PART II

GLOBAL IMPACTS

Global Impacts of a Global Climate Change Treaty
David Montgomery

International Impacts: An Australian View
Brian Fisher

Ecological Imperialism: The Prospective Costs of Kyoto for the Third World
Deepak Lal

1. GLOBAL IMPACTS OF A GLOBAL CLIMATE CHANGE TREATY

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Note: This paper is adapted from the Charles River Associates study "World Economic Impacts Of U.S. Commitments To Medium Term Carbon Emissions Limits" by Paul M. Bernstein, W. David Montgomery, and Thomas F. Rutherford, prepared for the American Petroleum Institute, January 1997

In December 1997, parties to the Framework Convention on Climate Change (FCCC) will assemble in Kyoto, Japan. At that meeting, they may adopt legally binding targets and timetables for limiting carbon emissions from industrial countries. During the negotiations leading up to Kyoto, the United States government endorsed the idea of setting firm emissions abatement targets that countries must meet sometime in the medium term (probably between the years 2005 to 2015). The U.S. government, however, stopped short of announcing support for any specific target or timetable.

In an attempt to assess the economic costs of a greenhouse gas abatement policy within the parameters of what the U.S. government announced a willingness to support, this paper uses the International Impact Assessment Model (IIAM) to analyze a representative carbon abatement policy, under which the OECD countries would be required to reduce their emissions to 90 percent of 1990 levels by the year 2010 and then maintain these emissions targets through 2030. This goal is less ambitious than the proposal of the European Union, for a limit of 85 percent of 1990 emissions in 2010.

Severe restrictions of energy use in a short period of time would lead to substantial GDP losses in industrial countries.

The IIAM is designed to analyze the impacts of climate policies on 80 individual countries and regions within a broader context of world trade. The IIAM builds on an extensive body of research on the economics of climate change and international trade theory. It uses a computable general equilibrium model of each country coupled with a model of international trade. The model is based on trade data from the United Nations, energy data from the International Energy Agency (IEA), and national economic data from a variety of sources.

Because energy use must be reduced significantly in a relatively short-time period, either proposal would lead to substantial GDP losses in the industrial countries undertaking emissions limits. Other countries' GDP would also be reduced. The energy exporting countries would suffer losses comparable to the Organization for Economic Cooperation and Development (OECD), even if they did not undertake emissions limits, because of depressed international markets for fossil fuels.

The ground rules for the current international negotiations on climate policy call for no additional commitments from developing countries. The entire world, however, is connected through international trade, and all countries will be affected if economic growth slows in the industrial countries. Therefore, the adoption of emissions limits by OECD countries would negatively impact most developing countries. Developing countries would face losses on average 10 percent as large as those affecting the OECD. These losses would arise because OECD countries would demand fewer exports from developing countries, shifting the terms of trade against developing countries, thus reducing their gains from trade. Losses could exceed one percent of GDP for countries that are highly dependent upon trade with OECD countries and have little scope for benefiting from lower-energy costs.

Potentially, some energy-importing developing countries, including South Korea and India, could benefit from having energy costs lower than those of the industrial countries with which they compete in world markets. Such countries would then be able to expand their energy-intensive industries and increase their share of world markets at the expense of industries in the OECD. However, the IIAM finds that these benefits of lower energy costs are strong enough to offset the shrinkage in export markets for only a very few countries.

Losses to developing countries would be much larger if the industrial countries protected their energy intensive domestic industries from competition with exports from countries enjoying the benefits of lower energy costs. All developing countries would face economic losses under these scenarios, while the costs to industrial countries would be reduced. There are also likely to be significant differences among OECD countries in the size and nature of impacts. For reasons unrelated to climate policy, Germany and the United Kingdom will find it much easier to achieve their emissions goals than will other members of the OECD. As a result, these countries will not encounter the kind of energy cost increases likely to occur in other OECD countries and will gain a competitive advantage over their OECD trading partners. Canada will suffer larger losses than other OECD countries because it has a more energy intensive economy and a large share of its GDP is generated through exports of oil and other energy intensive goods. The United States will be near the OECD average.

