Climate Policy and Economic Growth in Developing Countries

Barbara Buchner and Marzio Galeotti

NOTA DI LAVORO 91.2003

SEPTEMBER 2003

CLIM – Climate Change Modelling and Policy

Barbara Buchner, *Fondazione Eni Enrico Mattei*
Marzio Galeotti, *Università di Milano and Fondazione Eni Enrico Mattei*

Climate Policy and Economic Growth in Developing Countries

Summary

Although developing countries face a drastic increase in their greenhouse gas emissions, mitigation actions against climate change do not rank high among their priorities. The obvious reason lies in the necessity for them to continue the development process, which is characterised by pressing needs other than emission control. For developing countries the real problem is thus not emissions but economic growth. Therefore the key question is whether or not the Kyoto Protocol provides an opportunity for growth and thus for their economic development. The only way to accelerate the participation of developing countries in climate agreements - and therefore to come closer to the goal of a global climate control - is to design strategies which enable their economic development. The dilemma of reducing emissions on a global scale while ensuring growth in the poorer regions can only be solved if there are possibilities embedded in the agreements which can contribute to the sustainable development of those regions. As a consequence, greater emphasis must be placed on the economic development dimension of the Kyoto Protocol as far as the impact on developing countries is concerned.

Keywords: Climate Policy, Environmental Modeling, Integrated Assessment, Technical Change

JEL: H0, H2, H3

The authors are very grateful to Nicola Cantore for carrying out the simulations with the ETC-RICE model.

Address for correspondence:

Marzio Galeotti
Dipartimento di Economia Politica e Aziendale
Università degli Studi di Milano
Via Mercalli 23
I-20122 Milan
Italy
Phone: +39-02-50321534
Fax: +39-02-50321505/50321450
E-mail: marzio.galeotti@unimi.it

1. Introduction

For developing countries the problem of global warming is not equally important as for industrialised nations. Even if less developed countries (LDCs) are suffering from pollution and recognise that the fast-growing greenhouse gas (GHG) emissions pose serious problems to them, they have other more pressing needs to cope with. In particular, developing countries put the goal of continued economic growth at the first place in order to enhance their process of development.

Nonetheless, there is no doubt that global warming can only be tackled on a global scale in the long run. Due to its global public good nature, an approach designed to seriously induce nations to curb global warming has to include the participation of developing countries. The last decade demonstrates that LDCs are increasingly contributing to the build-up of greenhouse gases, even though their per-capita intensity is still very low compared to that of industrialised countries. The important role that developing countries play in the context of climate change policy is evidenced by the recent events: announcing the U.S. withdrawal from the Kyoto Protocol, President George W. Bush justified his decision on the basis of the high economic costs, one the one hand, and of the missing involvement of developing countries, on the other. Even if this aspect of the U.S, position is often regarded as too harsh given that industrialised countries clearly bear the main responsibility of the actual GHG accumulation, there is general consensus that developing countries need to be gradually involved in international efforts to curb global warming for a climate policy to be successful.

In fact, the United Nations Framework Convention on Climate Change (UNFCCC) itself mentions on several occasions the principle and goal of sustainability. In particular, Article 3 of the Convention calls for the promotion of sustainable development, taking into account the specific conditions of each Party and the fact that "… economic development is essential for adopting measures to address climate change" (UNFCCC, Art.3-4).

At the same time, even though they do not (yet) actively participate in international climate policy, developing countries are already affected by the ongoing efforts to curb global warming. International trade linkages imply that developing countries experience effects from the emission controls adopted in committed countries.[1] Issues that attracted attention in this context include the distribution of economic impacts induced among other reasons by shifts in energy-intensive industries, the problem of carbon leakage and the changes in the terms of trade and the capital flows between countries caused by international emissions trading. The key question is whether climate policy in general or international emissions trading in particular is capable of altering the distribution of abatement costs and of welfare gains in order to mitigate the effects on international competition, making the developing countries thus better off by the implementation of the Kyoto Protocol.

The present chapter is concerned precisely with this issue. In particular, we try to understand here whether climate policy could induce benefits for developing countries that enhance their economic growth. More specifically, we want to see if the Kyoto Protocol incorporates aspects apt to solve the actual dilemma of the developing world. This study is intended first to provide an overview of research studies undertaken in this context. Subsequently, using an integrated assessment model enriched with endogenous technical change, we provide additional new evidence to bear on the same key questions.

[1] On this aspect see Galeotti and Kemfert (2002).

2. The Effects of the Kyoto Protocol on Developing Countries

Under the 1997 Kyoto Protocol to the UNFCCC, industrialised countries committed themselves to binding emission reduction targets. Acknowledging the historic responsibility for the actual accumulation of greenhouse gases, the Kyoto agreement requires that industrialised countries make the first step towards global climate change control. In particular, all countries should take action in order to protect the global climate "in accordance with their common but differentiated responsibilities and respective capabilities (Preamble of the United Nations Framework Convention on Climate Change).

However, the international trade which characterises the world nowadays implies that the consequences of the GHG control measures - even if taken only by a subset of countries - will be transmitted to the whole world economy, and therefore also to those countries which have not agreed to reduce their GHG emissions. Even though LDCs have not taken obligations under the Kyoto Protocol, they can be affected by international climate policy, also depending on the scope of a possibly implemented emissions trading scheme. Through trade and investment links, developing countries are thus very likely to feel the economic consequences of abatement activities in industrialised countries. For instance, in order to meet their emission reduction targets, the Annex B group is likely to reduce its demand for fossil fuels which in turn would lead to the reduction in the world price for fossil fuels or to a relocation of energy-intensive industries (Polidano, Jotzo, Heyhoe, Jakeman, Woffenden, and Fisher, 2000). Developing countries can be influenced by the direct cost of emissions-reducing activities in industrialised countries or by the changes in investment due to expectations on future costs. Furthermore, LDCs can be affected by changes in terms of trade of energy and non-energy goods and by payments for emission permits (Bernstein, Montgomery, and Rutherford, 1999).

2.1 Welfare Effects

The key mechanism influencing the distribution of the welfare losses and gains consists in the shift in a country's terms of trade following the mitigation activities of the committed parties.[2]

2.1.1 The "Pure" Kyoto Protocol, Without Use of the Proposed Flexible Mechanisms

Under the Kyoto Protocol, GHG emission control in Annex B countries leads to changes in trade volumes and prices which in turn determine the losses and gains in Non-Annex B countries. In particular, emission restrictions cause Annex B countries to reduce their demand for domestic and imported energy since they will face a higher cost of using carbon-emitting fuels. As a consequence, the manufacturing costs of their energy-intensive goods are increased and so are the prices of their exports, some of them being directed towards the developing world. At the same time, the global demand for carbon-emitting fuels decreases, implying an overall reduction of the international prices. As an additional impact, emission control programs could being about an overall depression of economic activity in the committed countries which could in turn lower their demand for imports. Such a reduced demand could hurt developing countries, since some of the imports could come from them.

On the whole, emission restrictions will change the patterns of consumption and production within the Annex B countries, affecting the flow of internationally traded goods. This can have very complex consequences, benefiting some countries while hurting others. In particular, it is

[2] Terms of trade represent the suitably weighted ratio of the prices of a country's exports to the prices of its imports.

likely that energy exporting regions suffer adverse movements of their terms of trade while there is the tendency for energy importers to face favourable movements in their terms of trade.

Looking at the original version of the Protocol, the conclusion generally drawn in literature is that Annex B countries would suffer welfare losses in the range of 0.5 to 2.0% relative to a no-protocol situation (Jacoby, Eckaus, Ellerman, Prinn, Reiner, and Yang, 1997; Jacoby and Sue Wing, 1999; Light, Kolstad and Rutherford, 1999; Babiker and Jacoby, 1999; Burniaux and Truong 2002). At the same time Eastern European countries such as Russia would experience welfare gains due to their improved comparative advantage. If the Kyoto agreement is implemented without recourse to emissions trading, Non-Annex B countries are only affected through the prices and quantities of the goods traded with the Annex B group. In particular, developing countries will only be affected by changes in terms of trade and changes in investment.

As the main consequence of the Kyoto Protocol Ellerman, Jacoby, and Decaux (1998) expect an increase in the developing countries' production and export of energy intensive goods. By using the MIT's EPPA model which is based on the GTAP data set, Babiker and Jacoby (1999) and Babiker, Reilly and Jacoby (1999) investigate the situation of the Non-Annex B countries and come up with mixed findings: some of these countries suffer welfare losses in excess of those of the Annex B (e.g., the Persian Gulf), while others experience net welfare gains (e.g., India).

Using an intertemporal computable general equilibrium and multi regional trade model for the global economy, Kemfert (1999) identifies negative impacts of the Kyoto Protocol on developing countries, explaining this result by an decrease of international energy use which consequently leads to productivity and international energy price cutbacks.

Also Böhringer and Rutherford (1999) find substantial spillover effects from Annex B countries to the Non-Annex B. These are caused by the restriction of fossil fuel use which implies that primary factors are employed less productively and that economic activities in the industrialised countries are reduced. As a consequence, terms of trade deteriorate for developing countries, resulting into adverse effects and welfare losses.

Burniaux and Truong (2002) use an extended version of the GTAP model which is enriched by energy-environment linkages (referred to as GTAP-E) and also find that the energy exporters among the developing countries suffer adverse impacts and might even lose more than the Annex B countries.

Böhringer and Löschel (2002) base their carbon abatement policy analysis on a specific CGE model and find that adjustments on the international energy markets after the Kyoto Protocol's implementation represent the most important category of international spillovers resulting from trade. Their findings explain why developing regions that are fuel exporters suffer welfare losses whereas those regions being net importers of fuels in general can benefit from carbon abatement policies.

Brown, Kennedy, Polidano, Woffenden, Jakeman, Graham, Jotzo, and Fisher (1999) and Polidano et al. (2000) use GTEM, a global general equilibrium model, and confirm that the Kyoto Protocol will have a number of economic consequences for developing countries. In particular, the latter study finds trade and investments effects as the most important indirect impacts on LDCs. The lower world prices and lower export volumes to Annex B regions imply reduced earnings from fossil fuel export which represent, together with the higher import prices of energy-intense goods, the main negative impact. Conversely, positive effects are given by an increase in the export competitiveness of non-Annex B producers of energy-intensive goods and the associated increase in investment levels. The net impact will depend on the trade and

production structure of each country and the authors conclude that those developing countries with a more diversified pattern of production and exports will be the less affected ones.

