrances to the free movement of goods is attributable to its second limb, namely the 'measure having equivalent effect' (often abbreviated to the MEQR).

In this evolution, the Court played a major role through a long line of case law.

Two basic interpretations for the classification as a measure having equivalent effect were possible. Like in most trade agreements, the non-discrimination principle was used as a 'national treatment' requirement. This means that domestic measures have to be applied without making a distinction between imported and domestic products. If equally applicable measures have very disparate effects on domestic and imported goods, the domestic measure could be unlawful.

A more integrative approach goes further and also considers possible hindrance to the marketing opportunities for imported products. This means that any domestic measure that hinders trade in goods in general, also the trade in imported goods although this as an unforeseen consequence, is subject to judicial control by the Court.

The Dassonville Formula

For export restrictions, a classical interpretation of non-discrimination has been used, but for import restriction the Court introduced in Procureur du Roi v Dassonville in 1974 (case 8/74) a very broad concept of measures having equivalent effect (EC Law, 1995).
In this case, the litigation arose from the Belgian legislation that required an importer of Scotch whisky to hold a certificate of authenticity issued by the British customs authorities. Whisky had reached Belgium without such certificate via France where no such requirement was installed. But no certificate meant the closing of the Belgian market for the whisky. Only importers of whisky direct from Scotland could readily satisfy Belgian law, which lead to a distortion in the patterns of trade in Scotch whisky.
In this case, the Court stated that it prohibits as MEQRs 'all trading rules enacted by Member States which are capable of hindering, actually or potentially, directly or indirectly, intra-Community trade'. This very broad definition renders irrelevant the question whether a measure applied on a non-discriminatory basis or not. The arguments used when installed the measures are neither relevant. Furthermore, it is - important that the potential hindrance to free trade is sufficient : the Court does not require proof of the trade distortion.

The very wide concept of trade hindrance in the Dassonville Formula has been controversial. All other policies have no justification if there should be the potential for trade hindrance. As such it is not surprising that many observers have problems with this absolute free market interpretation of other valuable policies. Many books were issued on this and related subjects (see Limits to Competition, Group of Lisbon (1994) or The Case Against the Global Econoy, Mander and Goldsmith (1996)).
For others, the Dassonville Formula was welcomed as a substitute for the slow and difficult harmonization of national laws. But over the years, the Court had to moderate this strict formula for cases that were justified under the objectives of the Treaty. New policy areas had been introduced in Community law that justified domestic regulation affecting trade (rule of reason, mandatory requirements, see below) and there was also a limitation of the concept applied to trade hindrance.
Some interpret this as a proof of the inconsistency in the Court's approach but we should be aware that the Court must work within the confines of the complicated material that reaches it as a result of trade disputes. The Court cannot dictate the submission of ideal dispute cases on which it can formulate model

answers.

Ziegler (1996) states that the Dassonville Formula 'is much closer to the principle of a national market established, for example, by the commerce clause in the United States...than to the ordinary non-discrimination principle of a classical free trade agreement or the national treatment requirement in GATT'.

The Dassonville Formula is very important for countries that want to introduce product requirements, labels or marketing restrictions. These are freqently used instruments in environmental policy.

But as already mentioned, the Court had to moderate the effect of the wide Dassonville concept by introducing a set of reasons which preclude the application of Article 30. For certain recognized public interests - never completely listed -, referred to by the Court as **'mandatory requirements'**, national measures (dealing with health, environmental conservation,..), if they are necessary and proportionate (Cassis de Dijon doctrine), do not fall within the prohibition in Article 30. So the principle of proportionality allows to a certain extent measures that restrict imports if these measures are necessary to reach the environmental objective and if the effects on the internal market are considered to be proportionate to the environmental gain.

This ‘review’ of the Dassonville Formula is not surprising. The controversy had a long history. According to Walker (1993), the Dassonville Formula has always been in contrast to earlier definitions, like Directive 70/50 of 1969. In the preamble to this Directive we read : ‘Effects on the free movement of goods of measures which relate to the marketing of products are not as a general rule equivalent to those of quantitative restrictions, since such effects are normally inherent in the disparities between rules applied by Member States in this respect (Walker, 1993).’

Next to the interpretations of Article 36 that foresees mandatory exceptions for the application of Article 30, there was an important judgment of the Court that responded to the debate and provided another option to moderate Dassonville.

Case 120/78 in 1979 and the later concepts in the application of this case is often referred to as the **Cassis de Dijon doctrine** or **rule of reason**. This case arose because an importer was denied authorization to import Cassis de Dijon into Germany since it did not meet the minimum alcohol content (25%) required for certain liquors and other spirits under German law. The importer challenged this requirement as a measure having equivalent effect because only a modified Cassis de Dijon, with a higher alcohol content, could be sold in Germany. Germany argued that there was material and formal equality in their law and that the protection of their consumers could not be challenged by other countries, especially not because there was no European legislation on alcohol content. As such, Article 30 could be used for levelling national laws to the requirements of the least exigent state.

The Court judged that the German measure did not fall within the available exeptions under Article 36. The Court also stated that in spite of the applicability of the Dassonville Formula, certain national measures did not fall within the prohibition of Article 30 as 'obstacles to movement within the Community resulting from disparities between the national laws relating to the marketing of products'. In this case, Member States were given responsibility to regulate all matters relating to the production and marketing of alcoholic beverages on their own territory. If these national laws include restrictive provisions, they must be accepted in so far as they may be recognized as being necessary in order to satisfy mandatory requirements relating in particular to the effectiveness of fiscal supervision, the protection of public health, the fairness of commercial transactions and the defence of the consumer (Ziegler,1996). In the same decision, the Court states that a Member State has no justification for prohibiting the marketing of goods which have been lawfully produced or placed on the market in another Member State. But for this recognition of equivalent measures and regulations, the Court will judge each case on its merits.
This is a result of the insufficient harmonization of standards within the Community what lead to some national, rather protective regimes that have to be in any case suitable, necessary and proportionate. This rule of reason is as such the consequence from the installation of mandatory requirements. We should also remark that the list of mandatory requirements has subsequently been enlarged by the Court.

Next to the mandatory requirements, there were also some cases that judged the potential effect on trade as 'too problematic and remote' or not impending at all (Ziegler, 1996). And recently, the Court has openly admitted that it tends towards a reformulation of the Dassonville formula.
In contrast, there are also other cases from which authors like Walker (1993) indicate a return to Dassonville. In these cases (Milk Substitutes, Oosthoek and Buet,...), the Court has condemned internal rules regulating the sale of products under Article 30 even where both foreign and domestic producers bear the burden of the new rule equally. In the Cinetheque Case, the Court considered whether a restriction on the sale of videos in stores within one year after cinema release would violate Article 30 even though there was no effect of favouring national firms. This situation was not corresponding to the establishment of a single market in the EU because a video which can be released in one Member State, will be prohibited from entering another Member State. The Court determined that no violation had occured, but it stated that apparently lower national standards, that are not discriminatory, are allowed because they are also less restrictive of trade (Walker, 1993).

Notwithstanding these cases, we can state that the Dassonville Formula is reformulated. According to Ziegler, this would mean that domestic marketing restrictions are regarded as lying outside the scope of Article 30. This can be very important when it comes to specific green or environmental labels for the distinction of environmentally friendly products. Of course, it all depends on the market effect of these labels. If they only influence the mode of selling or conditions for the sale of the product, they do not fall

anymore under the Dassonville formula. If the product declaration however would partition the common market into separate segments by requiring different packagings for different countries, the measure will fall under Article 30. And there is in many cases only a thin line between product information strategies and fragmenting marketing conditions.
If, for example, we reconsider the case of an ecotax linked to other specifications (labels, take-back programmes) where the levy regulation requires an economic operator to alter the form, size or designation of the product, or the label under which the product is lawfully marketed in another Member States, and if this modification is not necessary for the proper functioning and objective of the levy, the required modification may be assessed under Article 30.
Technical requirements may not give to certain traders the ability to affect the imports of the products concerned, whereas others are prevented from doing so.
In communication COM(97)9, we also find that the Court has ruled that a measure, such as a deposit charged per bottle, as part of a recycling system for bottles, cannot itself qualify as a fiscal measure, and may therefore also be examined under Article 30.

The classic exception clause to Article 30 is Article 36. Like in the GATT/WTO and other international agreements, the exceptional non-application of certain treaty provisions is clairly defined and limited to some specific cases. For the EU, the approximation of laws is a permanent evolution and will make on the long term the application of Article 36 more and more limited. National measures are only legitimate as long as the Community itself has not taken comprehensive measures to avoid the inherent dangers.
The areas of Article 36 deal with public morality, public policy or public security, with the protection of health and life of humans, animals or plants, with the protection of national treasures and the protection of industrial and commercial property.
Not every area has its relevance for environmental policy but a good example is the influence of pesticides on health and the environment. In several cases the Court had to decide on the lawfulness of trade prohibitions and restrictions on pesticides or pesticide-treated products. In case 125/88 Criminal Proceedings against Nijdam (Ziegler, 1996), the Court stated that Member States were responsible for taking the necessary actions in fields where there was no comprehensive harmonization. The Dutch authorities had begun criminal proceedings against Mr.Nijman because he had been found in possession of a substance that was prohibited because of the dangereous effects it could have on the health of the users and the environment.
The level of protection necessary for safeguarding public health is in principle to be set by the Member States. The Dutch prohibition was therefore lawful under Article 36.

Another field of Article 36 that deserves our attention is the protection of wild flora and fauna. After years of controversy, the Community introduced in 1983 its Common Fishery Policy (Barnes and

Barnes,1994), that failed however to deliver satisfactory results. Now it is the ambition that in 1999, a new and complete policy, covering also the Mediterranean, can be installed. Over-capacity of the fleet, chronic depletion of stocks, the standard of living for fishermen and an excessively complex set of rules and regulations are the most cited causes. But before the 1983 legislation, some countries like the Netherlands did sign international fishery resources protection agreements that established trade-hindering quota. The conclusion of the Court was that the quota, that effectively and without any discussion hindered trade among Member States, served the long term objective to ensure future fish resources and could as such not be classified among the prohibitions by the Treaty (Joined cases 3, 4 and 6/76 Biological Resources of the Sea, (Ziegler (1996)).

It could be that considerations on the assimilative capacities of natural habitats like waters and soils make instruments necessary that manage the amount of emissions. Potential instruments are pollution permits schemes. These (tradable) quota to emit, and hence to produce, that make not part of other Community policies, could be motivated like in the fish quota case. The measure can hinder production during the period of adjustment and it isn't certain that producers have alternatives to deal with the emissions. But on the long run they will make harder and more costly measures like production prohibitions for certain periods, less needed.
This case can be relevant for measures that limit road transport in times of heavy air pollution or serious ozone concentrations. If no real measures are taken and road traffic keeps expanding during the coming years or decades, it is not unthinkable that in the future trucks are not allowed to pass by certain areas or cities. Probably, there will be strong protests for such drastic measures but the arguments of the concerned authorities can be similar (and might have similar results when it should come to a case).

Since the Court has defined the protection of health as a mandatory requirement under the rule of reason, some overlappings between this rule and Article 36 might arise. In their application, the non-discrimination requirement is only included in the rule of reason. This means not that authorities themselves could opt for the rule of reason or the list of exemptions in Article 36. While the Cassis de Dijon doctrine leads to a restriction of the scope of Article 30, Article 36 justifies national measures although they represent infringements of Article 30 (Ziegler, 1996).

3.2 Internal taxation

Article 95 states : No member State shall impose, directly or indirectly, on the products of other Member States any internal taxation of any kind in excess of that imposed directly or indirectly on similar domestic products. Furthermore, no Member State shall impose on the products of other Member states

any internal taxation of such a nature as to afford indirect protection to other products.
Article 95 applies the basic Treaty rule against discrimination on grounds of nationality found in Article 7 EEC (ECLaw, 1995). As a fiscal provision it is an important element ensuring the free movement of goods in the European Community. Articles 9 and 12 prohibit financial charges levied for the mere fact that goods cross the border within the Community, while Article 95 constitutes the necessary complement for a general prohibition on the discrimination of financial burdens. It is therefore a key provision in the integration of a market in which competition on quality, not origin, prevails.
The common market can be disturbed by regulatory differences between different countries. If the European divided power system seeks to foster trade - a single market where goods can move without hindrance -, the abolition of the regulatory differences can be necessary, even without clear discrimination. The Court can include discrimination as a necessary condition to abolish any regulatory hindrance or not. This will depend on the progress of the European integration and changing priorities over time..

In COM(97)9, the Commission states that Article 95 is infringed if a product of another Member State is more heavily charged than a domestic product. Taxes should be levied equally on imported and domestic goods and should not constitute a disguised restriction on trade. Hereby, the system applied to domestic products constitutes the point of reference.
Article 95 does not preclude differential taxation of different goods if it is objectively justified. This applies also in the case of environmental charges or taxes. Normally all kind of eco-taxes fall under Article 95 EC. For ecotaxes that are based on the polluter pays principle, the tax depends on the pollution caused by the production and not on the value of the product.

The Court has pointed out that a levy cannot be considered discriminatory solely because only products of other Member States fall within the most heavily taxed category, if this results from the application of objective and not discriminatory criteria. If, however, products of other Member States are, on the basis of arbitrary and/or discriminatory conditions, excluded in advance and/or by definition from benefitting from a reduced rate of the levy, there would be a breach of Article 95. This means that the system of taxation - with the detailed rules for the collection of the levy - must be transparent so that all parties involved can determine whether the burden falling on their products exceeds that falling on similar domestic products.
The Court considers products to be similar if they have similar characteristics and meet the same needs from the point of view of consumers.
It is also mentioned by the Commission that if the goods are not 'similar', but are still at least partially or potentially competing with foreign products, the second paragraph of Article 95 requires that the levy must not have the effect of protecting domestic products. In the assessment of this aspect, not only the

actual situation but also the potential market for foreign products, if no protectionist measures were involved, should be taken into consideration.
The broad interpretation of discrimination not only depends on the inclusion of potential market hindrance but is also related to the use of the revenue from the levy. The Court ruled that when the revenue from a levy is used to partly offset the burden borne by domestic products, the charge constitutes discriminatory taxation within the meaning of Article 95 (or even Article 92).

According to the Court, it is necessary to take into consideration :
- the rate of the levy;
- the provisions relating to the taxable base;
- the control systems of charging the levy, and;
- the detailed rules for the collection of the levy.

The taxes should also be collected at the same moment in the production process. In relation to specific prior-stage taxes, the Court refuses to allow Member States to levy an adjusting charge on imports in respect of a domestic specific prior charge. Duties must be imposed for the same products at the same marketing stage and the chargeable event giving rise to the duty must also be identical. Ziegler (1996) sees in this principle important consequences for the applicability of border tax adjustments related to a general energy tax or carbon tax, if the Court treats them in the same way. This principle will make unilateral introduction of carbon taxes unattractive.

The issue of the border tax adjustment (BTA) receives a lot of attention in the debate on trade and environment. Border tax adjustments allow for the application of domestic taxes on imports and the remission of domestic taxes on exports (COM(96)54 final). The objective is to ensure trade neutrality of domestic taxation. In the absence of an harmonized taxation system between trading partners, BTAs aim at preventing double taxation or loopholes in taxation, and thus to preserve the competitive equality between dometic and imported products.
In the eventual application of BTA, European countries have to comply to EC Law and to GATT/WTO rules. Already in 1968, the GATT established a Working Party on Border Tax Adjustments to examine the provisions of the General Agreement relevant to border tax adjustments and their possible effects on international trade.
In its examination, GATT used the definition of border tax adjustment applied in the OECD : '... any fiscal measures which put into effect, in whole or in part, the destination principle (WTO, WT/CTE/W/47, 1997).'
We will later discuss the relevant WTO rules but it is already worth mentioning that many clarifications on BTA rules will be needed during the coming years. There is the problem of the 'tax occultes' (i.e.

taxes on capital equipment, auxiliary materials and services used in the production of the taxable good, including taxes on energy), the asymmetrical elaboration of BTA rules for imports and for exports, and the different position on BTA for taxes on products and on production processes.

Finding the balance

It should also be noted that Article 95 does not give the Community a right to judge whether a levy in a Member State is excessively high in relation to its environmental objective. Again, the criteria of proportionality (causal link, necessary, in proportion) need to be applied for the environmental justification of specific measures.

Balancing the gain for the environment with the potential impact on the single market should only happen for administrative control measures of the levy. Next to the common market impact of the environmental objectives, the required environmental justification for differential or for equal taxation but with some indirect discrimination against foreign producers, may take into account e.g. the characteristics and consequences of pollutants, the mode of production or the effects of a product after its use such as the possibilities for its recycling. This broad perspective is depending on specific conditions in order not to raise issues with regard to the territoriality principle and the sovereignty of Member States to decide their own level of environmental protection. A famous similar case in GATT/WTO was the US restriction on imports of tuna (Walker, 1993).

Ziegler (1996) gives as an example Case 21/79 Commission versus Italy where the Court was confronted with an Italian measure favouring oil produced from recycled waste oil. This type of oil was granted a tax reduction which did not apply to normal oil, although fresh and regenerated oil could not be distinguished. This tax differentiation was justified, among other reasons, by environmental considerations. The Court held that Italy was permitted to distinguish between 'physically' identical products on the grounds of production process and raw materials used. But as the tax reduction, however, applied only to the domestic production (imports were not eligible for the tax reduction) it was considered as a discriminatory measure prohibited under Article 95.

To conclude, Article 95 has been interpreted very broadly and a very strict motivation is required for a de facto differential treatment that results from national taxation initiatives. The Court will always look behind the measures to analyse whether they constitute disguised protection. The effects of the proposed measures will be evaluated and can be a motivation for the Court to require other, less protectionist measures.

3.3 The harmonization of indirect taxation (Article 99)

Article 99 provides the Community with the competence to harmonize indirect taxation. For the moment, this harmonization has to be interpreted as a temporal phase in the evolution towards a Community wide uniformization of indirect taxation. A recent achievement was the harmonization of the minimum standards for value added taxes (VAT).

The Community legislation adopted under Article 99 contains also harmonised rules on tax structure and minimum rates for excise duties on mineral oils, tobacco and alcoholic beverages, next to other provisions that allow Member States to introduce indirect taxes on products, provided that those taxes do not give rise to border-crossing formalities in trade between Member States. All provisions (also future provisions) shall be taken by the Community to the extent that such harmonization is necessary to ensure the establishment and the functioning of the internal market. Future market dynamics and evolutions will as such be the guidelines for new provisions.

In the Task Force Report on the Environment and the Internal Market '1992' (EU, 1990), it is recognized that the Commission's proposals for fiscal harmonization introduce constraints on the selective use of tax instruments for environmental policy. From the products with a clear environmental impact, only oil can be taxed. For energy products, not only environmental considerations shape the tax policy. Oil taxes are and will remain an important source of income in all Member States.

Taxes on mineral oils as such deserve special attention under Article 99 when it comes to harmonization. The existing legislation will be broadened by the proposal for an Energy Product Tax (COM(97)30 - 12/03/97) that not only foresees minimum tax rates for all energy products - more than the hydrocarbon oils - but also links this tax increase with lower taxes on labour. Mandatory exemptions are made for highly energy intensive industries but unlike in the former carbon dioxide tax proposal, they will have to pay a minimum tax.

In the Communication we find that the legal basis of the energy tax proposal is Article 99 of the Treaty, which requires unanimous agreement of the Member States.

This measure would mean significant changes for most Member States with noticeable effects on the mineral oil and transport markets. This will surly be the case when the environmentally counterproductive tax advantage for diesel fuels might be removed. But as a general principle, Member States may request authorization from the Council to apply reduced tax rates or exemptions.

The question of complementary national taxes must also be raised and this strongly relates to vehicles. Examples are high luxury taxes for diesel cars, differences in diesel prices, different fees for road use, leaded versus unleaded fuel prices,...

As Article 99 does not apply to direct taxation and to production charges (like ecotaxes on products), the Member States maintain the right to introduce emission charges, environmental taxes, or pollution duties. We should keep in mind that no border-crossing formalities will be accepted. In this perspective, we could also ask the question whether a border tax adjustment is a border-crossing formality. We

assume they are more than just a formality - and are as such prohibited as such - but is clear that a precise formulation of ‘formalities’ would be welcomed.
Of course, the general principles of non-discrimination and non-protectionist use of internal taxes under Article 95 EC still apply for new environmental taxes.

As a general practise in international trade, the fiscal treatment of imported goods in the European market follows the destination principle : taxation in the country of final consumption. Ziegler (1996) states that before the final accomplishment of the harmonization of indirect taxation, a process that started in the mid-1980s and will take at least some additional years, the Community system allows for the reimbursement of domestic indirect taxes and taxation at the border of the importing country with a border tax adjustment when goods are imported. Article 96 provides that any reimbursement of internal taxation should not exceed the internal taxation imposed on whether directly or indirectly. 'Directly' relates to taxes levied on final products while 'indirectly' relates to raw materials and semi-finished goods in the manufacturing of exported goods.
But this mechanism of border tax adjustments can only be used at the common frontier of the European Union. For intra-Community trade, border tax adjustment to reimburse for differences in VAT cannot be applied because exports of goods are free from indirect taxation. A Belgian firm that buys inputs in Germany does not have to pay the German VAT and when it sells the inputs to other Belgian firms or consumers, the Belgian VAT will be paid to the Belgian fiscal authorities. So there is no need for border tax adjustments at all. The non-application of adjustment mechanisms makes it impossible to adjust for differences in other taxes like ecotaxes.

We should however be aware of the temporary nature of this practice. In July 1996, the Commission appoved a VAT-system for the integrated common market (Europese Commissie, Bulletin van de Europese Unie, 7/8 1996, 1.3.22, p.23), in order to install a fiscal union as a complement to the EMU. Harmonized tax levels will for all European firms be based on the principle of origin - the Belgian firm pays the VAT in Germany and can deduct this amount from its VAT receipts in Belgium - and will eliminate possible discriminations and uncertainties about the collection of the indirect taxes. The Commission proposed four stages that should be closely related to the progress of the EMU, at least this was the ambition. Therefore, many provisions are needed during 1998 and 1999. The final task would be some redistribution of tax receipts among Member States to ensure that everywhere the receipts are closely related to the real activities and the differences in VAT-rates do not create competitive distortions. This last ambition will be very hard to establish and needs excellent communication strategies to overview all international transactions. The Parliament and Council have modified the proposal of the Commission and a final version is still not presented. The earliest date of introduction of the principle of origin might be 2001or 2002, but even this is not certain.

From 1998 untill the end of 2002, the Fiscalis-programme will work out a Community infrastructure and impulses to enable the good functioning of the current and the future VAT-system. A direct information system will provide the necessary information (Bulletin 4/1997)

It is sure that mechanisms like the redistribution of tax collections (final element in the proposal of the Commission) or border tax adjustments (comparable to countervailing duties in dumping cases for products coming from outside the European Union) cannot be used for the collection of environmental taxes on foreign products. As already mentioned, any other reimbursement is neither possible because new environmental taxes may not give rise to border-crossing formalities.

As long as production- and emission-related duties and taxes are not harmonized under the provisions of the Treaty, Member States can introduce their own environmental taxes (that are not depending on Article 99 for indirect taxation).

A potential alternative for an ecotax with border tax adjustments, at least in theory, could be to make VAT-rates depending on the ecological burden of the product. Like in the mineral oil case, a low VAT could be installed if certain environmental conditions are fulfilled. This might sound attractive but the practical installation of this principle will be very difficult.
As Directive 92/81/EEC states that only one tax rate per product can be used, we cannot differ the tax according to the environmental burden caused by the production process although the Italian oil Case 21/79 under Article 95 showed a very hypothetical argument. In this case, the tax reduction on oils clearly was not an indirect tax.

Currently most Member States have only a few VAT-rates that vary between 15 and 21 percent of value added. A VAT that gives the same price signal as a 'traditional' ecotax will be unfeasable for products with a low price. A plastic bottle that might be ecotaxed with an fixed amount of half of its value will need a VAT of 50%. For other drinking containers like cans, the price effect of an ecotax of 0.2 ECU could only be achieved with a VAT of more than 100%.
Only for expensive products like household durables or cars, a VAT-differentiation based on the amount and type of energy used, could be a possibility. On this area, we should also consider Directives 91/542/EEC, 93/59/EEC, 94/12/EEC, adopted under Article 100a, concerning polluting emissions from motor vehicles, that contain specific frameworks for fiscal incentives related to the purchase of new vehicles (COM(97)9). Here again, Member States should avoid fiscal measures that constitute de facto technical requirements other than those harmonized at Community level. These fiscal incentives must be phased out when the new EU emission limits become mandatory and must be notified in due time to the Commission.

To conclude, we should mention that Article 99 does not provide a general safeguard clause allowing for more stringent national measures in the interest of the environment in general, Neither is there a general safeguard clause comparable to Article 36. Ziegler (1996) gives two exceptions. In the Commission's proposals for the introduction of a carbon dioxide or energy product tax, Member States are allowed to apply higher rates and as far as the recently adopted directive on vehicle taxes and tolls is concerned, only minimum standards for vehicle taxes are provided. In the latter case, the user charge should be in proportion to the duration of the use made of the infrastructure, which corresponds to the polluter pays principle.
For other products, we should keep as a guideline that Article 99 clearly implies that border tax adjustments for environmental taxes are not possible.

3.4 Fair and undistorted competition and the environment (Article 85)

In many environmental programmes that introduce ecotaxes, an essential role is played by private undertakings. They can create cooperative structures for the practical organization of waste collection and processing, the introduction of ecolabels, logistic arrangements, environmental R&D-programmes for clean technologies and so on. These activities with beneficial effects on the environment can also influence competitive relations. Some forms of collaborations can suppress competition and this will raise problems.

Article 85 (Cartels and Restrictive Practices) prohibits as incompatible with the common market : all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the common market, and in particular those which :

a. directly or indirectly fix purchase or selling prices or any other trading conditions;
b. limit or control production, markets, technical development, or investment;
c. share markets or sources of supply;
d. apply dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage;
e. make the conclusion of contracts subject to acceptance by other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts (EC Law,1995).

The principles elaborated in the Articles 85-90 primarily concern the distorting behaviour of private

undertakings, but they apply by implication to Member States taking action to support, facilitate, or allow such private behaviour. The definitions in Article 85 are also very broad and general and are most and for all 'effect based'. Neither the precise legal form of specific agreements, nor its actual content are of decisive relevance.
Furthermore, the agreement or concerted practice between undertakings must have an effect on trade between Member States for Article 85 to apply. This is essential. If a restrictive practice has implications only within a single Member State, then regulatory competence belongs solely at the national level. It should however be noted that the jurisdictional threshold used by the Court is very low so even when the (voluntary) agreements appear on first inspection to concern one state alone, it will be frequently possible to identify an effect on trade (EC Law, 1995).

Voluntary agreements among firms can defy the prohibitions of Article 85 but this is not a priori the case. We should always keep in mind that 'perfect competition' with maximum efficiency is a textbook hypothesis and therefore considered as unattainable for many reasons. This is reflected in the notion of 'workable competition' as the objective of Article 85. The European Court referred in Case 26/76 (ECR 1875, 1904) Metro vs Commission to '...the market of workable competition ...to ensure ... the creation of a single market achieving conditions similar to those of a domestic market.'

Also, for environmental policy programmes based on voluntary agreements, there is the crucial exemption under Article 85(3) for agreements that meet specified criteria reflecting overall beneficial effect. The exemption can be used for practices or agreements which contribute 'to improving the production or distribution of goods or to promote technical or economic progress, while allowing consumers a fair share of the resulting benefit, and which do not :

a. impose on the undertakings concerned restrictions which are not indispensable to the attainment of these objectives ;
b. afford such undertakings the possibility of eliminating competition in respect of a substantial part of the products in question (EC Law, 1995).

Undertakings can apply to the Commission for the grant of an exemption based on Article 85(3). To prevent an intolerable workload, block exemption regulations were developped for several categories of collaboration. If an agreement is of a type covered by a block exemption regulation, the firms can consult this regulation and do not have to seek an individual exemption. Of course, firms that do not find a solution in the block exemptions can directly contact the Commission.
Concerning voluntary agreements that are used in environmental policy, Reg.418/85 Research and Development agreements, Reg.2349/84 Patent licensing agreements and Reg.556/89 Know-how

licensing agreements are block exemptions that can be of direct use (Ziegler, 1996). For all types of voluntary agreements, the Commission can grant on request individual exemptions on a case-by-case basis.

The Commission underlined already several times, starting in its Report on Competition Policy of 1992, its intention to favour 'voluntary agreements to improve the environmental conditions in a given sector (EU, 1990)'. This position has been confirmed by COM(96)561 final on environmental agreements. The broadening of the range of instruments and the involvement of all levels of society in a spirit of shared responsibility has been recommended when reviewing past Action Programmes.
An interpretation of the conditions of Article 85(3) in the light of Article 130r(2), i.e. the need to integrate environmental concerns in all Community policies, and the general environmental objective of the Community under Article 2 EC, may lead to the acceptance of such voluntary agreements between undertakings. Ecologically sound production methods must, in a qualitative way, be considered as a production improvement in the sense of Article 85(3). Ziegler (1996) suggests further that general environmental principles like the precautionary principle and the 'polluter pays principle' should be included in the evaluation process of agreements under Article 85(1) and their admissibility under Article 85(3).
An indication for this evolution can be the case in which the Commission did not accept environmental justifications (under Reg 17/62/EEC) for the association of six European undertakings offering bulk liquid tank storage facilities (proceedings Vereniging van Onafhankelijke Tankopstang Bedrijven). They would raise prices by an uniform 'environmental charge' to cover investment costs required to reduce vapour emissions (VOCs), an important contributor to lower ozone problems. But as there was no differentiation between companies already applying higher standards and those which still used old technologies, the system did not observe the 'polluter pays' principle. The Commission indicated that a system whereby the undertakings invoiced a total price, clearly stating that it included the additional environmental investment costs, could *perhaps* have been accepted (Ziegler, 1996).

The future interpretation of Article 85(3) will to a large extent depend on the changing Community perspective on environmental priorities and instruments. And of course, the environment may not be abused for measures which are unduly distorting. The Commission will examine carefully all agreements between companies to see if they are indispensable to attain the environmental objectives. A general proportionality test will be the best instrument.

Article 86: abuse of a dominant position

Article 85 and Article 86 are closely interlinked. The monopoly provision of the EC Treaty has the same objective as the cartel provision : the European market should be a competitive market without monopolistic or oligopolistic distortions.

Like in Article 85, the monopolistic provision will be evaluated upon the effects of specific practices. Unfair pricing, arbitrary pricing and restrictive tying arrangements are elements of a non-exhaustive list of prohibited practices and effects (EC Law, 1995).

The relevance of this Article for voluntary agreements depends on the functioning of the agreement. If the system works with ecolabels and only products with those labels will be collected for further processing, the firms that do not receive the label for whatever reason, could be de facto excluded from the market. Article 86 deprives a dominant firm of the ability to pick and choose its customers, in this case suppliers of waste (like packaging materials or paper). The objective of exercising control over supply and demand conditions is to avoid damage to the market beyond that already inherent in dominance. In this respect we should remind that dominance in se is not unlawful. Its potential to foster inefficiency is subjected to supervision.

The leading case in this field is Case 7/76 Commercial solvents versus Commission. Commercial Solvents supplied aminobutanol to its regular customer Zoja that used it to produce ethambutol. Only three firms produced this product in the Community. Because Commercial Solvents wanted to start producing itself ethambutol, it refused to further supply Zoja (EC Law, 1995).

The Commission saw here a clear case of abuse because Zoja was a regular customer and the intentions of Commercial Solvents would disrupt the existing market structure.

In the case where firms can give ecolabels, the situation is clearly different. When the market is new, disruptive actions are hard to prove. Also, the refusal to give a label to a certain firm can have no or just a very small impact. The German voluntary agreement (Duales System Deutschland GmbH) works with some four to five hundred firms. When a small new firm can not get a label for the German market, is this a disturbance of existing power balances? Whether it will be a case of arbitrary discrimination will depend on the motivation of the label-emitting authority. If different technical requirements or conditions (the waste is not ready for further standard processing) motivate the label-refusal, the Court will not judge this as an abuse because the same technical conditions are also used for the other, already participating, firms. The imposition of other technical requirements is not the task of the Court and will distort existing practices and mechanisms.

Clearly, a crucial element in potential conflicts will be the importance of the voluntary agreement for the concerned industry. Does the agreement covers the whole sector, or is it an agreement between the most important market players of the industry?

Voluntary agreements are also initiatives that substitute future EU or national legislation on the field concerned. If the results of the agreement should be reached by national legislation there will also be cases where specific firms have to make serious adaptions in order to comply.

Public undertakings

Article 90(1) declares that in case of public undertakings and undertakings to which Member States grant special or exclusive rights, Member States shall neither enact nor maintain in force any measure contrary to the rules in the Treaty (EC Law, 1995).
As such, this Article covers undertakings to which special or exclusive rights have been granted, a practice that is often used in ecolabel and take-back programmes.
In principle, it is perfectly compatible with the Treaty to confer such rights on an undertaking. The effects of the exercising of those rights also have to be in accordance with the Treaty. Discriminatory pricing or the refusal to supply and other elements like in Article 86 are clearly prohibited.

Article 90(2) provides an exception that is very limited in scope (EC Law, 1995). If the undertaking is of a defined type (entrusted with the operation of services of general economic interest) and the competition rules obstruct the fulfiment of its tasks in the manner stipulated, the exception might be succesfully invoked. Also here, the principle of proportionality is applied so the immunity is very limited. Another interesting element for the future can be Article 90 (3). It reads : 'The Commission shall ensure the application of the provisions of this Article and shall, where necessary, address appropriate directives or decisions to Member States (EC Law, 1995).' It is a rarity in its conferral on the Commission of direct legislative competence. This little regarded provision might be used in the future to invigorate the application of Article 90 in other areas in which competition has been unjustifiable suppressed, such as the market for energy supply. For other areas, when we look at the positive attitude of the Commission towards voluntary agreements and other market-based instruments in environmental policy, Article 90(3) could be used to ensure an optimal and not prohibited application of these agreements under Article 90.

3.5 State aid (Article 92)

State aid is prohibited in the concept of the non-agricultural common market. An efficient allocation of production factors, stimulated by the elimination of trade barriers, is incompatible with an inefficient domestic industry that survives on state subsidies. Next to this obvious case, competition-distorting state aids can not be used to equalize different production conditions in Member States. State aid can play an important role in environmental investment decisions. In specific cases where higher production costs follow the application of a strict environmental policy, like the Dutch action programme against chlorofluorocarbons (CFCs) that include some technical and financial risk for the firms that had to innovate, the Commission approved the state aids to specific companies in the targeted sectors (Ziegler, 1996). Of course, such aid may not go beyond the environmental investment cost.

In cases where firms apply voluntarily more stringent environmental standards - not to compare with compulsory legal requirements -, the possible state aid has in recent guidelines even been limited to 30 per cent of the total environmental relevant cost.

The Treaty provides broader exceptions (not related to the environment) for sectors like agriculture and transport. And like in the Dutch CFC-case, there is special secondary legislation that makes it possible to provide environmental subsidies (Ziegler, 1996), in particular for investments in ecologically sound technologies. These subsidies do not follow the 'polluter pays principle' but the Commission sees its guidelines as a compromise to find a workable balance between the environmental arguments and the distorting effects on competition and trade.

Article 92 is only relevant when national aid affects trade between Member States. The capability of hindering trade is however a sufficient condition. If, for example, cheap energy is provided for all sectors in the economy, there can be no competition distorting effect as a result of this state aid. This would however be the case when the aid applies to some selected exporting sectors.

An important exception is provided by Article 92(3) which allows state aids to 'promote the execution of an important project of common European interest or to remedy a serious disturbance in the economy of a Member State (EC Law, 1995)'. The aid, clearly suitable for promoting the objective, must be proportionate to the importance of the objective, next to indispensable to achieve it.
Environmental programmes may be projects that serve common European interests. In 1975, the Commission announced that it would accept environmental state aid for a limited transitional period that should have ended in 1980. The application was extended for an additional period of some 15 years and in March 1994 the Commission published its currently applicable guidelines which follow in fact the approach used in 1975. The aid, limited to 15 per cent of the additional investments, is granted only to undertakings which had had installations in operation for at least two years before the entry into force of new higher environmental standards.
As already mentioned, for firms that voluntary go further than the compulsory level of protection, state aid can amount to 30 per cent of investments. The Article also requires any Member State to inform the Commission in due course (two-month period is sufficient) about its plans to grant or alter any kind of state aid. There is also the obligation for a Member State not to put its proposed measures into effect untill a final Commission decision has direct effect. This means that a competitor to the firm benefitting from the aid, could request a national court to take all appropriate measures in accordance with national law, including the suspension of further payments under the scheme, until the Commission has decided on the compatibility of the aid with the Treaty.
The same period is maintained for the prior notification by Member States of any technical regulations,

including those "which are linked to fiscal or financial measures affecting the consumption of products by encouraging compliance with such technical specifications or other requirements" (Directive 83/189/EEC in the field of technical standards and regulations).

Next to green investment aid (15 to 30 per cent), tax advantages can be considered as subsidies and as such ecotaxes can contain elements of state aid in cases where environmentally harmless products are not taxed and others are. The redistribution of the collected environmental taxes poses another possibility of state aid.
In the overview on Article 95, the discriminatory nature of the tax was considered, but still the tax has to be lawful under Article 92. As a general rule, an aid element contained in a levy system cannot be authorised by the Commission if other provisions of the Treaty are being infringed.

If the revenue is destined for a special purpose, state aid may be involved if certain enterprises or products are favoured. Exemptions from national product or emission levies also constitute state aid, even when these exemptions are necessary to prevent domestic firms from being placed at a disadvantage compared with their competitors in countries that do not have such levies (COM(97)9).
Notice that the same reasoning is not followed in the European energy product proposal because here the competitiveness issue is dealt with at the European level.
Temporary relief from new national *emission* levies may however be authorized where it is necessary to offset losses in competitiveness, since emission levies usually only apply to domestic firms.
In order to facilitate the assesment by the Commission, Member States are encouraged to state clearly how the revenues from the environmental levies are to be used.

What the Commission takes into account ;
- whether the revenue is spent in the same sector of economic activity as it was collected ;
- whether the activites financed by the proceeds of the levies can be provided on a normal commercial basis with a satisfactory result, or whether some form of aid is needed ;
- the intended duration of the measure,
- ...

For product levies on domestic and foreign products, if the revenues are used to fully offset the burden borne by domestic producers, then the charge has an equivalent effect to a customs duty ; if it is used to partly offset then discrimination under Article 95 can be possible.

This Article offers many possibilities for governments to develop their environmental policy. A crucial element will be a clear environmental objective that serves the common interest of the Community.

4. Principles and conditions for domestic environmental measures

The Commission states that there is considerable scope for actions by the Member States to implement instruments like environmental taxes and charges, take-back progammes, voluntary agreements, joint 'green' research and development,..
All have shown to be particularly attractive in improving the efficiency of specific environmental policies. As has been shown, the undistorted functioning of the single market is one of the major considerations when introducing environmental measures. National initiatives clearly need this European scope.