Global Climate Change Negotiations

Increased concern about global climate change has resulted in several international initiatives that could ultimately result in the adoption of policies designed to reduce greenhouse gas emissions. The first important milestone in international negotiations was the signing of the U.N. Framework Convention on Climate Change in Rio de Janeiro in 1992, where participating governments agreed to non-binding goals for reducing greenhouse gas emissions. Three years later, the first session of the Conference of the Parties to the Framework Convention on Climate Change

(COP-1) met to explore the "adequacy" of commitments made at the 1992 Framework Convention. At COP-1, participating governments decided that the non-binding commitments to reduce greenhouse gas emissions agreed to in Rio de Janeiro were not sufficient.

Therefore at COP-1, government representatives produced a decision document (known as the "Berlin Mandate") to establish a process that would "aim . . . to elaborate policies and measures," as well as "set quantified limitation and reduction objectives within specified time frames, such as 2005, 2010, and 2020" for greenhouse gas "emissions by sources and removals by sinks." Several proposals — each calling for some type of commitment from industrial countries to reduce emissions below 1990 levels during the 2000-2010 time frame — were tabled at COP-1. Environmental ministers convened again at COP-2 during the summer of 1996; among the stated goals of the COP-2 meeting was to "give fresh political impetus to the negotiations process."

At COP-2, the U.S. government first articulated support for firm ("legally binding") targets for reducing emissions. At that time, the U.S. government did not propose any specific targets or timetables, but indicated support for "medium-term goals," which implied that policies would probably become binding between the years 2005 and 2015. Decisions on these proposals will be made at a meeting in Kyoto, Japan, in December 1997.

Assessing Economic Impacts of Climate Change Policies

Studies of the economic impacts of global climate change policies in the past several years suggest that adoption of the various proposed emissions reduction plans over the next two decades could entail large economic costs for all countries. However, costs to developing countries have been downplayed because the focus of international negotiations has been on industrial countries that are assumed to adopt carbon limits.

To examine the consequences of carbon abatement policies on individual countries, particularly developing countries, Thomas Rutherford and Charles River Associates developed the International Impact Assessment Model, which is a computable general equilibrium model. The IIAM provides a new method for analyzing the impacts of greenhouse gas abatement policies: It allows users to examine the consequences of emissions abatement policies for 80 countries and regions. The model divides the world into five geopolitical regions: the Organization for Economic Cooperation and Development (OECD) nations, Non-OECD Asia (ASIA), Eastern Europe and Former Soviet Union or Centrally Planned Emerging Economies (CPEE), Middle East and North Africa (MIDE), and the rest of the world (ROW). By looking at the world as a whole, the model accounts for how countries are linked through international trade and energy markets. The IIAM builds on an extensive body of research on the economics of climate change and international trade theory. Papers based on this research are listed in the bibliography at the end of this report.

The Effect of Implementing Possible Emission Limits

Although the U.S. government has not yet proposed specific policies, it has, as noted above, expressed support for setting target limits. Two proposals have been prominent in presentations made by the U.S. administration. The first requires that OECD countries return their emissions to 1990 levels by the year 2010 and maintain them at this level through 2030 (hereafter we refer to this proposal as the "Stabilization" proposal). Under the second proposal, known as the "Reduction" proposal, OECD countries would be required to reduce their emissions to 90 percent of 1990 levels by the year 2010 and then maintain these emissions targets through 2030. This proposal goes less far than the current position of the European Union, which is calling for reductions to 85 percent of 1990 levels by 2010. Since it occupies a middle ground, we focus in this paper on the Reduction proposal.

For many policies that are currently being tabled, all Annex I countries (OECD countries plus economies in transition, namely the Former Soviet Union and Eastern Europe) would be required to reduce their emissions. For this study, however, it is assumed that only OECD countries adopt carbon limits. Because the former Centrally Planned Emerging Economies are facing many financial difficulties, this study assumes that these countries would not be forced to adopt emissions limits.