McKibbin, Ross, Shackleton, and Wilcoxen (1999) look at the implications of the Kyoto Protocol using the G-Cubed model which consists of a set of eight regional general equilibrium models linked by consistent international flows of goods and assets. As a consequence, the authors manage to highlight the role of international trade and capital flows in global responses to the Kyoto Protocol which indeed seem to be important. When the Kyoto targets are achieved without allowing for any flexible mechanisms, they find that countries characterised by high abatement costs suffer a reduction in GDP, an outflow of capital, a depreciation of their exchange rates while their exports are stimulated. Countries with low abatement costs experience the opposite effect, driven mainly by inflows of capital.[3] For the case of LDCs, the authors find particularly interesting results. Both their GDP and GNP rise while the absence of emission reduction commitments implies further significant benefits through international policy transmission. Due to the exchange rate appreciation, caused by capital inflows, "…[e]xports become less competitive but imports become cheaper and the dollar value of LDC international debt falls dramatically, leading to a net *improvement* in the LDCs' net international investment position in spite of significant capital inflows..." (McKibbin et al., 1999, p. 22) In addition, the Kyoto Protocol implies a decline in Annex B oil demand which consequently leads to a decline in the world oil prices, benefiting thereby the LDCs.

Using the multi-sector, multi-regional trade MS-MRT model, Bernstein, Montgomery, and Rutherford (1999) investigate the international trade aspects of climate change policy, looking among other things at the distribution of impacts across countries. Also their findings confirm that the Kyoto restrictions on industrialised countries have negative welfare on oil-producing countries and mixed spillover effects on other Non-Annex B countries, pointing at the positive effects on energy-importing developing countries. In particular, they find that only China and India gain from the obligations defined in the Kyoto Protocol.

From the discussion conducted above, we see that the main explanation of findings refers to changes in energy prices: due to the emission limits, demand for fossil fuel products in Annex B countries decreases, thereby lowering the market prices of all traded types of energy. As a further step, these effects on energy prices induce both changes in investment and output for energy-intensive industries and shifts in the terms of trade. In particular, manufacturing costs of energy intensive goods increase, even though the overall fall in Annex B demand for carbon-emitting fuels induces a downward pressure on the international prices of carbon-intensive fossil fuels. The decisive factor, as noted above, is the shift in the terms of trade which follows the imposition of emission controls in the Annex B region.

Looking at the shift in terms of trades from a Non-Annex B viewpoint, there are three potentially offsetting effects (Bernstein, Montgomery and Rutherford, 1999):

(i) As a consequence of the higher energy prices in the Annex B region caused by the emission limits, developing countries have to pay higher prices for the industrialised countries' exports;
(ii) Due to a negative income effect which will follow the emission controls in industrialised countries, their demand for carbon-intensive goods will fall, thus inducing a downward pressure on the international prices of carbon-intensive fossil fuels. The

[3] GDP increases because capital inflows reduce real interest rates and stimulate domestic demand in the short run while they raise the capital stock in the longer run. At the same time, capital inflows lead to reduced exports since they appreciate the exchange rate.

consequences will not only be felt by the Annex B but also by developing countries which receive lower revenues from their (oil) exports.

(iii) Since the manufacturing costs in industrialised countries increase, a substitution effect will strengthen the demand for energy-intensive goods produced in developing countries.

Depending on the relative strength of these three effects, terms of trade improve or deteriorate for a given country and induce positive and negative welfare impacts for specific regions. In general, terms of trade movements which transfer income across countries are unfavourable to developing countries and favourable to the industrial ones. This holds when the Kyoto Protocol is implemented without a global emissions trading that includes developing countries. In particular, energy importing countries are likely to profit from the Kyoto Protocol, while many energy exporters are facing welfare losses. The higher the dependence on oil proceeds, the stronger are the adverse movements in the terms of trade of the economies in consideration.[4] These "first-order" terms of trade effects in terms of energy price changes are transmitted to the rest of the Non-Annex B countries by the means of a larger set of income and price effects that propagate through the international economy. The literature shows that the implementation of the Kyoto Protocol does not benefit all Annex B economies because of positive terms of trade movements and that all Non-Annex B regions are adversely affected.[5] In addition, the distortions/problems related to the use of GNP as a measure of the welfare changes induced by GHG control are highlighted by basing their welfare estimates an equivalent variation criterion. As an example, notwithstanding the positive changes in their GNP, both China and South Africa suffer welfare losses from the implementation of the Kyoto Protocol as a consequence of their adverse terms of trade effects.

As a general rule, the results obtained in the existing research suggest that "…the higher GNP losses of Annex B are mitigated by favourable movements in these nations' terms of trade, whereas the relatively lower GNP losses for oil-exporting countries are aggravated by unfavourable movements in their terms of trade" (Babiker, Reilly, and Jacoby, 1999, p. 9).

In addition, Kemfert (2001) concludes that adverse effects suffered by certain developing countries due to negative international spillover effects are even stronger when the impacts of climate change are explicitly taken into account. Indeed, climate change impacts – covering both market and non-market damages – are particularly significant in those areas.

Table 1 summarises the numerical findings of most of the cited papers as for the impact of the Kyoto Protocol on developing countries when no flexibility mechanisms are allowed. The table reports welfare (equivalent variation) and terms of trade changes.

2.1.2 The Implementation of the Kyoto Protocol's Flexible Mechanisms

Ellerman, Jacoby, and Decaux (1998) examine the effects of the Kyoto Protocol on the developing countries using the marginal abatement curves generated by MIT's EPPA model, a

[4] For example, an oil-exporting Non-Annex B country will suffer welfare losses because its revenues from the oil exports shrink while at the same time it has to accept higher prices of energy-intensive goods from Kyoto-constrained regions.

[5] Bernstein, Montgomery and Rutherford (1999) find that other Asian countries more than offset the higher cost of imports from industrial countries with gains in terms of trade with OPEC. They are also able to shift to production of energy-intensive goods where they have an increased comparative advantage over the industrial countries. These countries also benefit from capital inflows and from their favourable position as exporters of energy-intensive goods.

computable general equilibrium model. In particular, the paper presents one of the first research studies addressing the question how differing schemes of CO_2 emission trading affect developing countries, taking possible trade restrictions, variations in the CDM nature and the changes in international trade flows in goods and services into account. As a consequence of global emissions trading, Non-Annex B countries face incentives to reduce emissions in order to generate emission permits - "rights to emit" - for export. In addition to Russia, China and India are responsible for the main supply of emission permits. As a consequence of global trading, the total costs of cutting the global emissions as required by the Kyoto Protocol are reduced dramatically and Annex B regions therefore experience strong gains. By exporting emission permits, also the Non-Annex B regions gain, even though only about 11% of the gain obtained by the Annex B. In comparison to an emission trading system taking place only among the Annex B countries, the big loser of a global trading system is Russia which is indeed made worse off by widening the market. Even though Russia still gains in comparison to a situation without emissions trading, the value of its "hot air" decreases drastically and it exports less since it faces less incentives to reduce emissions due to a higher overall permit supply and a lower price. Compared to the no trade situation, there will be revenues from exporting permits, but there will be no significant increase in production and exports of energy intensive goods. In both cases, no trading and global trading, energy exporting Non-Annex B countries will experience adverse effects, but due to the lower carbon price and the substitution opportunities enabled by the broader market, the implications are less drastic in the case of global trading.

Bernstein, Montgomery and Rutherford (1999) also find that the implementation of emissions trading improves the Kyoto Protocol's implications on developing countries. The increase in supply and consequent reduction in the permit price which follow the establishment of global emissions trading benefit Non-Annex B regions by increasing demand for exports and permits. However, an exception are China and India: both a trading system restricted only to the Annex B and global trade harm these two countries; in particular under global trading pecuniary externalities disappear, whereas they were present and positive in a situation of restricted trading.

The results obtained by Kemfert (1999) are in line with these findings. Indeed, emissions trading is found to improve both the situation of developed and developing countries. In particular, the model calculations reveal welfare improvements in the developing world which are due to international trade spillover effects.

The main conclusions of this line of research is thus that the implementation of an emissions trading system can not only reduce the industrialised countries' costs of meeting the Kyoto targets, but also provides a new source of export earnings for developing countries. Developing countries in general benefit from emissions trading, even though the effect will depend on the particular country and the success of emissions trading. In addition to the potential export revenues, energy exporting Non-Annex B countries are likely to have a strong interest in emissions trading since it specifically allows "Annex B parties to substitute reduced coal emissions abroad for reduced oil and gas emissions at home" (Ellerman, Jacoby, and Decaux, 1998, p.21). This strong interest makes the Non-Annex B countries clear rivals to Russia, which is made worse off by enlarging an Annex B trading scheme to a global one. However, emphasising that both importing and exporting regions can achieve substantial gains, the implementation of an emissions trading scheme can not only bring profits in terms of new export opportunities, but also in terms of a lower number of distortions related to the Annex B economies.

By changing the data set on which the EPPA model is based, Babiker and Jacoby (1999) and Babiker, Reilly, and Jacoby (1999) take into account the recent growth performance of key

nations like China and India.[6] Babiker and Jacoby (1999) analyse the case of an Annex B trading system open to China, which is granted about 95% of its projected 2020 emissions as a quota. In 2010 this initial allocation leads to an amount of 200MtC of Chinese "hot air". This benefits both the energy-exporting nations and the Annex B countries, the first group because the oil price falls even less than in the case restricted to Annex B trading, whereas the second one profits from the larger set of permit suppliers. As expected, the energy importers are made even more worse off than under Annex B trading. Not surprisingly, as a consequence of its hot air and its low-cost emission reduction opportunities, China is the big winner of the situation. Due to the strong competition on the supply side, Russia suffers the highest losses in comparison with a trading scheme restricted to Annex B. Summarising, the effects of emissions trading are enhanced by the participation of a large developing country. The overall results thus do not change and confirm that the gains from emissions trading are substantial not only for the countries directly involved in the process.

Böhringer and Löschel (2002) also emphasise the reduced international spillovers to Non-Annex B countries induced by the introduction of emissions trading due to the smaller impact on the change in comparative advantage, as e.g. terms of trade. Similarly, Brown et al. (1999) and Polidano et al. (2000) show that the implementation of an emissions trading scheme can substantially reduce both the costs for Annex B countries to meet their targets and therefore also the impacts of the Kyoto Protocol on the non-Annex B countries.

The findings of Burniaux and Truong (2002) confirm that emissions trading enables a lower fall of the international oil price which consequently leads to a substantial reduction in the losses incurred by energy-exporting developing countries. In particular, a worldwide trading scheme would not only reduce the economic costs for both Annex B countries and energy exporters in the Non-Annex B, but it would even imply net gains for the permit-selling regions, above all for China and India. Also this study finds that Russia has a strong interest in restricting emissions trading only to the Annex B.