To summarize the EU analysis, it is interesting to present some basic principles and conditions for domestic environmental measures.
In the Task Force Report on the Environment and the Internal Market, we find that new instruments must be developed based on four essential principles (EU, 1990) :

1. The prevention principle, particularly to prevent irreversible damage to the environmental patrimony of the Community;

2. The polluter pays principle, to ensure internalization of avoidance and damage costs to obtain a more cost-efficient application of Community environmental policy;

3. The subsidiarity principle i.e. the primary responsibility and decision-making competence should rest with the lowest possible level of authority of the political hierarchy;

4. Correction at source and the related principles of proximity and self-sufficiency should lead to the best solutions;

5. The principle of economic efficiency and cost-effectiveness, i.e. the appropriate economic instrument has to be chosen (to ensure static and dynamic efficiency - adjustments on short term and after long-term interactions on diverse fields);

6. The principle of legal efficiency i.e. legal instruments used should be readily applicable and enforceable.

These principles should not only be integrated in national or EU environmental programmes but are also applicable when it comes to the international dimension of Community environmental policy. Integration is as such the seventh principle. The Task Report mentions four main international environmental issues that are of particular significance in the context of the internal market : globalization of environmental policy, transboundary pollution, industrial relocation and environmental constraints on trade. 'In order to reduce the volume of transboundary pollution from Community sources, Community environmental policy should be based on the integral application of the PPP, taking also into consideration damage caused outside the Community borders. The Community should also promote the adoption of quality standards that are no less strict than those established by Community legislation (EU, 1990).'

These principles should be found in the environmental objectives and in the mechanisms that are used to make environmental measures work. Other considerations are of course imposed by the legal framework in which environmental policy will have to integrate. Following out of our analysis of 'conflicting' Articles and case law, we can see three major conditions for the installation of environmental measures that will have to be fulfilled :

1. National measures can only regulate an area where no exhaustive Community secondary law exists or where the latter leaves the Member States with the opportunity to adopt additional rules. Otherwise, national diverging rules have to be motivated as a legitimated exception on existing harmonization.

2. The measures have to have a clear environmental objective. The level of protection, the level of proof, the impact of the measure on trade and competition, the geographic scope and the European interest are issues that need a clear elaboration.
The relationship between the measures and the objectives attempted will be tested by the Court : the measure has to be capable of attaining the objective and should be the least trade-restricting measure leading to the desired level of protection.

3. Complementary to the second condition, the measure may not constitute a means of arbitrary discrimination or disguised protectionism. An environmentally motivated differentiation of the impact of the measure will have to be motivated in a proportionality test for which in most cases the effects at the national level will be the point of reference. The incidental burden on trade is not excessive in relation to the benefits.

The growing number of principles is an evolution that can result in conflicts. Ziegler (p.236) illustrates this with the Walloon Waste case and the famous Danish Bottles case where new environmental principles and their consequences can reshape basic elements of the Community order. In the latter case, the ecological effects of different types of drink containers were considered to be a valid characteristic

for distinguishing the products while in the former case, the origin of the product allowed a different treatment in comparison to local waste.
The cases redefined the non-discrimination principle in a way which is completely foreign to ‘traditional’ trade theory. These principles can as such influenve the Community legal order and it will be interesting to see what will be the ultimate long-term impact of principles like sustainability or safeguarding bio-diversity that are listed in the last Environmental Action Programmes in accordance with the decisions at the 1992 Rio Earth Summit.

The introduction of principles is an evolution that we find mainly in Community environmental policy. Some principles will be integrated in other areas, like the PPP in the Common Agricultural Policy. At first sight, this should be an improvement for the environment compared to the situation before. Some specialists however have serious doubts. At the Brussels conference (17-18 october 1997) 'Community's Environmental Policy at 25 : Stocktaking and Future Prospects', Ludwig Krämer (DGXI) illustrated the difficult translation of the 'polluter pays principle’ into national legislations.
Depending on the Member States, the PPP was (or will be) translated as the polluter shall, should, will, has to,... pay for his actual, past or future damaging pollution.
But what is the correct definition of a polluter and what is pollution? How, to what extent and when should he pay? Also here, there are many differing definitions and the impact of directives without clear specifications is questionable. Furthermore, we already stated that principles that are not translated in laws have no legal force.
The 'polluter pays' is an economic principle that was not developed to be included immediately into legal frameworks. The principle was formulated to influence and ensure environmental efficiency in economic behaviour. Again, principles are illustrative but are on itself not enforceable.
An individual or a firm cannot complain to the Commission or introduce a case because a neighbour does not pay for his pollution or does not correct at the source, notwithstanding the general acceptance of the validity of the principles.
And PPP is maybe one of the most 'applicable' principles.
More vague principles like precaution and sustainable development are probably more difficult to include in Community order. 'Correction at source' poses similar problems. It is clear that pollution should be corrected at the source but what is the final objective? Setting limits on car emissions does not guarantee the maintenance of specific air quality levels. If a level of air quality is the objective, can we achieve this objective by only setting emission levels for cars or the introduction of catalysts? If traffic keeps on growing, emissions per car will not lead to improved air quality, but we can say that 'we corrected at the source' and made 'the polluter pay' for his emissions.
Why then have principles been seen as a good way to work on environmental issues? This is not so clear but probably the attractiveness of principles lays in their obvious educational value. The 'polluter pays'

has some inherent common sense in it and is an application of the ancient Roman civil law rule that makes the responsible party pay for the caused damage if there is a causal link between action and damage. It became a well known slogan and makes environmental policy recognisable, even for people that are not interested in (environmental) policies ('let those dirty factories pays for the environment but do not tax further my fuel.’).

Prevention is another principle that seems to be difficult to apply. Many pesticides are really dangerous but analyses of risks take many years and real prohibitions seem to be very difficult to impose. Prevention should mean something else than waiting many years for some scientific certainty. But also here, the transposition of EC definitions is problematic. For hazardous wastes, there is an EC definition and a Community list of hazardous wastes that was adopted at the end of 1994 by a Council decision, but every Member State applies a separate national list.

A good illustration may be the European waste policies. For Krämer (L'Ecomanager 9/97), the first challenge in EU waste policy is to come to some kind of an agreement on a uniform definition of waste for all 15 Member States. 'We can't create a unified European market for products and then, once they have come to the end of their useful life and become waste, accept that their definitions differ from one Member State to the next. In the end, that will only serve to undermine any common market.'

The first definition of waste (1975) has not been successfully written into national laws and a main reason can be the lack of cooperations from the great economic operators that will be confronted with waste management at the European level. One of their inventions to stop the integrative approach was the use of 'primary' versus 'secondary' materials, two notions that did not exist in Community law and are used by the operators to escape from calling something 'waste'. Threatening with financial sanctions can be an option but real protection has to happen first in people's mind and is not the same as calling the use of a bottle for the second time 'waste' or 'product'. Krämer cites La Rochefoucault in that between strong and the weak, it is liberty that oppresses and regulation that liberates. And the environment is clearly at the weak side...

5. Community environmental law

We discussed the various interactions between national environmental measures and the principles of the common market. Many of the illustrative cases date from the 1970s and 1980s, the period before the Community was entrusted explicitly with the protection of the environment. The Single European Act (SEA) in 1987 with its new title VII, Environment, and Article 130r in particular, gave the Community the authority for a comprehensive environmental policy. In our introduction, we already stressed that Article 130r(2) has integrated environmental protection into all areas of Community action. Of course,

the existing Treaty provisions continued to be important for the adoption of specific environmental measures.
The competence for environmental protection is not exclusively given to the Community. The Community should only act where the interest concerned, that is the protection of the environment, can be better protected at Community level. The Community will have to justify why certain measures should be taken exhaustively at Community level and whether subsidiarity will not lead to the acceptance of locally desirable adjustments which do not jeopardize the Community system or the established system in a certain field.

Article 130r(2) reads (Ziegler, 1996) :
'Community policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Community. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay. Environmental protection requirements must be integrated into the definition and implementation of other Communitiy policies. In this context, harmonization measures answering these requirements shall include, where appropriate, a safeguard clause allowing Member States to take provisional measures, for non-economic reasons, subject to a Community inspection procedure.'
At the Amsterdam Summit (June 1997), the integration clause has been removed from Article 130r(2). It is replaced by the new Article 3d :
'Environmental protection requirements must be integrated into the definition and implementation of Community policies and activities referred to in Article 3, in particular with a view to promoting sustainable development (Klatte, 1997)'.

This text is an improvement compared to the Maastricht text because of its link with sustainable development and because the used 'other policies' is less concrete than 'activities referred to in Article 3'. Whether it will make a real difference in later practices is not so sure. The principle of integration should not only be judged on formal legal grounds but on the basis of tangible results like the improvement of the environment in specific areas. We can also wonder whether integration is the right solution for the disappointing results of European environmental policy so far.

The integration of a weak and difficult to implement policy principle in other policy areas is in our view not 'the ultimate solution' when no other options remain. If the 'polluter pays' principle is difficult to enforce in waste or water policies - due to different reasons for different countries - will it be enforceable in transport or agricultural policies where many other considerations are crucial?
As such, the integration has dangers. Suppose that in future cases, it proves to be very difficult to

integrate various principles and conflicting definitions in the European laws. If the Court, in its case-law, clearly does not impose PPP in certain transport, competition or industrial issues, these cases could stimulate other operators to fight the applicability of PPP in their (more environmental) domains. If the PPP is not integrated in agriculture, why should it then be integrated in other policies?

In our opinion, the use in other policies of environmental principles that are not clearly specified and are subject of discussion should be limited.

But non-integration of environmental concerns also has its price. The decision in 1985 to proceed with the completion of the Internal Market did not consider environmental consequences. This growth stimulus would result, unless further measures are taken, by the year 2010 in serious increases of SO_2 (+8-9%) and NO_X (+12-14%), above the levels which would be reached in the absence of the Internal Market. This situation would be even worser in countries like Greece (+17% and +15%) (EU, 1990). Of course one could argue that integration is a principle that is hardly applicable in a doctrine that wants to stimulate undistorted competition and free trade.

Article 130s states that the Council shall adopt general action programmes setting out priority objectives to be attained, followed by the measures necessary for the implementation. If the involved costs deemed disproportionate for the public authorities of a Member State, the Council can foresee temporary derogations and/or financial support from the Cohesion Fund.
Finally, Article 130t states : 'The protective measures adopted pursuant to Article 130s shall not prevent any Member State from maintaining or introducing more stringent protective measures. Such measures must be compatible with this Treaty. They shall be notified to the Commission.' Ziegler (1996) concludes that this Article reverses the principle that Member States are prevented from taking domestic action in harmonized fields and replaces it by the general lawfulness of such action in the field of environmental policy. The national measures obviously have to be more stringent and the Treaty provisions to be observed are first and foremost the general principle of non-discrimination and the principle of proportionality.

Before this explicit competence for environmental measures, most of the relevant harmonizing instruments were adopted on the basis of the general competence under Article 100, and sometimes in conjunction with Article 235 ('If action by the Community should prove necessary to attain, in the course of the operation of the Common Market, one of the objectives of the Community and this Treaty has not provided the necessary powers, the Council shall, acting unanimously on a proposal from the Commission and after consulting the European Parliament, take the appropriate measures.' (Ziegler,

1996)).
We should keep in mind that as Article 100 only allows the adoption of directives, the Member States always retain a certain autonomy when implementing Community measures. This practice has of course the risk of a heterogeneous realization of Community objectives and the misuse by Member States' authorities. Some state that the lax implementation of Community directives by the Member States is the major problem of today's Community environmental law.
The envisaged harmonization of environmental rules on the basis of Article 100 does however permit differing national provisions (the case law by the Court on Article 30 and the exceptions foreseen in Article 36 have a permanent power even after harmonization). Once a State has notified a divergent measure - there is a compulsory notification of almost all draft national environmental legislation -, the Commission may only check whether it is compatible with the general conditions of Article 36 and the rule of reason. An improper use of this provision will be brought before the Court by the Commission or by another Member State. From the limited number of cases so far, it seems to be that the Court requires a high standard in the arguments put forward for the justification of national derogations.

The mutual recognition of standards under Article 100b could be of great importance when barriers to trade did not fall under Article 100a or under Article 30. Although its applicability might be limited, this Article empowers the Council to require the recognition of national environmental rules and standards provided that they have not yet been harmonized under Article 100a.

6. External relations and environmental protection

Multilateral environmental agreements (MEAs) are the key-instrument for international negotiations to protect the environment. Article 130r(4) provides specific Community competence for international co-operation although there is still no intention to confer an exclusive external competence for MEAs on the Community. The principle of subsidiarity underlines the fact that the Community has the power to act internally and externally only if the objectives can be better attained at Community level. Most MEAs have been concluded as mixed agreements (Montréal Protocol, Vienna Convention) what allows both Member States and the Community to negotiate and ratify international conventions. This is possible even if the Community has already taken internal measures in a relevant area.
Also with MEAs, the possibility to implement more stringent measures is provided by Article 130t. To ensure a homogeneous application, the international agreements are implemented internally by Community regulations. This is necessary because any national restriction on imports from non-member countries which is not applied homogeneously in all the Member States can result in new trade barriers erected between Member States. Trade barriers and commercial policy are the exclusive competences of the Community.

Once the Community has ratified international conventions or treaties, they become part of Community law. They rank below primary Community law but above secondary legislation and therefore prevail over conflicting environmental directives.

(Ziegler, 1996) In general, the Community does not supervise the implementation of international conventions or environmental treaties by the Member States, even if the Community is a party to them. If the Community, however, has adopted secondary law for the implementation of environmental treaties in the internal legal order of the Community, these acts have to be observed by the Member States as normal Community law and the Community will control their implementation. As a general rule the Community and the Member States are responsible for the implementation of an international agreeement. To ensure a homogeneous implementation, the Community mostly uses regulations (and no directives).

This can even happen in cases where the Community has not signed specific agreements like the CITES Convention. The Community uses then regulations to avoid problems resulting from the non-uniform implementation of the trade instruments upon which CITES relies. This regulation allowed the Member States to avoid controls which parties to CITES are normally bound to implement at their national borders. Whenever the Community has not adopted any measures under Article 113, the Member States are authorized under the delegation doctrine to adopt trade measures against non-member countries. Of course, the planned measures have to be notified to the Commission that will interpret the restricitions under similar grounds as provided for by Article 36. Also the rule of reason should be included.

A problem that can rise, is when restricted products are legally brought into commerce in another Member State and are then exported to the import-restricting Member State. Any national measure has to be compatible with the relevant Treaty obligations even if the products' country of origin is a non-member country.

So as a general rule we can state that when the Community does not provide implementation regulation, Member States may not use its obligations arising out of a subsequent international treaty for the non-fulfilment of its Treaty obligations.

Like in the CITES Convention, an important instrument to enforce international agreements can be trade sanctions. Trade-related environmental measures (TREMs) can raise problems when implemented in the Common Market (Article 30 and 36) since the Community has the exclusive competence for commercial policy (Article 113). It is important to note that Community regulations to use TREMs in international agreements can be based on Article 130r or on Article 113 (before the SEA they were based on Article 235). Only in the latter case, the ability to adopt more stringent measures is foreseen.

This will depend on the nature of the measure : is it an environmental measure with a trade-impact or is it a trade measure with environmental effects?
As a general rule, TREMs should be based on Article 113 that excludes however options of taking diverging national measures unless Community regulation expressly endowes the Member States with the power to adopt more stringent requirements.

Part II WTO / International Trade Law

National environmental policies with a potential impact on trade and investment flows also have to consider GATT/WTO law. In the coming sections, we will discuss some 'environmental policy implications' of the relevant GATT/WTO Articles. We will then focus on some specific aspect like environmental taxes, border tax adjustments and measures that extend producer responsibility. In many cases, the similarities - mostly in terms of limitations - with EU law will be striking. This is not surprising since the objectives of GATT/WTO Articles are very similar to these of the European Treaty.
In this first section, we will discuss some aspects of WTO law that are relevant for our analysis.

1. GATT Articles and national environmental measures

For environmental policies, the Principle of National Treatment, Article 3 of GATT, is of crucial importance. This Article has been designed to limit the impact of barriers to trade. Policy makers are as such obliged to give an identical treatment - in all aspects - to imported products and to identical, or 'like', domestic products. Environmental instruments cannot disturb this equal treatment. But many imported products compete with different but similar products. As a result, the interpretation of this principle is under permanent review and the concept of identical or comparable products can become a key issue in WTO Panels that deal with environmental cases.
In the recent 1996 case on 'Japan - Taxes on alcoholic beverages', we find :
"the appropriate test to define whether two products are "like" or "directly competitive or substitutable" is the marketplace. ... [T]he decisive criterion in order to determine whether two products are directly competitive or substitutable is whether they have common end-uses, *inter alia*, as shown by elasticity of substitution. The wording of the term "like products" however, suggests that commonality of end-uses is a necessary but not a sufficient criterion to define likeness. ... [T"]he term "like products" suggests that for two products to fall under this category they must share, apart from commonality of end-uses, essentially the same physical characteristics (WTO Panel Report WT/DS8/11 e.a. , 1996). "

This purely textual interpretation of like products, essentially relying upon physical characteristics and consumer preferences, should be re-examinated in the light of the emerging constitutional function of the WTO (Cottier, 1998).

We have to stress that GATT Articles can not be used by private persons or firms in courts. The GATT provides no right to private individuals to challenge the administrative action of another state before a domestic court or before the GATT authorities. Only a contracting party can challenge another contracting party... The implication of this difference is that GATT contracting parties face a lower risk of having their legislation challenged than EC countries do under EC law.

GATT/WTO and the environment

In contrast to the General Agreement, the "environment" as such is expressly mentioned in the Agreement on Technical Barriers to Trade (TBT, Tokyo, 1979), commonly known as the GATT Standards Code. This agreement addresses non-tariff barriers arising from standards that have been installed to meet physical or performance characteristics, including environmental protection. The agreement further states that parties are obliged to use international standards where they exist, except where they should be inappropriate for human health or the environment.

Environmental measures and trade liberalization

For GATT/WTO rules, a difference is made between the consequences of restrictions on trade and clear discriminatory consequences. If a measure is judged to be a restriction but is imposed equally on both domestic and foreign products under Article III (National treatment), the measure may be GATT **legal** (Walker, 1993). But if the measure would be discriminatory, Article III will be violated.
Article III makes a difference between facial or de jure versus material or de facto discrimination. Material or de facto discrimination exists where a facially neutral measure has a disproportionately burdensome impact on foreign as opposed to domestic goods. Article III offers both versions. As a consequence, seemingly neutral environmental measures should not be applied with the intention to afford protection - directly or indirectly - to domestic producers. Like in EU laws, typical for Article III is the apparent irrelevance of the purpose of the measure in question to the issue of its validity.
In the Petroleum Tax case - also called Superfund case - on US import taxes, applied to imported products in order to offset the effect of certain domestic taxes on physically incorporated inputs to the like domestic products, the Panel was not interested in the justification for the imposition of the tax, but rather in its formal conformity with the GATT rules (Westin, 1997). The Panel wrote : 'Whether a sales tax is levied on a product for general purposes or to encourage the rational use of environmental

resources, is therefore not relevant for the determination of the eligibility of a tax for border tax adjustment (Walker, 1993)'. It is also interesting to note that since exports were exempted from the tax, this tax clearly defeated the application of the 'polluter pays principle' because the pollution was caused during the processing (Westin, 1997).

In contrast to taxation measures under Article III, if a prohibition falls under Article XI (General elimination of quantitative restrictions), the measure is always illegal under the GATT unless it can be exempted under one of the GATT exemptions. The measure does not have to discriminate explicitly foreign producers.
The applicable exemptions will most likely be Article XX b (necessary to protect human, animal or plant life or health) or Article XX g (relating to the conservation of exhaustible natural resources).

Article III offers more perspective for introducing environmental instruments than Article XI, but there are some problematic interpretations of the impact of environmental measures. A measure should not discriminate and therefore the impact of the measure is more important than the regulatory design that could be perfectly neutral.
If as a result of a neutral measure, foreign companies might be required to produce a special product line for the country concerned, thereby raising the cost of these products, particularly if the country's market is not a principal one, the measure would not be legal under the GATT.
For the EU, we discussed the implications of the Dassonville Formula. The potential impact of environmental measures on the marketing of foreign products has then been investigated. For the GATT/WTO, there has been a GATT Panel stating that Article III.4 establishes the principle of 'effective equality of opportunity for imported products' with respect to their sale, distribution or use (Walker, 1993). It is highly probable that bona fide environmental regulations and standards will frequently apply more favourably to domestic products than foreign ones because national legislators mostly tend to take into account specific local conditions and priorities. We can conclude that the threat to environmental measures under Article III is significant. If this absolute equality interpretation of non-discrimination will be used in all Panels, countries would have to resort with increasing frequency to the provisions of Article XX in order to defend the validity of their provisions. This raises the issue of whether GATT panels should protect facially neutral environmental regulations which require minor adjustments by foreign producers. An option could be a de minimis threshold demarcating significant from insignificant restrictive effects of environmental regulation.

The exceptions under Article XX

Article XX (b) and Article XX (g) foresee exceptions if there should be dangers for health or resource depletion. The applicability of Article XX (b) is not that evident because there is no indication from the GATT jurisprudence that degradation of other elements of the environment such as air and water would bring a measure within the 'life and health' designation.

Furthermore, it seems to be that Article XX(g) was intended primarily to authorize controls on the export of non-renewable natural resources such as minerals in danger of exhaustion from exploitation. Since the Tuna/Dolphin case, we know that the GATT panel agreed that tuna appeared to need conservation management (Westin, 1997). Fish are clearly no minerals, but is it plausible that coming GATT Panels will consider as a consequence clean air or water as exhaustible resources?

In the case of fisheries, the concept of conservation has evolved to include socio-economic as well as biological dimensions which have been embodied into international as well as bilateral agreements and treaties guiding fisheries management.

The acceptance of fish as a resource that needs protection was an important outcome from the Panel on Tuna and gave the US the right to impose sanctions on countries that used specific fishing techniques. Then the Panel asked whether the US measure was a necessity to protect the 'resource'. Were all other options reasonably available exhausted? These options could even include the negotiation of international cooperative arrangements. The Panel judged that the American measures were too restrictive. The Panel stated that a contracting party is not able to restrict imports of a product 'merely because it originates in a country with environmental policies different from its own (Westin, 1997).' The conclusion of this Panel are important because they are cited to conclude that states cannot regulate imports in respect of the processes by which that product was obtained or manufactured. Another conclusion is that products are considered alike regardless of how environmentally damaging their production is. Since not all aspects of the debate on production and process methods were included in this Panels, many elements are still uncertain.

Do international agreements offer an alternative on short term? Is it reasonable to require countries which prefer more stringent environmental protection standards to convince a sufficient number of other countries that they pursue the same environmental goals before such standards are considered 'necessary' under the GATT. This would take years and the outcome is always uncertain.

We can conclude that Article XX offers some escape roads but the required necessity is a significant limitation.

2. Environmental taxes and border tax adjustments

In publications of the WTO Committee on Trade and Environment (CTE), we find many arguments in favor of market-based environmental instruments. These instruments, like ecotaxes, are generally more transparent in their operation and provide less scope for discriminatory application, intentionally or otherwise, than administrative controls (e.g. import quotas). They are less prone to informal information and decision-making channels operating to the detriment of companies, sectors or groups without a strong domestic base. Ideally, all market participants - regardless of location, nationality, past economic performance, etc. - are being conveyed the same price information and afforded the same opportunities to respond. In turn, the transparency and predictability associated with such systems tend to facilitate foreign access, encourage longer-term consumption and investment planning and, thus, promote overall economic expansion.

These theoretical advantages do not guarantee that the instruments are GATT legal. Governments are in principle free to operate their fiscal regime according to national preferences and constraints. But from Article III, it follows that no discriminatory consequences are tolerated. In this perspective, it is remarkable to find that environmental taxes are mostly fixed at levels unlikely to have a strong structural impact. A recent OECD study concludes that 'one of the major problems of measuring the relationship between environmental taxes and trade is the fact that environmental taxes are generally low - in most cases probably quite below their optimal level - thus making it impossible to deduce with statistical methods the impact of optimally set environmental taxes on trade volumes and trade structures (OECD, 1996)'. In many countries, strict taxation of consumer goods on health grounds (e.g. tobacco and alcoholic products) seems to meet less public resistance than environmentally-motivated taxes with a potential impact on production and investment decisions (e.g. energy- and transport-related taxes).

If taxes are generally too low to have a structural impact on trade flows, can they have significant discriminatory effects? Any de minimis baseline to weight discrimination will have to include the specifications of the case concerned.

There is also a difference between consumption-related taxation and production-related taxation. Pollution that results from production can be taxed at the consumption stage.

This consumption tax can exonerate exports and supplies to downstream domestic industries, but include all supplies - domestic and foreign - for consumption. However, while appropriate to address consumption-related pollution, excise taxes are not geared to tackle production externalities which, of course, occur regardless of the final destination of a good. Moreover, in the absence of cross-border pollution, the inclusion of imports in the tax frameworks seems to lack a convincing environmental rationale. Their assessment could even result in "double taxation" if the exporting country relies on policies, e.g. administrative controls, whose costs to producers are non-transparent or otherwise do not qualify for refunds on exportation (WTO, 1997).

Border tax adjustments and WTO rules

In our overview of EU law, we already introduced the notion of border tax adjustments (BTA). The type of BTA determines the acceptance of the instrument by WTO. It is evident that border tax adjustments on imported products in excess of taxes borne by like domestic products are deemed to discriminate, and thus violate Article III of National Treatment. Similarly, exemptions or rebates of taxes on exported products in excess of internal taxes borne by like products destined for domestic consumption can be considered an export subsidies subject to the disciplines of the Agreement on Subsidies and Countervailing Measures.

The WTO's position on BTA follows the distinction between direct and indirect taxes, and between adjustments for imports and for exports. Direct taxes are imposed on producers while indirect taxes are imposed on products. Already in 1960, the Working Party on Article XVI:4 considered that the following measures were deemed to be export subsidies, and, therefore, did not fall under the category of taxes which were adjustable at the border:

> "(c) The remission, calculated in relation to exports, of direct taxes or social welfare charges on industrial or commercial enterprises;
>
> (d) The exemption, in respect of exported goods, of charges or taxes, other than charges in connection with importation or indirect taxes levied at one or several stages on the same goods if sold for internal consumption; or the payment, in respect of exported goods, of amounts exceeding those effectively levied at one or several stages on these goods in the form of indirect taxes or of charges in connection with importation or in both forms (WTO, 1997)."

In examining which taxes should be eligible for border tax adjustment, the 1970 Working Party endorsed that distinction and concluded that 'there was convergence of views to the effect that taxes directly levied on products [i.e. indirect taxes] were eligible for tax adjustment. Examples of such taxes comprised specific excise duties, sales taxes, cascade taxes and the value added tax (VAT). It was agreed that the VAT, regardless of its technical construction (fractioned collection), was equivalent in this respect to a tax levied directly -a retail or sales tax. Furthermore, the Working Party concluded that there was convergence of views to the effect that certain taxes that were not directly levied on products [i.e. direct taxes] were not eligible for tax adjustment. Examples of such taxes comprised social security charges whether on employers or employees and payroll taxes (WTO, 1997).'

The preference granted by the WTO (and by the OECD) to indirect taxes relies on the assumption that indirect taxes are shifted completely 'forward' by the taxpayer. They are reflected in the final price of the product and in the decision of the consumer. Direct taxes are shifted 'backward' since they are finally borne by the manufacturer of the product, and are not reflected in the final price of the product. To summarize, WTO provisions on border tax adjustment follow the destination principle for indirect taxes, and the origin principle for direct taxes. Border tax adjustment is therefore not possible for direct taxes, whether levied on imported or on exported products.

* Border tax adjustments on imported goods

One of the basic purposes of Article III National Treatment is to ensure that internal charges and regulations are not such as to frustrate the effect of tariff concessions granted under Article II.. However, Article III applies whether or not the product concerned is subject to a tariff concession and whether or not adverse trade effects occurred. The purpose of that provision is to establish certain competitive conditions for imported products in relation to domestic products; it is not to protect expectations on export volumes.

The relevant question becomes whether or not the BTA has a discriminatory impact on the imported products. This does not mean that the BTA should be identical to the internal tax level. In the Panel Report 'Japan - Taxes on alcoholic beverages' we find :

'There could be objective reasons proper to the tax in question which could justify or necessitate differences in the system of taxation for imported and for domestic products. ...[i]t could be also compatible with Article III:2 to allow two different methods of calculation of price for tax purposes. Since Article III:2 prohibited only discriminatory or protective tax burdens on imported products, what mattered was, ..., whether the application of the different taxation methods actually had a discriminatory or protective effect against imported products (WTO, Panel Report, 1996)'.

If the level of the BTA exceeds the internal tax level without a clear objective reason, the smallest amount of "excess" taxation is too much (ibid). So there is still no de minimis standard used to evaluate the trade effects of differences in taxation. In the Appellate Body Report on this case, we find however that a case-by-case approach is used so the principle of a de minimis impact is not excluded for other cases.

* Border tax adjustments on exported products

This BTA is also allowed under GATT provisions.

The exemption from, or refund of, taxes borne by like domestic products cannot be subject to anti-dumping or countervailing duties, as stated in Article VI:4 of GATT 1994:

"No product of the territory of any contracting party imported into the territory of any other contracting party shall be subject to anti-dumping or countervailing duty by reason of the exemption of such product from duties or taxes borne by the like product when destined for consumption in the country of origin or exportation, or by reason of the refund of such duties or taxes (WTO, 1997)."

The fact that border tax adjustment on exported products is not countervailable was confirmed by dispute settlement practice.

The Uruguay Round Agreement on Subsidies and Countervailing Measures (the "Subsidies Agreement") is based on the same principles. Its footnote 1 to Article 1.1(ii) states that

"In accordance with the provisions of Article XVI of GATT 1994 (Note to Article XVI) and the provisions of Annexes I through III of this Agreement, the exemption of an product from duties or taxes borne by the like product when destined for domestic consumption, or the remission of such duties or taxes in amounts not in excess of those which have accrued, shall not be deemed to be a subsidy."

Similarly to BTA on imported taxes, adjustment with respect to the full or partial exemption, remission, or deferral specifically related to exports, of direct taxes or social welfare charges paid or payable by industrial or commercial enterprises is an export subsidy and is not GATT legal. The exemption or remission, in respect of the production and distribution of exported products, of indirect taxes is considered to be an export subsidy only when the amount of taxes remitted or exempted exceeds the amount of such taxes levied in respect of the production and distribution of like products when sold for domestic consumption; such exemption or remission is then allowed if their amount is equivalent to that borne by domestic like products (Subsidies Code).

* Border tax adjustment on inputs incorporated or exhausted in the production process

While it is clear that border tax adjustments are possible for indirect taxes levied on products, the extent to which indirect taxes on inputs, incorporated or exhausted in the production process, to the final product can be adjusted at the border, whether on exports or on imports, remains to be clarified. This adjustment can be important for countries that want to introduce taxes on energy or carbon dioxide.

From Article II:2(a), it follows that border tax adjustment can be made with respect to 'a charge equivalent to an internal tax imposed consistently with the provisions of paragraph 2 of Article III [footnote omitted] in respect of the like imported product or in respect of an article from which the imported product has been manufactured or produced in whole or in part (WTO, 1997).'

Already during the negotiations of the Havana Charter, it was agreed that the word 'equivalent' meant, 'for example, if a [charge] is imposed on perfume because if contains alcohol, the [charge] to be imposed must take into consideration the value of the alcohol and not the value of the perfume, that is to say the value of the content and not the value of the whole (WTO, 1997).'

We already referred to the panel on 'United States - Taxes on Petroleum and Certain Imported Substances'. This panel examined whether the US tax on 'certain imported substances', which taxed certain downstream imported chemicals which were derivatives of taxable chemicals, fell under Article III.

It considered that 'the tax is imposed on the imported substances because they are produced from chemicals subject to an excise tax in the United States and the tax rate is determined in principle in relation to the amount of these chemicals used and not in relation to the value of the imported substance. The Panel therefore concluded that, to the extent that the tax on certain imported substances was equivalent to the tax borne by like domestic substances as a result of the tax on certain chemicals the tax met the national treatment requirement of Article III:2, first sentence (Panel Report).'

* Border tax adjustments for inputs incorporated in exported products

Similarly, exemption, remission or deferral of prior-stage cumulative indirect taxes on goods and services used in the production of exported products is permissible, but only to the extent that the goods and services in question are "consumed in the production process" and that the taxes exempted are not in excess of such taxes on goods and services used in the production of like products when destined for domestic consumption. Also allowed is the remission or drawback of import charges not "in excess" of those levied on imported inputs that are consumed in the production of the exported product (WTO, 1997)

The discussions on environmental taxes and border tax adjustments are not closed. An overview of recent - differing - positions by WTO Member can be found in CTE Press Releases.

3. Extended producer responsibility

Environmental taxes are mostly just a part from a programme that has many implications. In many countries, an important environmental policy development during the 1990s was the introduction of initiatives that required greater producer responsibility. Take-back programmes in the EU for packaging waste are a typical and well-known example.
The broader policy implications of Extended Producer Responsibility (EPR) remain largely unknown. There might be an impact on trade flows or on international competition. Also inside a country, a tendency towards more monopolistic behaviour could be a result of take-back obligations.
Considering EPR, when it comes to international trade barriers, we have to review the relevant provisions of the General Agreement on Tariffs and Trade (GATT) and of the Technical Barriers to Trade Agreements (TBT) under the WTO.
It is rather clear that currently no take-back programmes are in flagrant, obvious violations of WTO principles. There are however some actions that could be undertaken within take-back programmes which would lessen the threat of succesful challenge before the WTO. Jim Salzman - professor environmental law and OECD consultant - suggests actions that include careful scrutiny and avoidance of dumping collected recyclable material on international markets at below cost, identifying and alleviating barriers against particular products or packaging from least-developed countries, providing opportunities

for other countries to comment on proposed standards, effective notification to other countries of technical requirements for compliance, and development of relevant international standards through ISO or another international organisation (OECD, 1997).

We will concentrate on 4 categories :

1. dumping of collected recyclable material ;
2. de facto discrimination of imported products ;
3. requirements imposed by private actors ;
4. developing countries have more problems to adopt.

3.1. Summary of relevant trade law

First of all, waste programmes are not yet covered by GATT/WTO-principles and this will probably not change very soon. A problem is that GATT does not recognise a waste/non-waste distinction. The State Department of the United States and the European Court of Justice, for example, have both stated that traded wastes could be regarded as 'products' under trade law.

Since the GATT is a contract among national governments, the Agreement has no relevance for private actors like retailers that decide to ban the sale of products coming from a specific country.

Article III National Treatment

This Article would be violated if take-back programmes treat domestic goods different compared to imported goods and when this difference results in discrimination. Both categories of products have to be 'like' products and this depends to a large extent on personal interpretations. From the famous Tuna/Dolphin case, it follows that processing and production methods (PPMs) cannot be taken into consideration in differentiating among 'like' products.

Article VI Anti-dumping and countervailing duties

Countries can raise tariffs when they are faced with below-cost imports. This is also applicable for imported collected waste.

Article XXIII Nullification or impairment provision

This Article provides a remedy for countries that have negotiated a trade concession and this concession

is significantly diminished by an action that was not reasonably foreseeable.
Take-back laws can be a case where former concessions are reduced or influenced by unforeseen obligations.

Article XX Legitimate exceptions

Article XX's exceptions do not apply if the measures are applied in an arbitrary or unjustifiable manner, or operate as a disguided restriction on trade. Legitimate environmental protection are covered by Article XX(b) and XX(g). This last clause is important for laws that violate other GATT Articles but that are directed at conserving a domestic exhaustible natural resource and place comparable burdens on both domestic and imported products.

Technical Barriers to Trade Agreement (TBT)

The TBT was adopted during the recent Uruguay Round of trade negotiations. Its coverage includes technical standards (voluntary) and technical regulation (mandatory), including symbols, marketing and labelling requirements.
Article 2 of TBT deals with 'Preparation, Adoption and Application of Technical Regulations by Central **Government** Bodies'. These rules would apply to many environmental programmes in different countries but would probably not cover rules set by private collection companies such Duales System Deutschland (DSD). But government is assumed reponsible for private standard setting in the 'Code of Good Practice for Preparation, Adoption and Application of Standards'.
TBT Article 2.2

Regulation cannot be prepared with a view of creating unnecessary obstacles to international trade. A measure cannot be more trade restrictive than necessary for a legitimate objective, including environmental protection.

TBT Article 2.9

In preparing new technical standards, the government must notify the TBT Secretariat of the standards's objectives and rationale at an early stage that amendments from Member Countries can be introduced and taken into account.

3.2. Legal analysis of the hypotheticals

Hypothetical 1 : Dumping Recyclable Material

A high level of collection and recovery can cause problems when the country has insufficient recycling capacity. Germany confronted this problem immediately with plastic, paper and carton board. Much of the excess was pushed onto the international market at low or no cost to regions as distant as the Pacific Rim. This flooding of markets with cheap recyclable material can harm local recycling schemes. Why still collect own waste at a cost that exceeds the export price of foreign collected materials? It happened that with sorted plastic and paper on offer for little or nothing, re-processors turned away from local recycling organisations, denying them a substantial stream of income.
Like already mentioned, GATT does not make any difference between waste and other products thus recyclable material could be subject of a countervailing duty. Like other products, the duty will be calibrated to the 'margin of dumping' which restores the price to its level prior to lowering or subsidisation. But since German waste is not collected in order to gain a large market share abroad, and since there is no difference between the foreign and domestic price, the countervailing duty will be a false inflation of prices.
This problematic situation will probably not occur that often.
The EU Packaging Directive explicitly prohibits operation of packaging take-back programmes with a recycling requirement above 45 percent unless the country has a domestic recycling capacity to handle the excess amount without distorting the Internal Market.

A local variant to dumping, expressed as an industry subsidy, is also worth examining. It can be that take-back programmes result in national price advantages for products with an important recycled content, just because the government imposed or supported collection schemes. The Uruguay Round's Agreement on Subsidies and Countervailing Measures could apply. But mostly, the government does not pay a direct subsidy to the users of recycled material - comparable to unemployment measures that favour labourers without qualifications - so the situation is not countervailable.

Hypothetical 2 : De Facto Discrimination

Most GATT challenges to environmental measures have involved de jure discrimination, cases where the law openly treats foreign products differently.
With not openly discriminating laws, a de facto discrimination can be argued. There are three basic types of injuries ; added costs to meet different requirements in different countries, discrimination against

foreign goods' transit packaging (more robust for the longer trip) and an inferior bargaining power because foreign manufacturers will have little or no choice but to join large collection systems.

The leading GATT case on de facto discrimination is the 1994 dispute panel decision on Automobile Taxes. De jure discrimination was absent in the case but the Panel noted that for a measure to be subject to Article III, it does not have to regulate a product directly. It only has to affect the conditions of competition between domestic and imported products. But while facially neutral measures can violate Article III, both the effect and purpose must be inherently discriminatory.
And to show that the intent of the measure is to protect local companies is not that obvious.
The Panel concluded that the purpose of Article III is not to prevent contracting parties from using their fiscal and regulatory powers for purposes other than to afford protection to domestic production. Incidental trade barriers, if not intended to protect local companies, should not violate Article III.

An alternative might be Article XXIII, the nullification and impairment clause, that may become more important as take-back requirements extend to complex, high value goods which have negotiated tariffs (e.g. cars).
But if we assume that Article III or XXIII is violated, then country Z may still avoid a GATT violation by qualifying for the exception of Article XX(g) but until now, no dispute panel has addressed whether landfill qualifies as an exhaustible natural resource under Article XX.