Using the IIAM, we estimate the economic impacts of these two proposals on both major world regions and individual countries. This study reports how these two proposals impact a country's gross domestic product (GDP), non-energy exports, terms of trade, and carbon emissions. It also calculates a carbon tax necessary to achieve the goal. These impacts are measured relative to a business-as-usual scenario[1] in which carbon abatement policies are absent. The rest of this study is organized as follows: First, an explanation of the probable impacts on different country types is presented; next, results of these two proposals on world regions are discussed followed by an explanation of the effects on individual countries; and finally, sensitivity analysis on many of the key assumptions is conducted. In general, the impacts are reported as a percentage change from the levels in the business-as-usual scenario. This paper concentrates on the Reduction proposal, which lies between Stabilization of emissions and the reduction proposals put forward by the European Union.

Implications for Major World Regions

To understand the impact on different regions and countries, we first discuss the likely impacts on three country types and explore the reasons why different impacts can be expected. A carbon abatement policy's impact on a specific country first depends on how that country is categorized: OECD member, energy exporter, or developing country. The economic impact on the OECD countries should be negative. It is only OECD countries that must adopt carbon limits. These limits require them to reduce their consumption of fossil fuels by substituting more expensive fuels or employing more expensive manufacturing and production techniques. This would raise the costs of their domestically produced goods and make these goods less competitive internationally. In addition, fuel for final consumption would become more expensive; therefore, households would change their consumption mix. This would result in a loss of welfare (consumers' surplus) and real income for households.

Energy exporting nations would be adversely affected by carbon abatement policies. The price of fossil fuels would drop with a decline in the OECD countries' demand for these fuels. Thus, energy exporting countries would experience a loss of revenues from energy sales. Since these countries undertake no carbon limits, their domestic industries would benefit from lower energy prices. If an energy producing country such as Venezuela also has energy-intensive domestic industries, then its production costs could decline relative to the OECD and, therefore, make its goods more competitive internationally. Also, households would benefit from the lower energy prices. None of these potential benefits should be large enough to offset the loss in revenues from energy exports, but they should moderate GDP losses in energy exporting countries.

The effect of carbon abatement policies on developing countries is ambiguous. These countries would not be required to undertake any carbon limits; thus, they would receive the benefits of lower energy prices. But there are two offsetting effects: an "income effect" and a "substitution effect." Regarding the income effect, as the OECD's income declines, OECD purchasing power decreases, and the OECD countries can only afford to purchase fewer imports from the developing countries. Most of these countries conduct approximately 60 percent to 75 percent of their trade with OECD countries. Therefore, the developing countries could experience a loss in export revenue. On the other hand, they benefit from the substitution effect. That is, since these countries do not undertake any carbon limits, they receive the full benefit of lower world energy prices and their domestic industries receive a competitive advantage relative to those in the OECD. Therefore, the non-OECD countries export more goods to other non-OECD countries which displaces OECD exports to these countries. The net impact depends on which effect dominates and consequently whether the terms of trade for a particular country improves or deteriorates.