Using the G-Cubed model which allows for international flows of goods and assets, McKibbin et al. (1999) find that Annex B permit trading has little effects on non-participating countries.[7] In contrast, global trading would make the developing countries significantly worse off due to the substantial reduction of the amount of capital flows. Indeed, they would no longer benefit by capital inflows, exchange rate appreciations, reductions in the their debt burdens' value or by lower world oil prices. Correspondingly, these countries experience a lower GDP and GNP than in the Annex B case and the no-trading case.

Tables 2 and 3 summarise the numerical findings of the cited papers as for the impact of the Kyoto Protocol on developing countries when Annex B trading and global trade are respectively allowed. The tables report welfare (equivalent variation) and terms of trade changes.

Philibert (2000) proposes a different emissions trading scheme based on the combination of two types of stakeholders which would be complimentary to the Clean Development Mechanism: there are, as usual, Annex B countries which face a binding emission limit, and in addition Non-Annex B countries which are given emissions budgets rather than strict limits. Such a system

[6] The EPPA model is now based on the GTAP dataset, allowing thus a greater sectoral and regional detail and a more recent benchmark (changed from 1985 to 1995). The previous versions of the model used the OECD GREEN model database.

[7] In general, the authors find that the equalisation of marginal mitigation costs and permit prices under such an international permit trading regime, together with the reduction in overall abatement due to the sale of the so-called "hot air" reduces the economic impacts of the Protocol.

would be beneficial both to Annex B and Non-Annex B countries: industrialised countries benefit from lower overall compliance costs while developing countries gain by the substantial capital inflows which in turn stimulate their economic growth. In addition, there are also benefits for the global climate system since developing countries face incentives to engage in abatement efforts instead of relying mainly on the aspect of "hot air".

Besides the mechanism of emissions trading, Joint Implementation and the Clean Development Mechanism (CDM) have been included as flexible mechanisms into the Kyoto Protocol in order to enable the cost-effective reduction of GHG emissions. The latter one, CDM, has attracted a lot of attention as a possibility to make industrialised and developing countries work together with the aim of promoting sustainable development. This mechanism offers industrialised countries the possibility to finance emission reductions in developing countries in order to gain credits from these activities. Apart from using the industrialised world's technological knowledge to lower the carbon intensity of new investment in developing countries, the involvement of the developed world can substantially reduce the overall cost of meeting the Kyoto targets. The CDM has thus raised great expectations, but it is not yet clear whether there is any evidence for its positive implications on developing countries.

For instance, Kete, Baumert, and Bhandari (2001) emphasise that the way CDM is financed – either by the public or the private sector – is responsible for the implications of this mechanism. Pointing at the risks of priority shifting they conclude that "…limited aid resources should continue to be reserved for capacity and institution building and not be allowed to directly finance CDM projects…" (Kete, Baumert, and Bhandari, 2001, p. 8). Instead, private investment as the main source of funding CDM projects would guarantee additional financial flows to developing countries that could indeed speed up the process of sustainable economic development.

2.2 Environmental Effects

The implementation of the original version of the Kyoto Protocol leads to emission reductions in all the committed countries. When allowing for Annex B trading, Böhringer and Löschel (2002) find that global emissions increase with respect to the no-trade case due to the inclusion of "hot air", although the contribution of LDCs to the overall emissions results to be slightly smaller than in the case without trading. Den Elzen and de Moor (2001) instead find that global emissions decrease by almost 9%, again partly due to a smaller contribution by developing countries than in the no trade case.[8] The largest percentage reduction can however be achieved under global trading, even though some of the participating regions increase their emissions due to the higher supply of emission permits resulting from the inclusion of developing countries. The greater the scope of trading, the lower the emission reduction in Kyoto-constrained countries. Nonetheless, Non-Annex B countries are reducing their emissions as a consequence of the incentives to create emission allowances by 18%, and together with OECD and Eastern European countries on a global scale they generate a reduction by 14% in per capita emissions (Ellerman, Jacoby, and Decaux, 1998).

In the debate about the environmental implications of the Kyoto Protocol, an additional aspect that attracts a lot of attention is the so-called "carbon leakage" which has multiple causes and whose intensity depends on several factors. As a consequence of price and income effects provoked by emission control programs in Annex B countries, an increase in the emissions of

[8] Instead, Brown et al. (1999) find that developing countries increase their greenhouse gas emissions independently of the establishment of an Annex B trading scheme (which nonetheless reduces the amount of the emissions increase).

the non-constrained countries is expected. Therefore, efficiency losses take place. In particular, the increase in production costs of energy intensive goods in Annex B regions is likely to induce the outsourcing of these manufacturers to Non-Annex B countries. A second reason for leakage lies in the lower Annex B demand for carbon-emitting fuels, which induces a fall in the international energy prices. The lower price makes these fuels more attractive in non-constrained regions and thus encourages their use in developing countries. The phenomenon of carbon leakage is confirmed by research studies which put its rate at about 6% and higher, depending among other reasons on the treatment of the existing distortions in the energy market.[9] An interesting aspect of the findings concerning carbon leakage is that China alone is already responsible for 30% of the leakage, and just five countries - China, India, Brazil, South Korea, and Mexico - account for more than 60% of the estimated total figure (Babiker and Jacoby, 1999).

Table 4 summarise the numerical findings on carbon dioxide emissions under alternative regimens for the trading of emission permits.

3. Policy Measures Affecting the Implications of Kyoto Protocol

The results of the above-mentioned simulation studies which focused on emissions trading are to be taken with caution, since the models used typically assume complete economic rationality and negligible transaction costs. However, it is likely that the potential trading gains will not immediately be experienced in their full scope but will slowly emerge, in line with the development of experiences and removal of distortions in energy markets. Some papers have explored the mechanisms which affect the implications of Kyoto Protocol for Non-Annex B countries and have investigated policy measures which help moderating the effects of the Protocol on LDCs.

3.1 Strategic behaviour

The majority of studies investigating the effects of the Kyoto Protocol are based on the assumption of a competitive permit market. However, this idealistic picture is far from reality and can distort some of the conclusions. A few recent papers on the chances of the Kyoto Protocol's implementation chances have dealt with the incentives for strategic behaviour both on the demand and the supply side.[10] Above all in the case of global trading, strategic activities will also induce implications for developing countries.

Looking first at the supply side, a strong incentive to increase the profits from permits sales by restricting the overall supply are given. As has already extensively analysed in literature, the consequences of exerting monopoly power comprise a higher market permit price, increased energy resource costs and a drastic shift of the gains from trade to the suppliers. Ellerman, Jacoby and Decaux (1998) investigate two cases, one based on cartel by the Non-Annex B and the second consisting of a full supplier monopoly, including both the Non-Annex B countries and Russia. Both cases confirm the above-mentioned effects of a successful monopoly and

[9] A leakage rate of 6% is found by Babiker and Jacoby (1999) based on the EPPA-GTAP model and is in line with the results of the EPPA-GREEN model (Jacoby et al., 1997), the OECD's GREEN model (Burniaux, Martin, Nicoletti, and Oliveira-Martins, 1992) and the G-Cubed model (McKibbin et al., 1999). Burniaux and Truong (2002) find a leakage rate that amounts to 7%.

[10] For further details see Böhringer and Löschel (2001, 2002); Buonanno, Carraro, Castelnuovo, and Galeotti (2001); Buchner, Carraro, and Cersosimo (2002), Manne and Richels (2001).

demonstrate that all the involved countries always continue to gain from emissions trading. However, the stronger the monopoly, the lower are the gains for the Annex B countries and the higher are the profits for Non-Annex B countries and Russia. In particular, the gains for the Non-Annex B regions are tripled by establishing a full supplier monopoly.

Cases of strategic behaviour have also been discussed on the demand side. Particular attention has been attracted by the proposal of imposing a ceiling on permit imports, which would restrict the number of permits which Annex B countries can use in order to increase the percentage of domestic abatement activities[11]. Investigating three cases of increasingly restricted permit imports on global emissions trading, Ellerman, Jacoby and Decaux (1998) illustrate that demand-side restrictions lead to the expected results: the more drastic the quantitative import limit, the lower the demand for permits and therefore the lower the market prices. Consequently, the gains for the permit exporters, comprising Russia and the Non-Annex B, diminish consistently when the limit on permit imports are strengthened. Imposing for example an import limit of 25% reduces the Non-Annex B gains by almost 97%. At the same time, also the permit-importing regions lose notwithstanding the lower market price, because they have to engage in more expensive abatement activities and therefore face much higher overall costs. Kemfert (1999) analyses two types of ceilings on emissions trading, represented by a low and a high cap on trade. The results of this study confirm negative implications for developing countries resulting from permit restrictions. Again, the developments of the terms of trade induce international negative trade spillover effects. Summarising, import restrictions lead to two results: (i) the gains resulting from emissions trading are redistributed among the importers from those facing the highest abatement costs to those characterised by the lowest abatement costs, and (ii) the overall costs of meeting the emission reduction targets are increased since both importing and exporting regions are made worse off.

The first two columns of Table 5 summarise the findings.

3.2 Existing Energy Policies

Analyses of climate agreements like the Kyoto Protocol usually assume that emission control programs are implemented through imposition of a tax on fossil fuels, reflecting the fuels' differential carbon content, or of a cap-and-trade system which leads to a common price of carbon emissions across sources. However, circumstances are more complicated in reality since most countries already have a variety of fuel taxes that have been in use over decades. If existing fossil fuel taxes are not the efficient responses to the external effects of fuel use, then they will be responsible for the distortion of economic decisions. As a consequence, Babiker and Jacoby (1999) and Babiker, Reilly, and Jacoby (1999) investigate the interactions of the Kyoto-policies with existing fossil fuel taxes and analyse whether their removal improves economic efficiency and welfare. Indeed, the results demonstrate that the negative effects on energy-exporting regions are considerably decreased when replacing fuel taxes. As a consequence of the reduced fall in oil prices, a harmonisation halts the deterioration of the oil exporters' terms of trade and therefore restricts their welfare losses. These studies find that even non-oil-exporting Non-Annex B countries prefer carbon-based taxes to distorted fuel taxes. In addition, Annex B countries also benefit from a switch to a carbon-based increase in fuel prices, the magnitude of the gains being strongly correlated to the existing fuel tax distortions (e.g., the

[11] A ceiling has been proposed by the European Union in order to strengthen the "supplementarity" provision of the Kyoto Protocol. However, in the course of the negotiations on the Kyoto Protocol, the EU has abandoned its request for a concrete ceiling.

big winner is Europe). Summarising, a harmonised fuel tax appears to be beneficial to both Annex B and Non-Annex B regions.