Since TBT has not yet been interpreted by a WTO dispute panel, its application to take-back programmes is uncertain. A threshold question is whether the TBT applies at all, i.e., whether take-back laws meet the definition of a technical regulation. They might be considered product 'related processes' that can influence product design and this could be interpreted as a technical regulation that creates an unnecessary obstacle to international trade. To judge it as unnecessary, alternatives that do not distort competitive balances should be formulated.
In the future, take-back laws expand their reach from packaging to other, more valuable products like computers and this will imply re-use, special designs (with standardised components) and even the construction of regional processing facilities.

Hypothetical 3 : Private Actors

We wonder what could be the consequences when the private collection system does not accept a certain type of packaging and excludes as such foreign producers from the market.
GATT disciplines presumptively do not apply to private companies and since the standards used by this company are voluntary (one has the free choice to participate in the programme or not), the TBT Articles

do not apply.
If the used standards create problems for foreign producers, and simple measures could remove this concerns, the home country would be held responsible for bringing the standards in line with the dispute panel's holding.
The private firms that manage the take-back programmes exist in fact by state approval, are in some countries state-regulated monopolies, what makes that their acts qualify as government actions. The reach of the GATT and TBT to quasi-state entities is unclear, but the arguments above warrant consideration.

Hypothetical 4 : Developing Countries

GATT and TBT provide special treatment for developing countries. At the moment, private collection schemes do not appear to make special arrangements for products from developing countries. The resulted in some cases like that of the Kenyan flower crates where special assistance was necessary. With the expansion of take-back programmes among many countries and for more and more products, expensive assistance could be an unexpected consequence.

III. Conclusions

As could be expected, both the EU and the WTO offer the possibility to introduce national environmental instruments. The increased use of market-based instruments is clearly encouraged.

Many considerations have to be taken when designing the new instruments. The instrument should have no discriminatory impact, directly or indirectly, and the environmental objective should be clearly formulated. Exception clauses are foreseen by the EU and the WTO. In any case, the measure should always be in proportion to the environmental objective.

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Environmental Consumer Subsidies and Potential Reductions of CO_2 Emissions

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1. Introduction

In the environmental debate, global problems clearly gained importance. Successful international conventions could reduce the threats posed by acid rain, ozone depletion and hazardous wastes. Next to end-of-pipe solutions (like placing scrubbers), cleaner inputs (like low-sulphur coal), cleaner products or retrofit processes (replacing CFCs by HCFCs and HFCs) were available in due course.

Acid rain and ozone depletion are problems caused by specific industrial activities, processes or products, whereas global warming and the resulting climate change are the consequence of a multitude of factors, most of them related to energy use. This limits the possibility of solving the problem with just one set of substituting technologies. It will be necessary to work out a concerted strategy that exploits all potential efficiency gains in all layers of society. We will need to modify whole structures, institutions and behaviours. Therefore we can use economic instruments like taxes, subsidies and tradable permits.

We will try to estimate the potential of environmental subsidies in terms of reductions of energy use and CO_2 emissions. In the next sections, we will comment on the Kyoto Protocol and the projected CO_2 emissions in the European Union. Starting from data on sectoral energy efficiency, we will indicate policy priorities and will present a short overview of instruments. In the final sections, we work out three types of consumer subsidies and estimate their potential of reducing CO_2 emissions.

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We will conclude that these subsidies - basic but attractive instruments for politicians - can be an important step in achieving the Kyoto targets.

2. The Kyoto Protocol

In December 1997, developed countries agreed in Kyoto to reduce significantly emissions of greenhouse gases (GHG) resulting from human activities by the commitment period 2008 to 2012. Each developed country will have to demonstrate significant progress by 2005.
For the European Union, the agreed reduction will be 8% of the emissions in 1990. Compared to the initial European proposal to reduce emissions of greenhouse gases by 15% - a realistic reduction according to the EC-, the agreed reduction target should not pose serious problems. As a result of the important reductions of greenhouse gases in Germany and the UK, actual emissions in the EU only slightly exceed the 1990-level. This means that all the needed reductions will have to take place without delay. Furthermore, CO_2 and other emissions in Germany will not continue to decrease. This is crucial since the relative weight of German emissions in the total emissions in the EU amounts to almost 30%. For the period 1995 to 2005, German emissions are expected to increase by 10% if no measures are taken. In the scenario >with measures=, the German emissions could be reduced by an additional 3% (Climate Protection in Germany, 1997).
Until now, there is no further distribution of the total European reductions among the Member States so each country has the obligation to reduce its emissions by 8%. The initial EU proposal contained very generous provisions for Portugal (+40%), Greece (+30%), Spain (+17%), Ireland (+15%) and even Sweden [1](+5%). Not surprisingly, this differentiation[2] was strongly criticised by developing countries that were asked at the Kyoto Conference to engage in significant reductions of greenhouse gases.
For the US, the agreed reduction is 7%, Canada has to reduce emissions by 6% and for Japan the target is -5%. Countries like Australia, Iceland and Norway are allowed to further increase their emissions of greenhouse gases, by respectively 8%, 10% and 1% (Kyoto Protocol, FCCC, 1997). These increases of GHG has been criticised but in its Climate Change Report of 1997, Australia

[1] In 1990, emissions in Sweden were at a >historical minimum= with the completion of a nuclear building programme, industrial biomass utilization and energy conservation programmes in virtually all sectors.

[2] According to Michel Raquet (EU, DG XI), the final distribution of the European reduction will be according to the differentiation in the first proposal of the European Union.

states that its population is expected to grow by almost 33 % for the period 1990-2020. This increased population will consume and produce so the national energy needs will increase much stronger than in regions with lower population growth like Europe (expected population growth of +1.7% for the same period) and Japan.
In this perspective, the engagements of the US and Canada are remarkable because their expected population growth is just below the Australian figure.
If we link estimated population growth to the national engagements in Kyoto, the real efforts in terms of reducing emissions strongly differ. In Table I, we assumed that the Kyoto targets should be achieved over the period 1990-2020 so we can link reductions to the same period of population growth.

Table I - GHG reduction targets and estimated population growth, 1990-2020

Country :	Unit.States	Eur.Union	Canada	Australia.	Norway
Kyoto target (1990=100)	93	92	94	108	101
Population growth (1990=100)	126	101.7	128	133	109
Real needed reduction	- 26.2 %	- 9.5 %	- 26.6 %	- 18.8 %	- 7.4 %

Source for the population data : Australia=s Climate Change Report 1997, p.15

The calculated 9.5% reduction for the EU is facilitated by the German unification. Over the period from 1990 to 1995, the closing down of old and inefficient installations reduced total German greenhouse gases by 11.7% (Climate Protection in Germany, 1997, p.13). This means that, for the same period, total European GHG emissions were reduced by some 3 to 3.5%.

3. Projected CO_2 emissions in the European Union

As a consequence of the Rio Conference in 1992, the European Union elaborated some measures of which the controversial CO_2 tax received most attention. This CO_2 tax was first re-proposed in a very weakened and modified form and then >declared dead= in March 1996 (Howes, 1997). The tax was replaced in 1997 by a new proposal ; the Energy Product Tax (COM(97)30). This new tax will introduce higher minimum tax rates for all energy products. The proposed minimum tax rates are at least 33% higher than existing minimum rates on hydrocarbon oils and they will be increased by more than 10% automatically in the year 2000. Subject to adoption of the proposal by the Council, the Energy Product Tax should come into effect in 1998 (COM(97)30 - Information Note). But since industry will probably fight also this tax and the argument of international competitiveness will remain on top of the European agenda, the chances of the Energy Product Tax are limited. Other instruments like subsidies should therefore be considered.

If we reduce global warming to a problem of reducing CO_2 emissions - the most important greenhouse gas next to methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexofluoride (SF_6) - , our starting point should be the projected CO_2 emission in the EU for 2010 if no new measures are taken.
Table II presents the projected distribution of CO_2 emissions in the EU for 2010. Without new measures, total emissions will increase by 8%. We added some sectoral target values that lead to a reduction that complies to the Kyoto obligations for the EU.
The transport sector - including air transport - is responsible for the bulk of the projected increase. Another conclusion is that in 2010 residential, tertiary and institutional emissions will almost exceed total emissions by industry.

Table II - Sectoral emissions of carbon dioxide (CO_2) in the EU (mill.tons)

Sector/year	1990	2010	change	*Target for 2010*
Transport (incl.intern. air transport.)	743	1032	+ 39 %	*775 (+4%)*
Industry : combustion	626	532	- 15 %	*500 (-20%)*
Industry : industrial processes	141	158	+ 12 %	*120 (-15%)*
Residential/Commercial/Institutional	658	680	+ 4 %	*592 (-10%)*
Energy and transformation	1036	1057	+ 2 %	*930 (-5%)*
Total emissions	3200	3459	+ 8 %	*- 9 %*

Source : COM(97)481 + *own additions*

The foreseen reductions of CO_2 by industry are probably an underestimate. It is for instance illustrative that the potentials of Combined Heat and Power (CHP) installations are continuously upgraded. In the Netherlands, voluntary agreements with some 30 industrial sectors include the target of an improved energy efficiency by 10 to 25% for the year 2000 relative to 1989 (Second Netherlands= National Communication on Climate Change Policies, 1997) . From the first results and from experiences of global corporations like Hoechst (Hoechst Progress Report 1996) the targets will be met in most cases. For the remaining ten year, further reductions should be possible.
Less energy used means less carbon dioxide emitted. Since many industrial processes, like in the sectors of iron and steel, are still strongly depending on the burning of coal, potential reductions of CO_2 are still very great.
Similar remarks can be made for emissions by fossil fuel power plants. According to the EU, the

overall thermal efficiency of existing fossil fuel power plants in the EU was 38% around 1994 compared with new power plants that typically offer efficiencies of around or even above 50% (COM(97)481). Next to measures of thermal efficiency, there are still important extraction, transportation and tranformation losses.

4. Sectoral energy use efficiency and priorities for policy

Greenhouse policies clearly should focus on improving energy efficiency. Table III contains a balance of final energy consumption by sector and by energy service for Germany in 1992 (old Federal Länder). This final energy consumption of 7751 PJ was possible after the primary energy consumption of some 11000 PJ. The transformation losses and non-energy-related consumption of primary energy consumption still account for 35% of primary energy consumption in 1995.

In the transport sector, almost all consumed energy is converted into mechanical energy. The efficiency loss of this transformation processes is however very high. Only some 18% of the consumed energy is used in an efficient way. Also in other sectors, significant opportunities to improve efficiency remain.
If we link the projected increase of transport CO_2 emissions to the low efficiency of actual mechanical energy use in this sector, it is clear that technological improvements are urgently needed. Another conclusions is that the continuous improvements in industrial energy use should be enforced by efforts in the residential and tertiary sector.

Table III - Energy consumption by sector and efficiency of energy use, old Federal Länder, 1992

Sector	*Final energy*		*Usable energy*	
	PJ	Percentage	PJ	Percentage
Transport	**2194**	**100 %**	**396**	**18 %**
-heat	2	0.1	1	70
- mechanical	2189	99.8	394	18
- lights	3	0.1	0	7.5
Residential	**2069**	**100 %**	**1357**	**65.6 %**
- process heat	340	16.4	160	47.0
- indoor heat	1568	75.8	1145	73.0

Sector	*Final energy*		*Usable energy*	
- mechanical	126	6.1	50	40.0
Industry	**2212**	**100 %**	**1323**	**59.8 %**
- process heat	1521	68.8	882	58.0
- indoor heat	217	9.8	152	70.0
- mechanical	439	19.8	285	65.0
- lights	35	1.6	4	10.0

Source : Second Report of the Government of the Federal Republic of Germany Pursuant to the United Nations Framework Convention on Climate Change, p.45

5. Policy options and sets of instruments

We presented some indications for giving priority to energy issues in transport and in the residential/tertiary sector. Before discussing some instruments, it is interesting to refer to some estimates of total greenhouse policy costs. In COM(97)481, we read :
AFor a 15% reduction in CO_2 emissions compared to 1990 estimates of the direct compliance costs related to energy supply/demand mitigation actions range from around 15 bn Ecu to about 35 bn Ecu annually by 2010. This corresponds to roughly 0.2 and 0.4% of GDP in the year 2010.@
Since the European reductions will not be 15 but only 8%, total costs will be lower but still very impressive. Most estimates amount to 0.1% to 0.2% of GDP. Similar findings are presented by the Energy Technology Systems Analysis Programme (ETSAP), a cooperative research agreement among member countries of the International Energy Agency (IEA). Through partnerships, ETSAP uses the expertise of 60 teams in more than 30 countries that work with the MARKAL-MACRO family of energy/economy/environment models. ETSAP estimates that the marginal CO_2 reduction costs in 2010 can amount to $ 150 per ton reduced, depending on the specific country of analysis (ETSAT Kyoto Statement, 1997).
These high estimates of CO_2 abatement costs are derived from a framework that does not include the potential costs saving from emission permit trading or joint implementation that allows countries with high marginal abatement costs to buy credits from countries where abatement costs are much lower. Since many developing countries have very inefficient electricy plants, substantial reductions of emissions are possible on short term and at a low cost.
For the US, the economic costs of implementing CO_2 reduction measures are calculated using

the opportunities of international emissions permit trading, joint implementation and the Clean Development Mechanism. Dr.Janet Yellen of the President=s Council of Economic Advisors indicated in a recently given testimony that the abatement cost for carbon dioxide would be roughly $ 14 - $ 23 per ton. This would correlate to between 3-4 cents per gallon of gasoline, a modest increase (USIS, Embassy of the United States of America, 1997).
For reductions of emissions at the national level, various policy options and instruments are available :

1. Taxes on energy

Fiscal instruments are being increasingly used as a step towards implementing the Polluter Pays Principle (PPP). The Commission=s communication on environmental taxes and charges in the Single Market provides guidelines for Member States in designing, implementing and evaluating environmental levies and charges (COM(97)9). This communication came one year after the discussions on a European CO_2 tax so its future use will probably be more in the field of ecotaxes on products and packaging wastes.
Taxes on energy are among the most popular environmental instruments. But in many countries energy taxes are already very high. Additional taxes will result in >cigarette prices=: prices of which 75 to 90% consists of taxes. The health implications of smoking cigarettes are however more obvious for smokers than the negative consequences for the environment of burning fuels. High taxes on cigarettes are therefore an application of the *Killer Pays Principle*.
In other debates, energy taxes are presented versus labour taxes as >taxing the bad versus taxing the good=. The problem here is that we rather have to differentiate according to the efficient or inefficient use of energy. If we take a central heating burner of 1970 - of which many millions are still used in Europe - and compare this burner to the best types of 1998, the two installations have extreme differences in energy efficiency. For old burners the efficiency is around 50-60% while this percentage will be around 95% for the newest types.
If an energy tax would be installed because >using energy is bad=, families with the most efficient available heating installations will be punished for their efficient and optimal use of a natural resource. We should better tax inefficient burners or subsidize efficient types[3].
Therefore, we will work out some policy instruments that promote the most efficient use of energy (in heating installations, for cars and other engines and in households).
Furthermore, if we relate CO_2 to the external effects of generating and using energy - an approach

[3] A similar reasoning can be used when it comes to emissions of methane, one of the other important greenhouse gases. After eating grass, cattle or other animals emit methane. If we want to reduce emissions of methane, we can tax grass (like an energy tax) or the cattle. People with a lawn that do not own animals will clearly prefer the latter option. Otherwise, we would punish efficient users of the resources like polluting users.

in line with the Fifth Environmental Action Programme (5EAP) of the EU -, we have to consider the greenhouse external effects of transport, industry and other sectors. It is not easy to calculate these effects because there is still a significant element of uncertainty in many assessments of the consequences of global warming. As an example, the human-induced greenhouse effect has completely different consequences for countries that strongly depend on winter tourism compared to countries that will have better agricultural possibilities if average temperatures increase by some 1 or 2°C.

The Extern-E project AExternalities of Energy@ by DGXII (Joule Programme) calculated the complete external effects of energy generation and transport. The first results clearly demonstrate that emissions of Particulate Matter (PM) are much more important - in terms of external costs - than emissions of CO_2. PMs can have significant health effects for people with respiratory problems. For transport, PMs account for 80% of all external costs.

As could be expected, the same survey shows that burning coal generates much higher external costs compared to using other energy inputs.

Similar results - for transport - are presented by Proost and Van Regemorter (1998). Using the TRENER model for the EU JOULE II programme, they found that existing energy taxes per passenger kilometre already strongly exceed the external costs in terms of air pollution per passenger kilometre. Only for public transport where taxes are much lower (or even negative), the external costs for air pollution are not covered by the reference taxes.

To conclude, if we motivate a CO_2 tax by means of the Polluter Pays Principle (PPP), we open the door for many other taxes that better correct for external effects like a health tax on PMs or a tax on diesel. A strict application of the PPP would lead to reducing many energy taxes in private transport because they are already too high.

2. Subsidies

The sectors that contribute most to the emissions of CO_2, all have a tradition of subsidies and preferential regimes. Energy has always been a crucial resource for economic development and energy policies are closely linked to industrial and social policies. The oil crises and the Gulf War brought energy back on the political agenda.

Since the 19^{th} century, nations invested massively in their energy structure and many subsidies still have a clear impact on energy prices. According to a recent OECD-survey, adding up all subsidies and subsidy-equivalent market distortions still gives a total of $ 100 billion or 0.75% of the OECD-GDP. The total greenhouse gas mitigation opportunities identified in the case studies would total some 400 to 500 million tonnes of CO_2 in 2010 - about half of it in Russia.

Some promising areas for subsidy reform are :

- removing coal producer grants and price supports ;
- reforming subsidies to electricity supply industry investment or protection from risk, where

these support investment in coal-fired power stations ;
- removing barriers to trade that discourage the use of energy forms with fewer environmental effects ;
- removing sales tax exemptions for electricity (and other energy forms) ;
- eliminating subsidies and cross-subsidies to consumers in remote areas or to other groups ;
- removing electricity subsidies for energy-intensive industries.

The burning of coal generates most emissions of CO_2 (compared to oil and gas) and subsidies for coal industries were even during the 1990s very high. Total subsidies (and equivalents) in 1993 were $ 428 m in France, $ 6 688 m in Germany, $ 1 034 m in Japan, $ 856 m in Spain, $ 416 m in Turkey and $ 873 m in the United Kingdom (OECD, 1997). Substituting coal for oil and gas could be stimulated by eliminating these coal subsidies.
New - but different - subsidies can be used for stimulating behaviour that contributes to reduced CO_2 emissions. For industry, basic research, R&D programmes or clear implementation programmes could be sponsored to develop and diffuse new processes and applications to save energy during industrial activities.
For the residential and tertiary sectors, subsidies could be used for stimulating a wide range of energy-efficiency investments (from central heating systems and insulation materials to freezers, micro waves, computers, washing machines and many more). For transport, similar subsidies for clean cars should be elaborated.

3. Environmental agreements

Since the late 1980s, there has been increasing use of Environmental Agreements (EAs) as a new policy instrument in industrial environmental management. Since industry has most detailed information on its processes and their environmental impact, this knowledge should be used to work out various measures. In some cases, environmental agreements with clear targets could prevent new regulations.
Concerning energy-efficiency, the Voluntary Energy Efficiency Programme (VEEP 2005) is a good illustration of a European agreement to increase energy efficiency in the chemical industry. Energy is a very important element of costs in the basic chemical industry and since European prices were in 1996 already on average 65% to 24% higher than in the US, the European chemical industry, grouped by CEFIC, strongly opposed and will continue to oppose any European energy tax proposal. As an alternative, voluntary investments for saving energy have been made. The results are rather positive. Over the period 1980-1995, while chemical output growed by 55%, fuel and power consumption increased by >only= 9% (CEFIC, 1997). This is a 30% improvement in specific energy consumption. Over the same period, following the substitution of gaseous fuels for liquid ones, CO_2 emissions per unit were reduced by nearly

40%. Since 1992, the European chemical industry has been implementing VEEP 2005, a unilateral commitment to reduce its specific energy consumption by a further 20% between 1990 and 2005, provided that no additional energy taxes are introduced. According to CEFIC, to undertake the necessary efficiency investments, companies need a long-term stability of the business environment in which they operate.
We already referred to co-generation or Combined Heat and Power (CHP) generation, the process whereby electricity and steam are produced simultaneously. In many countries, CHP is still not widely used because monopolistic electricity structures can limit access to the grid for the generated surplus electricity. Or when access to the grid is given, the transportation prices of this electricity are very high. These remarks are made by companies that are interested in CHP but see their efforts blocked by existing monopolistic market behaviour. The liberalisation of the electricity market is clearly needed to stimulate CHP.

6. Reducing emissions at the lowest cost

In the following sections, we focus on reducing emissions in transport and in the residential/tertiary sector. We first illustrate how current tax levels differ for the same energy input that is used for a different purpose.
We start with a typical family that has a car on diesel and a central heating system that uses the same fuel, here called heating oil. If the house of the family has an average size and volume and is standing alone, the annual use of heating oil will be between 2000 to 4000 litres, depending on the orientation of the house, the efficiency of the heating system, the level of insulation, the number and surface of windows, lifestyle,... We assume that the burner/boiler of the central heating system dates from 10 to 15 years ago and that the installation consumes 3000 litres of fuel each year.
The same family uses its diesel car each year for some 30000 kilometres. This is a high estimate. If this recent diesel car needs 6.5 liters for 100 kilometres, the engine will burn 1950 litres of car diesel each year. The average European price for car diesel is around 0.65 Ecu. The average European price for heating diesel is around 0.25 (European Commision, 1997). There is a such already a large difference in price for the same energy that is used for different purposes. The CO_2 emitted by a diesel car is however exactly the same as the CO_2 emitted by the burner of a central heating system.
If we want to reduce CO_2 emissions, green taxes can be used. Higher energy taxes will generate significant tax incomes for reasons of very low energy price elasticities. The long-term price elasticity for the number of kilometres driven is estimated between -0.1 and -0.4 (European Commission, 1997). The elasticity for heating purposes is even lower. But since these taxes are much lower, this category of fuels seems to be a more >logical= choice when introducing additional energy taxes. Car use is already subject to many other (fixed) taxes and this is not the

case for heating systems.
Cars are the target of many environmental groups and green political proposals. Suppose we want to reduce diesel consumption for transport purposes by 10% (195 litres). If we assume an elasticity of -0.25, we need a 40% energy price increase. But since the number of cars is expected to grow by at least 20% for the period 1990 to 2020 (Netherland=s National Communication, 1997), a higher reduction of average diesel consumption for transport purposes is needed to stabilize transport emissions. A reduction of the number of kilometres by 20% could be obtained by a 80% price increase. There will clearly not be many political parties that want to start a campaign with these propositions.
What are the alternatives? In technical surveys, we find many opportunities to reduce the fuel consumption of heating systems. On average, burners/boilers that are installed in the 1970s consume 30 to 50% more than the most recent models that reach an efficiency of more than 95%. Replacing old thermostats, the devices which keep the heating system within a limited temperature range by automatically switching the supply of heat on and off, can reduce fuel consumption by 7%. Annual maintenance and operational control of burners will also reduce consumption by 4% (Eerste Belgische Nationale Mededeling, 1997) .
Returning to our family that consumes 3000 litres for heating purposes, the investment in a new thermostat (+/- 175 Ecu) could - at least in theory - reduce consumption by some 200 litres. As already illustrated, the same 200 litres could be saved by a 40% price increase of transport diesel. The annual cost of the additional energy taxes would be: [1750*(0.65+40%) - 1950*0.65] = 325 Ecu. If the thermostat has a lifetime of 15 years, opting for higher energy taxes on car diesel will cost the family in our example at least 4875 Ecu more over 15 years, compared to the cost of the thermostat. It is obvious that consumers would prefer to invest in equipment that saves energy compared to paying more taxes.
If we have doubts on the potential savings by replacing the thermostat, replacing the burner/boiler will have clearer benefits. We assume that the efficiency improvement by installing the new burner is only 25%. The cost of this investment is of course high, from 1500 Ecu to 3000 Ecu, depending on the size of the house. For our average family with a >normal= house, we take 2250 Ecu as the price of the new burner/boiler.
The 25% improvement of efficiency will enable the family to save 750 litres heating fuel. With constant energy prices, the pay-back of this investment is 2250/(750*0.25) or 12 years.
Saving 750 litres with an energy tax on car diesel is almost impossible without replacing the car by a new type that consumer less than 5 litres for 100 kilometres. With the actual car, the energy price should by increased by more than 150% to gain the same energy savings.
In terms of reducing CO_2 emissions, the actual technological possibilities clearly indicate that significant residential savings of energy at an acceptable costs can be obtained by replacing >old= equipment by the newest models. If energy prices remain constant, and there are no indications why they should increase suddenly during the coming years, the pay-backs are still

relatively long. To stimulate replacing investments with clear benefits in terms of emissions, subsidies to consumers can be an appropriate instrument.
In the next section, we will work out three types of subsidies ; subsidies for replacing old burners/boilers, subsidies for energy efficient cars and subsidies for other consumer products that have clear energy saving potentials.

7. Consumer subsidies

7.1 The microeconomics of consumer subsidies versus energy taxes

In the previous section, we considered the low energy price elasticity and high investment costs for consumers that want to replace inefficient burners or cars. If we reduce in our period of analysis the total costs of using a heating burner or a refrigerator to only two categories namely investment costs and energy costs, the rational consumer will base his decision on these two factors. He will opt for the product with the lowest total cost. In figure I, we present three options for a consumer that wants to buy a product with specific characteristics (like the cooling capacity or volume of a refrigerator). The three types **a**, **b** and **c** have identical characteristics. The relative energy prices determine the slopes of the lines through the three points on the iso-product curve. If we assume that more energy efficient equipment will cost more than inefficient types (for using special components, better insulation,..) this price difference will be important in the investment decision. Starting from model **a** on the iso-product curve in figure I and with energy prices that increase as a result of energy taxes, this will provide an incentive to buy a more efficient type (**b** or **c**). Compared to model **a**, the reduced energy needs of model **b** over the period will more than compensate the additional investment cost for the period. But if the consumer already thinks of buying model **c**, it is clear that a further increase in energy prices will not result in replacing this type by a more efficient type on the left side from model **c**. Due to budget limitations (model **c** is already very expensive) , the consumer has no choice but paying the higher energy prices.

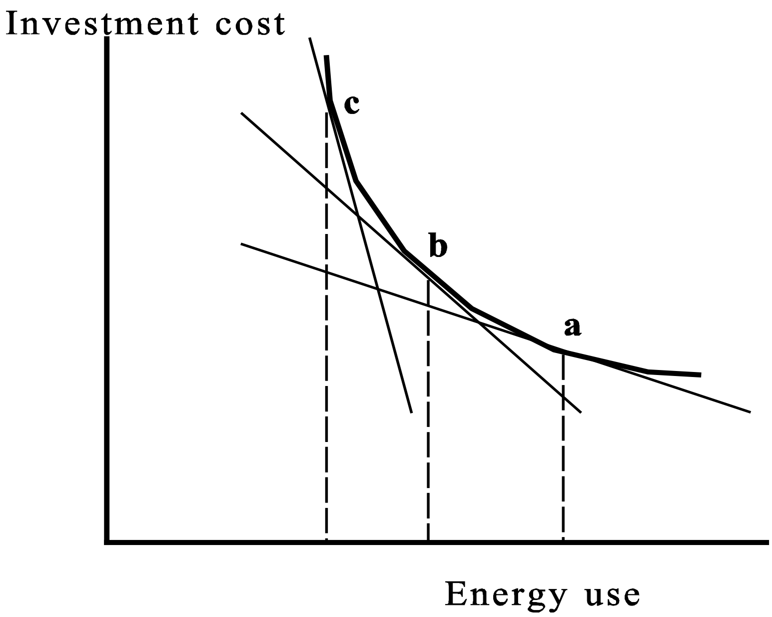

Figure I - Balancing investment and energy costs for identical products

In this analysis, we did not include technological progress in later periods. As a consequence, no new types will enable to reduce further emissions. But if new and expensive new types would be available, a subsidy offered to consumers that want to invest in a better model could then be a solution for governments that would like to stimulate household energy efficiency without introducing additional energy taxes.

In Figure II, we introduce technological progress in the next period. We define technological progress as the ability for producers to offer better models in terms of energy efficiency at a lower cost. In our analysis, the consumer has to replace his old model **a** with I as characteristics. The new sets of products have identical characteristics, so I = I= = I@. Again, the rational consumer will opt for the models with the lowest total costs. In our analysis, we are only interested in reducing energy needs.

If the government does not change energy prices, the consumer could opt for model **b** on I=. This means that as a result of this replacement, energy use over the period is reduced by the distance **|Ea - Eb|**. There is however a more energy efficient set of products (I@) on the market but their price is much higher. With unchanged energy prices and no subsidies, the rational consumer compares the vertical distance **|b= - b|** to **|Eb - Eb=|** and will not opt for **b=** on I@. If the government would pay a subsidy S to this consumer on the condition that he buys the most energy efficient model from the I@ set, the relative prices will change because energy becomes relatively more expensive. The subsidy reduces the pay-back period for this investment. As a result, the consumer will use the subsidy and buy the product suggested by the government, namely model **c** on I@. The consumer now compares **|c - b + S|** to **|Eb - Ec|**. In this case, the price difference is compensated by the subsidy. Choosing for product **c** will result in strongly reduced energy needs.

As a final remark, the subsidy could also be used the stimulate products on the left from model **b** on I=, if they are marketed. The cost of the subsidy will then be reduced. If energy labels are used, like in the coming section, it is however more interesting to attach the subsidy to products with the best energy label. As a consequence, labeling and the subsidies will encourage manufacturers to use efficiency as a feature of their sales campaign.

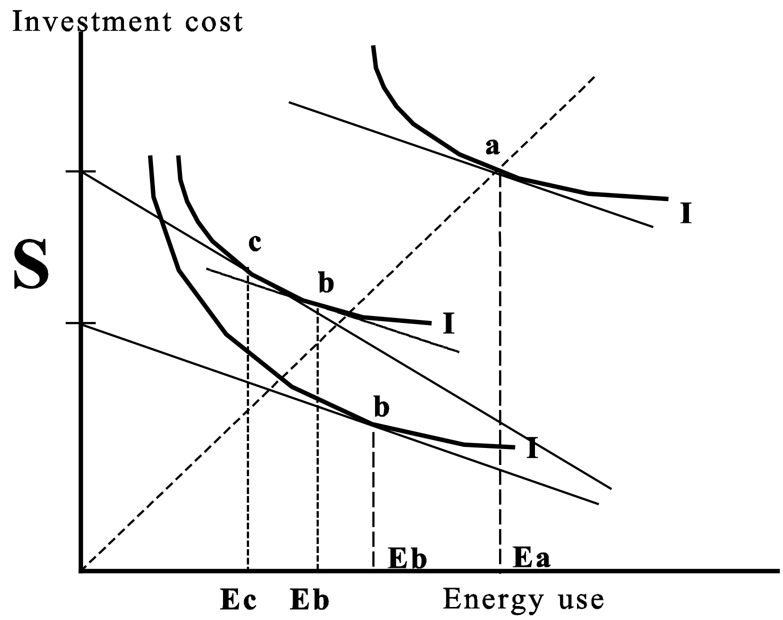

Figure II - Subsidies and the best choice

7.2 Subsidies for replacing heating systems

Investing in efficient burners will reduce emissions of CO_2, CO, NO_X and PM. The long pay-back could be a barrier for many people that will keep, as a consequence, their old and inefficient burners as long as possible.

In many countries, technical certification agencies provide efficiency labels that enable consumers to recognise the best installations. In the Netherlands, subsidies were available for the most efficient heating systems on gas, the HR-types. The subsidy policy started in 1988 and was immediately a great success. The number of installed HR-installations increased from year to year (50000 in 1988, already 200000 in 1989) and in 1994, already 40% of total private residential heating installations were burners of the most efficient types (Energieverslag Nederland, 1994).

If we provide a subsidy of 500 Ecu for each investment in high efficiency burners, the pay- back in our example will be around 9 years. If at the same time, a campaign supports this policy instruments, the reaction of consumers might be significant.

For each country, we can estimate the energy efficiency potential of new installed burners starting from the number of new houses built. It can be expected that in new houses that have an insulation efficiency that reduces the potential energy losses by at least 50% compared to houses built before 1970, only the newest models will be installed. The energy needs of new houses are therefore 50 to 75% lower than of similar older houses.

In existing houses, replacements will depend on the age of the burner and the incentives offered by the government. If the investment subsidies are announced as an initiative that will only be available for 2 or 3 years, the reaction can be expected to be direct.

In Belgium, with some 30000 to 40000 new houses built each year and with a potential of 50000 to 100000 replacements per year, the annual cost of the subsidy will be between 40 to 60 million Ecu.

If the subsidy will be available for 8 years and the public reacts as can be expected, the total residential energy needs can be reduced by 25%, especially if we assume that in older houses other replacing investments will also take place over time (energy efficient glass, new roofs, foams, insulating injections). In Belgium, emissions from total residential heating amounted to 23.8% of total emissions in 1994 (Belgian National Communication, 1997). The European average for 1990 was 20.4%.

A reduction of 25% of these emissions can reduce total national emissions by 5 to 6% if all the other sectors do not increase their emissions. Over this period of 8 years, the reductions of national emissions by 5% will cost some 400 to 500 million Ecu. At the same time, the sectors that produce and install heating installations will see their markets expand. These labour intensive sectors will create employment and generate additional revenues.

If this price is too high for the budget, governments could use the facilities offered by the Energy

Product Tax that will install higher minimum energy taxes on all fuels. From experiences in the past, we can assume that increasing the price of fuels for heating from 0.25 ECU to 0.35 Ecu per litre can generate annually 200 to 250 million Ecu in Belgium, at least in the first years after the higher energy taxes (Federaal Planbureau, 1995) . This price increase will further reduce the pay-back to 6.6 years (1750/750*0.35).

The generated incomes can also be used to finance other subsidies, like those presented in the following subsections.

7.3 Subsidies for energy efficient cars

7.3.1 Potentials

We already referred to the Extern-E project that concludes that the bulk of the external costs of transport (cars, buses, trucks and other vehicles) is caused by the emissions of PM resulting from inefficient burning. Reducing emissions is closely related to reducing energy consumption.

Since the average age of cars has been increasing the last year and is now around 7 years, the actual average fuel consumption of cars on gasoline is still between 8 and 11 litres for 100 kilometres. For diesel cars, the average fuel consumption is between 6 and 9 litres because older diesels typically have heavy engines.

There are however many possibilities to reduce these energy needs by half since gasoline is used very inefficiently in internal combustion engines. About 80% of its energy capacity is lost (see table III).

In 1997, the fuel cell technology reached the potential of short-term commercialisation. In the US, a partnership with the auto industry, funded by the Department of Energy, has lead to the potential creation of a new generation of vehicles that will use 84% of the gasoline in the fuel cell. This means that the energy efficiency will be increased by a factor four. Similar results were obtained from projects funded by the Defense Advanced Research Products Agency and the Commerce Department=s National Institute of Science and Technology.

GM, Ford, Chrysler and other members of the project already announced to commercialize fuel cell vehicles at competitive prices starting from 2001 or 2002 (USIS, Embassy of the United States of America, 1997). In the next century, powerful cars will be available that need only 2 to 3 litres per 100 kilometres. Emissions, other than CO_2, will be reduced by 90%.

In Japan, Honda did also develop fuel cell prototypes and will start commercialisation around 2002. Toyota will build next year hydro-cars that need only water and the Toyota Prius, a car with an electrical and conventional engine that both reduce energy needs to less than 5 litres per 100 kilometres is already a big success in Japan. In 1999, this car will be redesigned and commericalized for the European markets.

Of course, these promising developments for the future are no reason to wait. On our markets,

there are already many efficient cars. A recent example can be the GDI engines from Mitsubishi that will reduce energy consumption by 10% and CO_2 emissions by 20%. Volvo did already buy this GDI technology.
Other efficient cars can be detected in the European ECO-Tour, an annual contest in Europe. Each manufacturer can participate with a standard car. All cars have to follow an identical route of around 2000 kilometres on highways, in cities, in the mountains,... The best cars can pass the test with an average fuel consumption of less than 5 litres. The winning cars are not micro cars with very modest engines. The winner of 1994 was the Honda Civic VEi (1.6L, 90 HP), a car that can reach 195 km/h.

7.3.2 European proposals

Concerning energy efficiency and emissions, some European initiatives and proposals were taken. In COM(97)481, we read : AThe Council has already adopted a CO_2 emission target which corresponds to an improvement in the average fuel economy of new cars in the market in the order of 30% by 2005.@
Fiscal incentives can be used to encourage marketing of cleaner vehicles, if the measures apply to all new vehicles in conformity with future emissions limits foreseen by EU law.
Begin 1998, the Council reached a political agreement on two draft directives which set strict limits on emissions from cars and on quality standards for fuels. The directives are part of the EU=s Auto-Oil programme aimed at a better cooperation between the Commission, EU oil producers and car manufacturers. Emissions from private cars shall be reduced by setting limit values for certain pollutants (carbon monoxide, hydro-fuels, nitrogen oxide, particles from diesel), being indicative for all new vehicles from 2000 and compulsory from 2005. Member States that introduce vehicles that are able to prematurely respect the limit values set for 2000 and 2005 whall be allowed to introduce fiscal incentive measures, unless these incentives should disturb the functioning of the internal market. Manufacturers shall be held responsible for ensuring that their cars conform to the standards and that the pollution control mechanisms work properly. These measures are expected to lead to a 50% reduction in old vehicle emissions (EUR-OP Info, 3/1997).
The proposals currently on the table for minimum quality standards for petrol and diesel fuel will enter into effect on 1 January 2000. There is however a five-year derogation from new standards for a number of Member States from Southern Europe (Team Time, Volume 50, April 1998).
The Auto-Oil programme will also reduce emissions from light commercial vehicles from the year 2000. The objective is to reduce polluting emissions from road traffic by 60-70% between 1996 and 2010 (COM(97)248). This measure targets commercial vehicles such as vans up to 3.5 tonnes and cars over 2.5 tonnes which have been identified as being one of the major sources of urban pollution.

The European proposals might look ambitious but when they are weighted by the actual state of technology, they are not. The technology to reduce emissions from buses trucks and vans by more than 60% is already available and patented. Turbodyne Systems introduced last year its Turbopac and Dynacharger systems. The retrofit kits were tested on transit buses in Sao Paulo and other cities and demonstrated a 67% reduction in harmful emissions and an 11% improvement in fuel economy (Tubodyne Press Releases, 1998) . These results are mainly due to the shortening by Turbopac of the >turbo-lag=, the time lag during acceleration before the exhaust energy level rises sufficiently to activate the turbocharger rotor[4]. The Turbodyne systems can be installed on both gasoline and diesel applications.

Detroit Diesel Corporation (DCC), a leading global manufacturer of diesel engines purchased already 2500 Turbopac bus kits. On 7 April 1998, the United States Environmental Protection Agency gave official certification to Turbodyne under the Urban Bus Retrofit/Rebuild Program. Currently, Turbopac units have been installed for evaluation on representative public transit buses in Paris. If the test prove as succesfull as in other cities, all RATP (Régie Autonome des Transports Parisiens) buses might be retrofitted in the near future.