Results

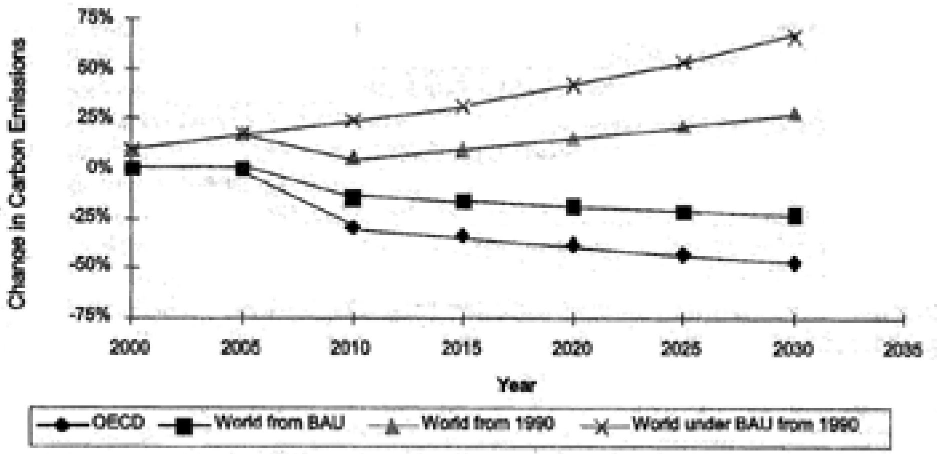
To compute the impacts of the two proposals, the model is first run under the business-as-usual scenario with a common set of assumptions. Using these same assumptions (these assumptions include using accepted elasticity values as well as IPCC reference scenarios), the model is then run under the proposed carbon limits. We report economic impacts on world regions and then on individual countries. In general, the impacts are reported as a percentage change from the levels in the business-as-usual scenario. All dollar figures are reported as 1992 U.S. dollars.

Results for World Regions

Carbon Emissions

According to the model's results, in 2010 the OECD region as a whole must reduce its carbon emissions by 30 percent from business-as-usual levels in order to comply with the emission limit (see Exhibit 1). In the year 2030, OECD countries must reduce their emissions further, by 47 percent. This increase in required emissions abatement over time occurs because, in the business-as-usual scenario, emissions in the OECD region are forecasted to grow from 2.8 billion metric tons in 1990 to 4.7 billion metric tons in 2030. Therefore, the gap between the OECD's emissions in the business-as-usual (BAU) scenario and the constant target of 90 percent of 1990 emissions levels continues to grow.

Exhibit1: Percentage Change in Carbon Emissions for the OECD and World Reduction Proposal



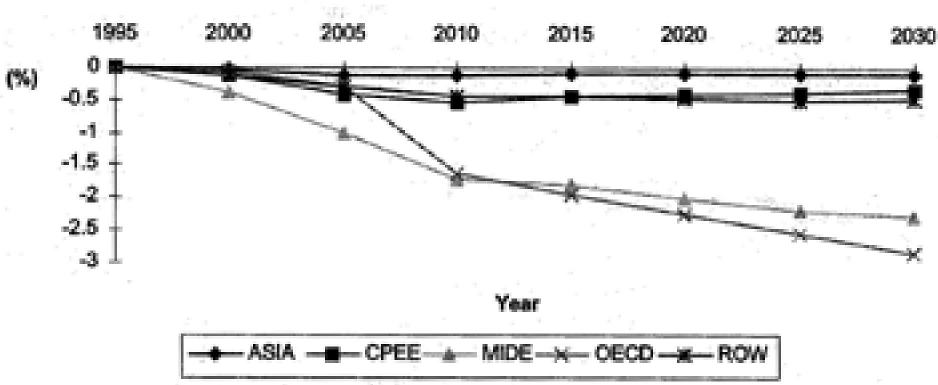
Reductions in OECD energy consumption and hence, emissions could be offset, at least in part, by increases in energy consumption and emissions in the non-OECD countries. First, because of the lower world energy prices under a carbon abatement policy, non-OECD countries are likely to consume more energy. The reduction in OECD fuel consumption causes a decline in world energy prices and induces the non-OECD countries to consume more fossil fuels. Second, because non-OECD countries experience lower fuel prices, some industries may relocate from OECD to non-OECD countries.

Even with OECD emission limits, world emissions would continue to increase from 1990 levels. Because non-OECD countries have no emissions restrictions placed upon them, their carbon emissions continue to grow (see lines denoted "World from 1990"). Under the Reduction proposal, there is an increase in world carbon emissions from 1990 levels of six percent in 2010 and 28 percent in 2030.