A further distortion which is prevailing in the energy system of many nations are subsidies to the production of coal, which intended to encourage the use of coal at the expense of other energy sources. Babiker, Reilly, and Jacoby (1999) therefore look at the removal of coal subsidies in the key countries - Europe and more generally the OECD - and find that the adverse effects on Non-Annex B energy exporters are reduced. However, the welfare effects are small, i.e. neutral or positive, and there are no significant changes for the oil-exporting developing countries. The authors explain this result by their model specifications which include a coal sector that is too small for making a difference to the OECD regions. The only observable positive impact is seen in South Africa where coal exports to the OECD play an important role.

The insights of the last two subsections demonstrate that a more efficiently implemented climate change control gains by smaller costs and the minimisation of unintended consequences. For example, inefficient supply implies a higher market price, greater world costs and fewer gains from trade. Notwithstanding these results, the mentioned studies conclude that the gains are still considerable. Similar implications are found in the context of distortions, such as import limitations and non-competitive pricing, which induce higher benefits for a small part of he market only in the initial phase, and therefore still justify the implementation of emissions trading.

The third column of Table 5 summarises the findings.

3.3 Direct Measures to Reduce the Effects on Developing Countries

In addition to the possibility to make policies more efficient by removing existing distortions, also direct measures that go beyond general accompanying policies can be used to reduce the effects of the Kyoto Protocol's implementation on developing countries.

Babiker, Reilly, and Jacoby (1999) consider two options: preferential tariff reductions for Non-Annex B countries, on one hand, and direct financial compensation for these countries, on the other.

The first strategy consists of removing tariffs for Non-Annex B countries from goods imported into Annex B regions, excluding energy and energy-intensive goods.[12] As has been expected, these concessions lead to welfare losses in all the Annex B countries with the exception of Russia. Developing countries are affected in differing ways, some of them benefiting while other ones which suffer strong welfare losses from the Kyoto Protocol are almost not influenced (e.g., the Persian Gulf countries). Therefore, such a policy would benefit developing countries in general, but would not produce relief to those regions which are especially negatively affected by the agreement's implementation.

The second possibility to change directly the effects of the Kyoto Protocol lies in direct financial compensations to developing countries. Babiker, Reilly, and Jacoby (1999) calculate the level of financial flows that would be required in order to compensate Non-Annex B countries for the losses arising from the Kyoto Protocol. They find that an overall annual financial transfer from OECD countries to Non-Annex B regions of $27.6 billion is needed in the year 2010, more than 50% being directed towards Persian Gulf nations. In addition, also

[12] The authors justify this exclusion by the conflict with the objectives of the Climate Convention.

North Africa, Venezuela, Mexico and Indonesia would need substantial transfers in order to cover their losses. The implementation of a permit trading scheme would reduce the direct transfers by about 25%, to $20 billion. Instead of eliminating all the welfare losses, a further strategy could only aim at mitigating the adverse effects which would drastically reduce the needed level of financial transfers to about $14.5 billion, still concentrated on a few regions.

4. The Impact of The Kyoto Protocol on Developing Countries When Technical Change Is Endogenous

One very important element for the study of the impact of a Climate agreement on individual nations or groups of countries is technological change. If, on the one hand, current rates of greenhouse gas emissions cannot be sustained in the long run, on the other no one really believes or is ready to accept that the solution of the climate change problem consists of reducing the pace of economic growth. This is especially true for developing nations. Instead, it is believed that changes in technology will bring about the longed decoupling of economic growth from generation of polluting emissions. There is a difference in attitude in this respect, though. Some maintain a faithful view that technological change, having a life of its own, will automatically solve the problem. Others express the conviction that the process of technological change by and large responds to impulses and incentives, and it has therefore to be fostered by appropriate policy actions.

The above remarks are reflected in climate models, the main quantitative tools designed either to depict long run energy and pollution scenarios or to assist in climate change policy analysis. Indeed, these models have traditionally accounted for the presence of technical change, albeit usually evolving in an exogenous fashion. By and large, this is also the case of the models used to produce the results reported in the previous sections. More recently, however, models have been proposed where the technology changes endogenously and/or its change is induced by deliberate choices of agents and government intervention.

The issue is clearly quite relevant. For instance, most arguments advanced in support of the introduction of ceilings to emission trading are based on the view that the widespread adoption of flexibility mechanisms reduces the incentives to carry out R&D, thereby reducing the effectiveness and increasing the costs of abatement options in the long run. Moreover, the incentives for R&D induced by the presence of ceilings on the use of flexibility mechanisms may spill over into other sectors, thus speeding up the “engine of growth”, and reducing the impact of climate change control on per capita income and welfare in the long-run. Finally, the stimuli to technical and social innovation in rich countries will sooner or later be transferred to poor countries via trade in goods and services and knowledge transmission. All these considerations demonstrate that a convincing analysis of climate policy design - particularly of the role of emission trading and of the ceilings issue - requires a careful specification of technical change (see Buonanno, Carraro, Castelnuovo, and Galeotti, 2001).

Recent theoretical work on endogenous growth has shown that aggregate technological externalities within countries may help explain many of the observed patterns of growth across countries. Castelnuovo, Galeotti, Gambarelli, and Vergalli (2002) and Buonanno, Carraro, and Galeotti (2003) modify a popular climate model which allows for both endogenous and induced technical change. Endogenous growth is captured by assuming that sectoral spillovers within countries and human capital induce increasing returns to scale in output production. Induced technical change takes place through R&D investments or via experience (Learning-by-Doing).

In particular, Buonanno, Carraro, Castelnuovo, and Galeotti (2001) and Buonanno, Carraro, and Galeotti (2003) assume that R&D investment accumulates into a stock of knowledge that affects both the production technology (endogenous technical change) and the emission-output ratio (induced technical change). Extending Nordhaus and Yang (1996)'s RICE model it is assumed that the stock of knowledge enters the production function as one of the production factors and, at the same time, affects the emission-output ratio. Thus, the idea is that more knowledge will help firms increase their productivity and reduce their negative impact on the environment. In this modified version, the central planner in each country chooses the optimal R&D effort that, in turn, increases the stock of technological knowledge. The amount of R&D is therefore a policy variable envisaged by the model.

Castelnuovo, Galeotti, Gambarelli, and Vergalli (2002) propose an alternative formulation of the same model allows for an alternative source of technical change, Learning by Doing. In particular, it is supposed that the accumulation of knowledge occurs not as a result of deliberate (R&D) efforts, but as a side effect of conventional economic activity. In this extension of the RICE model, the authors model LdB in the simplest way, that is by assuming that learning occurs as a side effect of the accumulation of new physical capital. This entails a production function that exhibits increasing returns to capital. In order to maintain the analogy with the R&D-based version of the model we also allow for the emission-output ratio to depend upon cumulated capacity, i.e. the sum of past physical investment efforts. It should be apparent that these model specifications make explicit reference to the recently developed theory of endogenous growth that emphasizes the role of knowledge, of physical and human capital, R&D activities, and LbD.

In this section we simulate the model just described, which we labeled "ETC-RICE", and consider separately the impact on Annex B and Non-Annex B countries of the implementation of the Kyoto Protocol. In particular we consider three regimens: a No Trade case, Annex B Trading, and Global Trade of emissions, all relative to the Business As Usual (BAU) scenario. In keeping with the previous section we concentrate on welfare and on emissions and compare the R&D and LbD versions of endogenous and induced technical change.[13]

The findings are presented in Table 6.

The first striking result is that the specification of endogenous/induced technical change does not seem to make a difference. Indeed, the reduction in regional emissions under the Protocol is larger with LbD that with R&D, though overall emissions are essentially unaffected by the difference. Welfare losses are a bit smaller for Annex B countries under R&D, but there is no difference for Non-Annex B regions.

The second result is that the findings are in line with previous research. The imposition of emission reduction targets adversely affects the welfare of Annex B regions, but this loss is moderated by resorting to emission trading. This is true of global trade in particular. What about Non-Annex B nations? Because they are not subject to emission limits their welfare does not suffer from implementation of the Kyoto Protocol. It is virtually unchanged regardless of the trading regime.

The same picture emerges if we look at output, where Non-Annex B countries experience slightly positive economic growth. This is stronger with global trade, possibly because of the

[13] The model is regional: we aggregate Annex B and Non-Annex B regions. Simulations are carried out up until 2100. The Global Trade scenario entails the Non-annex B regions entering the permit market in 2020 with BAU emissions as constraints. The model is described in the papers cited or in a companion paper to the present one (Galeotti, 2002).

positive effect of revenues generated by selling permits on the market. The fact that the permit price is lower under global trade relative to Annex B trade may help explain why Annex B nations can turn a slowdown into an expansion of economic activity (though numbers are very small).

The overall message relayed by these results appears to be twofold. The implementation of the Kyoto Protocol harms neither the welfare nor the economic growth of developing countries. Thus emission reductions can be achieved without imposing economic costs on the development process of those regions. It remains however true that overall emissions are met with the largest reductions when LDCs participate in the agreement and trade of rights to emit is open to all countries. In this case the results show that Non-Annex B countries essentially neither gain nor lose from a welfare or an output growth viewpoints.

5. Concluding Remarks

Although developing countries face a drastic increase in their greenhouse gas emissions, economic development represents in nearly all cases a priority relative to other issues like emission control. A crucial policy question is therefore whether international climate agreements like the Kyoto Protocol provide an opportunity for growth to this region, while curbing overall emissions.

The first step toward solving this problem is to provide an answer to what is the impact - qualitatively and quantitatively - of the Kyoto Protocol as it is now on developing countries. The present chapter has been concerned precisely with this issue. In particular, we provided an overview of research studies undertaken in this context. It turns out that important differences exist whether or not the Kyoto flexibility mechanisms - emission trading in particular – are in effect. Similarly, the issue of constraints on the demand and supply sides of the permit market, due to exogenously imposed ceilings or to market power, have important consequences for the impact of the Protocol on developing countries. Finally, we have noted that the role of endogenous and induced technical change is critical in that it is this process that in principle allows the decoupling of economic growth from harmful emissions.

References

Babiker, M. and H.D. Jacoby (1999), "Developing Country Effects of Kyoto-Type Emissions Restrictions", MIT Joint Program on the Science and Policy of Global Change Report No. 53.

Babiker, M., J. Reilly, and H.D. Jacoby (1999), "The Kyoto Protocol and Developing Countries", MIT Joint Program on the Science and Policy of Global Change Report No. 56.

Bernstein, P., W. Montgomery, and T. Rutherford (1999), "Global Impacts of the Kyoto Agreement: Results from the MS-MRT Model", *Resource and Energy Economics*, 21, 375-413.

Böhringer, C. and T. Rutherford (1999), "World Economic Impacts of the Kyoto Protocol", in R. Hillebrand, A. Ulph and P. J. (eds.), Welfens Internalization of Economy, Environmental Problems and New Policy Options, New York: Heidelberg.