The Turbopac model 1500 gave the same results when tested on passenger cars. In addition, the kit demonstrated a 25% average increase in rated engine power and a 30% improvement in engine torque, at substantial lower engine speeds. The Turbopac was installed on vehicles manufactured by Alfa Romeo, Fiat, Volkswagen, Audi, Toyota and Rover.

When relatively inexpensive technological solutions are already available at this moment, why does the EC works with a time horizon of more than 10 years? We clearly need to accelerate clean diffusion processes using other instruments than the slow regulatory process..

7.3.3 The fiscal burden on cars

Next to excise duties on motor fuels, there are taxes levied on the purchase and registration of new and old cars. Another important category are the annual car taxes. In some countries, these taxes generate more than 5% of total tax revenues.

To illustrate the tax differences in the EU, Table IV compares some European consumer prices before and after taxes.

The purchase tax or registration tax is in most countries decreasing with the age of the car. This means that the registration tax when buying a Jaguar 3.6L from 1984 can be lower than for a Volkwagen Golf Diesel 1.9L from 1997. It is clear that the driver of the Volkswagen will pollute

[4] Particulate emissions (PM) are the solid and liquid emissions resulting from the incomplete combustion of fuel. In turbocharged engines, the turbocharger provides the engine with more air than it can induce through natural aspiration. At low idle speed of the engine, there is very little energy in the engine exhaust and this prevents the turbocharger from providing a significant level of boost in the engine intake air system. The results of this inefficiency (the time lag) is the excessive smoke during acceleration.

only a fraction of the pollution generated by the Jaguar. Since value added taxes are taxes on the price, the other taxes could be redesigned in terms of age or pollution to stimulate the diffusion of cleaner cars. The benefits of these tax shifts could be used to finance other instruments like a subsidy for clean and energy efficient cars.

Table IV - European car prices, before and after taxes (in Ecu)

Country	Nissan Micra 1.0 before taxes	Nissan Micra 1.0 after taxes	Audi A6 2.6 before taxes	Audi A6 2.6 after taxes
Austria	9 307	11 727	24 333	33 288
Belgium	8 475	10 278	23 724	29 505
Denmark	5 833	15 208	25 792	52 244
Ireland	8 313	12 713	22 816	37 770
Netherlands	8 278	11 821	22 992	35 598
Portugal	7 479	10 005	20 992	33 742

Source : European Commision, Tax Provisions with a Potential Impact on Environmental Protection, 1997, Appendix 4.1 and appendix 4.3

7.3.4 Regulatory initiatives : Austria and the US

In many countries, the automobile industry argues that policy makers do not stimulate the diffusion of new and clean cars. The high level of taxes like value added taxes (VAT) and registration taxes make that many owners want to use their car as long as there are no important technical problems.

The promotion of clean and energy efficient cars can be achieved by regulation or by giving subsidies (an ecobonus) to consumers that buy these cars. Some countries have already taxes that are related to fuel consumption. In Austria, a part of the VAT was replaced by a 'standard fuel consumption tax' for cars that were built in 1992 or earlier. The standard fuel consumption is measured using the ECE-standard when driving at a constant speed of 90 km/h. Cars that consume more than 8.2 litres per 100 kilometres pay the highest tax (EC, 1997).

In the United States, the Gas Guzzler Excise Tax and the Corporate Average Fuel Economy (CAFE) federal standards regulate the energy efficiency of cars and light trucks. The Gas Guzzler tax was installed after the oil crises to improve US energy self-sufficiency. It was not an environmental tax. Cars that are less efficient than 22.5 miles/gallon (mpg) or 10.5 litres/100 kilometres were taxed with the Guzzler Tax that started from $ 1000 and could amount to $ 7700 (Westin, 1997).

This tax has been attacked by the European Community that stated that European cars were disproportionately taxed, especially since light trucks, which are very popular as alternatives to cars in the US, were not taxed under the Guzzler Tax.. Light trucks account for one third of the US car market. The GATT Panel rejected the European arguments on the theory that the law lacks a protectionist purpose.

The Guzzler Tax would only have impact on powerful cars and therefore the Corporate Average Fuel Economy provisions of the 1975 Clean Air Act are more important when it comes to the average fuel consumption of the US car fleet. The CAFE standards require that new cars average at least 27.5 mpg (8.5 l/100 km) and light trucks average 20.6 mpg (11.5 l/100 km). The CAFE is an average standard for the complete fleet of a manufacturer. Car makers still can produce vehicles which fail to meet the standards as long as enough other models meet the CAFE standards to balance out the 'guzzlers'. Since foreign manufacturers do not have the opportunity to compensate the fuel inefficiency of their top models - with the highest profit margins - by selling high volumes of their smaller and more efficient cars on the US market, manufacturers like BMW and Mercedes attacked CAFE under the GATT. This time, the CAFE tax case was decided in favor of the protesting nations because it was discriminatory. As a result, there will be no CAFE taxes on imported cars.

Since US car manufacturers reached this CAFE standard already in the 1980s, mainly by reducing weight, improvements in fuel economy have stagnated since then. Manufacturers invested in performance inprovements, safety and luxury aspects.

Environmental groups like the Sierra Club therefore want to adapt the CAFE standards to the actual technological possibilities. In his recent election campaign, President Clinton also sugge-sted an stricter CAFE standard for the coming years. The Sierra Club proposed an update of the CAFE law to 45 mpg (5.2 l/100 km) for cars, and 34 mpg (7.2 l/100 km) for light trucks. If these standards are met in the coming years, the new CAFE would >save more oil than the US import from the entire Persian Gulf (Sierra Club,1997)=.

Efficiency gains do not only depend on the fuel cell technology but can be achieved using multi-valve engines, variable valve timing, high-strength lightweight structures, optimized gearing, better aerodynamics, low rolling resistance tires and improved fuel quality.

7.3.5 The ecobonus for cars

There are no actual indications that in the near future a European CAFE standard might be imposed. European policy makers that are attracted be the principle will hesitate because structu-ral regulatory changes concerning the international car industry, are expected to come from the

European level. Furthermore, working with average fleet standards risks to discriminate certain exporting countries.
An alternative might be to introduce an environmental subsidy (ecobonus) that will be paid to consumers that buy the most energy efficient cars. In a first step, efficiency targets need to be defined. Using the new ECE average fuel consumption standards (a combination of traffic in cities and at 90 km/h), the subsidy could be given for cars than need less than 5.5 litres of gasoline for 100 kilometres and for cars that need less than 4.5 litres of diesel for 100 kilometres. Depending on the number of new cars that can qualify, a subsidy can be set. To make the subsidy really attractive for consumers, we will work with an ecobonus of 1000 Ecu. Compared to an average car price of 15000 Ecu, the ecobonus provides a significant discount and will become an essential element in marketing strategies.
Since the standards are rather strict, we assume that only 10% of the new sold cars meet the requirements for the ecobonus. For Belgium, with 400000 new cars sold each year, the financial impact would be 40 million Ecu. Since some 5 million cars are registered in Belgium, an average increase on annual car taxes by only 8 Ecu will be sufficient to compensate the government budget for the paid subsidies. Average car taxes amount to 175 Ecu so this is not a dramatic increase. Here we can redesign the car tax in a way that older cars with inefficient engines will be targeted with a higher tax increase than recent clean cars. Or these efficient cars could be exempted from the tax increase. This policy will make the ecobonus or subsidy even more attractive.
Other financing opportunities are increased registration taxes for old and inefficient cars that are sold on the second hand market or higher fuel taxes. This last instrument will also make energy efficient cars more attractive but does not differentiate between efficient and inefficient users of energy. And it is not energy on itself that should be targeted, but the inefficient use of energy.
If we want to reach more people with the ecobonus, a smaller ecobonus of 500 Ecu could be introduced for the first 10% of the new sold cars that did exceed the target. In this case, annual car taxes will have to be increased by 12 Ecu. Owners of old cars will as such have more incentives to replace their car by a more efficient type.
If the ecobonus is introduced, manufacturers will present their most efficient engines in their popular models. This means that the average fuel efficiency of all new cars will decrease. After a few years of investing in more efficient engines, the fuel efficiency targets for the ecobonus might be further downsized.
The results in terms of reduced CO_2 emissions are difficult to estimate. It is however a certainty that emissions after the introduction of the ecobonus will be lower than emissions without the ecobonus.
We tried to calculate the impact of this ecobonus for Belgium by assuming that the car fleet will increase by 15% for the period 1998-2010. We divided the actual car fleet in three segments : old cars that were built before 1993 (>guzzlers=), more recent and efficient cars, and finally the

cleanest cars. Each catergory has a different average fuel consumption. The more old cars that will be replaced by the cleanest cars, the faster the average fuel efficiency will increase.
In table V we start with annual sellings of 400000 cars of which only a limited fraction will be of the cleanest type. The other new cars will be classified under the recent cars. If the ecobonus will be a succesful instrument, the share of the cleanest cars in the new sold cars will increase strongly. The long term consequences of the accelerated diffusion of the cleanest cars in the total car fleet are very important because these cars will be used for some 9 to 12 years. After a few years, they will be sold on the second hand markets at low prices so everybody will be able to buy an efficient car. The scrapping of old and dirty cars will result in very significant reductions of average energy needs of the total car fleet.
Worldwide, every year millions of new cars will be sold, whether some groups like it or not. But if these cars are clean and replace old and inefficient cars, this will have positive consequences for the total environmental impact of the actual car fleet.

Table V - Composition of the Belgian car fleet in million, 1998-2010

Year	Old cars	Recent cars (from 1993)	Cleanest cars	Total
1998	2.8	2.1	0.1	5
1999	2.4	2.5	0.2	5.1
2000	2.15	2.8	0.3	5.25
2001	1.8	3	0.5	5.3
2002	1.45	3.2	0.7	5.35
2003	1.1	3.4	0.9	5.4
2004	0.75	3.5	1.2	5.45
2005	0.4	3.6	1.5	5.5
2006	0.25	3.6	1.7	5.55
2007	0.2	3.4	2	5.6
2008	0	3.4	2.3	5.65
2009	0	3.1	2.6	5.6
2010	0	2.75	3	5.75

If we take for 1998 as average fuel consumption for the three groups of cars respectively 10, 8 and 5 litres for 100 kilometres, the average fuel efficiency of the actual fleet is 9.06 litres for 100 kilometres. For 2010, we assume that the group of recent cars needs 7 litres and the cleanest cars need only 4 litres for 100 kilometres. This brings the average fuel efficiency of the fleet in 2010 to 5.43 litres for 100 kilometres, a reduction by 40% compared to 1998.

If the 5.75 million cars in 2010 are used for the same average number of kilometres as in 1998, total energy needs after the growth of the car fleet by 15% will still be reduced by 31%. And if we assume that each car in 2010 will make 10% more kilometres than the average car in 1998, the reduction of energy needs and CO_2 emissions will still be 25%.

Of course, also without the ecobonus, average fuel consumption will be reduced as a result of the scrapping of old and dirty cars . The ecobonus can accelerate the diffusion of the cleanest models. For engines of light vehicles, trucks and buses, similar improvements might be expected over a longer period since the lifetime of the best trucks is around 2 to 2.5 million kilometres. Furthermore, congestion problems may stimulate intermodal shift what can result in additional CO_2 reductions.

Stating that total transport emissions of CO_2 will be reduced in 2010 by some 15% compared to 1998, is not that speculative. Compared to 1990, a 10% reduction should be possible when cleanest technologies are strongly promoted.

Less combustion of fuel means also less pollution other than CO_2. The next generation of catalytic converters, like the types that will meet the most recent Californian laws on Ultra Low Emission Vehicles (ULEV) in 1999 and 2001, will further reduce other emissions by 90% compared to average car emissions in 1995. The Honda Accord 2.2 EX was the first car that did qualify for the new Californian emission standards (Honda, 1997).

7.4 Subsidies for other consumer products

Using environmental subsidies for heating installations and cars will have more impact than introducing subsidies for energy efficient refrigerators or washing machines. But every improvement in energy efficiency is important so we have to exploit all opportunities to save on domestic and tertiary energy needs.

This is also the European position : "On the end-use side there are numerous ways to improve efficiencies, both in the industrial and in the domestic and tertiary sectors. Refrigerators, computers, televisions, washing machines, light bulbs are only a few examples where use of existing technology will allow the same level of service with much less energy consumption. Electric motors used extensively in industry can similarly be improved. The EU has already developed mandatory energy efficiency labeling schemes for the principal 'white goods' and mandatory standards for refrigerators/freezers to improve efficiency. The Commission is now negotiating standards on a more extensive product range with the relevant industrial sectors (COM(97)481)."

The existing labels for energy efficient or white goods (Dir.92/75/EC, Dir.94/2/EC, Dir.95/13/E-C, Dir.96/57/EC, Dir.96/60/EC and Dir.97/17/EC) are the result of the European PACE Programme (Programme d'action communautaire visant à ameliorer l'efficacité d'utilisation de l'éléctricité) of which SAVE (Specific Actions for Vigourous Energy Efficiency) was an important subprogramme.
The European energy label uses a graphical indication of energy efficiency ranging with the labels A (more than 45% more efficient than average) to G (more than 25% less efficient than average). The EU has the intention to continuously update the labels in terms of average energy efficiency and to ban from the European markets in the year 2000 all products with the label G (Electrabel, 1997).
In Belgium, the electricity provider Electrabel used the European label in its campaign to improve 'rational energy use'. In order to attract attention, a subsidy of 50 Ecu was provided when consumers did buy a refrigerator or freezer with the label A. Electrabel finances this subsidy from its own resources. This subsidy was a great succes because it almost completely compensated for the price difference with less efficient types. As a consequence, many distributors of cooling equipment changed their product selection and started to present many types of the most efficient refrigerators and freezers. In their publicity, annual energy needs are provided for cooling equipment and for washing machines. As such the awareness of the public is strongly increased. In the near future, the energy label will also be used for washing and drying machines, dish washers, cooking equipment, electric mobile heating devices, light bulbs and air conditionings. From 1999, a subsidy of 75 Ecu will be provided when consumers opt for the most efficient washing machines and dish washers (Nieuwejaers, 1998).
The potential savings on energy and on CO_2 emissions might be considered as limited because we only deal with refrigerators or freezers. But both consumer goods have a long lifetime what makes that their cumulative energy savings can be significant.
Starting from the difference in annual energy needs between an efficient type and an inefficient type, expressed in kWh, table VI calculates the difference in total energy costs and total CO_2 emissions after a period of ten years. The calculations are made using an average electricity price of 5 BEF/kWh.

Table VI - Differences in energy costs over a 10 year period

E-difference	Difference in energy costs after 10 years	Actualised difference in energy costs	Difference in CO_2 emissions after 10 years
50 kWh	2500 BEF (Belg.Fr.)	2109 BEF	92 kg
100 kWh	5000 BEF	4218 BEF	184 kg

E-difference	Difference in energy costs after 10 years	Actualised difference in energy costs	Difference in CO_2 emissions after 10 years
150 kWh	7500 BEF	6326 BEF	276 kg
200 kWh	10000 BEF	8435 BEF	368 kg
250 kWh	12500 BEF	10544 BEF	460 kg
300 kWh	15000 BEF	12653 BEF	552 kg
350 kWh	17500 BEF	14762 BEF	664 kg

Source : VEI, Praktische instructies voor het gebruik van energielabels, p.11

In rich countries, a typical family has a big refrigerator with a freezing unit or a smaller refrigerator next to a freezer. This means that for every 4 to 5 people (average family size), we use 1 or 2 refrigerators and/or freezers. Cooling equipment is also used in the commercial circuit : in all enterprises, in the meat industry, in cold storage warehouses, for mobile cooling units, vending machines,...

If we start with an annual difference in energy needs of 250 kWh for each cooling unit and use a ratio of 1 refrigerator/freezer for 3.5 persons, some 10 million refrigerators are used in the EU and a major part could be replaced by more energy efficient types. Over a period of 10 years, the cumulative reduction of CO_2 emissions as a result of total replacements could be 4.6 million ton. This is 0.7% of total residential/tertiary emissions in the EU in 1990. If the ratio would be 1 refrigerator or freezer for 2.5 persons, around 14 million units could be replaced and over 10 years CO_2 emissions could be reduced by 6.4 million tonnes (almost 1% of all residential emission in 1990).

If we use a subsidy as an incentive to replace all old refrigerators, this policy will cost of course a lot of money. A possible funding can be found in the elimination of other existing energy subsidies like coal subsidies or special electricity prices for large users. Like in the case of Belgium, a part of the monopoly profits of the electricity sector can also be used to finance this instrument of energy efficiency.

If we add all the other consumer products, from washing machines and light bulbs to mobile heating devices, and assume that the 10 million European families can reduce their annual energy needs by 1500 kWh per family, some 12 million tonnes of CO_2 will not be emitted over a period of 10 years. This is almost 2% of the emissions in 1990. If over a longer period, when newer types further reduce energy needs, annual saving can be 3000 kWh per family, 23 million tonnes will not be emitted over a 10 year period.

If this replacement can be stimulated by subsidies, this is an instrument that has not marginal but clear results.

8. Legal implications of subsidies

Susidies paid to manufacturers can influence competition and are therefore prohibited by Article 92 (State Aid) of the European Treaty. But by paying the subsidy or ecobonus to consumers and not to manufacturers, this instrument does not distort competition nor protects the domestic market if all manufacturers have the same change of presenting their efficient products on this market. Since we do not work with average performance standards like CAFE, differences in market share or size of the exporter are not crucial.

Potential complaints can be eliminated if all exports have access to all needed information concerning the environmental subsidies. Certification procedures have to be transparent and affordable for small exporters. Government agencies that provide labels for efficient burners can continue their work. Their label can be used to attach a consumer subsidy. Exporters of cars already have to publish average fuel consumption using European standards. If current practices for certification and testing will be maintained in the future, potential protectionist abuses are limited.

9. Conclusions

Reducing CO_2 emissions in the EU by at least 8% will be rather easy compared to the Kyoto obligations for Canada and the US. The reductions will however require actions in all sectors that use or produce energy. Starting from proven technological possibilities, we analysed some opportunities for reductions in the sectors of transport, heating equipment and consumer durables. When energy taxes are already too high to increase them further, using subsidies to consumers clearly can accelerate the diffusion of cleanest and most efficient technologies and this is a necessity. Compared to paying more energy taxes, consumer will prefer to make investments that save energy and money.

In terms of ecological efficiency, we found significant emission reduction potentials for the transport and heating sectors. In the best scenarios, total emissions could be reduced by respectively 10 and 5% compared to the 1990-level. Minor reductions can be expected from the diffusion of more efficient refrigerators, freezers and other household durables.

If industry and the energy sector can further reduce their emissions, the Kyoto targets could be met at a very low social cost.

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Policy instruments and incentives for environmental R&D: a market-driven approach

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SUMMARY

Environmental policy instruments have an impact on the incentives to invest in environmental R&D and this link should deserve careful consideration when introducing new instruments. Some authors argue that evironmental taxes and tradable permits have rather comparable impacts on environmental R&D but we think that only very specific conditions do lead to this kind of conclusions. If we broaden the perspective by integrating elements from the Industrial Organisation literature and depart for Pigouvian settings, a market-driven approach would link the incentive to invest in new technologies to the market potential offered by the policy instruments. If taxes turn out to be very expensive for the polluting or emitting industries, we can assume that these targeted firms would be more interested to invest in new - emission reducing - technologies than in cases where the choosen policy instrument will lead to a very limited cost. We therefore developed a dynamic model that enables to compare the incentives on environmental R&D resulting from taxes, emission trading, voluntary approaches and subsidizing environmental R&D. We do not claim to capture all relevant market interactions, but our findings confirm the intuition that environmental taxes have a clearly different impact on environmental R&D compared to emission trading.

Keywords : Research and Development, environmental policy, environmental taxes, emission trading, voluntary approaches, market interactions

JEL Classification : Q28, O31, H23

NON TECHNICAL SUMMARY

Economists argue that market incentives will create opportunities for entrepreneurs to develop new products and processes. It is clear that many environmental problems need new technologies to eliminate the detrimental externalities. Waiting for these new clean technologies to arrive would be unacceptable and too risky and therefore environmental policy designed many instruments that should lead to a market behaviour that enables it to internalize external effects. Environmental policy instruments all have an impact on the incentives to invest in environmental R&D and this link should deserve careful consideration when introducing new instruments. Some authors argue that evironmental taxes and tradable permits have rather comparable impacts on environmental R&D but we think that only very specific conditions do lead to this kind of conclusions. If we broaden the perspective by integrating elements from the Industrial Organisation literature and depart for Pigouvian settings, a market-driven approach would link the incentive to invest in new technologies to the market potential offered by the policy instruments. If taxes turn out to be very expensive for the polluting or emitting industries, we can assume that these targeted firms would be more interested to invest in new - emission reducing - technologies than in cases where the choosen policy instrument will lead to a very limited cost. We therefore developed a dynamic model that enables to compare the incentives on environmental R&D resulting from taxes, emission trading, voluntary approaches and subsidizing environmental R&D. We do not claim to capture all relevant market interactions, but our findings confirm the intuition that environmental taxes have a clearly different impact on environmental R&D compared to emission trading.

The market - in terms of potentially avoidable costs -created by environmental taxes is always more important than the market resulting from a system of tradable permits that only captures emission reductions. This finding holds even when environmental taxes are low and permit prices much higher. Only when permits would be auctioned from the beginning of the programme, the impact on the incentive for environmental R&D would be comparable. We also found indications that other instruments like voluntary agreements and subsidies for technological R&D have a more interesting impact on the incentive for R&D compared to emission trading. In our model we could integrate and compare these four instruments since we included the cost of innovation and various parameters for uncertainty.

Our final conclusion is that environmental taxes, without important exceptions or escape clauses, offer the most clear incentives for the needed technological innovations.

CONTENTS

1. Introduction

For many environmental problems, technological innovations can offer fundamental solutions, especially when behavioural changes are limited by various inertia. Our industrial and technological infrastructure that did lead to significant externalities, can be transformed to limit detrimental environmental impacts. This transformation process is already happening very smoothly since environmental considerations started to influence all engineering and industrial designing phases. During the coming decades, our technological infrastructure will no longer be characterized by >brute-force= manipulation of scarce natural resources.

Efficiency could and should lead to sufficiency and sustainability (Huber, 1998). If this positive scenario works out, the most convinced >technology-believers= would even suggest that stringent and costly environmental policies could be postponed. For some areas like global warming policy, this possibility is considered because many scientific uncertainties could lead to the too early implementation of costly measures. We believe however that the strategy of waiting for superior technologies could turn out very disappointing. Like all other goods, technological products need an interesting market that stimulates the process of entrepreneurial and Schumpeterian dynamism. New technologies need to be commercialized and without clear and credible environmental policies or the threat to impose environmental measures in the near future, such markets for new technologies do not exist. Waiting has always a price in terms of lost opportunities and therefore we argue that an accelerated technological innovation and diffusion should be stimulated by the appropriate choice of environmental policy instruments. This consideration has already frequently been made during the 1970s and 1980s (Magat, 1979 ; Milliman and Prince, 1989) but recent environmental policy has not generally focused on the positive connection between environmental improvement and technological innovation. A possible explanation is that the early environmental movement often preoccupied itself with the adverse impacts of technology (OECD, 1997).

In the economic literature, many studies on the different effects of environmental policy instruments are based on the seminal paper by Weitzman (1974). He concluded that taxes should be prefered to quantity controls when expected marginal benefits were relatively flat. The relative curvature of the cost and damage functions is only part of the reason for preferring taxes. Weitzman also noted that when shocks to costs and benefits are correlated, this simple intuition breaks down (Pizer, 1997 ; Stavins, 1996).

Basic elements of Industrial Organization literature were integrated by authors like Biglaiser and Horrowitz (1995) and Parry (1995, 1996). These authors work with Pigouvian taxes and permit price levels equalling marginal environmental damage under perfectly competitive conditions with homogeneous firms in terms of production and abatement costs. These market conditions are hard to find what makes the conclusions of the studies difficult to generalize.

Parry (1996) concludes that the incentives for environmental R&D are empirically similar under the Pigouvian tax and under the Pigouvian quantity of permits when innovations are minor and

there is a well-functioning permit market. In our work, we will depart from Pigouvian settings of taxes and quantities and illustrate that the different impact on the incentive for Research and Development (R&D) resulting from taxes or permits is very significant.
Furthermore, each sector or environmental problem has very specific characteristics that are not found in other industries or policies objectives. As a result, the >overall= effects of the environmental regulation on R&D tends to be ambiguous (Palmer, Oates and Portney, 1995).
In this paper, we have the ambition to work out in more detail the linkages between environmental instruments and the behaviour of the innovating sector. We introduce an investment decision that is made by firms that have the potential to invest in environmental R&D. We see innovation as an endogeneous and continuous process. By the latter, we mean that the decision to innovate - not to compare with the decision to imitate - can be made at any moment in our analysis and not only at the starting point of the simulation.
In our approach, firms are not identical. Each of the polluting firms has different marginal abatement costs. To capture these differences in our model, we make use of probability density functions.

2. Presentation of the model

In our model, we work with two sectors ; the group of polluting firms and the group of firms investing in R&D to provide an abatement technology to the polluting sectors.
The group of the polluting firms causes the externality and is the target of the environmental policy. Government can use various instruments like taxes, tradable permits, technological standards, performance standards, product bans, environmental agreements and the disclosure of environmental information (e.g. compliance records). Each instrument has a different impact on the process of technological innovation and diffusion. A comparative approach would be preferred but is only possible for a limited selection of all available instruments. We therefore prefer to simulate the incentives for environmental R&D that are the result of specific instruments. Our findings could be an interesting complement to algebraic or game-theoretical approaches.

2.1 The polluting sector

We assume that abatement costs for the polluting firms differ. This is a realistic assumption in line with the findings of Hartman, Wheeler and Singh (1994) who used the U.S. Department of Commerce=s annual 20000-plant random survey of pollution abatement costs and expenditures (PACE). For 37 sectors, the average abatement costs in $US (1993) per tonne were calculated for seven air pollutant categories : suspended particulate matter, sulphur dioxide, nitrogen oxides and carbon monoxide, hydrocarbons, lead, hazardous (toxic) emissions and other emissions.

They concluded that maximum/minimum ratios are frequently near ten, and occasionally near one hundred. Abatement costs for a selection of air pollutants and US industries are presented in Table I.

Table I - Average abatement costs by sector, 1979-1985 ($1993/ton)

Industry	Particulates	Sulphur oxides	NO_2, CO	Hydro-carbons	Lead
Food	86	521	229	162	46612
Leather	132	377	8430	633	132
Industrial chemicals	46	75	304	213	1300
Chemical products	212	681	48	157	29
Metal products	343	1563	461	399	161
Electrical machinery	373	483	1559	215	365
Transport equipment	635	1266	468	1006	468
Motor vehicles	350	1523	1155	2441	21483

Source : Hartman, Wheeler and Singh, 1994, p.4

Another conclusion from the empirical analysis was that scale economies may apply to some abatement processes.
The polluting industry can develop its own abatement technologies or can buy technological solutions provided by the technological sector. Since end-of-pipe solutions were used for air pollution abatement, the data by Hartman e.a.(1994) are in most cases payments to technology providers. In our model, we assume that the polluting industry will always *buy* clean technologies. There will be no in-house development because these firms have no experience with environmental technology development and commercialization.
If abatement costs for air pollutants can vary from $10 to $ 46000 per tonne (Hartman e.a., 1994), it will be very complicated to determine ex-ante the optimal Pigouvian tax or permit price. We think it is useful to assume that abatement costs follow a normal distribution over the polluting firms.

2.2 The innovating sector

In our model, we consider the decision to innovate and the marketing of the resulting innovations as endogeneous. The innovating sector operates in a commercial environment and will base its decision to invest in environmental R&D on factors like the cost of the innovation, the chance to achieve technological success, the discounted profits following from the commercialization, the rate of return of the project and the possibility of patent protection. In our threshold innovation model, we assume that firms want to invest in innovation if the cost of innovation (CI) does not exceed a critical value, determined by the discounted profits from innovation.

We calculate these discounted profits from innovation (DPI) for *i* years as :

$$DPI = \rho\sum [(p_i - c_i)*q_i]/ (1+r)^i ,$$

with p_i = price for technology on the market ;
c_i = cost of producing the technology ;
q_i = quantity sold to polluting industries ;
r = internal rate of return ;
ñ = success probability (technical success and the possibility to commercialize the innovation) or uncertainty factor ($0 < \rho < 1$)

Investing in technological innovations is an activity with many business risks. We follow the approach indicated by Mansfield and identify three different success probabilities : (1) the probability that technological goals would be achieved ; (2) the probability that, conditional upon technical success, the resulting product or process would be commercialized ; and (3) given commercialization, the probability that the project yielded a return on investment at least as high as the opportunity cost of the firms capital (Scherer and Ross, 1990).
Scherer and Ross (1990) also present the empirical results of the investigations by Mansfield. For the firms in his analysis, the average probabilities were :

Technical success (ρ_1)	0.57
Commercialization, given technical success (ρ_2)	0.65
Financial success, given commercialization (ρ_3)	0.74

with $\rho = \rho_1 * \rho_2 * \rho_3$ (=0.274)

It is clear that the choice of the used environmental policy instrument has a strong impact on the probability of realizing a financial success but not on the technical success probability. Suppose that in this example, the best environmental policy results in a financial success probability of 0.95 compared to a probability of only 0.55 for the worst policy option, the difference in total success probability would be 0.15 (0.35 - 0.20) what is much less than two times 0.20.
Some authors link total success probability to the number of firms that invest in environmental R&D. The higher the number of involved firms, the more limited is the probability of financial success. This is a reasonable assumption in the case when there is *only one* technology that can

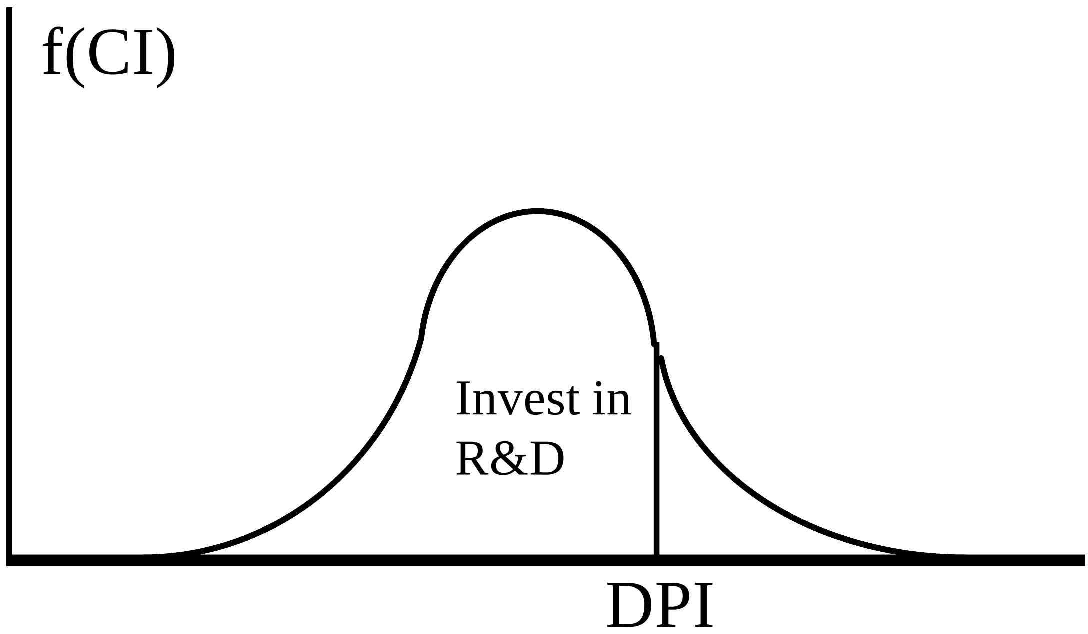
be innovated and developed. In reality, many technologies offer positive environmental outcomes and we have a competition among new technologies on the market. For many pollution abatement possibilities, there is also a competition between new clean technologies and new cleaner inputs. Car emissions can be reduced by diverse types of new engines (electric vehicles, fuel cell vehicles, hybrid vehicles, engines using compressed air,...), the increased use of weight-saving materials and the introduction of cleaner and alternative fuels (low-sulphur fuels, biofuels, ethanol, methanol,...).

When analysing the findings of Hartman e.a.(1994), we think that the differences in sectoral abatement costs are partly explained by different technological needs for each sector and for each pollutant to abate.

We also should be aware of cluster economies or external economies of scale resulting from collective or simultaneous R&D efforts. Spill-over effects can generate additional market dynamics that contribute to the long term profitability of the environmental R&D sector.

The cost of the innovation (CI) differs for each firm, especially if we assume that many technologies will be developed. From the business literature, many examples of very cheap and very expensive R&D projects can be found. Scherer and Ross (1990) conclude that it is useful to think about R&D project costs in terms of a frequency distribution. In reality, this distribution could turn out to be highly skewed but we will start working with a normal distribution like in Figure I.

Figure I - Distribution of innovating costs for the environmental technology industry



In our threshold approach, only when the discounted profits from the innovation exceed the costs of innovation, firms are prepared to invest in environmental R&D. The proportion of firms that will invest in R&D given a certain DPI can be found on the left side of DPI. It is clear that when DPI increases, more firms will be prepared to invest in environmental R&D.

In our later simulation, we assume that each firm uses the same r for calculating DPI, that market demand for the environmental technology is linear ($p_i = a - bq_i$) and that producing the technology gains positive economies of scale ($c_i = d - eq_i$).

The calculation and evaluation of DPI is not restricted to the beginning of our simulation. We consider it as a continuous process. Firms that have the potential to innovate are already familiar with the technological needs of their future products. If they decide not to invest in environmental R&D because the potential market is not attractive enough, they can wait and re-evaluate the market during the coming years when new events like changed priorities in strategic management of the polluting firms, unexpected price developments, scientific findings or goverment policies have a significant impact. So it is possible that they decide to invest in environmental R&D some years later and develop then a new technology.

2.3 Adoption of the new technology

After its development, we assume that the diffusion of the new technology will follow a pattern of a threshold model. Like in Kemp (1997), we first attribute to the polluting industry a willingness to pay (W) for the environmentally desirable innovation. In their investment decision, these firms include the emission reduction achieved by the technology or the reduction of used environmental inputs and the price level of the emission or environmental input.

Some firms can also include other elements like management priorities, the reduced risk for environmental liabilities and/or penalties, positive impacts on the firms= image, etc. As a result, we assume that this willingness to pay will be distributed normally.

If the willingness to pay exceeds the market price of the environmental technology p_i, the firms will be prepared to buy and install the new technology.

2.4 The market potential for environmental technologies

Firms will invest in environmental R&D if DPI exceeds CI. Polluting firms will buy the environmental technology if W exceeds p_i. The value of DPI depends mainly on the expected maket reaction (p_i, q_i). The quantity of environmental technologies sold, q_i, depends on the effective need to reduce emissions. We therefore need to focus on the different impact each environmental instrument has on the needed reductions of emissions by the polluting industries. If the reduction target is ambitious, this will stimulate or even force these industries to install the technologies presented by the innovating sector.

An instrument with only price implications, like environmental taxes, offers less certainty on the effective reduction of emissions than quantity instruments like trabable emission rights. In the case of environmental taxes, the innovating sector needs information on the expected tax level

and the price elasticity for the demand of the taxed good. Additional problems are related to built-in tax exceptions or rebates for industries that are very intensive in the use of the taxed input. This is a very relevant element in many energy tax systems based on carbon content (see the European proposal for a CO_2 tax).
In the case of quantity instruments, there are clear emission reduction or emission stabilization targets when the instrument is introduced. This reduction target can increase over time. The environmental effectiveness and price implications of quantity instruments depend to a significant extent to the initial (and annual) allocation of the permits. Are these emission rights distributed for free (grandfathered) or are they auctioned?
A similar clear reduction target is included in most voluntary agreements proposed by industry. Potential innovators can estimate their potential market for new technologies starting from these reduction targets that industry wants to achieve as a result of internal process changes and the installation of bought environmental technologies.
When total emissions of a target group - like the most important utilities in a region - need to be reduced by *x* percent, total sales of environmental technology (э q) over the period of analysis depend on the ratio (total emission reduction / reduction by new technology (R_E)) ;

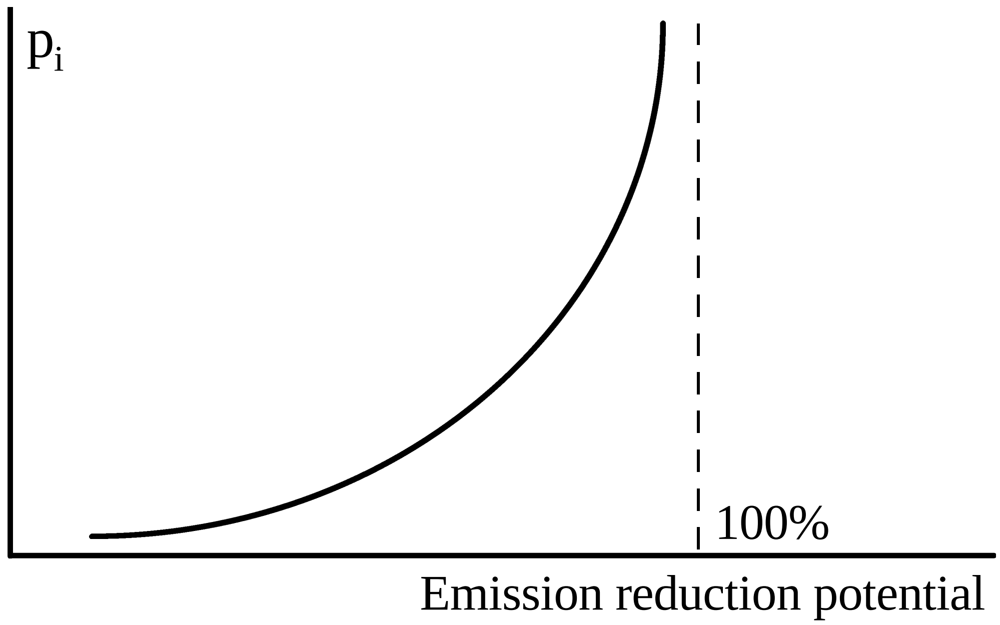
э $q = v(x(1+g)FE_F)/R_E$,

with F : number of facilities that need to reduce emissions ;
E_F : emissions per facility ;
x : emission reduction target (%) ;
g : projected growth of industrial activity ;
R_E : emission reduction (%) by the new technology ;
v : vintage effect with $0 < v < 1$.

Economic growth (g>0) can lead to increased emissions in the business-as-usual scenario. High growth of sectoral output could be positive for the potential sales of emission reduction technologies, especially when auctioned quantity instruments are used and when the proportion of emissions to output is relatively stable over time. In the case of price instruments, growth of industrial activity can be anticipated by setting higher levels of the environmental taxes. It is mostly assumed that as a result of the environmental taxes, the growth of industrial emissions will be limited. This is however never certain and could be a partial explanation for the limited environmental success of some environmental tax programmes.
The vintage effect indicates what fraction of the needed reduction will lead to the installation of environmental technologies. Some firms will not invest in environmental R&D or technologies because these new investments cannot be easily integrated into their long term investment cycle. Investment planning follows here a vintage model. Other firms do not invest because they are not interested in, or aware of, the environmental instrument. Finally, they also could just prefer to buy emission rights on the market or pay the environmental taxes..