GDP

Under both proposals, the required reduction in OECD carbon emissions causes a reduction in GDP in all regions (see Exhibit 2). Even though the proposals require only the OECD countries to adopt carbon limits, other countries are impacted through international trade in energy and non-energy goods.[2]

Exhibit 2: Percentage Change in GDP



The OECD is directly affected by the carbon abatement policies. Their collective GDP declines by 2.8 percent in the year 2030. Non-OECD regions' GDP are negatively impacted by the OECD's loss of income. The large decline in the OECD's demand for fossil fuel energy causes the energy exporting countries to suffer almost as much as the OECD countries. In 2030, these nations experience a loss in GDP of 2.3 percent.

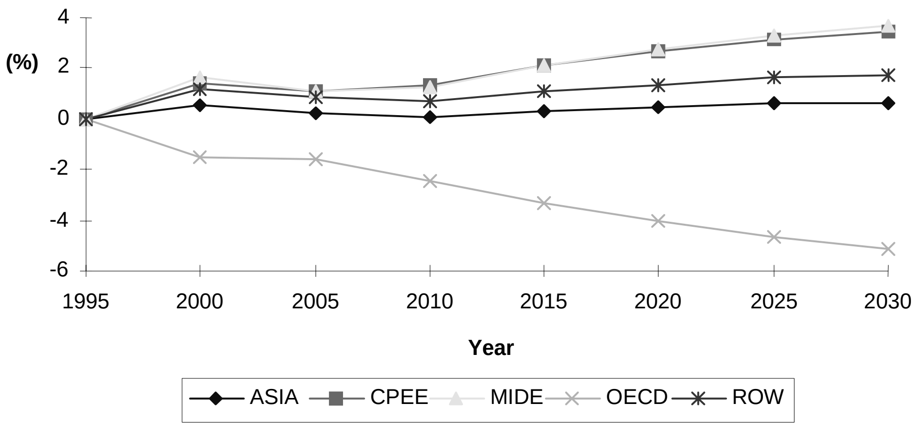
The former Centrally Planned Emerging Economies (CPEE) and rest of the world (ROW) regions experience GDP losses in the range of 0.3 percent to 0.5 percent. These losses are greater than the losses in the ASIA region because the CPEE and ROW regions contain some countries that are significant energy exporters, whereas ASIA is dominated by countries that are non-energy exporters and energy importers.

For all three of these regions, the decline in GDP lessens in the more distant years because each region has significant time to reorganize its economy and make use of competitive advantages from lower world energy prices. In addition, in each future year, the OECD must use less energy per unit of output; this continues to raise their production costs. Therefore, the developing countries gain more of a competitive advantage and begin to benefit more from this advantage.

Trade Effects

If the OECD countries were to adopt either the Stabilization or Reduction proposal, each region would experience significant effects on trade. The changes in each region's non-energy exports and terms of trade provide insights into how these proposals impact each region's GDP. Under either proposal, non-energy exports from all non-OECD regions increase from their business-as-usual levels, whereas the OECD's non-energy exports decrease (see Exhibit 3). This occurs because as OECD countries are required to further reduce emissions from business-as-usual levels, they must continue to substitute away from energy to produce their goods. These inefficient changes in production drive up the price of OECD goods relative to those of non-OECD goods resulting in a decline in OECD exports and an increase in non-OECD exports.

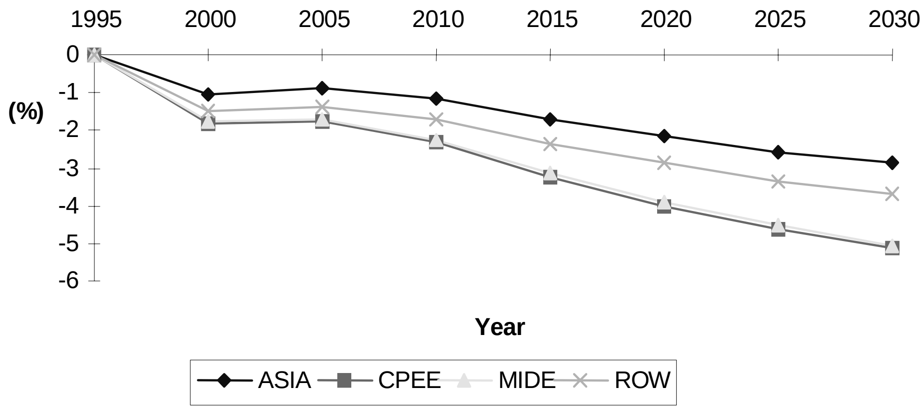
Exhibit 3. Percentage Change in Non-Energy Exports