Böhringer, C. and A. Löschel (2001), "Market Power in International Emissions Trading: The Impact of U.S. Withdrawal from the Kyoto Protocol", ZEW Discussion Paper No. 01-58.

Böhringer, C. and A. Löschel (2002), "Economic Impacts of Carbon Abatement Strategies", in C. Böhringer, M. Finus, and C. Vogt (eds.), Controlling Global Warming – Perspectives from Economics, Game Theory and Public Choice, Cheltenham: Edward Elgar, 105-177.

Brown, S., D. Kennedy, C. Polidano, K. Woffenden, G. Jakeman, B. Graham, F. Jotzo, and B.S. Fisher (1999), "Economic Impacts of the Kyoto Protocol: Accounting for the Three Major Greenhouse Gases", ABARE Research Report No. 99.6.

Buchner, B., Carraro, C. and I. Cersosimo (2002), "On the Consequences of the U.S. Withdrawal from the Kyoto/Bonn Protocol", *Climate Policy*, 2, 273-292.

Buonanno, P., C. Carraro, and M. Galeotti (2003), "Endogenous Induced Technical Change and the Costs of Kyoto", *Resource and Energy Economics*.

Buonanno, P., C. Carraro, E. Castelnuovo, and M. Galeotti (2001), "Emission Trading Restrictions with Endogenous Technological Change", *International Environmental Agreements. Law Politics Economics*.

Burniaux, J.-M. and T.P. Truong (2002), "GTAP-E: An Energy-Environmental Version of the GTAP Model", GTAP Technical Paper No. 16.

Castelnuovo, E., M. Galeotti, G. Gambarelli, and S. Vergalli (2002), "Learning by Doing vs. Learning by Researching in a Model for Climate Policy Analysis", Fondazione Eni Enrico Mattei Nota di lavoro No. 11-2003.

Den Elzen, M.G.J. and A.P.G. de Moor (2001), "Evaluating the Bonn Agreement and Some Key Issues", RIVM Report No. 728001016/2001.

Ellerman, A.D. and A. Decaux (1998), "Analysis of Post-Kyoto Emissions Trading Using Marginal Abatement Curves", MIT Joint Program on the Science and Policy of Global Change Report No. 40.

Ellerman, A.D., H.D. Jacoby, and A. Decaux (1998), "The Effects on Developing Countries of the Kyoto Protocol and CO2 Emissions Trading", MIT Joint Program on the Science and Policy of Global Change Report No. 41.

Galeotti, M. and C. Kemfert (2002), "Interactions between Climate and Trade Policies: A Survey", mimeo.

Galeotti, M. (2002), "Climate Policy and Economic Growth in Developed Countries", mimeo.

Jacoby, H. D., R. Eckaus, D. Ellerman, R. Prinn, D. Reiner, and Z. Yang (1997), "CO2 Emissions Limits: Economic Adjustments and the Distribution of Burdens", *Energy Journal*, 18, 31-58.

Jacoby, H. D. and I. Sue Wing (1999), "Adjustment Time, Capital Malleability and Policy Cost", *Energy Journal Special Issue* (The Costs of the Kyoto Protocol: A Multi-Model Evaluation), 73-92.

Kemfert, C. (1999) "The Impacts of Emissions Trading on World Economies: Contemplation of baseline emissions paths and a ceiling on emissions trading", mimeo.

Kemfert, C. (2001), "Economic Impact Assessment of Alternative Climate Policy Strategies", FEEM Working Paper No. 86.01.

Kete, N., K.A. Baumert, and R. Bhandari (2001), "Should Development Aid be Used to Finance the Clean Development Mechanism?", World Resources Institute Climate Notes, Washimgton. D.C., available at http://www.wri.org/pdf/ruchi.pdf.

Light, M., C. Kolstad, and T. Rutherford (1999), "Coal Markets and the Kyoto Protocol", University of Colorado at Boulder Working Paper No. 99-23.

Manne, A.S. and Richels, R.G. (2001), "US Rejection of the Kyoto Protocol: The Impact on Compliance Csts and CO2 Emissions", Working Paper No. 01-12, AEI-Brookings Joint Center for Regulatory Studies.

McKibbin, W.J. and P.J. Wilcoxen (2000), "Designing a Realistic Climate Change Policy that Includes Developing Countries", Australian National University and The Brookings Institution, mimeo.

McKibbin, W.J., M.T. Ross, R. Shackleton, and P.J. Wilcoxen (1999), "Emissions Trading, Capital Flows and the Kyoto Protocol", Brookings Discussion Papers in International Economics No. 144.

Nordhaus, W.D. and Yang, Z. (1996) A regional dynamic general-equilibrium model of alternative climate-change strategies, *American Economic Review,* 4, 741-765.

Burniaux, J.-M., J.P. Martin, G. Nicoletti, and J. Oliveira-Martins (1992), "GREEN - A multi-sector, Multi-region Dynamic General Equilibrium Model for Quantifying the Costs of Curbing CO_2 Emissions: A Technical Manual", OECD Economics Department Working Paper No. 116.

Philibert, C. (2000), "How Could Emissions Trading Benefit Developing Countries?", Paper Presented at the Second EFIEA Climate Policy Workshop 'From Kyoto to The Hague - European Perspectives on Making the Kyoto Protocol Work", Amsterdam, April 18-19.

Polidano, C., F. Jotzo, E. Heyhoe, G. Jakeman, K. Woffenden, and B.S. Fisher (2000), "The Kyoto Protocol and Developing Countries: Impacts and Implications for Mechanisms Design", ABARE Research Report No. 2000.4.

Table 1: Impacts of the Kyoto Protocol on Developing Countries in the No Trade Case

	BAU vs. Kyoto Without Trading Percentage Change[a]							
	Non-Annex B						Annex B	
	Energy-Importing Countries		Energy-Exporting Countries		Total		Total	
	EV[b]	Terms of Trade	EV	Terms of Trade	EV	Terms of Trade	EV	Terms of Trade
Babiker and Jacoby (1999)	+ 0.55	+ 2.32	-10.80	- 28.93	- 10.25	- 26.61	- 4.95	+ 1.17
Babiker, Reilly, and Jacoby (1999)	+ 0.55	+ 2.32	- 10.80	- 28.93	- 10.25	- 26.61	- 4.95	+ 1.17
Bernstein et al. (1999)(i)[c]	+ 0.02	- 0.85	- 1.35	- 3.53	- 1.33	- 4.38	- 3.04	- 1.34
Bernstein et al. (1999)(ii)	- 0.04	-	- 1.39	-	- 1.43	-	- 2.99	-
Böhringer and Rutherford (1999)	- 0.55%	-	- 1.45%	-	- 2.00%	-	- 1.19%	+ 0.04%
Burniaux and Truong (2002)[d]	+ 0.24	+ 0.29	- 1.0	- 3.02	- 0.76	- 2.73	- 3.05	+ 1.11
Böhringer and Löschel (2002)[e]	+ 0.45	-	- 0.54	-	- 0.09	-	- 1.72	-

Notes to the table:

a) Percentage changes are computed with respect to the amount of emissions in the reference case without any climate agreement in 2010.
b) EV is the Equivalent Variation measure of welfare expressed in percentage terms It roughly shows by how much regional well-being - basically the level of consumption - changes as a result of policy intervention. Secondary benefits of pollution control or the benefits of a lowered risk of climate change are not considered.
c) This analysis investigates different baseline scenarios. We replicate the results for the medium case, the so-called reference scenario.
d) This analysis uses welfare effects in terms of percentage change in per capita utility of the representative household.
e) Welfare effects are measured in percentage change of real consumption as compared to Business As Usual (BAU).

Table 2: Impacts of the Kyoto Protocol on Developing Countries with Annex B Trading

	BAU vs. Kyoto With Annex B Trading Percentage Change							
	Non-Annex B						Annex B	
	Energy-Importing Countries		Energy-Exporting Countries		Total		Total	
	EV	Terms of Trade	EV	Terms of Trade	EV	Terms of Trade	EV	Terms of Trade
Babiker and Jacoby (1999)	+ 0.52	-	- 7.86	-	- 7.34	-	+ 4.04	-
Babiker, Reilly, and Jacoby (1999)	+ 0.52	-	- 7.86	-	- 7.34	-	+ 4.04	-
Bernstein et al. (1999)(i)	- 0.03	- 0.22	- 1.13	- 2.43	- 1.16	- 2.65	+ 2.73	+ 0.05
Bernstein et al. (1999)(ii)	+ 0.09	-	- 1.15	-	- 1.06	-	+ 2.84	-
Burniaux and Truong (2002)	+ 0.18	+ 0.21	- 0.73	- 2.19	- 0.55	- 1.98	+ 1.09	+ 1.76
Böhringer and Löschel (2002)	+ 0.33	-	- 0.43	-	- 0.1	-	+ 4.92	-

Notes to the table: see Table 1.

Table 3: Impacts of the Kyoto Protocol on Developing Countries with Global Trading

	BAU vs. Kyoto With Annex B Trading Percentage Change							
	Non-Annex B						Annex B	
	Energy-Importing Countries		Energy-Exporting Countries		Total		Total	
	EV	Terms of Trade	EV	Terms of Trade	EV	Terms of Trade	EV	Terms of Trade
Babiker and Jacoby (1999)	+ 0.28	-	- 3.12	-	- 2.84	-	+ 0.97	-
Babiker, Reilly, and Jacoby (1999)	-	-	-	-	-	-	-	-
Bernstein et al. (1999)(i)	+ 0.63	- 0.06	- 0.38	- 1.40	+ 0.25	- 1.46	- 0.04	- 0.68
Bernstein et al. (1999)(ii)	+ 0.81	-	- 0.36	-	+ 0.45	-	- 0.04	-
Burniaux and Truong (2002)	+ 0.54	- 0.48	- 0.53	- 1.47	+ 0.01	- 1.95	- 0.05	+ 0.38
Böhringer and Löschel (2002)	+ 0.36	-	- 0.53	-	- 0.17	-	+ 2.21	-

Notes to the table: see Table 1.

Table 4: Implications of the Kyoto Protocol - Changes in World Emissions

	Emissions (in Non-Annex B countries)[a]		
	No Emissions Trading	Annex B Emissions Trading	Global Emissions Trading
Burniaux and Truong (2002)	+ 2	+ 1	- 19
Ellerman, Jacoby and Decaux (1998)[b]	+/- 0	+/- 0	- 18
Ellerman and Decaux (1998)[c]	- 13.74	- 13.50	- 13.89
Den Elzen and de Moor (2001)	+/- 0	- 2.4	-

Notes to the table:

a) Percentage changes are computed with respect to the amount of emissions in the reference case without any climate agreement in 2010.

b) These are per capita emissions in Non-Annex B countries. It is assumed that they are at the reference level of 0.74 tC/cap until global emissions trading is allowed for.

c) World emissions.