The market for the environmental technologies is also influenced by the emission reduction potential of the developed technologies. If the new technologies are very efficient - like in the extreme case where they reduce plant emissions by 100% - the market will be readily saturated with a low sales volume for the innovating firms. But when the technologies can only reduce plant emissions by 10%, it will take much longer to achieve a significant reduction of emissions. The price of the environmental technology (p_i) is also depending on the emission reduction potential. This is illustrated in Figure II where the price increases exponentially with the emission reduction potential (R_E). This pattern could develop when shadow prices of emissions increase strongly over time (e.g. as a result of stricter emission reduction targets).

Figure II - Emission reduction potential and price of the technology



Very performant technologies will have a higher price that will compensate for the lower sales volume. Presenting a radical technology to the market has the limitation of a smaller market in terms of quantities sold and the higher business risk, but this is compensated by the reduced risk for imitation or outperformance by better technologies. It is obvious that incremental technological improvements are more vulnerable for outperformance by competing technologies.

3. Taxes versus permits

In a first step, we will use a part of our model to shed some light on the different market incentives for technological innovation that result from using environmental taxes compared to quantity instruments like tradable permits. We focus on the market potential created by the choosen instrument. If the policy instrument turns out to be very expensive for the polluters, the incentives to capture this flourishing market for technological innovations are great. If the cost of the instrument is neglectable, the market potential for innovators is limited and the investment in environmental R&D very risky.

Before we compare two instruments, it is necessary to define the relevant characteristics of the instruments. We will focus on the differences resulting from grandfathering (and not of auctioning) of tradable permits and environmental tax regimes that include (temporary) exceptions for some heavy polluting or emitting industries.

For industry, both environmental instruments will lead to a cost : paying taxes or buying permits. In the case of taxes, emissions constitute the taxable base while in the case of grandfathered permits, *only* the reduction of emissions will lead to costs to pay. This is a fundamental difference and those who argue that industry will behave more or less similar towards both instruments should consider this. But again, the latter conclusion is only relevant when permits are (each year) grandfathered based on past emission trends. When the permits are auctioned and need to be bought from the initial instalment of the policy instrument, we can compare the emission base for the environmental taxes with the spend budget for emission permits.

We worked out a basic simulation excercise to indicate the potential differences between taxes and grandfathered emission rights. We want to stress that the difference depends on the period of analysis. In a stable regulatory framework, taxes not only need to be paid this year but also during the coming years. Permits need to be bought over the complete period (*i* years) and the foreseen reductions of emissions will strongly influence the demand for permits on the market. We defined total tax and permit cost (*i* years) as :

$$\text{Tax Cost} = t \ni (1+g_i)(1-z_i)FE_F$$

$$\text{Permit Cost} = p_p \ni (1+g_i)\, x_i FE_F$$

with t = environmental tax ;

g_i = evolution in industrial growth over time ;

z_i = evolution of exemptions from environmental taxes ;

x_i = evolution of emission reduction over time (as % of initial emissions) ;

p_p = permit price.

We assumed that the exemptions permitted in the tax policy will be reduced over time and that emission reduction objectives in permit trading programmes will increase over time. The absolute cap on emissions is held constant.

In our simulation for a period of 10 years, we started with 1000 firms (F=1000), each releasing 1000 tonnes of a substance (e.g. CO_2 ; E_F=1000). We kept these numbers constant and then calculated tax costs and permit cost for 10 moments over a period of 10 years. Each calculation for year *i* represents total costs if the time horizon of the instrument would be limited to the first *i* years. For instance, we conclude from Table II that after 5 years during which taxes have been paid and permits have been bought each year, the total cost of the tax programme would be $ 145

million while the cost of the permit programme would be only $ 15 million for the emitting industry. The tax progamme would be 9.59 times more expensive. So it is no surprise that in this basic case, industry would be in favour of permit trading (after a free grandfathering) compared to paying environmental taxes.
The calculations in Table II are based on a tax of $ 50, a permit price of $ 50, a percentage of tax exceptions of 50% in the first year that will be reduced to 0% after 10 years and an emission reduction target for the permit programme that starts at 3.5% for the first year and increases to 15% in the last year. The growth rate of industrial activity starts at 1.5% and increases to 3.5%. After the first year, the difference is the greatest because after this year the cumulative permit cost increases faster than the cumulative tax cost. However, the absolute difference between the two policies per annum increases during the first years (26.16 - 1.77 = 24.39 difference for year 1 / cost for permits in year 2 : 4.19 - 1.77 = 2.42 - cost for taxes in year 2 : 53.62 - 26.16 = 27.46 / difference for year 2 : 27.46 - 2.42 = 25.04) . As a result, the cumulative values in Table II will converge over time

Table II - Tax cost versus permit cost, $ mln (period of 10 years)

Year	permit cost	tax cost	ratio (tax/permit)
1	1.77	26.16	14.71
2	4.19	53.62	12.79
3	7.37	82.64	11.20
4	10.95	113.05	10.32
5	15.17	145.58	9.59
6	20.19	180.01	8.92
7	25.74	215.63	8.38
8	31.70	254.02	8.01
9	38.08	305.86	8.03
10	45.27	357.90	7.90

Our calculations for Table II are of course parameter-specific. A different situation will develop if exceptions for the environmental taxes change or when the permit price differs from the tax price. We therefore present in Table III the oucomes of the simulations for seven other scenarios.

For each scenario, the values of the parameters and evolution patterns for the variables are given below. Changes compared to the preceding scenario are presented in italic.

Scenario 1 : t=50	p_p=100	z_i : 50% -> 0%	x_i : 3.5% -> 15%
Scenario 2 : t=50	p_p=100	*z_i : 30% -> 0%*	x_i : 3.5% -> 15%
Scenario 3 : t=50	p_p=100	z_i : 30% -> 0%	*x_i : 5% -> 40%*
Scenario 4 : t=50	p_p=100	z_i : 30% -> 0%	*x_i : 1% -> 8%*
Scenario 5 : t=50	p_p=100	*z_i : 10% -> 0%*	x_i : 1% -> 8%
Scenario 6 : t=50	*p_p= 75*	*z_i : 33% -> 0%*	*x_i : 1% -> 15%*
Scenario 7 : t=50	*p_p=100*	*z_i : 0% -> 0%*	*x_i : 5% -> 20%*

Table III - Ratios of (tax cost / permit cost) for 7 scenarios

Scenario	1	2	3	4	5	6	7
Year 1	7.36	9.93	7.32	23.17	29.83	45.00	9.05
2	6.39	8.48	6.22	21.54	28.00	33.57	8.14
3	5.60	7.33	4.72	17.70	23.12	22.98	7.29
4	5.16	6.69	3.89	14.39	18.71	17.95	6.64
5	4.80	6.16	3.39	12.02	15.45	14.03	6.31
6	4.46	5.68	3.04	10.43	13.27	12.18	5.98
7	4.19	5.33	2.76	9.56	11.96	10.47	5.70
8	4.01	5.11	2.51	9.08	11.07	9.21	5.37
9	4.02	4.94	2.29	8.70	10.34	8.25	5.02
10	3.95	4.73	2.11	8.34	9.72	7.54	4.72

In each of the seven cases, permit prices are much higher than taxes and still the total cost of taxes is much higher than the cost of the permit programme for the polluters. It is also no surprise that each scenario leads to a different outcome. Tax programmes without exemptions are clearly much more expensive for industry compared to buying permits for the share of emissions that needs to be reduced. If we had taken the combination of a high energy tax with a cheap tradable permit, the difference would be even more pronounced. In the case of carbon dioxide emissions, the probability that we end up with very cheap permits is relatively high if Russia will be able to sell its excess permits - resulting from the economic recession - to the energy-intensive developed countries.

As a result, the different costs for industry resulting from both instruments clearly creates a bigger market for environmental technologies in the case of environmental taxes. Only when the permit price and the emission reduction objective are high (like in scenario 3), the total costs are somehow comparable.

In this basic simulation, we did not include many other important aspects like the performance of the technological innovation (in terms of reduced emissions), the price of the technology, scale economies in the production of new environmental technologies, etc.

We will integrate these elements in the next sections.

4. The general model

For a period of 15 years, we analyse the incentive to invest in environmental R&D by making use of the assumptions used to define DPI and total sales of the new environmental technology (Σq). For the first model runs in the base-line situation without an environmental policy instrument implemented, there is only a reduction target for emissions that the innovating sectors assumes to become the effective target in later policy frameworks. So there are no environmental policy instruments used at this moment and we focus on the proportion of potential innovators that will each year effectively invest in environmental R&D as it was presented in Figure I. We will work out a graphical presentation for the total period of analysis. Therefore we need to introduce CI, the cost of the technological innovation. We assume that CI consists of a fixed cost, set at $ 1 million in our model, and a variable part since each product sold on the market will result in some feedback from clients that demand for adaptations of the technology to their specific demands.

We then define a new variable, *R&D Incentive = (DPI - CI)/CI,* to qualify the difference between DPI and CI over time like used in Figure I.

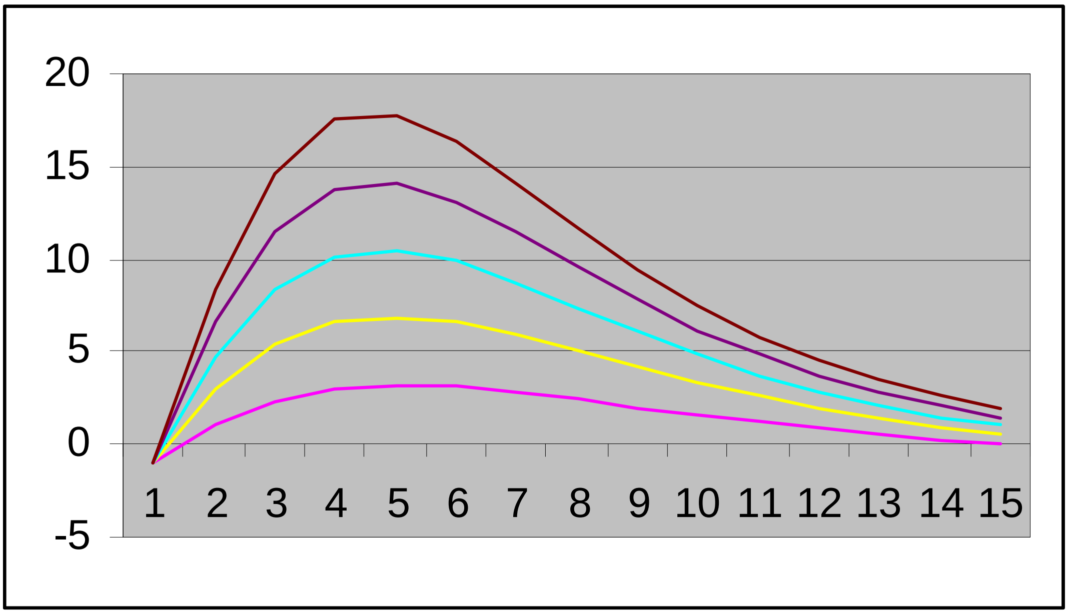
We present our findings making use of the following settings : p=20000 - 0.03q ; c=15000 - 0.03q; $R_E = 0.2 + 2q/1000000$; an industrial growth rate starting at 1.5% and increasing by 10% (0.10 * 1.5%) each year; ρ_1=0.33 ; ρ_2 =0.33 ; $\nu = 0.75$.

The reduction of the emissions is linked to the technological performance of the new technology - in terms of emission reduction - what results in a sales estimate for the new technology. The manufacturers then set initial prices and production costs that should both decline over time. Only when the profits from future sales outweight the costs of the technological innovation by a certain factor or baseline, manufacturers will start investing.

In Figure III, a sensitivity analysis was made for the variable R&D Incentive when the initial reduction target - used by the innovating industries in their investment decision - ranges from 5% to 25% with an increase by 10% each year. We notice that the value for R&D Incentive exceeds 1 in most cases. Industry is however aware of the many uncertainties surrounding the environmental policy process and could therefore work with very short pay-back periods for environmental investments or could require that R&D Incentives exceeds factor 5 before starting

the new investment programme. Only when environmental policy instruments are implemented by a transparent and stable regulation with detailed information for all involved parties, a baseline set at 1 would sufficiently capture all uncertainties.
If the baseline was set at 5, and the reduction target starts at 5% of total emissions, there will be no incentive to invest. The market created by the low reduction target is too small. For entrepreneurs that are less risk averse, a lower baseline could be used. We also notice that the incentive to invest increases over time. If industrial activity grows and the reduction target also increases over time, the market for the new technology becomes more attractive. The price for the technology will decline over time for various reasons - new entrants, outperforming new technologies - what reduces the market attractiveness.

Figure III - R&D Incentive for 5 reduction targets



It is clear that the higher the reduction target for emissions, the more attractive the market for the new technologies becomes. Similar findings can be found when we include a sensitivity analysis for the parameter ρ_2 in our model. The initial and fixed value for ρ_2 was set at 0.33 but when we include values from 0.2 to 0.6, the incentives for R&D change develop a same pattern as in Figure III. The reduction of the uncertainty leads to a increased market for the environmental technologies.

4.1 Environmental taxes on emissions

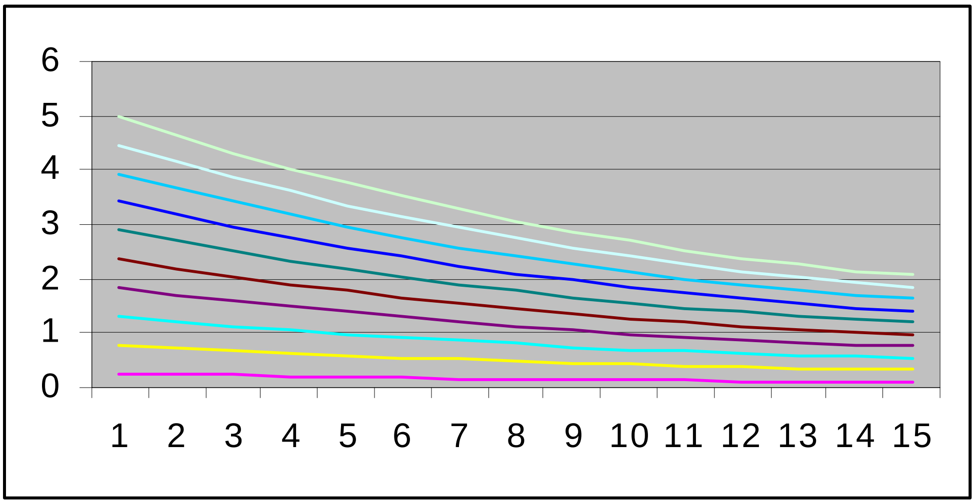
If government decides to install taxes on emissions, polluting firms can opt for paying the taxes

or they can invest in new emission reducing technology. Their choice will depend on the relative cost of both alternatives that are calculated in our model. As a result, the level of the environmental tax and the price of the new technology are two crucial variables.
We first compare the total cost of the tax option with the total cost of the technology option. We calculate the preference for technology as :

PrefT = (cost tax option) / (cost technology option)

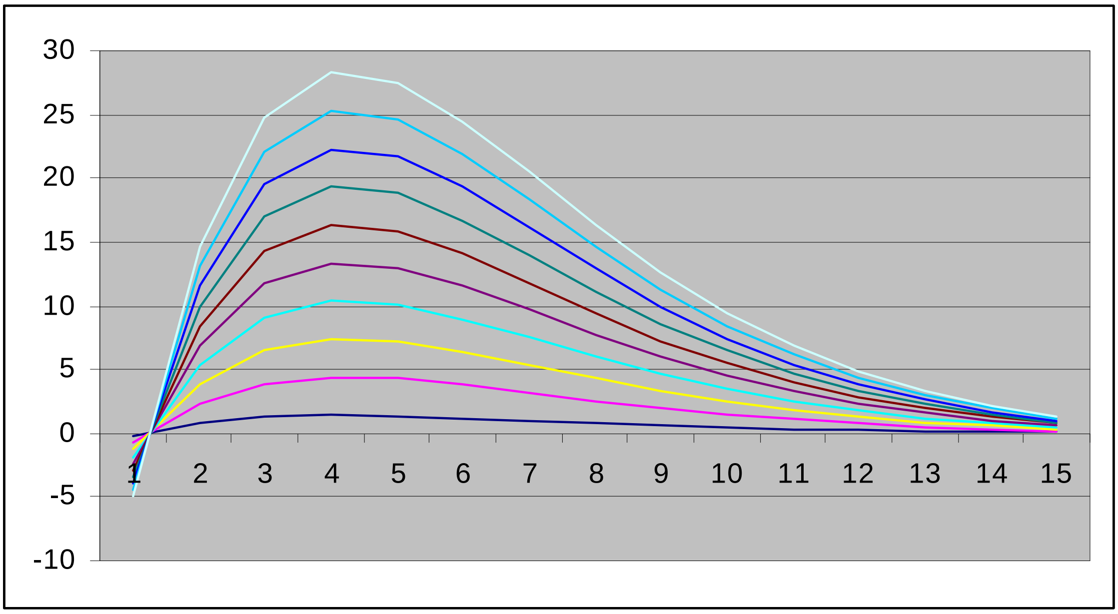
For simplicity, we assume that every firms or industry needs to pay the tax : there are no exceptions or preferential regimes. We did run the model for 10 levels of the environmental tax : ranging from $ 25 per tonne emissions to $ 500 per tonne. The taxes are set to achieve a clear environmental target in terms of a percentage reduction of emissions.
The results are presented in Figure IV. It is clear that in the cases with low tax levels, the cost of paying taxes is lower than the cost of investing in new environmental technologies as specified in our model (PrefT <1). When environmental taxes exceed $ 150, paying taxes turns out to be more expensive than investing in new technologies at the given market prices. In our situation of an effective environmental policy with an increasing emission reduction target and a slowly increasing environmental performance of the technologies, opting for investing in technology becomes also more expensive over time. Only when technological progress would develop very fast, all the lines in Figure IV would have positive slopes.
Over time, the emission reduction potential of the new technology increases but the demand for new technologies will increase since the reduction target and industrial activity also increase over time. This growing demand for the emission reduction technologies leads to the declining ratio of PrefT, even when the price of the technology decreases. Setting a reduction target that changes over time requires a dynamic approach and for this objectives a fixed tax is a rather arbitrary policy tool.

Figure IV - Preference for technology in the case of environmental taxes



If we include these findings in the a priori investment decisions of the firms that can invest in environmental R&D, the impact on our variable R&D Incentive might be significant. In Figure V, we present our findings for tax levels from $ 25 to $ 500 per tonne emissions reduced. The emission reduction target is not changed.

Figure V - R&D Incentive for 10 environmental tax levels ($25 -> $500)

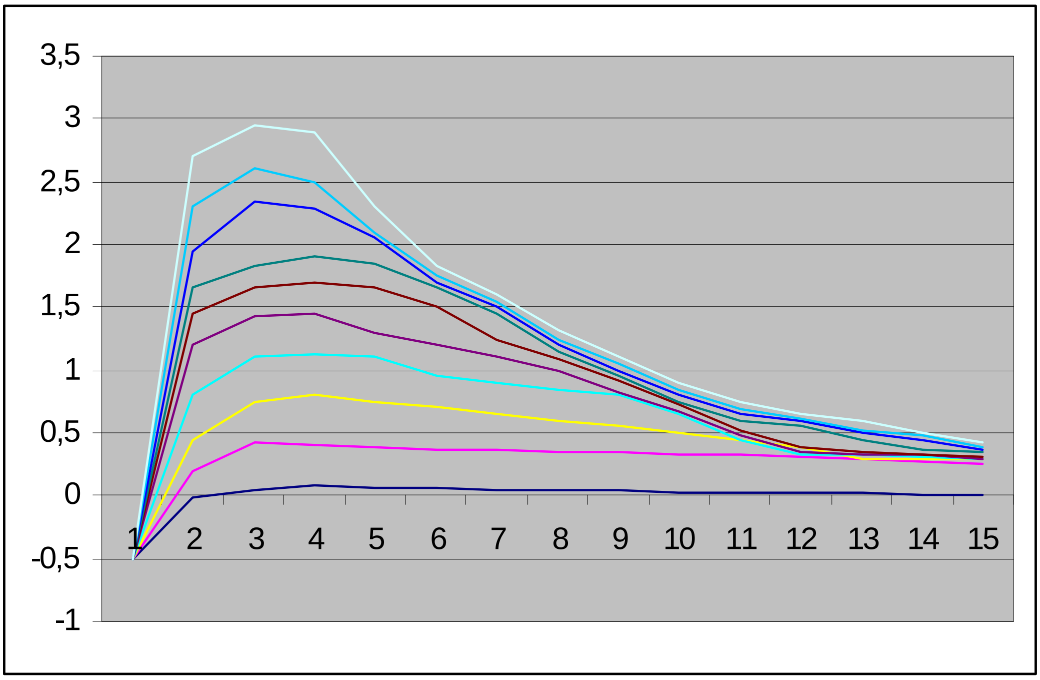


Compared to Figure III, it is clear that high environmental taxes have the same incentive effect as the highest reduction targets for emissions. Without the environmental taxes, the maximum value for R&D Incentive would be 7.32 if the same reduction target as in Figure V would be used. High environmental taxes without exceptions provide clearly an attractive market even for very risk averse investors.

4.2 Tradable emission permits

We repeat the same analysis when no taxes are used but tradable permits are introduced to reduce total emissions by a certain percentage. Polluting firms can reduce emissions by installing new technologies or they can buy permits if their emissions exceed a certain threshold. The preference for technologies is calculated as the cost of buying the needed permits divided by the cost of installing new environmental technologies. As could be expected - see section 3 -, it is more expensive to introduce new technologies when permit prices are not extremely high. The highest value for PrefT was 0.5 in the first year. For the other years, the value declines to 0.23.
The two crucial variables for our model with this instrument are permit price and the reduction target for total emissions. In Figure VI, we present the model output for 10 permit price levels - from $25 to $500 per tonne emissions - and a reduction target that starts at 10%. The highest calculated value for R&D Incentive is 2.91 what provides a low incentive to innovate. If we set the reduction target at 20%, the resulting model output is similar to Figure VI. The highest value is in this case 5.38, still much below the incentive provided by environmental taxes..

Figure VI - R&D incentive for 10 emission permit prices



We arrive at the conclusion that using tradable permits offers less incentives to the innovating industry compared to introducing environmental taxes.

4.3 Voluntary agreements to reduce emissions

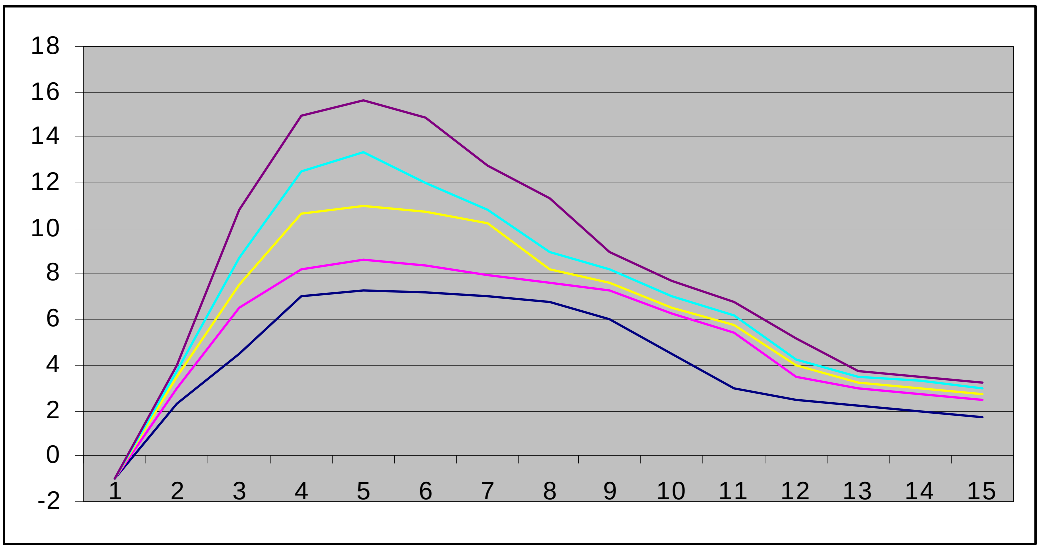
Another approach would be to negotiate a voluntary agreement with industry to reduce emissions. This instrument offers the advantage to industry that environmental investments can be optimally integrated into their long-term investment decision. For the innovating sector, this agreement does not create immediately a market for new tecnologies, especially when the time frame to accomplish the agreed reduction target is relatively long. Agreements offer however another type of certainty to the innovating sector since industry needs to reduce emissions. This compensates for the uncertainty on the existence of the future market for emission reduction technology.

We included an approximation of the effect of voluntary agreements in our model by assuming that the reduction of uncertainty - a higher value for ρ_2 , the probability for a successful commercialization - captures the impact on the incentive for environmental R&D.

$_2$ varied from 0.33 to 0.66. Another possibility to integrate the effect of voluntary agreements was by setting a higher price because industry surely needs to invest in cleaner technologies and this dependency on future innovations could influence price developments on the markets for these new technologies. This is however uncertain because it could also be possible that the polluting industry selects certain partners that will benefit more form the emission reduction programmes than external firms. In this latter case, the finding in Figure VII are not valid for all firms in the industry.

From the results, it is clear that voluntary agreements create an incentive to innovating firms that outweights our model simulations in the case of emission trading.

Figure VII - R&D Incentive and voluntary agreements



4.4 Subsidies for technological R&D

Government could also opt for subsidizing R&D of environmental technologies. In principle, this policy would provide a very strong incentive for the firms that will receive these subsidies. If new entrants to the R&D market have no access to this funding, the subsidy could create a barrier. We wanted to introduce the subsidy option in our model and therefore assumed that every firm will receive the subsidy - or at least projects to receive this funding for the investment decision- and that each firm receive the same amount. As a result, the subsidy reduces CI (the cost of the environmental R&D). Since the incentive to invest depends on the difference between DPI and CI, it is obvious that subsidies are important for the investment decision of innovating firms.

We introduced five levels of the subsidy; from no subsidies to a subsidy of $500000, each step increasing by $100000.
We found that the value for R&D Incentive increased to 14.01 in the case of the highest subsidy. When the subsidy was $400000, R&D Incentive amounted to 11.08 and with a subsidy of $100000 the calculated value was 8.5. Compared to our findings in the case of emission trading, subsidizing environmental R&D has a more interesting impact on the incentive to invest in new technologies.

5. Conclusions

Environmental policy instruments have an impact on the incentives to invest in environmental R&D and this link should deserve careful consideration when introducing new instruments. Some authors argue that evironmental taxes and tradable permits have rather comparable impacts on environmental R&D but we think that only very specific conditions do lead to this kind of conclusions. If we broaden the perspective by integrating elements from the Industrial Organisation literature and depart for Pigouvian settings, a market-driven approach would link the incentive to invest in new technologies to the market potential offered by the policy instruments. If taxes turn out to be very expensive for the polluting or emitting industries, we can assume that these targeted firms would be more interested to invest in new - emission reducing - technologies than in cases where the choosen policy instrument will lead to a very limited cost. We therefore developed a model that enables to compare the incentives on environmental R&D resulting from taxes, emission trading, voluntary approaches and subsidizing environmental R&D. We do not claim to capture all relevant market interactions, but our findings confirm the intuition that environmental taxes have a clearly different impact on environmental R&D compared to emission trading. The market - in terms of potentially avoidable costs -created by environmental taxes is always more important than the market resulting from a system of tradable permits that only captures emission reductions. This finding holds even when environmental taxes are low and permit prices much higher. Only when permits would be auctioned from the beginning of the programme, the impact on the incentive for environmental R&D would be comparable. We also found indications that other instruments like voluntary agreements and subsidies for technological R&D have a more interesting impact on the incentive for R&D compared to emission trading. In our model we could integrate and compare these four instruments since we included the cost of innovation and various parameters for uncertainty.

Our final conclusion is that environmental taxes, without important exceptions or escape clauses, offer the most clear incentives for the needed technological innovations.

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Environmental policy and new technologies : to create or to scrap?

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Abstract :
Policy instruments like environmental taxes on emissions can influence the innovation process and lead to more efficient abatement technologies. However, by scrapping parts of the old capital stock entrepreneurs can also lower emissions without investing in environmental R&D. In this paper, a capital stock rotation example illustrates how the scrapping of old capital can lead to the same impact on emissions as the development of more energy efficient technologies. Scrapping has a positive cost and we therefore present a numerical simulation to compare the impact of scrapping to that of technological innovations. In the simulation, we use the concept of technological optimism. We find that the higher this optimism, the lower the environmental tax needs to be to stimulate technological innovations. In a next step, we compare the emission reduction contribution of scrapping to that of innovating. We conclude that the indirect effects of technological innovations – scrapping opportunities – can outweigh the direct effects of lower abatement costs.

Keywords : environmental taxes, technological innovation, capital stock rotation, scrapping

JEL Classification : Q28, O31, H23

1. Introduction

In his last State of the Union Address to Congress, President Clinton repeated that ‘global warming is the greatest environmental challenge of the new century (Clinton, 2000).’ Since most economists focus on reducing greenhouse gas (GHG) emissions as the first strategy in climate policy, new technologies that improve energy efficiency or capture emissions deserve special attention when economic instruments or regulations are introduced. The incentive to develop new environmental technologies depends on an attractive buyers’ market that stimulates the process of entrepreneurial dynamism. Clear and credible environmental policies or the threat to impose environmental measures in the near future can create these markets. In this paper, we analyze the link between a policy instrument like environmental taxes and the incentive for technological innovation. The impact of technological innovations on the incentive to scrap or eliminate old capital is explicitly considered. We wonder whether innovating and scrapping policies are complements or substitutes.

The analysis in this paper is based on environmental taxes as the policy instrument. Other instruments can have different impacts on innovations and other investment decisions. In the literature, many studies on the different effects of environmental policy instruments are based on the seminal 'prices versus quantities' paper by Weitzman (1974). He concluded that taxes should be prefered to quantity controls when expected marginal benefits were relatively flat. Weitzman also noted that when shocks to costs and benefits are correlated, this simple intuition breaks down (Pizer, 1997 ; Stavins, 1996). Biglaiser and Horrowitz (1995) and Parry (1995, 1996) integrate basic elements of Industrial Organization literature in the analysis of economic instruments. They present Pigouvian taxes and permit price levels that equal marginal environmental damage under perfectly competitive conditions with homogeneous firms.

Parry (1996) concludes that the incentives for environmental Research and Development (R&D) are empirically similar under the Pigouvian tax and under the Pigouvian quantity of permits when innovations are minor and there is a well-functioning permit market. But since each sector or environmental problem has very specific characteristics, the 'overall effects of the environmental regulation on R&D tends to be ambiguous (Palmer, Oates and Portney, 1995)'. It is striking that scrapping decisions are not explicitly integrated in this literature. In the next section we show the role scrapping can play in emission reduction strategies.

Economic instruments can stimulate technological innovations but the short-term impact on total emissions of even the most successful innovations can turn out to be modest. Since GHG emissions are closely connected to many aspects of economic activity (production, consumption, transportation, residential functions,...), it is not realistic to assume that significant reductions are possible without important capital replacement efforts. The economic inability to scrap energy-inefficient capital can be a serious restriction for emissions reduction targets. We therefore illustrate in the next section the importance of capital stock rotation and possible reductions in total energy use.

2. Capital stock rotation and inertia

In response to the conferences in Rio and Kyoto, many countries took measures to improve the energy efficiency of the most important economic sectors. Despite these and future efforts, most analyses show that GHG emissions of developed countries will continue to rise in business-as-usual scenarios. The ability to depart from these pessimistic scenarios will depend on the diffusion of new technologies that can be stimulated by climate policy instruments. Behavioral changes are of equal importance. But even with the optimal instrument mix, it can take a long time before we notice the needed emission reductions.

2.1 A simulation

We illustrate this time gap in the following basic simulation with two capital stocks : the existing capital stock at the moment of the analysis and the new capital stock that will be integrated in the economy. In energy-intensive sectors, the capital cycles are generally long. Cars and motorcycles are replaced after some ten years but industrial engines are used for 20 to 30 years. The cement industry can use the same production facility for 40 years. Houses, commercial buildings and the transport infrastructure have longer life cycles.

We start in the simulation with an initial capital stock of 100 units. We set the average level of energy efficiency of the total capital stock equal to 1. Over the period in the simulation (50 years), a significant part of this old capital stock will be scrapped. Each year, one unit of the 100 initial capital units is scrapped and replaced by more energy-efficient capital. We assume that no retrofitting of existing technologies takes place. After 50 years, the capital stock that existed at the beginning of our analysis is halved.

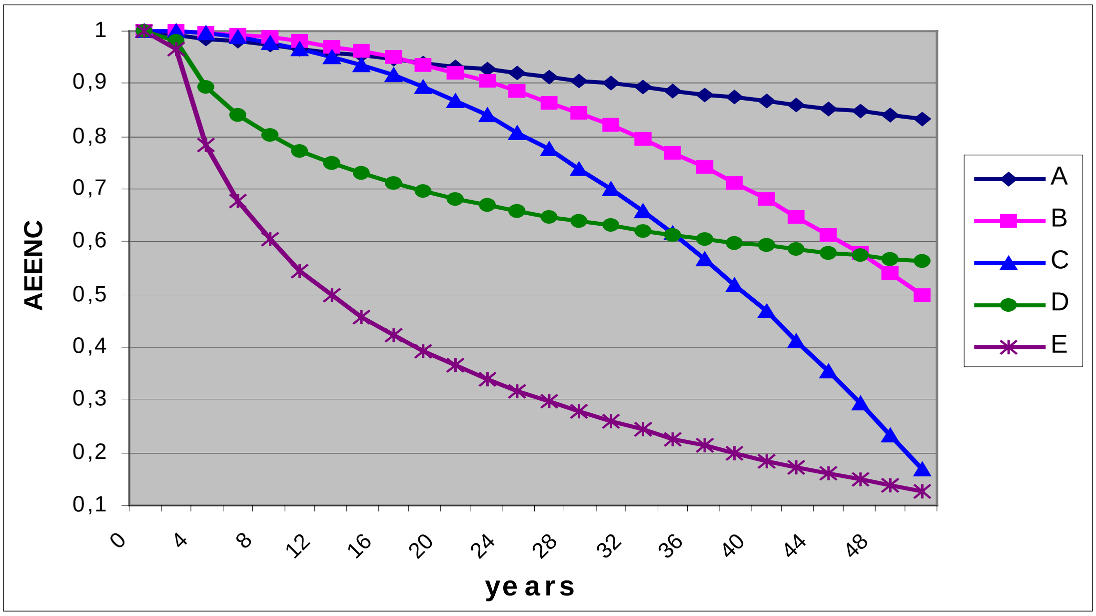
We assume in the simulation a fixed capital growth of two new capital units each year. After 50 years, we end up with a capital stock of 150 units (100 - 50*1 + 50*2) or an increase by 50%.

The impact of the shift to new and energy-efficient technologies is modelled in the average energy efficiency of new capital (AEENC) for each moment in our analysis. In Figure I, we present five scenarios for this shift to new technologies. We always start with an average energy efficiency that equals 1.

Scenario A is a very conservative business-as-usual forecast : the average energy efficiency of new capital would improve by less than 1% per annum for a period of 50 years. Such a period of technological stagnancy is hard to imagine with promising applications of fuel-cell technologies just around the corner. The other scenarios are more optimistic. Important technological breakthroughs will be widely commercialized and have a significant impact on AEENC. The only remaining uncertainty is the ‘when uncertainty’. It is a certainty that there will be a moment that every new sold car needs only 3 litres for 100 kilometres. We only do not know when. In the scenarios B and C, AEENC improves slowly in the first 20 years. After 50 years, AEENC equals 0.5 in scenario B and 0.166 in scenario C.

In the scenarios D and E, important technological breakthroughs are realized in the first decades of the analysis. The engines, cars, televisions, refrigerators, airconditionings and insulation materials that are then sold, will lead to AEENC-values of 0.77 (D) and 0.54 (E) after 10 years. At the end of the period, AEENC equals 0.56 in scenario D and 0.12 in scenario E. The functional forms used for the five scenarios can be found in the appendix.

Figure I – Five scenarios for the average energy efficiency of new capital (AEENC)

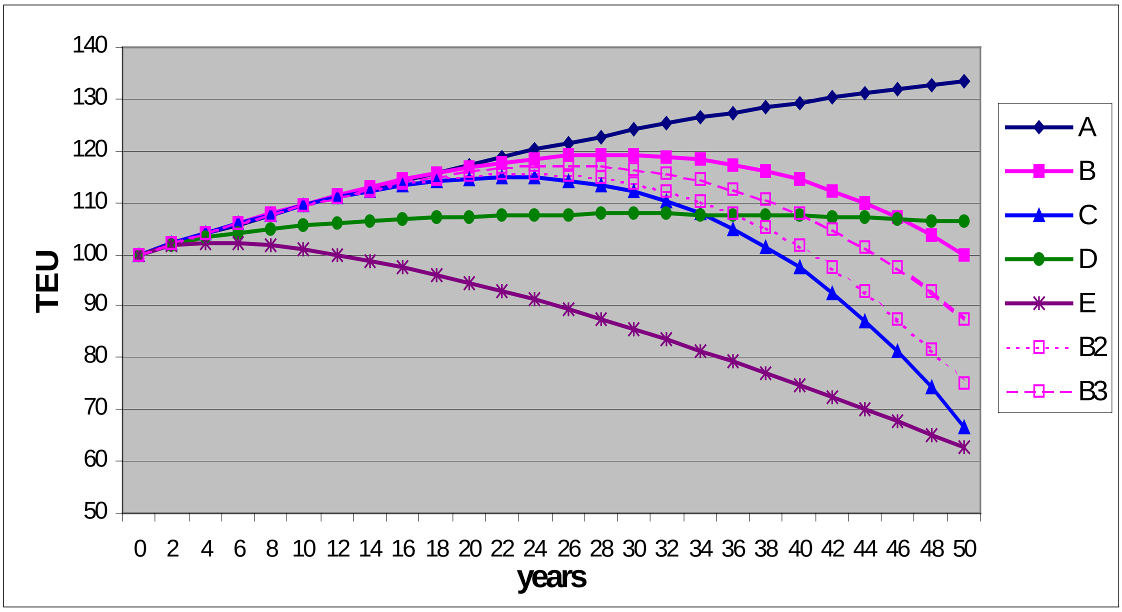


In the five scenarios, the availability of new energy technologies is the result of a market-based selection process that has been finalized in the broad commercialization of a specific group of new technologies. The sooner the market barriers that block these technologies are eliminated, the faster the process of innovation and diffusion can start.

What are the outcomes of the assumptions in the four scenarios? Therefore, we calculated total annual energy use (TEU, in tonnes oil equivalent) as the sum of energy use of the existing and the new capital stock. In Figure II, we present our findings.

Over the 50 years in our analysis, the total capital stock increased from 100 to 150 units but even in the business-as-usual scenario (A), the increase of total energy use is lower than 50%. In this scenario, TEU increases by 33% after 50 years. Figure II also shows that while the improvements in AEENC in Figure I may look spectacular, the impact of these shifts to new technologies on total energy use (and hence CO_2 emissions) is less spectacular.