Changes in terms of trade can be used to evaluate the relative change in a country's trade pattern. Terms of trade is measured as the ratio (in value terms) of a country's exports to its imports. Therefore, the change in a region's terms of trade from the business-as-usual scenario captures the change in the relative value of goods that it exports to the value of goods that it imports. For example, if the value of a country's exports increase and its imports decrease, the country's terms of trade increases and its trade position improves.

The terms of trade in non-OECD regions, relative to that of OECD countries, declines for two reasons (see Exhibit 4). First, the cost of imports from the OECD increases because production costs are higher in the OECD under carbon emissions limits. Second, the decline in OECD income under either of these proposals means that OECD expenditures on the combination of domestically produced and imported goods will decline relative to the business-as-usual scenario. However, depending on the change in the cost of imports relative to domestic goods, the OECD countries' expenditures on imports could either increase or decrease. Since the percentage change in terms of trade for these non-OECD countries is negative, the cost advantage achieved by non-OECD countries is not, on balance, large enough to induce the OECD countries to increase their expenditures on imports. Although the non-OECD countries' overall level of exports increases (since their exports

Exhibit 4. Percentage Change in Terms of Trade Relative to the OECD



to other non-OECD countries increase by supplanting OECD exports), they receive fewer imported goods in return because they must still purchase high-cost OECD goods.[3]

Results for Individual Countries

This section describes the differences among countries within the various regions. First is a comparison of the economic impacts on the following seven OECD countries: Canada, France, Germany, United Kingdom, Italy, Japan, and the United States. Second, the economic impacts on developing countries are studied, determining the economic profile needed for a developing country to benefit when carbon limits are placed on OECD countries. Finally, the paper analyzes impacts on energy exporters of the Reduction proposal. The Stabilization proposal would have a similar pattern of impacts, but they would be somewhat smaller. The European Union proposal would have similar but larger impacts.

OECD Countries

These seven OECD countries experience very different GDP losses. Four major factors influence the varying degree of impacts among OECD countries: growth in emissions in the baseline, levels of pre-existing energy taxes, energy intensity, and exposure to competition in international trade.

- Baseline emissions growth: Factors affecting baseline emissions growth such as population growth, output growth, and relative shares of fossil fuel use, differ across countries. Greater required reductions in carbon emissions, expressed as a percentage of baseline emissions, imply larger GDP losses (see Exhibit 5).
- Pre-existing energy taxes: Since pre-existing taxes in Italy, France, and

Japan are much higher than in the U.S. and Canada, the carbon taxes required to achieve a given reduction are also much higher in the former countries.