Table 5: Implications of the Kyoto Protocol for Developing Countries - The Role of Strategic Behaviour and Adaptation Policies

	Policies Affecting the Implications of the Kyoto Protocol for Non-Annex B Countries[a]		
	Strategic Behaviour		Energy Policy
	Supply Side	Demand Side	
Babiker and Jacoby (1999)[b]	No cartel: - 10.25 "OPEC cartel": - 22.64	-	Distortions: - 10.25 Harmonisation: - 8.28
Babiker, Reilly, and Jacoby (1999)[b]	-	-	Distortions: - 10.25 Harmonisation: - 8.28"
Ellerman and Decaux (1998)[c]	Annex B Cartel: + 119.9 Annex B+Russia: + 194.6	-	-
Ellerman, Jacoby, and Decaux (1998)[c]	Annex B Cartel: + 119.9 Annex B+Russia: + 194.6	Import limitations: 25% limit: - 97.1 50% limit: - 66.7 75% limit: - 6.9	-
Kemfert (1999)[d]		Ceiling compared to Annex B trading: 10% limit: - 0.93 80% limit - 1.82	-

Notes to the table:

a) Percentage changes.

b) Changes refer to Equivalent Variation relative to baseline cases.

c) Changes refer to gains from trade relative to baseline cases

d) These results correspond to the assumption of a medium emissions level.

Table 5: Implications of the Kyoto Protocol for Developing Countries - The Role of Strategic Behaviour and Adaptation Policies

	Policies Affecting the Implications of the Kyoto Protocol for Non-Annex B Countries[a]		
	Strategic Behaviour		Energy Policy
	Supply Side	Demand Side	
Babiker and Jacoby (1999)[b]	No cartel: - 10.25 "OPEC cartel": - 22.64	-	Distortions: - 10.25 Harmonisation: - 8.28
Babiker, Reilly, and Jacoby (1999)[b]	-	-	Distortions: - 10.25 Harmonisation: - 8.28"
Ellerman and Decaux (1998)[c]	Annex B Cartel: + 119.9 Annex B+Russia: + 194.6	-	-
Ellerman, Jacoby, and Decaux (1998)[c]	Annex B Cartel: + 119.9 Annex B+Russia: + 194.6	Import limitations: 25% limit: - 97.1 50% limit: - 66.7 75% limit: - 6.9	-

Notes to the table:

e) Percentage changes.

f) Changes refer to Equivalent Variation relative to baseline cases.

g) Changes refer to gains from trade relative to baseline cases

Table6: Implications of the Kyoto Protocol Under Endogenous and Induced Technical Change[a]

	Non-Annex B			Annex B Countries		
	No Trade vs BAU	Annex B Trade vs BAU	Non-Annex B Trade vs BAU	No Trade vs BAU	Annex B Trade vs BAU	Non-Annex B Trade vs BAU
	R&D - Based Technical Change					
Welfare[b]	+ 0.01	+ 0.01	0	- 0.20	- 0.11	- 0.03
Emissions	0	0	- 17	- 41	-419	- 14
Output	+ 0.02	+ 0.02	+ 0.04	- 0.81	- 0.30	+ 0.14
Overall Emissions	No Trade vs BAU		Annex B Trade vs BAU		Global Trade vs BAU	
	- 11		- 11		- 16	
	LbD - Based Technical Change					
Welfare	+ 0.01	+ 0.01	+ 0.01	- 0.35	- 0.30	- 0.09
Emissions	0	0	- 16	- 45	- 45	- 14
Output	+ 0.03	+ 0.03	+ 0.02	- 0.73	- 0.54	+ 0.18
Overall Emissions	No Trade vs BAU		Annex B Trade vs BAU		Global Trade vs BAU	
	- 11		- 11		- 15	

Notes to the table:

a) Percentage changes are computed with respect to the amount of emissions in the reference case without any climate agreement in 2010.

b) Welfare is defined as the present discounted value of consumption.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI
Fondazione Eni Enrico Mattei Working Paper Series
Our working papers are available on the Internet at the following addresses:
http://www.feem.it/Feem/Pub/Publications/WPapers/default.html
http://papers.ssrn.com

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

NRM	31.2002	*Carlo GIUPPONI and Paolo ROSATO:* Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon
NRM	32.2002	*Robert N. STAVINS*: National Environmental Policy During the Clinton Years
KNOW	33.2002	*A. SOUBEYRAN and H. STAHN* : Do Investments in Specialized Knowledge Lead to Composite Good Industries?
KNOW	34.2002	*G. BRUNELLO, M.L. PARISI and Daniela SONEDDA:* Labor Taxes, Wage Setting and the Relative Wage Effect
CLIM	35.2002	*C. BOEMARE and P. QUIRION* (lv): Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences
CLIM	36.2002	*T.TIETENBERG* (lv): The Tradable Permits Approach to Protecting the Commons: What Have We Learned?
CLIM	37.2002	*K. REHDANZ and R.J.S. TOL* (lv): On National and International Trade in Greenhouse Gas Emission Permits
CLIM	38.2002	*C. FISCHER* (lv): Multinational Taxation and International Emissions Trading
SUST	39.2002	*G. SIGNORELLO and G. PAPPALARDO:* Farm Animal Biodiversity Conservation Activities in Europe under the Framework of Agenda 2000
NRM	40.2002	*S .M. CAVANAGH, W. M. HANEMANN and R. N. STAVINS:* Muffled Price Signals: Household Water Demand under Increasing-Block Prices
NRM	41.2002	*A. J. PLANTINGA, R. N. LUBOWSKI and R. N. STAVINS:* The Effects of Potential Land Development on Agricultural Land Prices
CLIM	42.2002	*C. OHL* (lvi): Inducing Environmental Co-operation by the Design of Emission Permits
CLIM	43.2002	*J. EYCKMANS, D. VAN REGEMORTER and V. VAN STEENBERGHE* (lvi): Is Kyoto Fatally Flawed? An Analysis with MacGEM
CLIM	44.2002	*A. ANTOCI and S. BORGHESI* (lvi): Working Too Much in a Polluted World: A North-South Evolutionary Model
ETA	45.2002	*P. G. FREDRIKSSON, Johan A. LIST and Daniel MILLIMET* (lvi): Chasing the Smokestack: Strategic Policymaking with Multiple Instruments
ETA	46.2002	*Z. YU* (lvi): A Theory of Strategic Vertical DFI and the Missing Pollution-Haven Effect
SUST	47.2002	*Y. H. FARZIN*: Can an Exhaustible Resource Economy Be Sustainable?
SUST	48.2002	*Y. H. FARZIN*: Sustainability and Hamiltonian Value
KNOW	49.2002	*C. PIGA and M. VIVARELLI*: Cooperation in R&D and Sample Selection
Coalition Theory Network	50.2002	*M. SERTEL and A. SLINKO* (liv): Ranking Committees, Words or Multisets
Coalition Theory Network	51.2002	*Sergio CURRARINI* (liv): Stable Organizations with Externalities
ETA	52.2002	*Robert N. STAVINS*: Experience with Market-Based Policy Instruments
ETA	53.2002	*C.C. JAEGER, M. LEIMBACH, C. CARRARO, K. HASSELMANN, J.C. HOURCADE, A. KEELER and R. KLEIN* (liii): Integrated Assessment Modeling: Modules for Cooperation
CLIM	54.2002	*Scott BARRETT* (liii)*:* Towards a Better Climate Treaty
ETA	55.2002	*Richard G. NEWELL and Robert N. STAVINS*: Cost Heterogeneity and the Potential Savings from Market-Based Policies
SUST	56.2002	*Paolo ROSATO and Edi DEFRANCESCO*: Individual Travel Cost Method and Flow Fixed Costs
SUST	57.2002	*Vladimir KOTOV and Elena NIKITINA* (lvii): Reorganisation of Environmental Policy in Russia: The Decade of Success and Failures in Implementation of Perspective Quests
SUST	58.2002	*Vladimir KOTOV* (lvii): Policy in Transition: New Framework for Russia's Climate Policy
SUST	59.2002	*Fanny MISSFELDT and Arturo VILLAVICENCO* (lvii): How Can Economies in Transition Pursue Emissions Trading or Joint Implementation?
VOL	60.2002	*Giovanni DI BARTOLOMEO, Jacob ENGWERDA, Joseph PLASMANS and Bas VAN AARLE:* Staying Together or Breaking Apart: Policy-Makers' Endogenous Coalitions Formation in the European Economic and Monetary Union
ETA	61.2002	*Robert N. STAVINS, Alexander F.WAGNER and Gernot WAGNER*: Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity
PRIV	62.2002	*Carlo CAPUANO*: Demand Growth, Entry and Collusion Sustainability
PRIV	63.2002	*Federico MUNARI and Raffaele ORIANI*: Privatization and R&D Performance: An Empirical Analysis Based on Tobin's Q
PRIV	64.2002	*Federico MUNARI and Maurizio SOBRERO*: The Effects of Privatization on R&D Investments and Patent Productivity
SUST	65.2002	*Orley ASHENFELTER and Michael GREENSTONE*: Using Mandated Speed Limits to Measure the Value of a Statistical Life
ETA	66.2002	*Paolo SURICO:* US Monetary Policy Rules: the Case for Asymmetric Preferences
PRIV	67.2002	*Rinaldo BRAU and Massimo FLORIO*: Privatisations as Price Reforms: Evaluating Consumers' Welfare Changes in the U.K.
CLIM	68.2002	*Barbara K. BUCHNER and Roberto ROSON*: Conflicting Perspectives in Trade and Environmental Negotiations
CLIM	69.2002	*Philippe QUIRION*: Complying with the Kyoto Protocol under Uncertainty: Taxes or Tradable Permits?
SUST	70.2002	*Anna ALBERINI, Patrizia RIGANTI and Alberto LONGO*: Can People Value the Aesthetic and Use Services of Urban Sites? Evidence from a Survey of Belfast Residents
SUST	71.2002	*Marco PERCOCO:* Discounting Environmental Effects in Project Appraisal