Figure II - Total energy use (TEU, in tonnes oil equivalent) for the two capital stocks



At the end of the period, scenario B leads to the same total energy use as in the beginning of the simulation. A reduction of AEENC by half after 50 years is insufficient to reduce emissions when the capital stock grows. With scenario C, TEU rises during the first 26 years in the simulation. After 40 years, TEU is lower than the initial energy use and after 50 years TEU equals 66.6. Scenario D presents a specific case. TEU is very slowly increasing during the first 30 years of the simulation and then remains more or less stable. The technological breakthroughs in the beginning of the simulation are insufficient to lower TEU at the end of the period. As could be expected, scenario E with early technological breakthroughs leads to the best results. At the end of the analysis, TEU is 62.6, what is close to the final value for C. The difference is of course that aggregated total energy use over the period is much lower in scenario E.

What matters for environmental protection goals is total aggregated energy use over the period. We found that scenario A consumes most energy, 6205 tonnes oil equivalent (toe) in total. Total energy consumption is lowest for scenario E with 4553 toe or 73.3% of the total for A. Compared to A, the totals for B, C and D amount to 93.8%, 86.5% and 89%.

New technologies can lead to a reduction of total energy use in growing economies. It is however interesting to consider the role of scrapping old capital. Therefore we included in Figure II a sensitivity analysis based on scenario B. In the sensitivity scenarios B2 and B3, we accelerated the scrapping of old capital units and the replacement investments with new capital. At each moment in the analysis, the capital stock in scenario B equals that of the scenarios B1 and B2. The specifications are given in the appendix.

With scenario B2, TEU reaches its maximum after 24 years and then decreases to 75 at the end of the period. With scenario B3, we end with 87.5 as final value. Especially scenario B2 comes very close to scenario C. As a result, scrapping policies for old technologies can in specific cases be substitutes for technology policies that want to encourage the development of new technologies. Of course, this conclusion is based on a simulation that excludes retrofitting of existing capital.

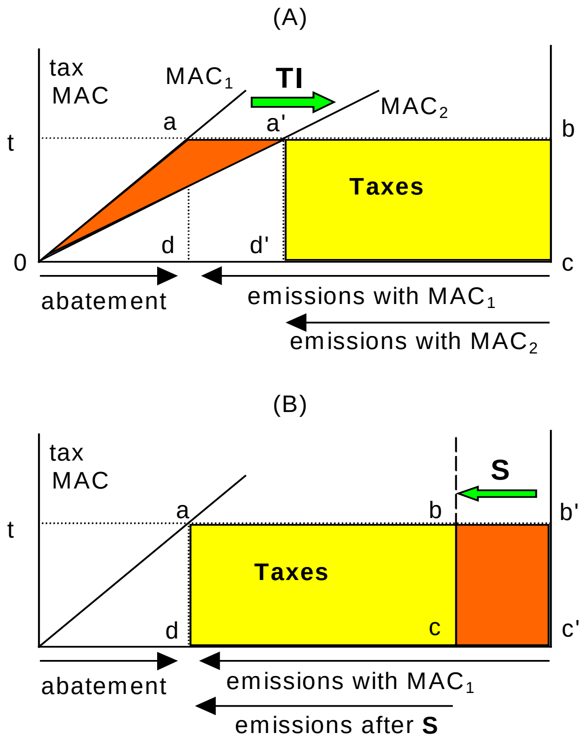
Whatever policy instrument is choosen in climate policy, it will take some time before we can see the impact on total energy use and aggregated GHG emissions. If national emissions need to be reduced over a short period (like 1990-2010 in the Kyoto Protocol), a significant part of the energy-inefficient capital stock need to be scrapped.

3. Innovating or scrapping?

Emissions can be reduced by implementing new technologies and by the elimination of old inefficient capital. The introduction of economic instruments in environmental protection strategies can stimulate the process of technological discovery and innovation to reduce abatement costs. Taxes or other price instruments can also create an incentive to scrap capital units that are responsible for the emissions that are taxed. Attrative scrapping opportunities can as such delay investments in environmental R&D.

When an environmental tax is introduced, Figure III illustrates the two alternatives to reduce emissions that we will further elaborate : technological innovations (TI) leading to lower marginal abatement costs (MAC_1 -> MAC_2) or scrapping policies (S) that make it possible to reduce emissions without investing in new abatement technologies. The most important difference between scrapping and innovating is that the former reduces the tax base directly while the latter option leads to lower abatement costs – as a result of the innovation - that still have to be paid, even by the innovating firm. A more detailed interpretation of Figure III is integrated in the next section.

Figure III – Environmental taxes and innovating versus scrapping



4. Numerical Analysis

In this section, we analyze how scrapping policies can contribute to the further reduction of emissions next to technological innovations that lower abatement costs and stimulate abatement efforts by polluters. Scrapping can be defined as the end of an asset's life for a particular use. It is possible that the asset may acquire another life in another industry or in another country. In our model, we do not consider possible positive market values of scrapped assets (we assume this market value equals zero).

We start with an economy without taxes on pollution. There is one firm in the economy that has two options to reduce emissions : to invest in new abatement technologies with lower marginal abatement costs compared to the existing technology, or to scrap old capital that is still in use. The firm can choose to combine both options.

The regulator wants to find the best tax level that will maximize social welfare. The regulator is interested in total welfare and not in stimulating technological innovations. During the period of the analysis, the polluter has the possibility to react on the introduced tax by using existing abatement technology or by investing in technological innovations and develop more efficient abatament technologies. There are however limits on the potential for technological improvements. We assume that technological efficiency of the abatement equipment can be increased by less than 100%. This means that the costs for one unit of abatement can almost be halved in the best technological case.

In the analysis, we therefore introduce L as the level of technological efficiency. We start with L=1 as the current level of technological efficiency. The highest possible value of L after the technological innovation is lower than 2. Each innovation increases L by 0.1 each step or generation. In our analysis there are 10 possible technological generations.

Polluters invest in new technologies to reduce abatement costs. We assume that marginal abatement costs are linear with C(L) as slope. The higher the level of technological efficiency, the lower the marginal abatement costs :

$$C(L) = e^{-L} a^2/2 \qquad \text{(a is a constant)} \qquad (1)$$

The R&D-costs to produce new technologies that lower C(L), depend on the desired level of technological efficiency L. The more ambitious the technological improvements, the higher R&D(L) :

$$R\&D(L) = b\,L^2 \qquad \text{(b is a constant)} \qquad (2)$$

The polluter compares the cost-reduction potential of the new abatement technology to the R&D-cost of the new technologies. The lower abatement costs - as a result of the higher L and lower C(L) – lead to monetary savings (area 0aa' in Figure III, Panel (A)) that are used to finance the R&D-cost. These savings are denoted by SAV in equation (7). The specification of SAV is given in equation (8).

We assume that the new abatement technologies replace all possibly existing abatement technologies without any cost. Only when the possible savings exceed R&D(L), the firm will decide to invest in new technologies. This is the first decision rule in the simulation. In this world without technological risks, the R&D-efforts are successful and lead to a higher L.

The net-benefits for the innovating firm after the introduction of the pollution tax are modest. The savings in abatement costs generated from the new technology are partly used to finance the necessary R&D-costs. For the remaining emissions after the additional abatement, the firms needs to pay the environmental taxes (a'bcd' in Figure III, Panel (A)).

The other possibility is to scrap part of the old capital stock. We assume that there are three categories of capital : old capital (in use for already 20 years), recent capital (in use for 5 years) and new machines that are just available on the market. The older the machines, the less energy or resource-efficient they are. Replacing the oldest machines by machines with a normal efficiency, leads to a reduction of average emissions of the total capital stock. Higher levels of L lead to increasing emission reduction potentials. We model this reduction of emissions (ER) as :

$$ER(L) = E^*(L_{-2})^2/cL \qquad (3)$$

with E = total emissions and L_{-2} = L with a lag of 2 technological generations (i.e when L now equals 1.5, we use the lower value 1.3), c is a constant

When we denote the environmental tax by t, the monetary value of this emission reduction equals:

$$\text{Value of scrapping} = tER(L) \qquad (4)$$

The scrapping of capital that still can be used for production has of course a cost. We assume that this cost (S) is always positive[1] :

$$S(L) = d/(fL)^2 \text{ (d and f are constants)} \qquad (5)$$

When tER(L) > S(L), the polluter will have an incentive to scrap old capital. This is the second decision rule used in the simulation. The scrapping decision will lead to lower emissions and lower environmental taxes to pay. It is of course possible that firms decide to scrap or sell assets for other reasons than avoided emissions. Song and Gao (2000) argue that once the discounted value of operational profits falls under the resale price by a certain proportion, the option value of selling the asset increases strongly.

When emissions are reduced as a result of abatement or scrapping efforts, social benefits are the result of the reduction of emissions. We assume that resulting marginal environmental benefits are constant. We use the parameter b_e in (7) for the constant environmental benefits.

[1] This does not necessarily need to be the case in some climate policy investments. New combined-cycle gas turbines can strongly lower the production cost per kWh. With the higher profit margins, it is possible that there are no net scrapping costs for old coal plants.

4.1 Setting the tax level

A first step in the simulation is the introduction of an environmental tax t on emissions. With this tax, the producer has an incentive to reduce emissions. Starting from the existing technological level L, the producer considers MAC_1 of the available abatement technology in Figure III, (Panel (A)).

With MAC_1, total abatement (A^{TI}) in units or tonnes will equal |0d| ;

$$A^{TI} = t/C(L) \qquad (6)$$

Total emissions will be |dc| = |0c| - |0d|.

In a next step, the producer has to look forward and estimate the technological possibilities to reduce abatement costs. When he considers the next technological generation (L+0.1), abatement costs will be lower ($MAC_2 < MAC_1$) and total abatement can be |0d'| as in Figure III (Panel (A)). The area 0aa' in the same figure represents the monetary value of the reduced abatement costs. We assume that this monetary value or SAV is used as the budget to finance R&D-costs. When the producer decides to invest in R&D, a higher level of L will be reached.

The producer has the freedom to choose his preferred technological level (L needs to be lower than 2). Each technological level can be reached but the R&D-cost will increase accordingly. An entrepreneur that is a 'technological optimist' will set L at a higher level than other entrepreneurs. The difference between the new and initial level of L is a measure of technological optimism (TO):

$$TO = L^n - L^i, \text{ with } L^i = 1 \qquad (7)$$

The new abatement function with $C(L^n)$ makes it possible to increase total abatement. The difference in abated units is |dd'| in Figure III (Panel (A)). This reduction of emissions is included in the calculation of total welfare.

Another option for the polluting industry is to scrap part of its old and inefficient capital. The expected reduction of emissions by scrapping depends partly on the level of L^n. $ER(L^n)$ is |cc'| in Figure III (Panel (B)) and $t*ER(L^n)$ equals to area bb'c'c.

We then calculate total welfare for 20 emission tax levels between 0 an 10 :

W = tax income + benefits of emission reduction – costs to realize emission reductions (abatement + scrapping), or ;

$$W = t(E - A^{TI} - ER(L^n)) + b_e(A^{TI} + ER(L^n)) – (R\&D(L) – SAV)) – S(L) \quad (8)$$

$$\text{with } SAV = 0.5(t^2/C(L^n) – t^2/C(L^i)) \quad (9)$$

In (8), tax incomes are included in total welfare. Whether or not these transfer payments form industry need to be included in welfare, depends on the use of the taxes by the collecting authorities. We also present results without these tax incomes but with a decomposition of welfare as generated by the technological innovation (W_{TI}) strategy and by the scrapping strategy (W_S):

$$W_{TI} = b_e A^{TI} – (R\&D(L) – SAV) \quad (10)$$

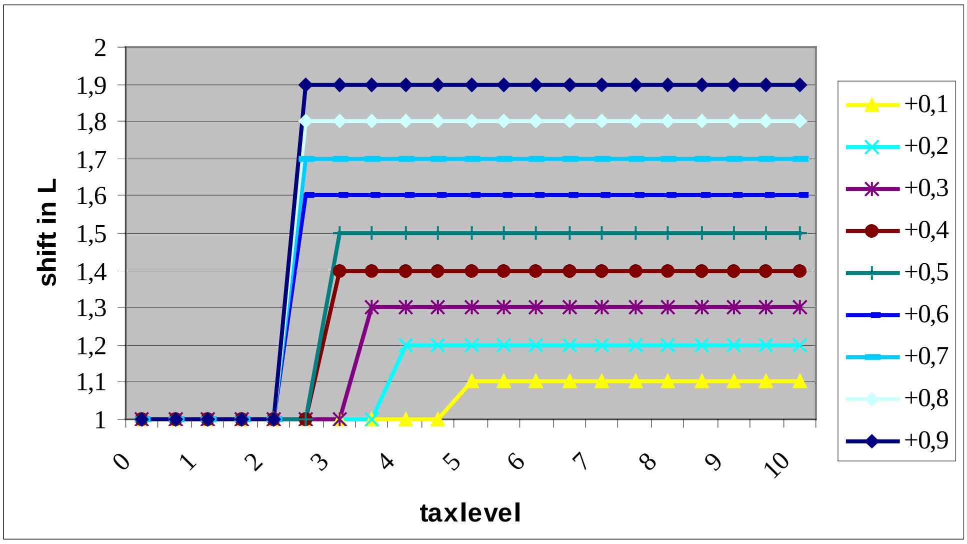
$$W_{SC} = b_e ER(L^n) – S(L) \quad (11)$$

4.2 Results

We used the presented model to analyze how the tax level can impact the level of technological innovations, to compare the relevance of technological innovations to scrapping and to illustrate the impact of both emission reduction strategies on welfare. The used parameter values are given in the appendix. We made simulations for different levels of technological optimism as defined in equation (6).

In Figure IV, the impact of the tax and the level of technological optimism (TO) on the effective shift to the desired technological level is presented. The level of TO determines the final value of L. We see that for each level of TO, a specific tax threshold can be distinguished. The higher the level of technological optimism, the lower the introduced taxes need to be for stimulating industry to invest in expensive R&D. The lowest tax levels do not lead to technological innovations and it is not necessary to introduce the highest possible taxes to have better ‘innovation results’.

Figure IV – Technological shifts

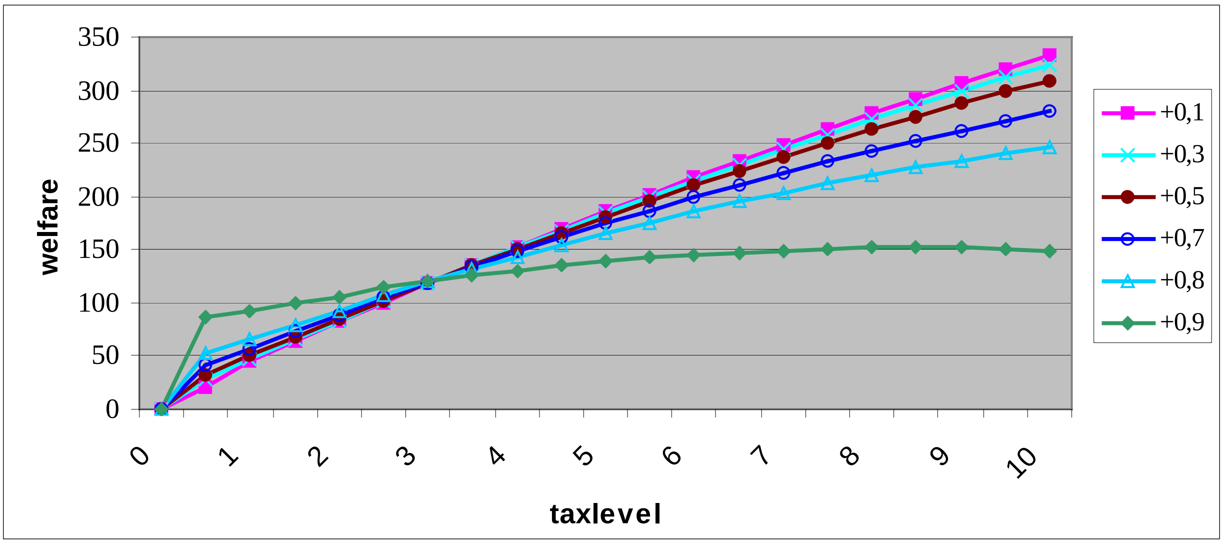


The impact of the combination of TO and tax levels on welfare is presented in Figure V. In the simulation, we used equation (7) that includes the tax income. An important conclusion is that with the highest levels of TO, total welfare is strongly impacted, especially when the taxes are higher than the marginal environmentel benefits from emission reductions. As we used in this simulation constant environmental benefits equal to 3, once emissions start to shrink as a result of successful abatement and scrapping efforts, the tax base is eroded what leads to lower welfare levels.

This means that when regulators use economic instruments in environmental policies that have the price effect of a tax, important technological innovations can lead to strong and maybe unexpected reductions of emissions. With modest technological improvements, higher taxes imply higher tax and welfare gains. The welfare levels with high taxes can vary between 100 and more than 300, depending on the level of technological optimism.

When we combine Figures IV and V, it is shown that regulators need to have good information on the relevant level of technological optimism. Possible sources for this type of information are experiences of competitors of the regulated industry in other countries with similar technological levels and knowledge bases. When the regulator can assume a very high level of technological optimism, other instruments than taxes can be considered. With systems of tradable permits, the regulator can determine the annual emissions but then the price is uncertain. Furthermore, with grandfathered emission rights, there are no welfare flows from industry to the regulator.

Figure V - Welfare effects of innovating and scrapping



In Figure VI and VII, results from working with equations (10) and (11) are presented. The presented welfare levels do not include tax incomes.

Figure VI - Partial welfare effects of innovating (for 6 levels of L)

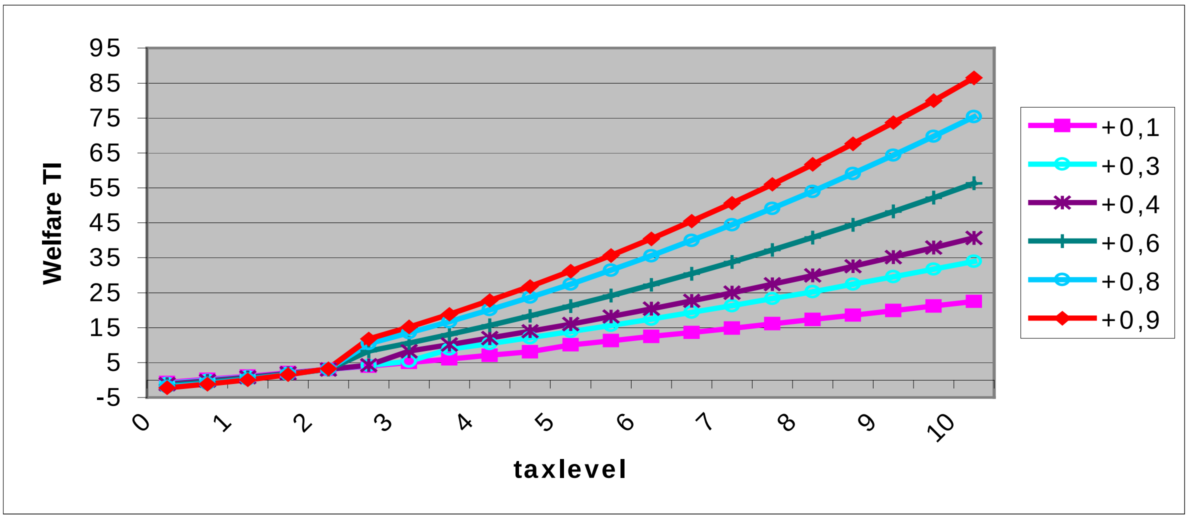
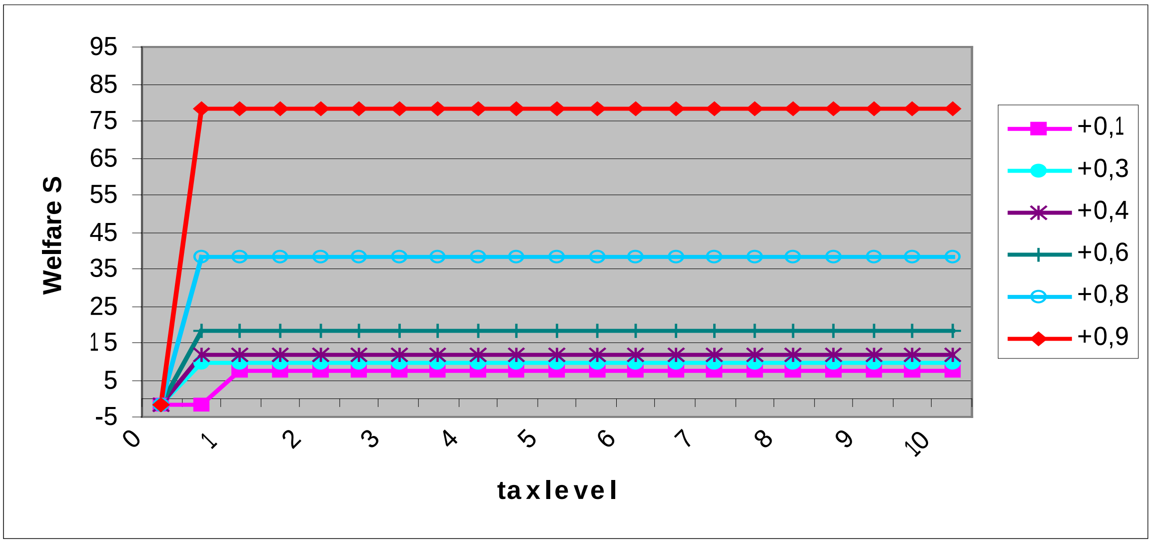


Figure VI illustrates the creation of welfare with the introduction of more efficient abatement technologies. The higher the level of technological optimism, the more abatement can take place and the higher the monetary savings as a result of the lower taxes. The link between new technologies and monetary savings with better abatament equipment is the most importance difference compared to the scrapping strategy. In fact, scrapping opportunities make it possible to reduce emissions without investing in new technologies. The short-term environmental consequences in terms of emissions are identical, but the long-term impact on technological dynamism can be significantly different. In section 2, we illustrated that early technological breakthroughs are necessary in order to reduce emissions, even over a long period. When these breakthroughs are less needed, scrapping strategies without technological efforts can hypothesize the chances to reduce emissions in the future.

Figure VI makes clear that in this simplified world, not the tax level is important but the level of technological optimism. The welfare with the lowest L is some four times smaller than the welfare that results from the highest level of technological optimism. The importance of the tax level is limited to triggering the mechanism. Once the tax level exceeds 2.5, the welfare differences become apparent.

Figure VII shows the welfare creation with scrapping strategies. The level of technological optimism leads to scrapping opportunities and reduces the relative cost of scrapping. Once the decision to scrap is taken, the welfare creation is fixed.

Figure VII - Partial welfare effects of scrapping (for 6 levels of L)

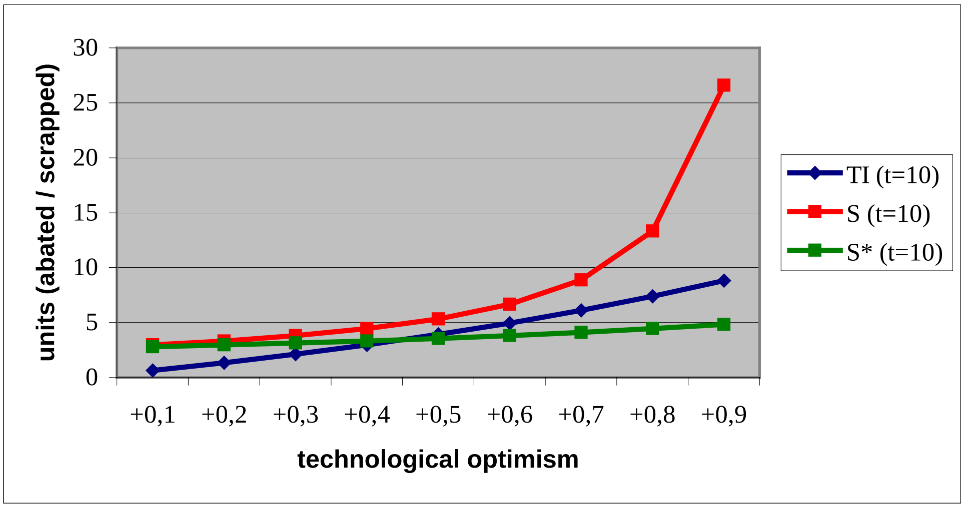


When we compare Figure VII to Figure VI, scrapping opportunities are attractive with low tax levels. In the case of high technological optimism (L=1.9), the created welfare is very high and can only be reached with much higher tax levels in the innovation scenario.

Figure VIII shows which option – scrapping or innovating – is most effective in reducing emissions. In this simulation, the tax level has been fixed at the highest level (t=10). The results are given for 6 levels of technological optimism. Two scrapping cases and one innovation case are presented. In the scrapping cases (SC) and (SC*), the impact of L on ER is as in equation (3) but in the second case (SC*), the constant c has been changed to limit the role of L on ER.

With S – the scrapping case that depends more directly on L - we find that the emission reductions from scrapping exceeds emission reductions from new technologies for all levels of technological optimism. When the environmental benefits of scrapping are less depending on technological innovations – (SC*) -, the cases with technological optimism lead to higher reductions from abatement technologies than from scrapping.

Figure VIII – Scrapping or innovating?



4.3 Limitations

The presented analysis suggests that scrapping can play an important role in environmental policy. Instruments like subsidies for new technologies can influence scrapping decisions. We did not include this type of subsidies in the analysis because instruments that favor existing technologies can slow down the innovation process that will ultimately lead to new technologies. Adda and Cooper (1997) found that subsidies to replace old cars in France did stimulate the automobile industry in the short run. The subsidies created also the basis for subsequent low activity of car producers in the field of energy and environmental efficiency. It is of course possible that after the scrapping of old cars, it was rational for industry not to allocate scarce resources in further efficiency improvements.

5. Conclusions

Technological innovations are the result of the alertness of entrepreneurs. To reduce greenhouse gases, new technologies are needed. The slow diffusion of innovations will limit the contribution of new technologies to the reduction of emissions. We presented an example of how the scrapping of old capital does lead to the same impact on emissions as the development of more energy efficient technologies.

Policy instruments like environmental taxes on emissions can influence the innovation process, leading to new abatement technologies. By scrapping part of the old capital stock, entrepreneurs can also lower emissions without having to invest in R&D. Scrapping has a cost and we therefore developed a numerical simulation to compare the impact of scrapping to that of technological innovations. In the simulation, we defined the concept of technological optimism. We found that the higher this optimism, the lower the environmental tax needs to be to stimulate technological innovations. High technological optimism – and hence investments in new technologies – can lead to a strong reduction of emissions and taxes on emissions. This pattern has important welfare implications. In a next step, we compared the emission reduction contribution and welfare implications of scrapping to that of innovating. When we assume that the potential to reduce emissions by scrapping depends on technological progress, the indirect effects of technological innovations – scrapping opportunities – can outweigh the direct effects of lower abatement costs and more abatement.

Appendix

Scenario A ; $AEENC_A(t) = 1- t/300$
Scenario B ; $AEENC_B(t) = 1- t^2/5000$
Scenario C ; $AEENC_C(t) = 1- t^2/300$
Scenario D ; $AEENC_D(t) = 1- 0.3 \log (t/1.75)$
Scenario E ; $AEENC_E(t) = 1- 0.6 \log (t/1.75)$
Scenario B ; $TEU_B(t) = 100 - t + 2t*AEENC_B(t) = 100 + t -t^3/2500$
Scenario B1 ; $TEU_{B1}(t) = 100 - 2t + 3t*AEENC_B(t)$
Scenario B2 ; $TEU_{B2}(t) = 100 -1.5 + 2.5t*AEENC_B(t)$

$C(L) = e^{-L} a^2/2$	with a=3
$R\&D(L) = b L^2$	with b=0.6
$ER(L) = E(L_{-l2})^2/cL$	with E=40 and c=7.5
$S(L) = d/(fL)^2$	with d=15 and f=3

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Abstract

Starting from CO_2 emissions data collected during both the production phase and during the lifetime of cars and trucks, we argue that impressive opportunities to reduce emissions can be found in the consumption phase. It is however obvious that energy taxes alone will not lead to a strong reduction of transport emissions. New instruments that stimulate technological innovations should therefore focus on emissions during product use.

In our opinion, current designs and proposals for CO_2 emission trading systems do not provide incentives to stimulate cross-sectoral energy efficiency investments like the development of cleaner cars and trucks. We think manufacturers should be >rewarded= when their products allow consumers to save energy during consumption.

To adapt these flexible designs, we introduced the concept of a >tradable certificate=, an allowance for each tonne CO_2 avoided as a result of selling a vehicle that is much more energy efficient than other new vehicles. We then developed two dynamic models in which we linked the value of these certificates to the diffusion of the cleanest vehicles. We found that the introduction of the certificate in tradable permit systems can lead to very significant reductions of CO_2 emissions. Our models indicate that emissions resulting from the car fleet can be reduced by 25 to 38% over a period of 15 years (starting in 1999). The potential of this new instrument is less spectacular for the truck market as a result of some fundamental differences compared to technological evolutions for car engines. But if the value of the certificate were high enough, emissions resulting from the truck fleet could be reduced by 12% over the same period.

Non-technical Abstract

In climate policy, new instruments are considered to reduce the emissions of greenhouse gases. One of the most interesting new instruments is emission or allowance trading that is already used in the U.S. Acid Rain Program. We think however that most designs for CO_2 emission trading are too strongly based on SO_2 trading designs while the abatement strategies for both environmental problems are clearly different. In our paper, we focus on CO_2 emissions in transport.

Starting from CO_2 emissions data collected during both the production phase and lifetime of cars and trucks, we argue that impressive opportunities to reduce emissions can be found in the consumption phase. We calculated the relative importance of the production and consumption phase in terms of total CO_2 emissions. We found that for the production of cars, emissions during the lifetime are 25 times more important than emissions during manufacturing. For trucks, emissions during lifetime are 375 times more important than emissions during manufacturing. Most policies do focus however on emissions during production and just assume that higher energy prices for consumers will lead to lower emissions.

It is however obvious that energy taxes alone will not lead to a strong reduction of transport emissions. Even in the countries with the highest energy taxes, total emissions in transport continue to increase. New instruments that stimulate technological innovations should therefore focus on emissions during product use.

In our opinion, current designs and proposals for CO_2 emission trading systems do not provide incentives to stimulate cross-sectoral energy efficiency investments like the development of cleaner cars and trucks. We think manufacturers should be >rewarded= when their products allow consumers to save energy during consumption.

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Making CO_2 Emission Trading More Effective : Integrating Cross-sectoral Energy Efficiency Opportunities

Johan Albrecht, University of Ghent-CEEM[*]

Abstract
Starting from CO_2 emissions data collected during both the production phase and during the lifetime of cars and trucks, we argue that impressive opportunities to reduce emissions can be found in the consumption phase. It is however obvious that energy taxes alone will not lead to a strong reduction of transport emissions. New instruments that stimulate technological innovations should therefore focus on emissions during product use.
In our opinion, current designs and proposals for CO_2 emission trading systems do not provide incentives to stimulate cross-sectoral energy efficiency investments like the development of cleaner cars and trucks. We think manufacturers should be >rewarded= when their products allow consumers to save energy during consumption.
To adapt these flexible designs, we introduced the concept of a >tradable certificate=, an allowance for each tonne CO_2 avoided as a result of selling a vehicle that is much more energy efficient than other new vehicles. We then developed two dynamic models in which we linked the value of these certificates to the diffusion of the cleanest vehicles. We found that the introduction of the certificate in tradable permit systems can lead to very significant reductions of CO_2 emissions. Our models indicate that emissions resulting from the car fleet can be reduced by 25 to 38% over a period of 15 years (starting in 1999). The potential of this new instrument is less spectacular for the truck market as a result of some fundamental differences compared to technological evolutions for car engines. But if the value of the certificate were high enough, emissions resulting from the truck fleet could be reduced by 12% over the same period.

Keywords : emission trading, greenhouse gases, energy efficiency, clean technologies, car and truck industry
JEL Classification : Q25, Q28, O3, L62

1. Introduction

Reducing greenhouse gas emissions will require a strategy that combines various policy measures and economic instruments. Next to traditional instruments like taxes on energy or the reduction of subsidies to energy-related sectors, some relatively new instruments entered the international fora. Systems of tradable permits for greenhouse gases (GHG), Joint Implementation (JI) and the Clean Development Mechanism (CDM) are currently considered or already in an experimental phase. Many of these instruments are of special importance for international emission reduction efforts but they do not provide a stand-alone solution. If they will be introduced in the near future, they will function next to many other instruments, depending on national priorities and political sensitivities.

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New instruments with a national scope followed. In late 1998, the Credit for Early Voluntary Action Act of 1998 has been submitted to US Congress (EDF, 1998). The Early Credit was part of President Clinton=s Climate Change Proposal of October 1997 and will provide emission reduction credits for early voluntary action (pre-2008) to US industries that reduce greenhouse gas emissions.

In this paper, we discuss current designs of tradable permit or allowance systems for carbon dioxide emissions and propose some modifications that could improve the environmental effectiveness of the instrument. We start from the general perception that the >flexible= instrument of permit trading has some clear advantages. It is accepted that permit trading will enable to reduce average abatement costs for developed countries as the trading will involve participation of developing countries and regions with lower abatement costs. The estimated savings through emissions trading with developing countries, compared to the GDP cost of unilateral emission stabilisation policies vary from 50% for the group of Annex I countries to 75% for specific countries like Japan (Mullins and Baron, 1997). Even among developed countries, there could be cost savings up to 50% by implementing carbon dioxide (CO_2) emission trading (Bohm, 1998). There are however still many uncertainties and discussions on implementation issues. An important issue will be the share allocated to (international) emission trading in total greenhouse gas reduction policies.

We will focus our attention on the environmental effectiveness resulting from permit or allowance trading. Can current designs of tradable systems result in accelerated reductions of carbon dioxide and other greenhouse gases, or will the trading mainly result in achieving the >emissions cap=, with or without an active market for tradable rights?

There are two other questions that we try to answer in this paper ; are current designs of CO_2 emission trading the most optimal designs and if not, can we redesign the mechanisms of allocation and trading to achieve better results? In case we can, how significant would be the improvement and at what cost?

In the next sections, we will elaborate on the need and opportunity to stimulate cross-sectoral energy efficiency investments, using data from the production of cars and trucks. Then we introduce a specific type of tradable allowance that enables to integrate these cross-sectoral efficiency investments in existing designs of emission trading. In the last sections, we present the output of dynamic models for the car and truck fleet that we have developed to estimate the impact of our instrument on CO_2 emissions for a period of 15 years. We also briefly illustrate that one of the used concepts is already introduced in another field of air quality policy in the United States.

2. The missing link

Most proposals for designs of systems of tradable emission rights start from an initial distribution of permits based on the production of carbon : >*The first step is to measure emissions of carbon* *dioxide into the atmosphere in terms of the fuels that consumers and industry actually buy (EC, 1998)*=. In this paper, we focus on carbon dioxide since it is the most important greenhouse gas. This initial entitlement of rights to emit is of course a crucial element for the political acceptability and the effectiveness of the system. Every year there will be an allocation of emission rights and by reducing the annual entitlement, total emissions can be reduced.

After the allocation of emission rights to a few sectors like energy producers and importers, price implications for the other sectors need to be considered. On this issue, opinions differ. If we assume that administrative costs need to be limited and that permits are allocated or >grandfathered= based on the carbon *produced* by the heavy industries or the importation of energy, the most important consequence of emission trading will be that energy prices increase for the consuming sectors in the economy ; households, light industries and the tertiary sector. These sectors will pay more for their electricity needs and for fuels used in transport and for internal power generation. The increase of the energy price will depend on the permit or allowance price that reflects the imbalances between demand and supply on the emission market. The results of this mechanism will be similar to those of energy taxes. The chance that emissions by households and transport decrease strongly is limited, due to low energy price elasticities that are currently experienced in most developed countries (Albrecht, 1998). It is a striking reality that in every developed country, even in those with high energy taxes, transport CO_2 emissions *continue* to increase. Next to energy taxes, other instruments are clearly needed.

In other CO_2 trading designs that are less depending on the role of a limited number of energy producers and importers, every economic agent (including households) has a personal private electronic account with carbon units. Individuals can escape from a general rise of energy prices if they consume less than their initial carbon unit credit or allowance : >*Purchases and sales of quota [carbon units] are made through automatic teller machines (ATMs), over the counter of banks and post offices and energy retailers, by direct debit arrangements with energy suppliers, and in numerous other ways... (EC, 1998).*=

We believe that these personalised emission trading designs have some advantages - consumers have clear incentives to save on energy used - but it will probably take a long time before these systems will function properly. Why not just include carbon units in existing electricity bills? This would be much cheaper compared to installing ATMs everywhere. The administrative costs of these multi-source-systems are also assumed to be very high. Therefore, we work in the next section with the more traditional designs of CO_2 trading that are in many cases based on the positive experiences with SO_2 trading in the United States. The Clean Air Act of 1990 created the sulphur dioxide trading program that started in 1994. According to the US Environmental Protection Agency (EPA,1997), the program is a success because utilities could reduce their emissions to a level below allocated emissions (e.g. 35 percent below allocated levels in 1995). Many participating utilities probably overcontrolled their SO_2 emissions in order to bank their allowances for use in future years (Phase II of the Acid Rain Program that starts in 2000) but some environmental groups stated that the initial allocations by EPA were simply too generous.

We would also like to stress that real reductions of SO_2 emissions are the result of cleaner inputs used like lower sulphur coal and on-site technological process improvements like placing scrubbers. Technological improvements will remain an essential condition for the realization of environmental targets. The trading between polluters provided an incentive to overcontrol emissions and diffuse reductions over the group of participating utilities. In the SO_2 program, the typical end-of-pipe technological option is strongly emphasized while CO_2 trading offers in our opinion much more potential for clean technologies of which saving energy is the cleanest of all.

The main difference with an energy tax is that permit trading - if effectively monitored and enforced - will always lead to the desired level of total emissions. The uncertainty of achieving specific emission targets is strongly reduced.

If trading with developing countries is allowed, the price of this emission cap would be limited compared to making use of energy taxes. But can permit trading offer something more than reducing average abatement costs? In the Kyoto Protocol it is stated that further reductions are needed after the initial commitment period that ends in 2012 (UNFCCC, 1997). Suppose that a reduction of 25% is needed in 2020 (relative to 1990). Will it be enough just to reduce the cap or the allocation of permits and will all parties accept this further reduction? Will majority voting procedures be applied during these negotiations? It is always possible that some countries do not want to reduce emissions further after 2012. Other complications could emerge when China, Indonesia or other developing countries do not open their gigantic markets for Western energy efficiency projects. Can we then easily enforce additional reduction of GHG emission to our already efficient electricity and industry sectors? The answer to one of these questions might be >no=...

Therefore, a strategy to reduce emissions by using trading mechanisms that only involve developed countries is very valuable to start with. In this perspective, the Early Credit could turn out to be an interesting experiment.

Currently, the allocation of permits is mostly modelled as an >upstream= or >downstream= system (Zhang, 1998 ; UNCTAD, 1998). Upstream systems allocate emission rights only over fossil fuel producers and importers. The participation in emission trading would be limited and many other policy measures will be needed. If transparancy and effectiveness of climate policies are a priority, we suggest that it would be better to develop a broad and integrated mechanism of emission trading. The use of many different instruments could result in conflicting means and targets.

More participation in emission trading is offered by downstream systems that include also other sectors, especially large industrial sources. Small sources will probably not be included for reasons of too high administrative costs. For instance, monitoring and enforcement costs in applying trading mechanisms to individual motor vehicle owners may be prohibitive (Hinchy e.a., 1998).

We can assume that the traditional energy-intensive sectors will be targeted. Some of these sectors have already formulated policy statements on permit trading. CEFIC, the European chemical industry council, will not oppose CO_2 emissions trading but explicitly demands for a *relative* grandfathering based on the changes in industrial production (CEFIC, 1998).

Industry can sell emission rights if the sector reduces its own CO_2 emissions. But if industry and the electricity sector are already efficient, how can we then reduce further GHG emissions at an acceptable cost? The answer on this question is not integrated in current tradable emission designs but is rather evident : we need to create incentives that make it interesting (not to say profitable) for industry and the electricity sector to reduce the GHG emissions of other sectors (transport, households and the tertiary sector). This is possible for each product that needs energy during the use or consumption. And many technical surveys indicate that the energy efficiency in transport and household energy use is still relatively low (Albrecht, 1998).

Therefore, we should stimulate cross-sectoral efficiency investments. Emission trading systems need to integrate cross-sectoral transactions like permits allocated to car manufacturers because they did sell very energy efficient cars to households. Therefore a new type of permits should be created for efforts that lead to reductions of emissions in other sectors. If the electricity sector, or another industry, provides a technology to a firm or industry that can reduce, just by the implementation of this technology, its own GHG emission by x tonnes, the provider of the technology should receive a number of tradable allowances[2] - in terms of GHG reduction units - for its sold product or technology. Later we will use the term >certificate= for this type of allowance. If other manufacturers, like the car industry or producers of heating systems or refrigerators, present a new energy efficient type, they could also receive a similar allowance or permit for the realized reductions. These allowances can be sold on the GHG Permit Market. The benefits from selling will reward industries for investing in GHG reductions realised by other sectors.

In the next section, we will work out an example for the car and truck industry to illustrate that what we propose is not just a further complication of existing proposals for permit systems but will offer significant environmental potentials.

3. Car and truck manufacturers and the tradable certificate

Next to many other sources, GHG emissions result from the production and the use of cars and trucks in transport. In most OECD-countries, transport accounts for more than 25% of all GHG emissions. The relative share of transport is estimated to increase further (COM(97)481). The

[2] Credits are denominated in terms of a pollutant flow such as tonnes per year. Allowances are defined in discrete terms like tonne CO_2, without a time specification. Working with allowances facilitates the development of future markets (Tietenberg, 1997).

CO_2 emitted in the production phase is however identical to the CO_2 emitted while using the car or truck. As a result of an upstream or downstream system of tradable permits, energy prices will increase and the already efficient car and truck manufacturing industry will further invest in abatement at the production phase or will buy emission rights.

In this >traditional= CO_2 emission trading system, the households that buy the cars will pay higher energy prices. The shift to very efficient cars will be insignificant. Considering the very low energy price elasticities for transport purposes, the diffusion of energy efficient cars will not be stimulated because industry is not *directly* rewarded for investing in reducing transport GHG emissions. Industry is only rewarded for reducing its *own* GHG emissions. We do not think that this should be the major environmental priority for car and truck manufacturers.

In Table I, we calculated total CO_2 emissions for producing one car in 1997. The data are collected for European Volvo plants. For other manufacturers, there could be significant differences. In our example, we limit the in-house production phase of cars to the four operations in Table I. The total CO_2 emissions in this table are relatively high compared to data for some other Volvo plants. We also included one tonne of steel per car in the example. This is probably too much ; the 1995 U.S. family car weighted 1470 kg (RMI, 1998). Another consideration is that CO_2 emissions depend on the used fuel mix used during production . A good illustration is the Volvo plant in Floby (Sweden) that has *no* CO_2 emissions because it uses district heating based on biofuel.

Table I - CO_2 emissions for the production of one car in 1997

Operations	Volvo Plant	unit	tonne CO_2/unit
Pressing of car body components	Olofström, Sweden	1 tonne of sheet steel	0.125
Production of gearboxes, rear axles and drives	Köping, Sweden	1 set of components	0.013
Foundry ; engine manufacturing	Skövde, Sweden	1 car engine	0.219
Assembly and painting	Ghent, Belgium	1 car	0.281
Total			0.638

Source : own calculations based on Volvo (1998a), Environmental data for Volvo production plants 1997

For the other supplies (seats, glass, electrical components,...) that are used during the assembly, we assume that the resulting CO_2 emissions amount to half of the in-house generated emissions. This results in total CO_2 emissions around 1 tonne per Volvo passenger car produced. Adding emissions during transportation and the end-of-life phases, we used in our further calculations (Box I) a figure between 1 and 2 tonnes carbon dioxide emissions per car. As a result of future

emission caps and allocations in permit systems, this figure could decrease over time if the producer (here Volvo) does not prefer to buy permits on the emission market but will opt for internal emission reduction. The reduction will probably not be spectacular, at most a reduction of 0.5 tonne CO_2 per car. The cost of this emission reduction could be considerable.
The produced car is then sold and used in traffic. The average fuel efficiency of this car is around 10 litres for 100 kilometres (Volvo, 1998b). We estimate that one kilometre in traffic results in an average emission of 25 g CO_2 per litre fuel consumed (calculation based on EC, 1998b). For the car in our analysis, CO_2 emissions will be around 250 g/km. Assuming that the car will be used for 150000 kilometres and that the average fuel efficiency will be constant as a result of good maintenance, total emissions of CO_2 during the lifetime will be 37.5 tonnes. Emissions during car use clearly outweigh emissions during production.
On the issue of total CO_2 emissions of popular cars, some organizations even publish lists with the worst and the best cars in terms of environmental damage. In 1990, it was calculated that the BMW 750iL with an average fuel efficiency around 17 l/100 km produced 66 tonnes of CO_2 during its lifetime (Public Citizen, 1990).
If industry should make a choice between investing in reducing emissions during manufacturing or investing in cars that need less fuel during their lifetime, the best environmental results will be achieved by the latter option, probably at the lowest cost.
This is even more clear in the similar case of trucks and buses. We define trucks as heavy duty vehicles, starting from 16 tonnes. Trucks that are used for long-distance transport have an average lifetime ranging between one and one and a half million kilometres, depending on the quality of the truck and the maintenance. For trucks that are used for short distances (e.g. each day ten journeys of 30 km), the lifetime ranges from 750000 and one million kilometres. If we take average emissions of CO_2 around 30 g/km per litre fuel needed - truck engines mostly burn diesel - and an average fuel efficiency[3] of 40 l/100 km, a lifetime of 1.25 million kilometres leads to total emissions of 1500 tonnes CO_2. If the truck were very efficient and consumed only 30 l/100 km with a shorter lifetime of only 750000 kilometres, total emissions of CO_2 would still be 675 tonnes. Compared to emissions during the production of trucks, estimated around 3 to 5 tonnes, the difference is extreme. Box I summarizes our two examples.

[3] In this paper, all assumptions on fuel efficiency and lifetime or mileage of trucks are based on interviews with experienced maintenance engineers at SCANIA Belgium. We would especially like to thank Mr. Roger Lauwers. Data from Volvo (1998) and interviews at four transportation firms that use trucks of Renault, Iveco and Mercedes confirm our data.

Box I - CO_2 emissions during production and use of the product

	Car	**Truck**
emissions during production	1 - 2 tonnes CO_2	3 - 5 tonnes CO_2
emissions during lifetime	37.5 tonnes (150000 km)	1500 tonnes (1.25 million km)
relative importance of consumption phase	37.5/1.5 = 25	1500/4 = 375

–> conclusion : instruments should target emissions during product use

As shown in the examples, we think that policy instruments should focus on the emissions during the use of the product. The problem is that the car or truck manufacturer does not yet receive a tradable permit or allowance for his investment in clean vehicles. But if the new product of this manufacturer emits 10 tonnes CO_2 less over its lifetime, why not allocate allowances for this reduction to the manufacturer? In this perspective, it is interesting to note that some surveys mention the emission reduction potential of electric cars but then link this reduction of emissions to increased emissions for electricity generators. When the increases of emissions in one sector are more than offset by emission reductions in another sector, the term >negative leakage= is used (Nordhaus e.a., 1998). We think that this case illustrates that too often emissions reduction efforts are connected to electricity producers or to the group of energy-intensive industries. The fact that emissions in transport can be reduced is of equal importance.

The manufacturer of cars and trucks would then be able to sell these allowances on the permit market and use the benefits for lowering the price of the new and highly efficient product or for financing further R&D in ecodesigns. To emphasize the difference with other credits of permits, we will call this received allowance for realizing reductions in other sectors a >tradable certificate=.

4. Advantages of the tradable certificate

Next to the stimulation of intensive research in energy efficiency, the main advantage of the tradable certificate is the broadening or acceleration of industry involvement. Every firm with products that need energy can be rewarded for energy savings during the lifetime of its product. If the permit or certificate price is high, the price of these highly efficient products can be significantly lowered and this will stimulate their market penetration. A competitive advantage can be created when cross-sectoral reductions of CO_2 can be sold on allowance markets.

We can also be sure that at least a few firms will realise fundamental breakthroughs that can change our patterns of energy consumption significantly during the coming decades. Another advantage is that we create a permit market with much more activity and less dependency on some economic sectors. Not only the electricity providers or energy importers will be on the market - probably buying permits from Russia and increasing the energy price for consumers-, but every firm that realized cross-sectoral energy savings can participate. The supply of energy efficiency will come from many parties. The stricter the caps imposed on the main emitting sectors, the more attractive their efficiency gains.

Some other issues need to be considered. In the case that manufacturers of cars or refrigerators can improve the energy efficiency of their products by making use of light materials or insulation solutions provided by the chemical or other industries, the allocation of the certificate is partly made possible by the inputs from other industries. These supply industries could claim a part of the certificates for themselves. It would however be very complicated to calculate the specific contribution of each input in total energy savings. Another option is that car or refrigerator manufacturers just pay a higher price for these specific inputs. On the other hand, the increased interest in energy saving technologies and inputs creates new and important markets for these supplying industries. They can increase their sales and this is partly made possible by the allocation of the certificates to the car and refrigerator industries.

If we introduce certificates for car manufacturers or other sectors to increase their CO_2 emissions during production, it is clear that the allocation of other - probably grandfathered - emission rights needs to be reduced. Otherwise, total emissions would increase. In our later model, we will explain that each year only a part of total received certificates will be available on the market for emission rights. We suggest that this annual inflow of certificates on the emission market will be deducted from the annual allocation that is planned for the country or industries in the analysis.

Compared to the Early Credit, the main difference is the cross-sectoral incentive to improve energy efficiency. Many aspects associated with the Early Credit are also valid for the tradable certificate : reward real reductions and not gaming, no predetermination of the eventual domestic regulatory program to control domestic GHG emissions, focus is on domestic early action, a mechanism that is not made contingent upon ratification of the Kyoto or later protocols,...

If the tradable certificate were developed as a voluntary mechanism, it would provide at the moment of the introduction of international emission trading some form of recognition for past voluntary GHG emissions. This should be preferred compared to a grandfathering mechanism that does not include past efforts. This is an important aspect since most observers estimate that international trading of emissions will not be a reality before 2004.

5. Performance standards

If we want to allocate certificates based on improved energy efficiency, a baseline to measure the efficiency gains is needed. The measurement of the energy efficiency improvement is rather easy to establish. For cars and trucks, detailed information on CO_2 emissions per kilometre are available in most countries. In our example, we calculated the efficiency gain as the reduction of emissions per kilometre.

Electronic devices need electricity and their electricity consumption is expressed in kilowatt-hours (kWh). In Europe, the most efficient refrigerators are already differentiated form the least efficient by energy labels. The price difference was in some countries reduced by a subsidy for the most efficient or A-types. If we want to allocate a certificate to the manufacturer, we can use an average CO_2 emission rate per kWh. Most figures fall inside the interval 400 - 800 g CO_2 per kWh used, depending on the input mix of the national electricity providers (EC, 1998). In the calculations in Box II, we assume 500 g CO_2/kWh. For countries that depend strongly on renewable or nuclear energy, lower values should be used. If we assume all refrigerators are equal in volume and quality, the difference in energy consumption per sold refrigerator should be multiplied by the number of sold products on the relevant market.

In Box II we present three examples with a sales volume typical for an important manufacturer selling in an average European country. We assume a lifetime of 15 years for the three products in the example and find that selling energy efficient products can reduce annual emissions of CO_2 with thousands of tonnes. Equal reductions will probably not be possible during the production phases.

Box II - Calculations of emission reductions based on performance standards

	Refrigerator	**Car**	**Truck**
Baseline	2 kWh/day	250 g CO_2/km	1200 g CO_2/km
Expected lifetime	15 years	150000 km	1500000 km
Efficiency new type	0.6 kWh	150 g	900 g
Savings (lifetime)	3.8 tonnes CO_2	15 tonnes CO_2	450 tonnes CO_2
Sales	10000	40000	5000
Total savings			
- lifetime (15 year)	38 000 tonnes	600 000 tonnes	2 250 000 tonnes

On the permit markets, the certificates allocated to the manufacturers of only three products, would lead to an annual inflow of 212 533 tonnes CO_2 equivalents during a period of 15 years. This inflow of certificates needs to be deducted from the total annual allocation of CO_2 emissions. If the baselines are set stricter, the inflow will be limited.

6. Modelling the impact of the certificate on the car and truck market

In this section we present two dynamic models to estimate the potential reductions of CO_2 emissions that could be realized if the tradable certificate were integrated in permit systems. We present two separated markets : the car market and the truck market.

We believe that the truck market receives much too little attention compared to the many policy initiatives for cars that have been taken in many countries. Heavy duty vehicles are of course less in number but with a mileage tenfold the car mileage and an average fuel efficiency five times the car fuel efficiency, a small truck fleet is responsible for the same level of CO_2 emissions as a car fleet that is 50 times bigger.

6.1 The car market

We start with a car fleet of 5 million vehicles and annual sales of 500000 cars. These assumptions are close to the actual situation of the Belgian car market.
We introduce three stock variables : existing car fleet, ecocars and other new cars. There are two types of new sold cars : an ecocar or a >normal= new car. The difference between the two categories is based on average fuel efficiency. Over a period of 15 years, we assume that the fuel efficiency of ecocars will fall from 5.5 l/100 km to 3.5 l/100 km. This is a realistic assumption (Von Weizsäcker, 1997 ; Lovins, 1996). A good example is the recent commercialization of Toyota=s Prius, a hybrid electric-gasoline car. The Prius consumes only 3 to 4 l/100 km with CO_2 emissions that are half of those of a conventional car. Emissions of toxic gases are reduced by 90%. Since the launch in December 1997, 3500 hybrid cars are sold each month in Japan and Toyota employees need to work overtime (Hinrichs, 1998). The reason for this >success= is the competitive price of the Prius in Japan ($ 16500) that is only 10 to 15% higher than the price of comparable but less fuel efficient cars. Some market analysts suggest that Toyota is not making profits on the Prius but wants to build up experience with the coming generation of ecocars.
Most surveys on the costs of ecocars estimate that hybrid and fuel cell vehicles would cost $ 4000 to $ 7000 more than comparable cars with traditional internal-combustion engines. Some manufacturers, like Ford and Mercedes - both corporations did invest heavily in the applications of fuel cell technology -, predict that the difference could be smaller (Leslie, 1998).
The fuel efficiency of the other new cars in our model will start at 8 l/100 km and will remain more or less constant in the first 5 years. Then the fuel efficiency will also improve and converge to the level of the ecocars. This assumption is made because we believe that when major corporations develop new engines and car bodies for their ecocars (35-75 kW), these new technologies will also be used - in a later phase - in their other types (more than 75 kW). Manufacturers will not develop car types based on two completely different technological trajectories. This would be too expensive.
For each of the stock variables, we defined a scrapping rate. Evidently, we used in the first phase a scrapping rate for the existing car fleet that is higher than the scrapping rates for the new cars. During the subsequent periods, the scrapping rates converge. We also assumed the scrapping rate of the existing car fleet to be dependent on the declining price of the energy efficient cars. Once these ecocars overcome their initial price disadvantage as a result of scale economies in the production, their inflow in the car market will increase and the scrapping of older cars will accelerate.
In our model, we introduced tradable certificates based on a fuel efficiency baseline of 9 l/100 km. The setting of this baseline is arbitrary. In the car example in Box II we took a baseline of 10 l/100 km. We calculated that the use of the more efficient new car will make it possible to

avoid the emission of 15 tonnes CO_2. This improvement will result in an allocation of 15 certificates to the manufacturer, each with an intrinsic value of abating one tonne of CO_2 emissions. These 15 certificates cannot be sold in the first year because they are based on the use during the complete lifetime of the vehicle. We assumed that manufacturers can only sell 20% in the first year. Of the total certificates, 80% will be banked[4] and sold in the next years.

We assumed that reducing the average fuel efficiency by one litre (for 100 kilometres) results in receiving four allowances, each representing one tonne CO_2. The efficient car in Box II consumes 4 litres fuel less than the baseline type. As a result, emissions will be reduced by 100 g/km. As already mentioned, over the lifetime of the car, 15 tonnes CO_2 are not emitted compared to the less efficient type.

The value of these earned certificates is linked to price developments on the permit market. Prices will depend on abatement costs for carbon producing industries, major market developments (like China or Indonesia participate in GHG emission trading) and the functioning of the market. In order to attract developing countries, it is obvious that permit prices need to be relatively stable, preferably at a high level. Making abstraction of other different opinions on climate policy and burden sharing between developed and developing countries, it will be hard to convince developing countries to join emission trading schemes if the price of the permits is very unstable and crashes frequently. We therefore assumed a mechanism of market intervention to keep permit prices inside a range. Using annual emission allocation quota that depend on average price developments and on the number of introduced certificates, could be an approach for this market intervention. If the allowance or permit price is falling, the allocation to energy intensive industries could be lowered to increase demand for permits and support the price level. If average abatement costs turn out to be around \$ 30 - \$ 40 /tonne CO_2 , we assume that the premit price will be around \$ 40 - \$ 50. In our model we will test for some widely accepted price levels, but not exceeding \$100 - \$150 (Bohm, 1998). Higher prices could however be possible since the marginal CO_2 abatement cost for some countries is estimated to be much higher (Mullins and Barron, 1998).

To reduce emissions, the market share of the efficient ecocars needs to increase. The commercial success of the ecocars will depend on the price difference compared to the other new cars. The price of the Prius is comparable - i.e. some 15% higher - to the price of its direct competitors and this is a crucial part of its success.

It would be too optimistic to assume that consumer preferences will shift to light microcars that are of course very efficient. We prefered therefore only to work in our model with rather large

[4] Banking means saving allowances for future use or for selling them to other participants in the future. A general advantage of banking is the provided flexibility for participants to go further than their required emission limit (Mullins and Baron, 1997).

cars with high comfort levels. Of this car with a high price of $ 30000, only two types are sold on the market. We clearly do not limit the category of ecocars to small cars because we think it is necessary to compare levels of comfort offered by cars. If an ecocar with only two places costs the same as a small family car with four places, the relative price of the ecocar is de facto twice the price of the other car. Many very efficient cars are small to reduce weight. This might be a positive development but households with three children that are also interested in efficient cars, are more concerned about the comfort level of their car. So we need to upgrade our average ecocar to the quality level of the average family car. We assume in our model that the ecotype of the average family car is 15% more expensive compared to the other type. We remind that the difference is probably smaller, especially for average cars with turbo diesel engines. In most countries, cars with the very efficient turbo diesel engines of Volkswagen and Seat cost some 5 to 10% more than the models of their competitors. The assumptions in our model are therefore rather conservative. If price differences are smaller, many stories like the Prius would follow. The same conclusion holds when the market share of small cars would increase.

Production prices of ecocars will fall as a result of economies of scale. For the new engines and materials, the economies of scale will be more important than for existing models.

We further assumed that prices to consumers will be reduced by the total actual value of the certificates that will be allocated to the manufacturer when selling an ecocar. We assumed that the banked certificates will not lose or gain value.

It is clear that buyers will only opt for the ecocar if the price is good and the comfort level comparable. In our model, 500000 new cars will be sold each year. If the price of the very efficient car equals the price of the other car, we assume that the market share of the ecocars will be 75% because comfort levels are identical. There will always be consumers that do not care about fuel efficiency and consider other characteristics more important. If the price of the ecocars is only 5% higher than the price of the other cars, we assume a market share of 30% for the ecocars. These buyers include the discounted energy savings in their decision to buy. If the price of the ecocar is 10% less than the other cars, we assume a market share of 95%.

The diffusion of the ecocars and the reduction of CO_2 emissions depend mainly on the difference in production cost and the value of the certificates that the producers of ecocars receive *more* than the producers of the other cars. If the baseline is set at 9 l/100 km, for *every* new sold car certificates will be received. Box III summarizes the main interactions that determine the market share of ecocars in our model.

Box III- Determining the market share of ecocars

fuel efficiency baseline (9 l/100 km) : b
fuel efficiency ecocars : f_{eco} (< b)   fuel efficiency other cars : f_{other} (< b)
production cost eco : P_{eco} production cost other cars : P_{other}
value tradable certificate (4 certificates/saved litre) : VTC

IF (P_{eco} - 4 * (b -f_{eco})*VTC) < (P_{other} - 4*(b - f_{other})*VTC)
THEN market share ecocars increases, or :

IF (P_{eco} - P_{other}) < ((f_{other} - f_{eco})* 4 * VTC) THEN market share ecocars increases

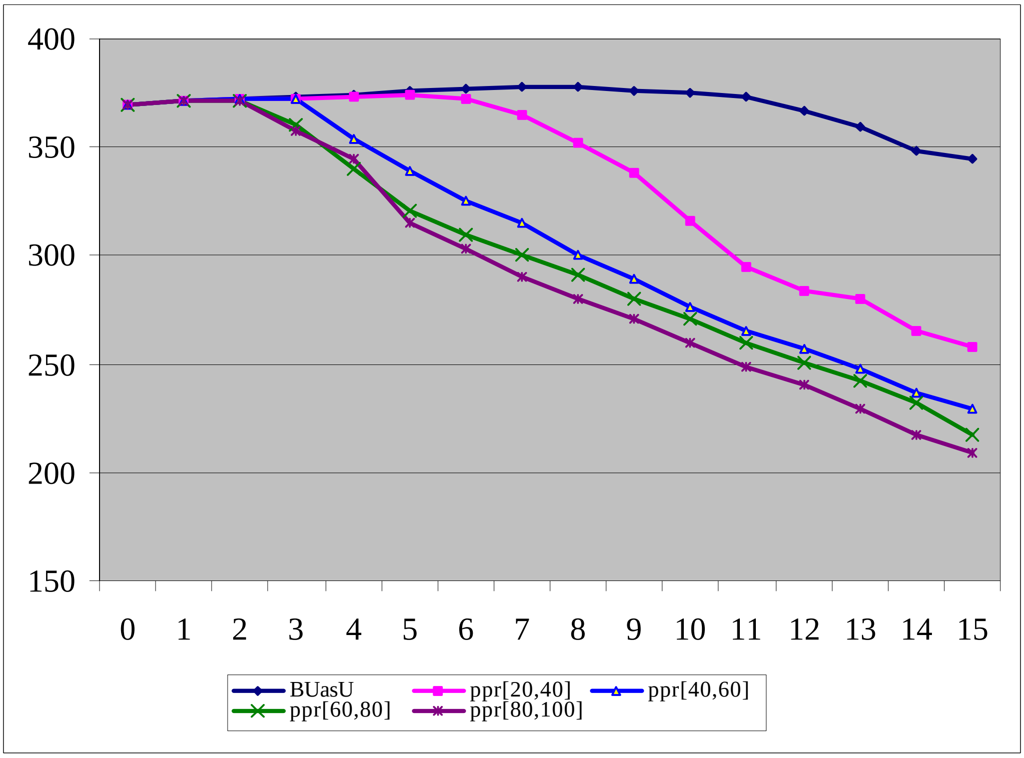
When the baseline is higher than the two levels of fuel efficiency, the total difference (f_{other} - f_{eco}) will lead to receiving certificates. If the baseline is between the two levels of fuel efficiency, the instrument of certificates is less powerful because the manufacturer of the ecocars does not receive certificates for the total reduction in fuel needs he offers to his customers. He will only receive certificates for the difference (b - f_{eco}). We conclude therefore that relatively high baselines could indeed lead to high inflows of certificates but they guarantee that the total difference in fuel efficiency is valuated on the market.

6.2 Results of the car model

To estimate the potential of the permit system with tradable certificates, we first calculated the future development of CO_2 emissions without the tradable certificates. This is the business-as-usual scenario (BUasU in Figure I). The start of our model is the year 1999. This should be kept in mind when comparing our model output to other models that start in 1990. We find that without certificates, the market share of the ecocars will remain too insignificant to have a clear impact on emissions.
In our model, the car fleet increases with 15% but due to the scrapping of the oldest cars first, CO_2 emissions do not rise similarly. Cars sold before 1985 can have an average fuel efficiency that is 50 to 75% higher compared to the cars sold in 2000. This improvement of efficiency can outweigh increases in the fleet and car use (km/year). As a result, only during the first 8 years, emissions rise slightly and when the most inefficient and polluting cars - cars sold during the 1980s and early 1990s - are scrapped, the average fuel efficiency of the car fleet will lead to a stabilization and modest reduction of CO_2 emissions starting from 2010. This (positive) development is of course depending on the ability and goodwill of manufactures to produce efficient cars without strong incentives like in the case with the certificates.
We then introduced tradable certicates into our model for an average car of the upper segment of the market (price :$ 30000). We took four price levels (in $) for the certificates or permits on the emission market : 20-40, 40-60, 60-80 and 80-100.

From Figure I - permit price ranges are indicated as ppr[,] - it is clear that the reduction of CO_2 emissions strongly depends on the introduction of the certificate. However, the differences for each price interval are small once prices on the permit market exceed $ 40. The patterns presented in Figure I are trend lines derived from numerous runs for each permit price interval. For each run, random permit prices were selected out of the relevant price interval.

Figure I - CO_2 emissions of the car fleet (million tonnes, 15 years)



Since our baseline remains at 9 l/100 km, there is a strong incentive for the most efficient manufacturers but certificates will also be received by other manufacturers. As a result, the level of the total reduction depends also on the improved fuel efficiency for the other cars. The improved average efficiency of all new cars is as important as the market share of ecocars.

Compared to the scenario without certificates (business-as-usual), the reductions of CO_2 emissions range between 25 and 38%, depending on the value of the certificate. Compared to the level of emissions in the first year of the model, the reductions are even higher : from 32 to 43%. If we had included in our model an increasing market share for small cars, the reductions would have been even more impressive. Since emissions from transport are assumed to increase more than emissions from other sources - for the European Union, transport emissions are projected to increase by 39% for the period 1990-2010 if no measures are taken (COM(97)481) - the potential of our instrument proves to be very attractive, even when working with this market segment of expensive cars. For smaller ecocars, compared to other cars of average size, the value of the certificates will lead to a more explicit price advantage.

6.3 The truck market

We developed a similar model for heavy duty trucks, starting from 16 tonnes. The success of CO_2 policies will also depend on evolutions in fuel efficiency for these vehicles. Many authors who write on the car market assume that developments for the truck market will be similar. There are however a few fundamental differences.

First of all, the truck market is more competitive than the car market. Buyers are very interested in the energy consumption of the truck they will use for many kilometres. The strong competition on the transportation market guarantees that transportation firms want to lower their energy costs. If the price of the most efficient trucks will fall, the reaction of transporters would be significant and the market share of ecotrucks would increase strongly.

Another difference with evolutions on the car market is related to the link between fuel efficiency and payload. The fuel efficiency of cars can be improved by reducing the weight of the cars. Trucks are developed to transport a heavy load. The use of weightsaving materials in the production of trucks will not yield similar results as in the car industry because the load remains heavy. The heavy load also has other implications. The average fuel efficiency of heavy trucks ranges between 30 and 40 litres for 100 km. In very congested traffic, the fuel consumption can even double. The two most important determinants of the fuel efficiency are not engine performance aspects but very basic elements : aerodynamics of the truck and load and tire pressure (the latter as a result of the weight of the load). Surprisingly, driving an empty or full container results in a difference in fuel consumption of only 5 litres. More surprisingly, driving an open (no roof) or closed container results in the same difference, with or without load. And the same additional 5 litres will also be consumed when the tire pressure is 25% below the optimal level (8 to 8.5 bar).

A rather conterintuitive difference is that for heavy vehicles, cleaner engines are less fuel efficient engines. There is generally a trade-off between exhaust emissions and fuel consumption (Samuelsson, 1998). Reducing emissions of pollutants did result in increased fuel consumption of turbo diesel engines. This depends to a large extent on the link beteen NO_X (nitrogen oxides) emissions and fuel efficiency. And from Table II, it follows that the focus of emission reduction requirements by the EC has been on reducing NO_X.

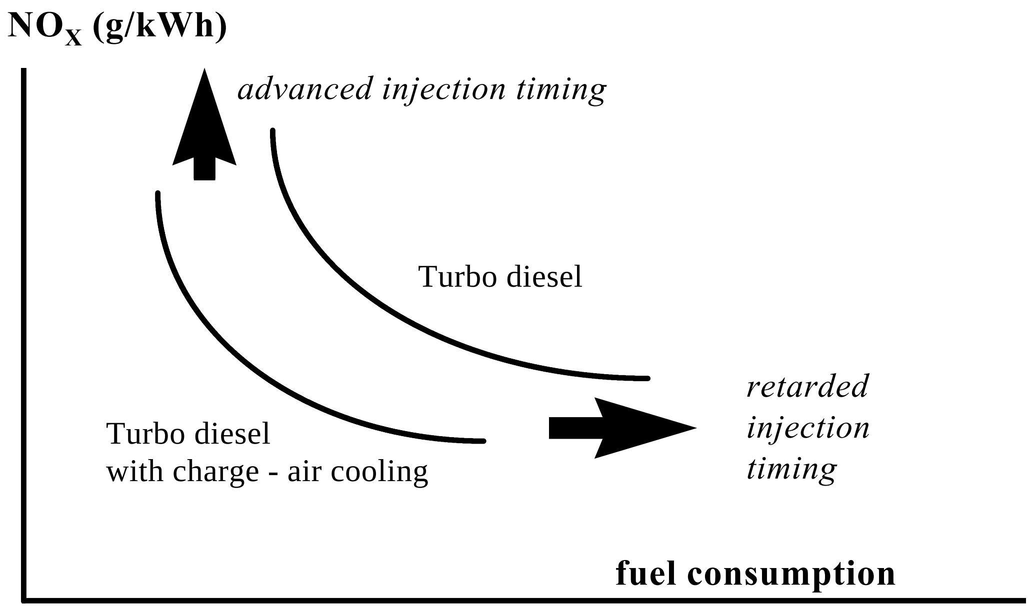
The relationship between NO_X and fuel consumption is shown in Figure II.. The emissions of turbo diesel engines depends on the timing of the injection. When the injection is retarded, the emissions of NO_X (g/kWh) will be reduced but the fuel consumption will increase. The challenge in most engineering departments of truck manufacturers is to anticipate the stricter Euro III standard while keeping fuel consumption stable. For SCANIA, it is expected that fuel consumption will increase by 0.5 to one litre per 100 kilometres as a result of the Euro III standard. For other manufacturers that are less advanced in the reduction in NO_X, the increase in fuel consumption is expected to be up to 5 litres! This is a good illustration of the benefits from investing first in clean technologies.

Table II - Development of emission requirements for trucks, g/kWh, 1989-1999

Standard	Year	NO_X	HC	CO	Particulates
ECE R 49	1982	18	3.5	14	-
Germany	1986	14.4	2.8	11.2	-
EEC	1990	14.4	2.4	11.2	-
Euro I	1992-development 1992-commercial	8.0 9.0	1.1 1.25	4.5 5.0	0.36 0.40
Euro II	1995/1996	7.0	1.1	4.0	0.15
Euro III	1999	under disc.	u.d.	u.d	u.d.
SCANIA	1989	14	0.5	1	-
SCANIA	1991	7.8	0.5	1	0.25

Source : SCANIA, 1998

Figure II - Relationship between NO_X and fuel consumption (diesel engines)



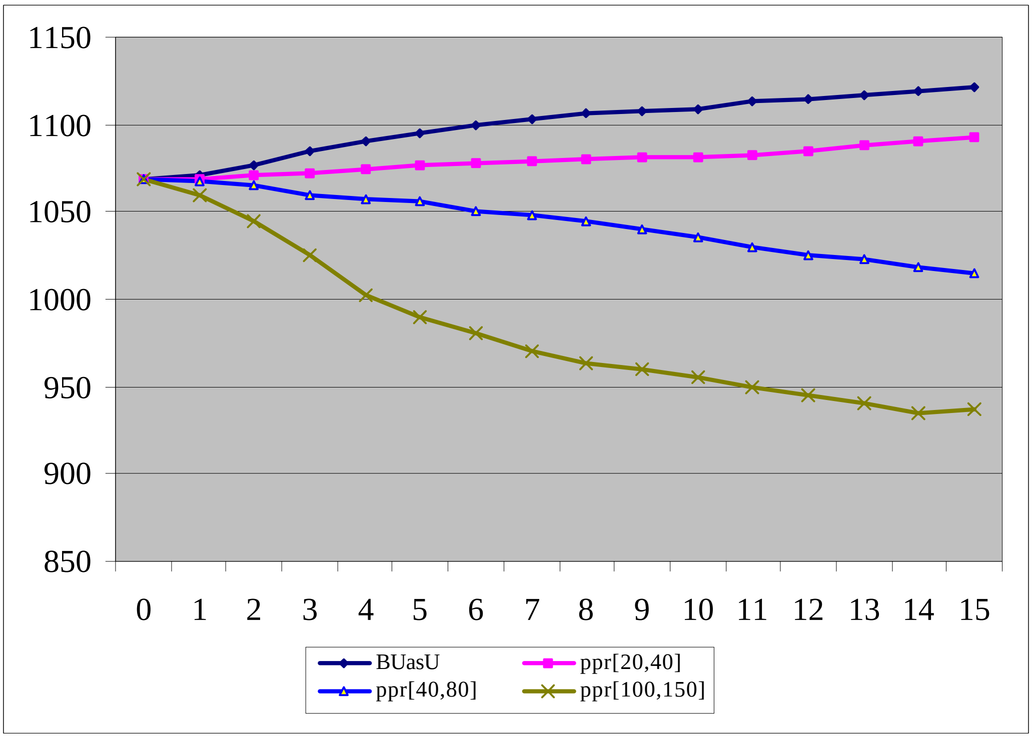
Source : Nylin, 1991

As a result of this trade-off, we cannot expect that the average fuel efficiency of the truck fleet will be strongly reduced in a few years. It will take more time. Furthermore, it is not speculative to state that the firms with the cleanest engines will have a significant advantage over their competitors who invested later in the development of clean engines. This difference could lead to lobbying activities to influence the implementation of new standards.

6.4 Results of the truck model

In our model we start with a truck fleet of 570000 units. Over a period of 15 years, the fleet increases with 12% to 638883 trucks. We first work with a production price of $ 65000 for a new truck (average fuel efficiency of 37.5 l/100 km) and $ 70000 for an ecotruck (average fuel efficiency of 32.5 l/100 km). The baseline for fuel efficiency was 45 litres/100 km. In later runs, we increased the production prices and changed the efficiency baseline.
In the scenario without the tradable certificate, we found that CO_2 emissions will increase by 6%. We then introduced the certificate at three permit price levels (ppr in $) : 20-40, 40-80 and 100-150. The results are presented in Figure III.

Figure III - CO_2 emissions of the truck fleet (million tonnes, 15 years)



It is shown that with the low value of the permits ([$ 20,$ 40]), the certificate will not have a strong impact on emissions : emissions will increase by only 3% compared to 6% in the business-as-usual scenario (BUasU). If the permit price ranges between $40 and $80, we found that CO_2 emissions will be reduced by 3 to 6%. With the high permit prices, the reductions are significant : - 12%. As indicated in Box III, the level of the baseline is important in determining the number of certificates a manufacturer will receive. We therefore did run the truck model with baselines from 35 to 50 l/100 km. The results - best and worst model output for the specific baseline - are presented in Table III. As already suggested, too low and too high levels for the baseline reduce the attractiveness and environmental impact of the tradable certificates. The best baseline in the emission trading design is a fuel efficiency that slightly exceeds the fuel efficiency of the other new vehicles sold on the market. For the truck market, the differences resulting from the changes in the baseline are not that spectacular. From Table III, it is shown that we reach the best results with a baseline of 40 l/100 km.

For all the runs used for Table III, the price of the permits was selected at random from the interval [$20, $100]. The percentage reductions are always calculated compared to the start of the model.

Table III - Fuel efficiency baselines for trucks and CO_2 emissions

Fuel efficiency baseline for the certificate	Change of CO_2 emissions *worst case(% change)*	Change of CO_2 emissions *best case(% change)*
35 l/100 km	+2	-7
37.5 l/100 km	+1	-5
40 l/100 km	+0.5	-8
45 l/100 km	+1	-6
50 l/100 km	+1.5	-5

Finally, we present some results when the average production costs in the truck model were increased from $ 65000 - $ 70000 to $ 80000 - $ 85000 and to $ 90000 - $ 95000. The price difference of $ 5000 is relatively smaller for expensive trucks. The output of the model is similar for the two cases with higher prices. The reduction in fuel costs and the value of the certificates will in both cases lead to an earlier shift to ecotrucks if the certificate is introduced. We found that with prices for trucks between $ 80000 and $ 85000 and permit prices taken from [$20, $100], CO_2 reductions will decrease by 4 to 10% over 15 years. With production prices of $90000 and $ 95000, the projected reductions range between 3 and 9%.

6.5 Conclusions of the models

It is clear that emissions of CO_2 can only be reduced when the diffusion of cleaner engines and new vehicle designs is strongly stimulated. This could be achieved with subsidies but then some sectors would be more able than others to influence the subsidy mechanisms. If we should opt for certificates fitting in permit system designs, we increase transparency and limit administrative costs. The potential reductions depend on many specifications of which the used baseline to allocate the certificates might be an important one. With realistic permit prices, we found that the system with tradable certificates offers very significant reduction potentials, especially for the car market. For the truck market, the reduction potential is more limited but still very interesting.

7. The case of permits for scrapping

The tradable certificate, like we have presented it, receives its value from avoiding CO_2 emissions. We found another case related to cars - especially to very old cars - where permits were also allocated as a result of avoided emissions. There are however many differences in the case that we will briefly present. The term >permit= is here an air quality permit, like city and county permits and should not be compared with permits in emission trading.

The Clain Air Act amendements of 1990 required US states to consider possible remedies for pollution from old cars. These cars pose serious problems. Tests in the early 1990s on thousands of vehicles in Los Angeles, Chicago and elsewhere showed that 50% of all carbonmonoxide (CO) emissions came from only 10% of the cars on the road. Similarly, half of the hydrocarbons (HC) were emitted by 14% of the vehicles (Totten and Settina, 1993).