NRM	72.2002	*Philippe BONTEMS and Pascal FAVARD*: Input Use and Capacity Constraint under Uncertainty: The Case of Irrigation
PRIV	73.2002	*Mohammed OMRAN:* The Performance of State-Owned Enterprises and Newly Privatized Firms: Empirical Evidence from Egypt
PRIV	74.2002	*Mike BURKART, Fausto PANUNZI and Andrei SHLEIFER:* Family Firms
PRIV	75.2002	*Emmanuelle AURIOL, Pierre M. PICARD:* Privatizations in Developing Countries and the Government Budget Constraint
PRIV	76.2002	*Nichole M. CASTATER***:** Privatization as a Means to Societal Transformation: An Empirical Study of Privatization in Central and Eastern Europe and the Former Soviet Union
PRIV	77.2002	*Christoph LÜLSFESMANN*: Benevolent Government, Managerial Incentives, and the Virtues of Privatization
PRIV	78.2002	*Kate BISHOP, Igor FILATOTCHEV and Tomasz MICKIEWICZ*: Endogenous Ownership Structure: Factors Affecting the Post-Privatisation Equity in Largest Hungarian Firms
PRIV	79.2002	*Theodora WELCH and Rick MOLZ*: How Does Trade Sale Privatization Work? Evidence from the Fixed-Line Telecommunications Sector in Developing Economies
PRIV	80.2002	*Alberto R. PETRUCCI*: Government Debt, Agent Heterogeneity and Wealth Displacement in a Small Open Economy
CLIM	81.2002	*Timothy SWANSON and Robin MASON* (lvi): The Impact of International Environmental Agreements: The Case of the Montreal Protocol
PRIV	82.2002	*George R.G. CLARKE and Lixin Colin XU:* Privatization, Competition and Corruption: How Characteristics of Bribe Takers and Payers Affect Bribe Payments to Utilities
PRIV	83.2002	*Massimo FLORIO and Katiuscia MANZONI*: The Abnormal Returns of UK Privatisations: From Underpricing to Outperformance
NRM	84.2002	*Nelson LOURENÇO, Carlos RUSSO MACHADO, Maria do ROSÁRIO JORGE and Luís RODRIGUES*: An Integrated Approach to Understand Territory Dynamics. The Coastal Alentejo (Portugal)
CLIM	85.2002	*Peter ZAPFEL and Matti VAINIO* (lv): Pathways to European Greenhouse Gas Emissions Trading History and Misconceptions
CLIM	86.2002	*Pierre COURTOIS*: Influence Processes in Climate Change Negotiations: Modelling the Rounds
ETA	87.2002	*Vito FRAGNELLI and Maria Erminia MARINA* (lviii): Environmental Pollution Risk and Insurance
ETA	88.2002	*Laurent FRANCKX* (lviii): Environmental Enforcement with Endogenous Ambient Monitoring
ETA	89.2002	*Timo GOESCHL and Timothy M. SWANSON* (lviii): Lost Horizons. The noncooperative management of an evolutionary biological system.
ETA	90.2002	*Hans KEIDING* (lviii): Environmental Effects of Consumption: An Approach Using DEA and Cost Sharing
ETA	91.2002	*Wietze LISE* (lviii): A Game Model of People's Participation in Forest Management in Northern India
CLIM	92.2002	*Jens HORBACH*: Structural Change and Environmental Kuznets Curves
ETA	93.2002	*Martin P. GROSSKOPF:* Towards a More Appropriate Method for Determining the Optimal Scale of Production Units
VOL	94.2002	*Scott BARRETT and Robert STAVINS*: Increasing Participation and Compliance in International Climate Change Agreements
CLIM	95.2002	*Banu BAYRAMOGLU LISE and Wietze LISE:* Climate Change, Environmental NGOs and Public Awareness in the Netherlands: Perceptions and Reality
CLIM	96.2002	*Matthieu GLACHANT*: The Political Economy of Emission Tax Design in Environmental Policy
KNOW	97.2002	*Kenn ARIGA and Giorgio BRUNELLO*: Are the More Educated Receiving More Training? Evidence from Thailand
ETA	98.2002	*Gianfranco FORTE and Matteo MANERA*: Forecasting Volatility in European Stock Markets with Non-linear GARCH Models
ETA	99.2002	*Geoffrey HEAL*: Bundling Biodiversity
ETA	100.2002	*Geoffrey HEAL, Brian WALKER, Simon LEVIN, Kenneth ARROW, Partha DASGUPTA, Gretchen DAILY, Paul EHRLICH, Karl-Goran MALER, Nils KAUTSKY, Jane LUBCHENCO, Steve SCHNEIDER and David STARRETT*: Genetic Diversity and Interdependent Crop Choices in Agriculture
ETA	101.2002	*Geoffrey HEAL:* Biodiversity and Globalization
VOL	102.2002	*Andreas LANGE*: Heterogeneous International Agreements – If per capita emission levels matter
ETA	103.2002	*Pierre-André JOUVET and Walid OUESLATI*: Tax Reform and Public Spending Trade-offs in an Endogenous Growth Model with Environmental Externality
ETA	104.2002	*Anna BOTTASSO and Alessandro SEMBENELLI*: Does Ownership Affect Firms' Efficiency? Panel Data Evidence on Italy
PRIV	105.2002	*Bernardo BORTOLOTTI, Frank DE JONG, Giovanna NICODANO and Ibolya SCHINDELE*: Privatization and Stock Market Liquidity
ETA	106.2002	*Haruo IMAI and Mayumi HORIE* (lviii): Pre-Negotiation for an International Emission Reduction Game
PRIV	107.2002	*Sudeshna GHOSH BANERJEE and Michael C. MUNGER*: Move to Markets? An Empirical Analysis of Privatisation in Developing Countries
PRIV	108.2002	*Guillaume GIRMENS and Michel GUILLARD*: Privatization and Investment: Crowding-Out Effect vs Financial Diversification
PRIV	109.2002	*Alberto CHONG and Florencio LÓPEZ-DE-SILANES*: Privatization and Labor Force Restructuring Around the World
PRIV	110.2002	*Nandini GUPTA*: Partial Privatization and Firm Performance
PRIV	111.2002	*François DEGEORGE, Dirk JENTER, Alberto MOEL and Peter TUFANO*: Selling Company Shares to Reluctant Employees: France Telecom's Experience

PRIV	112.2002	*Isaac OTCHERE*: Intra-Industry Effects of Privatization Announcements: Evidence from Developed and Developing Countries
PRIV	113.2002	*Yannis KATSOULAKOS and Elissavet LIKOYANNI*: Fiscal and Other Macroeconomic Effects of Privatization
PRIV	114.2002	*Guillaume GIRMENS:* Privatization, International Asset Trade and Financial Markets
PRIV	115.2002	*D. Teja FLOTHO:* A Note on Consumption Correlations and European Financial Integration
PRIV	116.2002	*Ibolya SCHINDELE and Enrico C. PEROTTI*: Pricing Initial Public Offerings in Premature Capital Markets: The Case of Hungary
PRIV	1.2003	*Gabriella CHIESA and Giovanna NICODANO*: Privatization and Financial Market Development: Theoretical Issues
PRIV	2.2003	*Ibolya SCHINDELE*: Theory of Privatization in Eastern Europe: Literature Review
PRIV	3.2003	*Wietze LISE, Claudia KEMFERT and Richard S.J. TOL*: Strategic Action in the Liberalised German Electricity Market
CLIM	4.2003	*Laura MARSILIANI and Thomas I. RENSTRÖM*: Environmental Policy and Capital Movements: The Role of Government Commitment
KNOW	5.2003	*Reyer GERLAGH*: Induced Technological Change under Technological Competition
ETA	6.2003	*Efrem CASTELNUOVO*: Squeezing the Interest Rate Smoothing Weight with a Hybrid Expectations Model
SIEV	7.2003	*Anna ALBERINI, Alberto LONGO, Stefania TONIN, Francesco TROMBETTA and Margherita TURVANI:* The Role of Liability, Regulation and Economic Incentives in Brownfield Remediation and Redevelopment: Evidence from Surveys of Developers
NRM	8.2003	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Natural Resources: A Blessing or a Curse?
CLIM	9.2003	*A. CAPARRÓS, J.-C. PEREAU and T. TAZDAÏT*: North-South Climate Change Negotiations: a Sequential Game with Asymmetric Information
KNOW	10.2003	*Giorgio BRUNELLO and Daniele CHECCHI*: School Quality and Family Background in Italy
CLIM	11.2003	*Efrem CASTELNUOVO and Marzio GALEOTTI*: Learning By Doing vs Learning By Researching in a Model of Climate Change Policy Analysis
KNOW	12.2003	*Carole MAIGNAN, Gianmarco OTTAVIANO and Dino PINELLI (eds.)*: Economic Growth, Innovation, Cultural Diversity: What are we all talking about? A critical survey of the state-of-the-art
KNOW	13.2003	*Carole MAIGNAN, Gianmarco OTTAVIANO, Dino PINELLI and Francesco RULLANI* (lix): Bio-Ecological Diversity vs. Socio-Economic Diversity. A Comparison of Existing Measures
KNOW	14.2003	*Maddy JANSSENS and Chris STEYAERT* (lix): Theories of Diversity within Organisation Studies: Debates and Future Trajectories
KNOW	15.2003	*Tuzin BAYCAN LEVENT, Enno MASUREL and Peter NIJKAMP* (lix): Diversity in Entrepreneurship: Ethnic and Female Roles in Urban Economic Life
KNOW	16.2003	*Alexandra BITUSIKOVA* (lix): Post-Communist City on its Way from Grey to Colourful: The Case Study from Slovakia
KNOW	17.2003	*Billy E. VAUGHN and Katarina MLEKOV* (lix): A Stage Model of Developing an Inclusive Community
KNOW	18.2003	*Selma van LONDEN and Arie de RUIJTER* (lix): Managing Diversity in a Glocalizing World
Coalition Theory Network	19.2003	*Sergio CURRARINI:* On the Stability of Hierarchies in Games with Externalities
PRIV	20.2003	*Giacomo CALZOLARI and Alessandro PAVAN* (lx): Monopoly with Resale
PRIV	21.2003	*Claudio MEZZETTI* (lx): Auction Design with Interdependent Valuations: The Generalized Revelation Principle, Efficiency, Full Surplus Extraction and Information Acquisition
PRIV	22.2003	*Marco LiCalzi and Alessandro PAVAN* (lx): Tilting the Supply Schedule to Enhance Competition in Uniform-Price Auctions
PRIV	23.2003	*David ETTINGER* (lx): Bidding among Friends and Enemies
PRIV	24.2003	*Hannu VARTIAINEN* (lx): Auction Design without Commitment
PRIV	25.2003	*Matti KELOHARJU, Kjell G. NYBORG and Kristian RYDQVIST* (lx): Strategic Behavior and Underpricing in Uniform Price Auctions: Evidence from Finnish Treasury Auctions
PRIV	26.2003	*Christine A. PARLOUR and Uday RAJAN* (lx): Rationing in IPOs
PRIV	27.2003	*Kjell G. NYBORG and Ilya A. STREBULAEV* (lx): Multiple Unit Auctions and Short Squeezes
PRIV	28.2003	*Anders LUNANDER and Jan-Eric NILSSON* (lx): Taking the Lab to the Field: Experimental Tests of Alternative Mechanisms to Procure Multiple Contracts
PRIV	29.2003	*TangaMcDANIEL and Karsten NEUHOFF* (lx): Use of Long-term Auctions for Network Investment
PRIV	30.2003	*Emiel MAASLAND and Sander ONDERSTAL* (lx): Auctions with Financial Externalities
ETA	31.2003	*Michael FINUS and Bianca RUNDSHAGEN:* A Non-cooperative Foundation of Core-Stability in Positive Externality NTU-Coalition Games
KNOW	32.2003	*Michele MORETTO*: Competition and Irreversible Investments under Uncertainty
PRIV	33.2003	*Philippe QUIRION:* Relative Quotas: Correct Answer to Uncertainty or Case of Regulatory Capture?
KNOW	34.2003	*Giuseppe MEDA, Claudio PIGA and Donald SIEGEL*: On the Relationship between R&D and Productivity: A Treatment Effect Analysis
ETA	35.2003	*Alessandra DEL BOCA, Marzio GALEOTTI and Paola ROTA:* Non-convexities in the Adjustment of Different Capital Inputs: A Firm-level Investigation