A few programs were established to accelerate the scrapping of these older cars. The first was SCRAP (South Coast Recycled Auto Project). SCRAP could offer $ 700 to each owner that sold his old car. Compared to our case, SCRAP gave the owner the certificate for avoided emissions and he sold it immediately on the CO- or HC-market for $ 700. In the first phase of SCRAP, 8400 cars were bought. This resulted in the elimination of 13 million pounds of pollutants from the air. To make the program more attractive, participation of other corporations could be stimulated by linking their construction permits to proven reductions from other sources. These firms would then estimate their future emissions and buy the necessary number of old cars to >offset= their own pollution debt (Totten and Settina, 1993).

Another program is the Bay Area Vehicle Buy Back program (San Francisco). Since 1996, this program has already bought 2000 old cars and paid each owner $500 (BAAQMD, 1998). By recently adding 1980 and 1981 model years to the program, the potential pool of eligible vehicles in the Bay Area approximates 100000 vehicles, each 5 to 50 times more polluting than new cars.

Almost every environmental program receives criticism from action groups but these scrapping programs were opposed by some unexpected groups next to environmental organizations. Associations of collectors of old cars tried to stop the scrapping because the prices of spare parts for collectors would increase as a result of the scarcity. Some of these groups used however interesting arguments to oppose the scrapping[5]. They stated that when the pollution credits resulting from the scrapping are applied for permitting new plants - and this was the basic

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[5] An overview of the position of these groups with economic and environmental arguments can be found at <http://home.fuse.net/sdun/Scrappage.htm> (visited 16/10/98).

principle when introducing SCRAP -, there is no net change in emissions and air quality. When the owners who scrapped their old car, replace this vehicle by another relatively old and dirty car, total emissions could even increase.
Environmental groups complained that some cars for which their owner received the scrapping premium were barely running. They argue that the realized reductions by the program are much lower.

8. Conclusions

Starting from reliable data on CO_2 emissions during the production and the use of cars and trucks, we found that opportunities for reducing emissions are impressive in the consumption phase. Emissions during the production phase are almost negligible compared to emissions during the use of the vehicles. The only available instruments that directly influence energy use by households and industry are energy taxes. The price elasticity of energy used in tranport is however much too low to have a significant impact on transport emissions. It is striking that in every developed country, even in those with the highest energy taxes, transport emissions continue to increase. New instruments should therefore focus on emissions during the phase of product use or lifetime but current designs and proposals for tradable CO_2 emission systems do not provide incentives to stimulate cross-sectoral energy efficiency investments. We argue that manufacturers should be rewarded for their products when they make it possible for consumers to save energy during consumption.
To modify these designs, we introduced the concept of a >tradable certificate=, an allowance for each tonne CO_2 avoided as a result of selling a vehicle that is much more energy efficient than other new vehicles. We then developed two dynamic models in which we linked the value of these certificates to the diffusion of the cleanest vehicles. We found that the introduction of the certificate in tradable permit systems did lead to very significant reductions of CO_2 emissions. Emissions resulting from the car fleet will be reduced by 25 to 38% over a period of 15 years (starting in 1999). The accelerated scrapping of old and energy inefficient cars is also very important in this process.
The potential of the new instrument is less spectacular for the truck market as a result of some fundamental technological differences. But when the value of the certificate would be high enough, emissions resulting from the truck fleet could be reduced by 12% over the same period.

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Voluntary Agreements with Emission Trading Options in Climate Policy

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ABSTRACT

Recent political and corporate initiatives indicate that voluntary agreements and emission trading will play a crucial role in climate policy. We show that when emission trading is integrated as an option in voluntary agreement contracts, the overall efficiency of the use of flexible climate policy instruments is strongly increased. The emission trading option, formalized as a CO_2 allowance call option contract that can be traded, provides clear incentives to overcomply with the target of the voluntary agreement. The option mechanism also delivers a market price for eventual non-compliance, based on differences in abatement costs. With an example, we illustrate that the option mechanism can result in stimulating financial benefits for the firms that are most succesful in reducing emissions.

1. Introduction

At the 1997 Kyoto Conference of Parties, developed countries agreed to set reduction targets for carbon dioxide (CO_2) and five other greenhouse gas emissions as a first step to stabilize the atmospheric concentration levels of these heat-trapping gases. For this purpose, the use of flexible instruments like emission trading has been integrated in the Kyoto Protocol. The Kyoto Protocol also foresees that the set of flexible instruments needs to be further developed. Voluntary approaches have already been considered since the Rio Conference in 1992.

In this paper, we first briefly present some experiences with voluntary instruments and emission trading. Although both instruments have similar goals, there are no formal connecting mechanisms. The flexibility that both instruments are expected to offer depends on aspects like the emission reduction target. Strong economic growth renders absolute reduction targets more challenging while economic recessions offer 'opportunities' to overcomply. In the later sections we will focus on the opportunities to motivate firms to overcomply when this is technically possible.

In the final section, we propose a combined instrument to reduce industrial greenhouse gas emissions : a voluntary agreement with an emission trading option.

2. Voluntary agreements and Climate Policy

The growing body of international experience with voluntary or negotiated agreements provides valuable information for all countries. For an overview of voluntary agreements to reduce greenhouse gases, we refer to UNEP (1997). In this section we concentrate on recent developments in Canada, the United States and the Netherlands.

Canada was one of the first countries that attributed an important role to voluntary agreements (VAs) in climate policy. The Climate Change Voluntary Challenge and Register Programme (VCR) has been launched in late 1994. In June 1999, already 910 companies and organizations, representing a majority of sources of greenhouse gas emissions in Canada, had registered to the programme. Most energy-intensive sectors participate in VCR. One of the VCR success stories is DuPont Canada's Maitland facility that produced almost 2% of total Canadian GHG emissions in 1990. By the end of 1999, emissions from this facility will be reduced by 95% (VCR, 1999). Some important participants to Canada’s VCR are also GERT Pilot partners. GERT is the Greenhouse Gas Emissions Reduction Trading Pilot, launched by a multstakeholder partnership in June 1998 (GERT, 1998). The Pilot is designed is provide all participants with practical experience in emission reduction trading, to assess environmental and economic benefits of the mechanism and help building the foundations of a possible future emission trading system in Canada. Since important energy-intensive firms and industries participate in voluntary agreements as well as in emission trading, the opportunity to combine the positive elements from both instruments needs to be considered.

In the US, the Energy Policy act of 1992 (EPACT, Sections 1605 (b) and (c)) introduced a Voluntary Reporting of Greenhouse Gases Program. In 1998, 156 industries or firms reported 1229 projects that either reduce emissions of carbon dioxide or sequester carbon dioxide. In April 1999, Senators Murkowski and Hagel introduced the Energy and Climate Policy Act of 1999 (U.S. Senate, 1999). The most important purpose of the Act is the further promotion of voluntary efforts to reduce or avoid greenhouse gas emissions and improve energy efficiency by expanding and strenghtening the voluntary reporting guidelines and reporting procedures under Section 1605 of the Energy Policy Act of 1992.

The Energy Efficiency Benchmarking Covenant has been developed in the Netherlands as the follow-up of the long terms agreements on energy efficiency progress for the energy-intensive industry (Commissie Milieu, Verkeer en Vervoer, 1999). In the new covenant, energy-intensive industries commit themselves to permanently belong to the world top concerning the energy-efficiency of process installations from 2012 onwards, but preferably sooner. In return, the Ministers will aim to prevent the imposition of any additional specific national energy saving requirements or CO_2 reduction measures till then, as well as the introduction of national energy taxes aimed at those companies (MinEZ, 1999). Facilities consuming at least 0.5 Peta Joule (PJ) a year (equal to 15 million cubic metres of natural gas) can participate. The Confederation of Netherlands Industry and Employers VNO-NCW and all sectoral organisations from energy-intensive industry have committed themselves to the covenant. It is estimated that approximately 80% of the Dutch industrial energy-use is covered by the agreement. This would lead to an annual reduction in CO_2 emissions of 5 to 10 Megaton (Mton) compared to a situation without benchmarking (Energy Efficiency Benchmarking Covenant, 1999).

Determining who belongs to the world top is the responsability of the companies. This task will be performed by an expert third party once every four years . The Benchmarking Commission, with representatives of all parties, will co-ordinate the implementation of the covenant, monitor the progress of its implementation and publish an annual public report (MinEZ, 1999). The benchmarking covenant is subject to some criticism. Due to the fact that Dutch companies are already close to the world top in terms of energy efficiency, the environmental gains are believed to be modest (Milieudefensie, 1999). As energy efficiency gains are coupled to similar developments in foreign countries, international competitiveness is explicitly taken into account.

Although it is not the purpose to give a complete overview of the different steps to be taken by companies signing the covenant, one particular stipulation has to be mentioned when examining the link between voluntary agreements and emission trading: if companies have not realised the best international standard by 2008, they are allowed to make use of flexible instruments such as emission trading (VNO-NCW, 2000).

A common feature of the voluntary agreements in this section is that the link with emission trading, if any, remains unclear. No practical guidelines to opt for those flexible instruments when the targets of the agreement cannot be reached are taken into account. After giving an overview of some recently developed emission trading systems, we propose a practical mechanism that can be used to explicitly include the use of flexible mechanisms in voluntary agreements.

3. Internal Emissions Trading , the Prototype Carbon Fund and Gets2

Many economic actors are not just passively awaiting the outcome of political discussions concerning the use of flexible mechanisms to reach the objectives of the Kyoto Protocol. In this section we give a few examples (the list is certainly not exhaustive) of companies and organizations that have anticipated on the results of such a debate by installing an internal emission trading system.

3.1 BP Amoco's Greenhouse Gas Emissions Trading

A well documented emission trading project is the one launched in september 1998 by BP Amoco. The purpose of the system is to reduce the cost of emission reductions by allowing the different sites of the company to find the lowest cost of abatement. Since January 2000, all activities of BP Amoco are included. At the core of the project is the statement of Group Chief Executive Sir John Browne that by the year 2010, the company will have reduced its greenhouse gas emissions to 10% below 1990 levels. Based on a business as usual projection, this equales to a 30 million tonnes reduction.

BP Amoco's emissions trading system is based on a cap and trade concept. A target is defined which sets the cap on emissions. 1998 has been chosen as a base year to set the Group cap and this Group cap will steer progress towards the GHG target. A fixed number of tradeable annual allowances to emit greenhouse gases is allocated to each Business Unit (BU). Both carbon dioxide (CO_2) and methane (CH_4) emissions are included. Initial allocations are grandfathered based on the actual emissions of BUs in 1998.

A record of the flow of allowances (= units traded) will be kept, this is important in the event that regulation takes place at the national level. Compliance is assured by fixing the greenhouse gas allocations in performance contracts and reporting the progress in meeting those targets in the financial performance indicators for the company. Banking of allowances (carrying over from one year to the next) is allowed, but regulated. The system does not include emissions from imported power used in the companies' operations.

BP Amoco is also proactive in the field of Joint Implementation (JI) and the Clean Development Mechanism (CDM). When a specific project -projects outside the BUs operations included- is undertaken that results in a CO_2 reduction, CO_2 equivalent credits are generated. This approach is called Credit Based trading (CBT). Restricions will be imposed on the use of this mechanism.

The document "Greenhouse Gas Emissions Trading in BP Amoco" states that "*Trading is an important policy alternative to taxation, and has the important advantage that it can work with other policy initiatives such as voluntary agreements between industries and governments* (BP Amoco, 1999)." The system developed by the company links voluntary agreements and internal emission trading. In Section 4, we extend this approach to external (i.e. with companies outside the VA) emission trading.

3.2 The Shell Tradeable Emission Permit System (STEPS)

The Royal Dutch/Shell Group recently launched 'STEPS', the Shell Tradeable Emission Permit System, a cap and trade system with very similar characteristics as the one previously described. The Group has set itself an overall reduction target of 10% of its greenhouse gas emissions by 2002, compared with its 1990 levels. This target can partly be reached by making use of an internal emission trading system. Each permit is worth 100 tonnes of CO_2 emissions or its CH_4 equivalent. Allocation of the permits is based on 1998 levels. Each participant will receive permits up to a level of 98% of the emissions during that year. They commit themselves to make a 2% reduction over the next three years. Permits for the three years have been given in advance, therefore a futures market is expected to develop. In the first year, participants receive 95% of their allocated permits. The remaining 5% is being held in reserve for early auction among the companies.
Emissions covered by STEPS make up 30% of the Groups total emissions and participation is restricted to the companies operating in Annex I countries. Marginal costs are estimated in the range of $5 to $40 per tonne of carbon abated. Banking is possible and penalties are levied for non-compliance. Transaction costs will be minimised by making use of a Trading Manager, through which all trades will be channelled. In addition, the Group is establishing guidelines for a Shell-internal CDM-scheme (Shell, 2000).

3.3 The Prototype Carbon Fund

The Prototype Carbon Fund (PCF) was launched by the World Bank in January 2000. The Fund will invest in projects in the framework of JI and the CDM (Prototype Carbon Fund, 2000). It is a market-based mechanism aimed at addressing climate change and promoting the financing and transfer of climate-friendly technologies to developing countries. The PCF consists of contributions from governments and private companies. The purpose of the Fund is to reduce greenhouse gas emissions by making investments in cleaner technologies in the developing countries and transition economies. The main focus is on renewable energy technologies. After an independent verification and certification of the emission reductions, they will be transfered to the Fund's contributors. This will be done in the form of emission reduction certificates. The World Bank will act as a broker in helping to negotiate a price for the emission reductions that is reasonable for both buyers and sellers. The emission reductions from PCF projects may eventually be used against industrializes countries' commitments to reduce their greenhouse gas emissions, dependent on what rules will be developed by the Parties to the UN Framework Convention on Climate Change (The World Bank, 2000). However, PCF is a pilot activity and does not endeaver to compete in the emissions reductions market; it is restricted to US $150 million. Termination of the project is sheduled for 2012.   As interest in the Fund shows to be greater than previously expected, the Bank's management decided to ask its Executive Board to raise the $150 million cap (Prototype Carbon Fund News Page, 2000).

3.4 Gets2

Another interesting initiative is Gets 2, the Greenhouse & Energy Trading Simulation n°2. This program runs under the aegis of ParisBourse and Eurelectric. During Gets2 sessions, more than 35 fictional companies from 6 industrial sectors (Utilities, Petroleum, Steel, Cement, Chemicals, Pulp and Paper) are trading emissions permits over the internet. The results will be presented at the Sixth Conference of the Parties (COP-6) to the UNFCCC (Gets2, 2000).

4. VAs with an emission trading option

In the overview of flexible instruments, we did only find possibilities to combine both instruments. Specific guidelines for the integration of policy instruments are lacking. When two sets of instruments with the same purpose exist next to each other, possibilities to combine the best characteristics of both instruments need to be considered. Therefore we develop a mechanism that relates voluntary agreements with external emissions trading

How to combine both instruments is an important question for policymakers and especially for European policymakers. In May 1999, the European Union declared seeking to restrict the use of emission trading under the Kyoto Protocol. At least 50% of total GHG reductions need to be achieved via domestic actions (JIQ, 1999). The United States has consistently opposed such restrictions, and will strongly oppose them in future negotiations (Foley, 1999). The U.S. Department of State even argues that since the EU first accepted a text that includes no quantitative limit on flexible instruments, this new position from the EU '*is an attempt to rewrite the Kyoto Protocol* (Foley,1999)'. The European Commission explained its position in the recent Green Paper on greenhouse gas emission trading within the European Union (COM(2000)87). This paper states that the relation with environmental agreements deserves special attention.

In our analysis we argue that the connection to external emission trading markets should be *conditional* and that this access therefore needs to be priced. The mechanism should at the same time allow the needed flexibility ánd limit the incentive not to participate in emission reduction efforts. We therefore propose the inclusion of a type of options - as a financial asset - that can be bought to have access from the VA to the emission trading markets (inside the VA and external markets). The use of options that provide access to buy the underlying tonnes of CO_2 allowances should be prefered over setting quantitative limits on the access to trading markets because such limits would imply that regulators knew all relevant marginal abatement costs (MAC) for emission reductions in advance and could compare them with price development on allowance markets.

4.1 The argument of cost-effectiveness and the price of access to ETM

When firms or industries are confronted with the cost consequences of different climate policy instruments, we can expect that the comparison of the costs of all available instruments will determine the willingness to participate in voluntary emission reduction policies. Since voluntary agreements are agreements with industries or groups of industries inside a country or a region, the sources of emissions are more homogeneous than in the case of international emission trading. Global emission trading allows all sources - national and international - to participate and such a heterogeneity is expected to lead to a lower aggregated marginal abatement cost curve than that of the firms participating in a VA. The existence of emission trading systems with low allowance prices can deter firms that are confronted with high internal abatement costs inside the VA.

An additional complication follows from the different emission reduction targets for both the VAs and emission trading mechanisms. In Kyoto, it has been agreed that emissions of the six greenhouse gases of Annex I countries need to be reduced on average with 5.2% by the commitment period 2008-2012. There are however VAs with more ambitious reduction targets, like a reduction of emissions by 25% over relatively short periods. And there are VAs with easier targets like a modest improvement of the *relative* energy efficiency without absolute targets. Since the reduction target is the most visible characteristic of VAs, we can expect that policymakers will not be prepared to set 'easy' targets. Too ambitious reduction targets can lead to high probabilities of non-compliance. With the emission trading option, possibilities to realize the target of the VA are strongly increased.

In Figure I, we present the aggregated marginal abatement cost curves for sources that participate in a VA (MAC_{VA}) and for the other sources that participate in international ETM (MAC_{ETM}). Each source is committed to one instrument. We assume that emission sources inside the VA face higher abatement costs than outside sources. A different reduction target is set for both policy instruments. The total cost of achieving the target R_{VA} of the VA (area $OabR_{VA}$) is much higher than the cost of the reduction target R_{ETM} of the trading mechanism (area $OcdR_{ETM}$). For each R^*, $MAC_{VA}(R^*)$ exceeds $MAC_{ETM}(R^*)$. If the firms in the VA would have perfect information on all MAC, they would be able to calculate that the additional or excess cost of the VA compared to buying emission reductions at the ETM to reach the reduction target is the shaded area *abec*.

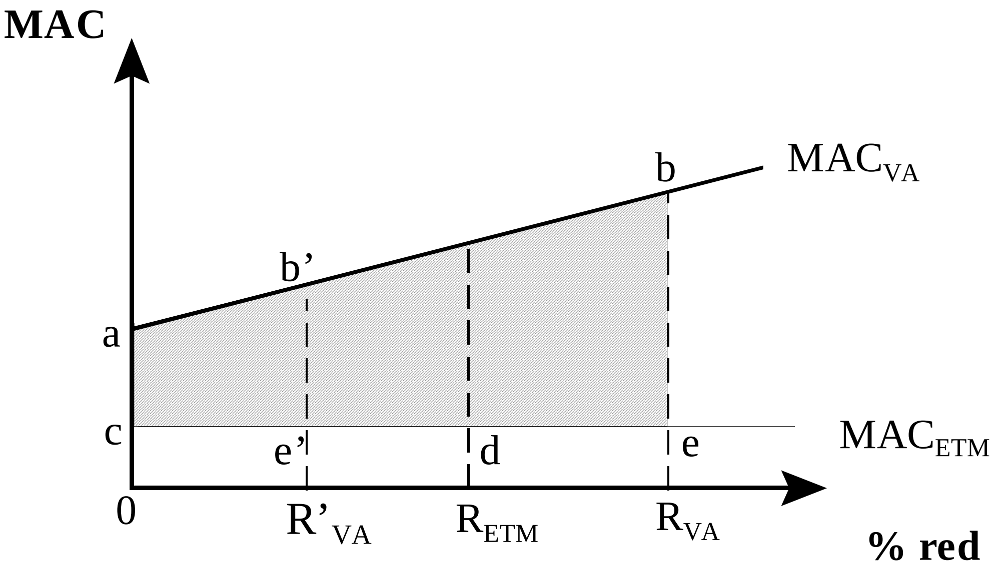

Figure I - The value of access to ETM for sources in VA

The shaded area *abec* is the maximum value or price that unlimited access to the ETM has for firms participating in the VA with reduction target R_{VA}. Figure I also shows that even with the lower R'_{VA} the total cost of achieving this target would be higher than the reduction cost for the emission sources on the ETM (R_{ETM}). In this case, the value of access to the ETM - *ab'e'c* - is lower.

When the value of access to the ETM is high, a price for this access or for trading among sources in the VA can be installed. And by allowing trading, incentives for overcompliance - not relevant in the situation in Figure I - are given to firms that have the potential to abate emissions at a low cost. Furthermore, due to the high marginal cost curve of the VA, it is clear that when overcomplying firms want to sell this overcompliance, they will prefer to sell to firms that participate in the VA. The firms in the VA will be prepared to pay a higher price than firms that have unlimited access to ETM. Summarized, in a world with international emission trading, VAs represent isolated markets with a higher emission reduction scarcity. This situation generates higher prices for overcompliance and a willingness to pay for access to the world market for emission reductions.

4.2 Design of the mechanism

In order to limit administrative complications, information and transaction costs for participating firms in VAs with access to the ETM, the connection between both instruments should be established by some type of market maker, here called the Supervising Body (SB). As shown in Figure II, this Supervising Body will provide the participating firms or industries with all information concerning the Emission Trading Market and will write standard option contracts that are transparent and tradeable.

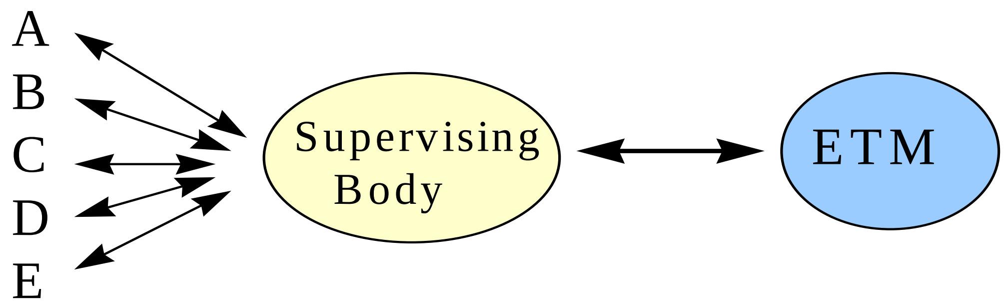

Figure II - Market structure for VAs with ETM

4.3 The role of information and the cost of non-compliance

The targets for emission reductions in voluntary agreements are determined after a process of information gathering, processing, analysis and negotiations. After the complete audit process, a selection of investment projects needs to be made by the participants in the VA. Projects with an acceptable pay-back period will be chosen to realize the reduction targets. The quality of the estimates in the audit of the long-term development of marginal and average abatement costs will strongly determine the success of the realization of the emission reduction targets. Industries are aware of the uncertainties surrounding future abatement costs and have as such an incentive to exaggerate these estimates in the negotiations in order to lower the emission reduction target that will be agreed upon in the

VA. But even despite all efforts, abatement costs can strongly differ from the predictions. In Figure III, we present two situations.

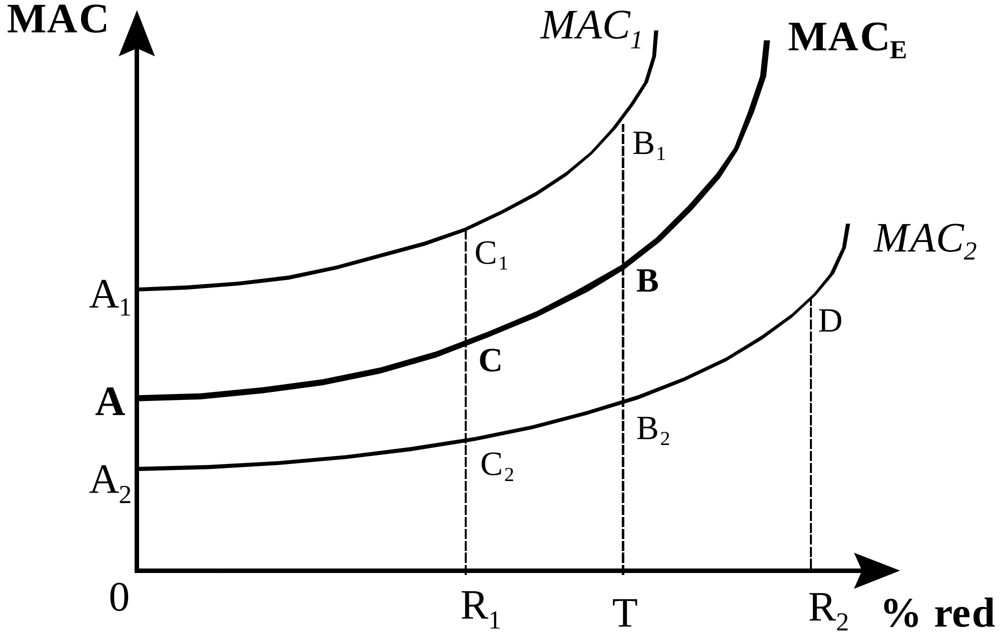

Figure III - Total abatement costs and emission reduction targets

We assume a voluntary agreement where the emission reduction target for a specific period is T. Before this agreement, the firm or industry estimated its long-term abatement costs curve (MAC_E) and decided to start with an abatement investment programme that was expected to cost OABT, or the area under MAC_E. From the start of the VA, these investment funds have been integrated in the long-term investment planning. If the actual MAC equals the estimated MAC_E, there is a good chance - *ceteris paribus* - that the firm will achieve its reduction target.

Suppose however that the energy audit was not an accurate analysis and that the actual abatement costs turn out to be much higher than estimated. With MAC_1, the initially allocated funds for abatement investments will not lead to the achievement of reduction target T but to a lower level of reductions like R_1 in Figure III. Although the industry did spend the same amount of money on abatement equipment and improved processes, the low quality of the internal audit led to a case of non-compliance. If the industry wants to comply when abatement costs are MAC_1, the needed additional investments will cost

$R_1C_1B_1T$. We can compare these additional investments with penalties for non-compliance set by the regulator. If the penalty for non-compliance were higher than the costs of the additional investments, industry would prefer the internal investments. In this specific case, non-compliance is partly caused by using inadequate information when negotiating the targets of the VA. The regulator sanctions the weak efforts - or even the inability - of industry to collect the necessary high quality information.

Figure III also shows the opposite case when actual abatement costs are lower than estimated. With MAC_2, the same fixed investment funds could be used for the realization of the higher emission reduction target R_2. But since there is no possibility to trade or monetize these additional reductions of emissions, industry will probably not opt for investing the available funds that will lead to this overcompliance. These funds - TB_2DR_2 - can be used for other investments. Furthermore, possible uncertainties on future reduction targets and regulatory initiatives could be an incentive to postpone abatement investments. In both cases, access to the ETM can offer interesting alternatives : needed reductions can be bought or overcompliance can be sold.

4.4 Call options and access to emission trading markets

In this section we present a hypothetical voluntary agreement for an industry that consists of five firms. In the VA, total emissions of the industry will be reduced by an agreed percentage over the period 2005-2015. We assume that all firms have to reduce their emissions by the same percentage. The use of a uniform target can favour some specific firms since abatement costs are assumed to differ. Other firms will have difficulties in reaching the target. Another problem that arises is the fact that a uniform reduction percentage without the possibility to trade emission allowances could eliminate potential investment projects that lead to overcompliance. The easy target for these specific firms with low abatement costs therefore limits the theoretical effectiveness of the VA : the instrument does not enable to realize all technical emission reduction opportunities that are available.

Linking the VA to the ETM can overcome both problems : firms confronted with too strict targets are allowed to buy allowances - if necessary - and firms that can overcomply will now have access to a market to sell this overcompliance. Since we want to allocate a price on this access to the ETM, we offer the participating firms the possibility to buy or sell an option position at the start of the VA in 2005. A second possibility to write call options is given in 2010. Otherwise, the price of the option contracts would be too strongly influenced by the fixed supply. In Table I, the five firms made two projections of the level of emissions in 2015. These projections will determine the strategic behaviour of firms in the VA and transactions on the option contract market. The first projection is made in 2005, the second in 2010.

The option contract is clearly a voluntary contract. With the uniform reduction target, firms that fear not to be able to realize the needed reductions, but signed the VA anyhow, can buy a call option that allows them to buy allowances from other firms in the VA or from other sources outside the VA. Firms that think to overcomply, can sell these call options to possibly non-complying firms that want to buy them.

The conditions for these option contracts are specified by the Supervising Body (SB) that operates as a market maker. A call option could be written as : *"This title gives the holder the right to buy 1000 allowances of 1 tonne of* CO_2 *from firms participating in the VA or operating on the international Emission Trading Market, at a price determined by the Supervising Body but not differing by more than x% from the market price."*

The price of the option (*e.g.* \$3 per tonne CO_2) and the strike or exercise price of the option (*e.g.* market price plus 10%) will be determined by the SB. To encourage overcompliance in the VA, the strike price for selling can be set higher than the free market price on ETM. The price at which industries can sell options in the initial phase of the VA offers the first revenues from climate protection measures, even before investments in emission abatement have been made. When this price is high enough - *e.g.* around \$3 per tonne - firms will be strongly motivated to make the best decisions concerning their future emissions and abatement strategies. Firms that see financial opportunities in this mechanism will be motivated to participate in the VA. Especially if there are only a few opportunities to write new options (in Table I there are 2 such moments), firms need to invest in the collection of the best available information.

Figure I showed that the potential value of access to emission trading markets can be very important. Even when energy costs have a low share in total costs, differences in abatement costs make that the best strategy can be very profitable over longer periods. The price of the call options will strongly depend on the development of actual emissions versus projected emissions. Existing options can be traded at specific moments in the VA; there could be for instance one trade opportunity each year. If at the end of the VA more access to emission trading markets is needed than estimated in 2005 and in 2010, the price of the options will rise and this will benefit the option holders. If however emissions are much lower than estimated, the value of the options will be low because emissions reductions are not scarce.

Table I contains the following information: actual emissions in 2005, a binding VA target for emissions by 2015, a projection (made in 2005) of emissions in 2015, the difference between the target and the projection made in 2005, the position in call options (CO) taken by the firm in 2005, a new projection of emissions in 2015 (made in 2010), the resulting changes in the CO position, emissions in 2015, the difference between emissions in 2015 and the target of the VA, and the final transactions in 2015.

Table I - Emissions and option position in a VA with five firms (thousand tonnes)

Firms in the VA	A	B	C	D	E
Emissions in 2005	100	100	200	300	400
Target of VA for 2015 *(set in 2005)*	90	90	180	270	360
Projection for 2015 (*made in 2005*)	90	70	190	260	320
Target *minus* projection *(i)*	0	20	-10	10	40
Call Option (CO) Position *(in 2005)*	-	Sell 20	Buy 10	Sell 10	Sell 40
Projections for 2015 *(made in 2010)*	90	75	205	250	320
Target minus projection	-	15	-25	20	40
Changes in CO position *(in 2010)*	-	Buy 5	Buy 15	Sell 10	-
Emissions in 2015	95	80	230	230	340
Target *minus* emissions in 2015 / Option Position	-5 / No options	10 / Sell 15	-50 / Buy 25	40 / Sell 20	20 / Sell 40
Final transactions in 2015	Buy 5	Buy 5	Buy 25	Sell 20	Buy 20

All available abatement and technical information, gathered to make possible a profitable position in call option contracts, should enable the firms to make a reliable projection in 2005 of their emissions for 2015 when the VA comes to an end. In a first step, they compare their projections with the emission targets as agreed in the VA. If there are differences between both emission levels, the firms can opt to sell the theoretically available emission reductions or buy the needed reductions.

For the five firms, the difference between the target and the projection made in 2005 (row *(i)* in Table I) is respectively 0, 20, -10, 10 and 40. The net difference is +60. This positive difference indicates the need for access to external emission trading markets because not all excess emission reductions can be sold inside the VA.

The firms all have the possibility to take a position in call options in 2005 and in 2010. Firm A does not take an option position because it projects to meet the emission reduction target. At first, firm B projects that in 2015 its emissions will be lower than the target in the VA. This potential overcompliance can be sold and therefore firm B will be prepared to sell call options to firms that want to buy this excess emission reductions later on. Therefore, in 2005 firm B communicates to the Supervising Body its willingness to sell - or to write - a call option that allows the exercisers to buy allowances for 20 thousand tonnes of CO_2 emissions. In 2010, B estimates that the difference between its emissions and the target of the VA will only be 15 tonnes. Since B will not be able to sell 20 tonnes of realized reductions, it will buy back 5 call options. Firm C expects a strong market growth and projects that emissions will not meet the emission reduction target of the VA in 2015. Firm C wants to buy emission allowances from sources inside or outside the VA. In 2005 it will express its willingness to buy 10 units of allowances and will therefore buy call options. In 2010, it becomes obvious that its emissions will be much higher and C will buy additional call options. Firms D and E both expect that emissions in 2015 will be lower than the target and therefore want to sell emission allowances.

The Supervising Body collects all information on call options and after a process of multilateral communication with the 5 firms it determines an initial price for the option contracts. Firms estimated their internal marginal abatement cost curve; they only want to buy allowances if the total cost - the price of the call option added to price of the emission permits - is lower than their own MAC. The option price should be high enough so that sellers receive an advance payment for their later efforts in terms of emission reductions. Furthermore, a too low option price would make it too attractive to buy options instead of starting internal efficiency investments.

The SB could opt for an option price close to the lowest marginal abatement costs of the five firms. In the example of Figure I, this would result in an option price between 0c and 0a when MAC_{VA} is the marginal abatement cost curve that is estimated by the SB. In 2015, the SB will determine the price – based on the price on the ETM - for the allowances that can be bought when using the call options. It also organizes a final trade in call options since it can be expected that some firms did buy too much or not enough of them.

In what follows, we discuss the situation in 2015 for each firm in Table I

Firm A : No options have been bought by A but emissions in 2015 exceed the VA target for A by 5 units. Once firm A detects this non-compliance, it will buy call options for 5 units and use these options to buy emission reductions inside or outside the VA.

Firm B : B wrote options to sell 20 units of emission reductions in 2005 and did buy 5 units of them in 2010. In 2015, it turns out that emissions are higher than anticipated and B can sell only 10 units. As a result, B needs to buy back option contracts for 5 units.

Firm C : C anticipated to buy 10 emission units in 2005 but in 2015 it is clear that it will need access to 40 additional units. C did buy 15 call options in 2010 and will need 25 additional call options in 2015.

Firm D: D did foresee to sell 20 emission units in 2015 but as a result of diverse factors, the firm's emissions are only 230. D can sell 20 additional emission units.

Firm E: E anticipated to sell 40 emission units but its emissions in 2015 are higher than expected. E can only sell 20 units. E did write option contracts for 40 units in 2005 and cannot fulfull its obligations. It will buy back 20 call options in 2015.

In 2015, the differences between target and emissions are known. The net-difference is +15. This means that the target of the VA will be met. The SB can sell emission permits on the emission trading market. If emissions were much higher, the price paid by the five firms for emission permits would be the market price of non-compliance. In 2010, only firm D can sell additional reductions and this firm will clearly benefit from the market mechanism. Without this opportunity to sell, D could limit its efforts and emit 270 instead of 230 units. B and E have sold too much emission reductions and they cannot deliver what they promised. Therefore D will be prepared to take over their obligation to sell reductions. B and E will pay D a price above the initial value of the option contract in 2005, otherwise they would be rewarded for failing to fulfill their voluntary contractual obligations. Since B and E have no direct access to the international emission trading market, the price they pay to D can be higher than the price at which allowances are traded at that moment. The strike price for the sold emission reductions will be determined by the SB. This price will be based on the ETM price level. We believe this is a pragmatic position. When emission permits trade at $15 per tonne CO_2, there is no need for the SB to price emission reductions at $100 even when there are contractual buyers at this price. In this case, the cost or price of non-compliance is market-based and not determined by regulators. On the other hand, the price should be above $15 since we assume that firms in the VA have higher marginal abatement costs than sources that reduce emissions for the ETM. Very low prices would make emission reduction an unprofitable investment for firms that sell excess reductions. Of course, when emission permits trade at $150, the costs of non-compliance will be higher.

4.5 The benefits of linking VAs to emission trading

In absence of the link to emission trading, the five firms in Table I would focus on the emission target and not on the potential emission reductions. They would also strongly concentrate on the policy process that enables them to influence reduction targets. The opportunities resulting from the emission trading option provide a clear incentive to analyse energy flows and potential savings in greater detail than when excess reductions of emissions have no value. Without the link to the ETM, the internally projected emissions for 2015 could be much higher because a more limited audit did probably not reveal all available opportunities. Confronted with the same reduction target, the behaviour of the five firms in the VA could be different. Since they would not have the ambition to realize the projected level of possible emission reductions in 2015 without ETM access, we can expect that emissions will be higher compared to situations with incentives to limit emissions and sell excess reductions. For instance, firm B projected to emit 70 units and sold 20 emission units. To fulfill its contractual obligations, the firm will accept higher abatement costs for additional investments while with the normal VA, this would not be the case (see Figure III). When B emits 80 after the maximal reduction effort, what would be emissions without market-incentives? Would emissions be 90 or 100? We do not have the answer, but it would not be surprising that emissions exceed 80.

D is the best performer in Table I. It can reduce emissions from 300 to 230. D monetized the reduction of emissions at three occasions. First it wrote a call option for 10 units and received a price determined by the SB. In 2010, 10 additional call option contracts have been written and sold. In 2015, it became obvious that only D could sell more emission reductions inside the VA while other firms that initially also claimed to sell, had to reduce their position in options. These firms had to transfer their obligation to sell emission reductions to the SB. Via the SB a part of their obligation has been passed on to D. In return, D received a price higher than the initial value of the option. Finally, D can sell the emission reductions at a strike price that is probably higher than the price on the international emission trading market. We do not suggest that these financial opportunities led to the low level of emissions, but it is clear that without these market-incentives, emissions of D could be much higher, even above 270.

To conclude, the linking of both instruments led to lower levels of emissions for the firms participating in the VA. An additional benefit is that non-compliance of the VA has a clear price that is partly based on the price developments on the ETM. The mechanism further provides additional benefits for overcompliance and makes it possible to trade emission reductions at interesting prices. Compared to emission trading without the VA, the proposed mechanism ensures reduction efforts for industries that face much higher marginal abatement costs than the sources that will deliver the majority of emission reductions in international trading designs. In fact, this mechanism does not limit the flexibility of emission trading but adapts emission trading for regions and industries that cannot compete with allowance prices on the international emission market. The VA offers a degree of protection against very competitive price conditions on international ETMs.

5. Conclusions

Recent political and corporate initiatives indicate that voluntary agreements and emission trading will play a crucial role in future climate policy. We started with a short overview of existing flexible instruments for climate policy. An important conclusion was that voluntary agreements are not connected with emission trading markets by a specific market mechanism. Since both instruments have the same goal – the reduction of greenhouse gases – the isolated use of instruments can have serious drawbacks. How these instruments can be combined is an important question, especially for European climate policy. We show that when emission trading is integrated as an option in voluntary agreement contracts, the overall efficiency of the use of flexible climate policy instruments is strongly increased. The emission trading option, formalized as a CO_2 allowance call option contract that can be traded, provides clear incentives to overcomply with the target of the voluntary agreement. The option mechanism also delivers a market price for eventual non-compliance, based on differences in abatement costs. With an example, we illustrate that the option mechanism can result in stimulating financial benefits for the firms that are most succesful in reducing emissions.

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