GG	36.2003	*Matthieu GLACHANT*: Voluntary Agreements under Endogenous Legislative Threats
PRIV	37.2003	*Narjess BOUBAKRI, Jean-Claude COSSET and Omrane GUEDHAMI*: Postprivatization Corporate Governance: the Role of Ownership Structure and Investor Protection
CLIM	38.2003	*Rolf GOLOMBEK and Michael HOEL*: Climate Policy under Technology Spillovers
KNOW	39.2003	*Slim BEN YOUSSEF*: Transboundary Pollution, R&D Spillovers and International Trade
CTN	40.2003	*Carlo CARRARO and Carmen MARCHIORI*: Endogenous Strategic Issue Linkage in International Negotiations
KNOW	41.2003	*Sonia OREFFICE*: Abortion and Female Power in the Household: Evidence from Labor Supply
KNOW	42.2003	*Timo GOESCHL and Timothy SWANSON*: On Biology and Technology: The Economics of Managing Biotechnologies
ETA	43.2003	*Giorgio BUSETTI and Matteo MANERA*: STAR-GARCH Models for Stock Market Interactions in the Pacific Basin Region, Japan and US
CLIM	44.2003	*Katrin MILLOCK and Céline NAUGES*: The French Tax on Air Pollution: Some Preliminary Results on its Effectiveness
PRIV	45.2003	*Bernardo BORTOLOTTI and Paolo PINOTTI*: The Political Economy of Privatization
SIEV	46.2003	*Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH*: Burn or Bury? A Social Cost Comparison of Final Waste Disposal Methods
ETA	47.2003	*Jens HORBACH*: Employment and Innovations in the Environmental Sector: Determinants and Econometrical Results for Germany
CLIM	48.2003	*Lori SNYDER, Nolan MILLER and Robert STAVINS:* The Effects of Environmental Regulation on Technology Diffusion: The Case of Chlorine Manufacturing
CLIM	49.2003	*Lori SNYDER, Robert STAVINS and Alexander F. WAGNER*: Private Options to Use Public Goods. Exploiting Revealed Preferences to Estimate Environmental Benefits
CTN	50.2003	*László Á. KÓCZY and Luc LAUWERS* (lxi): The Minimal Dominant Set is a Non-Empty Core-Extension
CTN	51.2003	*Matthew O. JACKSON* (lxi)*:*Allocation Rules for Network Games
CTN	52.2003	*Ana MAULEON and Vincent VANNETELBOSCH* (lxi): Farsightedness and Cautiousness in Coalition Formation
CTN	53.2003	*Fernando VEGA-REDONDO* (lxi): Building Up Social Capital in a Changing World: a network approach
CTN	54.2003	*Matthew HAAG and Roger LAGUNOFF* (lxi): On the Size and Structure of Group Cooperation
CTN	55.2003	*Taiji FURUSAWA and Hideo KONISHI* (lxi): Free Trade Networks
CTN	56.2003	*Halis Murat YILDIZ* (lxi): National Versus International Mergers and Trade Liberalization
CTN	57.2003	*Santiago RUBIO and Alistair ULPH* (lxi): An Infinite-Horizon Model of Dynamic Membership of International Environmental Agreements
KNOW	58.2003	*Carole MAIGNAN, Dino PINELLI and Gianmarco I.P. OTTAVIANO*: ICT, Clusters and Regional Cohesion: A Summary of Theoretical and Empirical Research
KNOW	59.2003	*Giorgio BELLETTINI and Gianmarco I.P. OTTAVIANO:* Special Interests and Technological Change
ETA	60.2003	*Ronnie SCHÖB:* The Double Dividend Hypothesis of Environmental Taxes: A Survey
CLIM	61.2003	*Michael FINUS, Ekko van IERLAND and Robert DELLINK*: Stability of Climate Coalitions in a Cartel Formation Game
GG	62.2003	*Michael FINUS and Bianca RUNDSHAGEN*: How the Rules of Coalition Formation Affect Stability of International Environmental Agreements
SIEV	63.2003	*Alberto PETRUCCI:* Taxing Land Rent in an Open Economy
CLIM	64.2003	*Joseph E. ALDY, Scott BARRETT and Robert N. STAVINS*: Thirteen Plus One: A Comparison of Global Climate Policy Architectures
SIEV	65.2003	*Edi DEFRANCESCO*: The Beginning of Organic Fish Farming in Italy
SIEV	66.2003	*Klaus CONRAD*: Price Competition and Product Differentiation when Consumers Care for the Environment
SIEV	67.2003	*Paulo A.L.D. NUNES, Luca ROSSETTO, Arianne DE BLAEIJ*: Monetary Value Assessment of Clam Fishing Management Practices in the Venice Lagoon: Results from a Stated Choice Exercise
CLIM	68.2003	*ZhongXiang ZHANG:* Open Trade with the U.S. Without Compromising Canada's Ability to Comply with its Kyoto Target
KNOW	69.2003	*David FRANTZ* (lix): Lorenzo Market between Diversity and Mutation
KNOW	70.2003	*Ercole SORI* (lix): Mapping Diversity in Social History
KNOW	71.2003	*Ljiljana DERU SIMIC* (lxii): What is Specific about Art/Cultural Projects?
KNOW	72.2003	*Natalya V. TARANOVA* (lxii):The Role of the City in Fostering Intergroup Communication in a Multicultural Environment: Saint-Petersburg's Case
KNOW	73.2003	*Kristine CRANE* (lxii)*:* The City as an Arena for the Expression of Multiple Identities in the Age of Globalisation and Migration
KNOW	74.2003	*Kazuma MATOBA* (lxii): Glocal Dialogue- Transformation through Transcultural Communication
KNOW	75.2003	*Catarina REIS OLIVEIRA* (lxii): Immigrants' Entrepreneurial Opportunities: The Case of the Chinese in Portugal
KNOW	76.2003	*Sandra WALLMAN* (lxii): The Diversity of Diversity - towards a typology of urban systems

KNOW	77.2003	*Richard PEARCE* (lxii): A Biologist's View of Individual Cultural Identity for the Study of Cities
KNOW	78.2003	*Vincent MERK* (lxii): Communication Across Cultures: from Cultural Awareness to Reconciliation of the Dilemmas
KNOW	79.2003	*Giorgio BELLETTINI, Carlotta BERTI CERONI and Gianmarco I.P.OTTAVIANO*: Child Labor and Resistance to Change
ETA	80.2003	*Michele MORETTO, Paolo M. PANTEGHINI and Carlo SCARPA*: Investment Size and Firm's Value under Profit Sharing Regulation
IEM	81.2003	*Alessandro LANZA, Matteo MANERA and Massimo GIOVANNINI:* Oil and Product Dynamics in International Petroleum Markets
CLIM	82.2003	*Y. Hossein FARZIN and Jinhua ZHAO*: Pollution Abatement Investment When Firms Lobby Against Environmental Regulation
CLIM	83.2003	*Giuseppe DI VITA*: Is the Discount Rate Relevant in Explaining the Environmental Kuznets Curve?
CLIM	84.2003	*Reyer GERLAGH and Wietze LISE*: Induced Technological Change Under Carbon Taxes
NRM	85.2003	*Rinaldo BRAU, Alessandro LANZA and Francesco PIGLIARU*: How Fast are the Tourism Countries Growing? The cross-country evidence
KNOW	86.2003	*Elena BELLINI, Gianmarco I.P. OTTAVIANO and Dino PINELLI:* The ICT Revolution: opportunities and risks for the Mezzogiorno
SIEV	87.2003	*Lucas BRETSCGHER and Sjak SMULDERS:* Sustainability and Substitution of Exhaustible Natural Resources. How resource prices affect long-term R&D investments
CLIM	88.2003	*Johan EYCKMANS and Michael FINUS:* New Roads to International Environmental Agreements: The Case of Global Warming
CLIM	89.2003	*Marzio GALEOTTI:* Economic Development and Environmental Protection
CLIM	90.2003	*Marzio GALEOTTI*: Environment and Economic Growth: Is Technical Change the Key to Decoupling?
CLIM	91.2003	*Marzio GALEOTTI and Barbara BUCHNER*: Climate Policy and Economic Growth in Developing Countries

(l) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001
(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001
(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001
(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001
(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002
(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001
(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy "The International Dimension of Environmental Policy", organised with the collaboration of the Fondazione Eni Enrico Mattei , Acquafredda di Maratea, October 6-11, 2001
(lvii) This paper was presented at the First Workshop of "CFEWE – Carbon Flows between Eastern and Western Europe", organised by the Fondazione Eni Enrico Mattei and Zentrum fur Europaische Integrationsforschung (ZEI), Milan, July 5-6, 2001
(lviii) This paper was presented at the Workshop on "Game Practice and the Environment", jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002
(lix) This paper was presented at the ENGIME Workshop on "Mapping Diversity", Leuven, May 16-17, 2002
(lx) This paper was presented at the EuroConference on "Auctions and Market Design: Theory, Evidence and Applications", organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002
(lxi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003
(lxii) This paper was presented at the ENGIME Workshop on "Communication across Cultures in Multicultural Cities", The Hague, November 7-8, 2002

2002 SERIES

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

VOL *Voluntary and International Agreements* (Editor: Carlo Carraro)

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

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

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

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

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

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

2003 SERIES

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

GG *Global Governance* (Editor: Carlo Carraro)

SIEV *Sustainability Indicators and Environmental Valuation* (Editor: Anna Alberini)

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

KNOW *Knowledge, Technology, Human Capital* (Editor: Gianmarco Ottaviano)

IEM *International Energy Markets* (Editor: Anil Markandya)

CSRM *Corporate Social Responsibility and Management* (Editor: Sabina Ratti)

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

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

CTN *Coalition Theory Network*