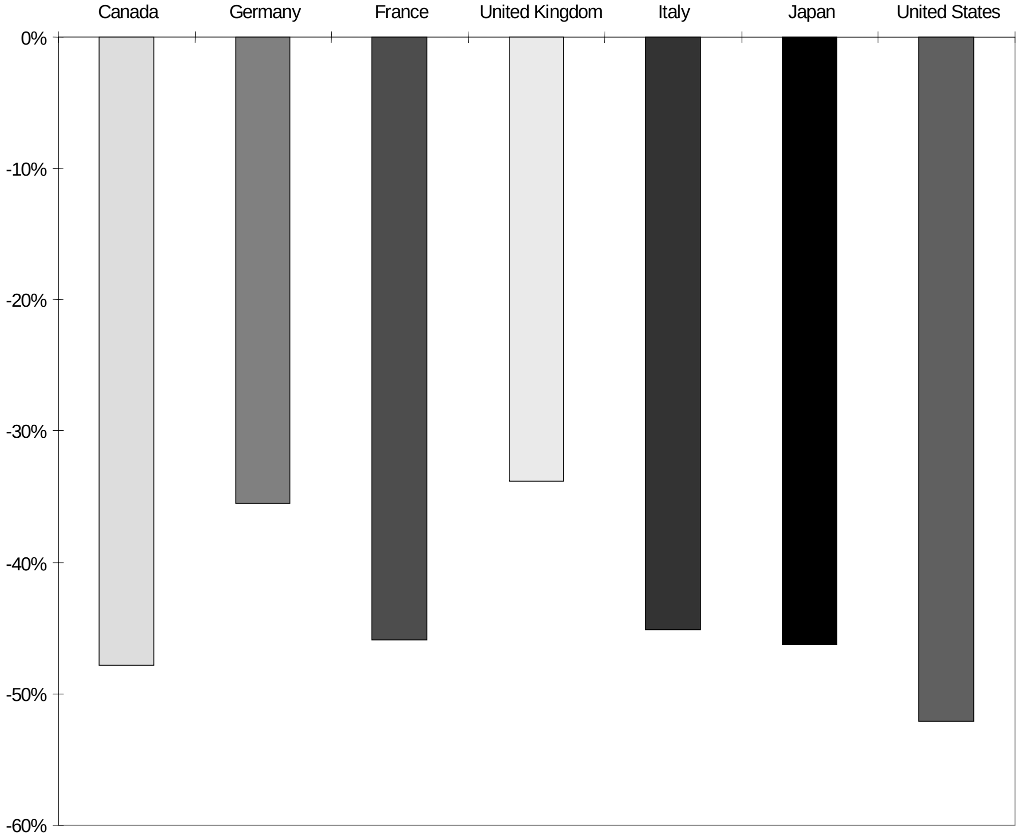
- Energy intensity: Countries in the OECD that have relatively energy-intensive industries or economies will face higher costs of reducing emissions, in absolute terms and as a share of GDP.
- Industry structure: Countries with energy-intensive processes or industries that are also heavily involved in international trade, and trade mostly with other OECD countries, will be hurt more than others. These countries will face greater than average increases in the costs of producing goods that compete in international markets, and greater imports and exports as a share of GDP make international competition more important in the overall economic picture. In addition, trade competition among OECD countries is treated as being more intense than trade competition between OECD and non-OECD countries. Therefore, countries whose trade is oriented toward other OECD countries will be hurt more than countries whose trade is more oriented toward non-OECD countries. Most OECD countries benefit from lower world oil prices, but oil-exporting OECD countries also suffer from lower world oil demand and lower prices.

Under both proposals, Germany and the United Kingdom are impacted the least because their emissions are forecast to grow more slowly than those of the other six OECD countries. In 2030, Germany and the United Kingdom need to reduce their emissions by 36 percent and 34 percent, respectively, from the business-as-usual to meet the requirements of the Reduction proposal. Canada and the U.S., however, need to reduce their emissions by 48 percent and 52 percent, respectively, from the business-as-usual in order to comply with the Reduction proposal (see Exhibit 6).

Both Germany and the United Kingdom have announced that they will be able to meet the goal of holding emissions at 1990 levels through 2000 because of policies and events *independent* of climate policy. Germany's emissions growth is halted for a time because its base year included the former East Germany. Energy use was dominated by extremely inefficient use of coal in that country. Contraction of the former East German economy and replacement of its inefficient patterns of energy use have reduced emissions from that part of Germany and held total emissions for the reunited country down relative to the rest of Europe. In the United Kingdom, policies to reduce subsidies to the coal industries and deregulation of energy industries, both of which began independently of climate change concerns, have also served to hold down emissions by encouraging substitution of natural gas for coal. Britain's somewhat higher costs, compared to Germany, are partly explained by the losses in oil export revenue that Britain faces.

Because of these developments in the German and British economies, their costs of near-term limits on carbon emissions are significantly smaller than in the rest of the OECD. The percentage increase in energy costs (measured by the

Exhibit 5: Required Reductions in Emissions from Baseline

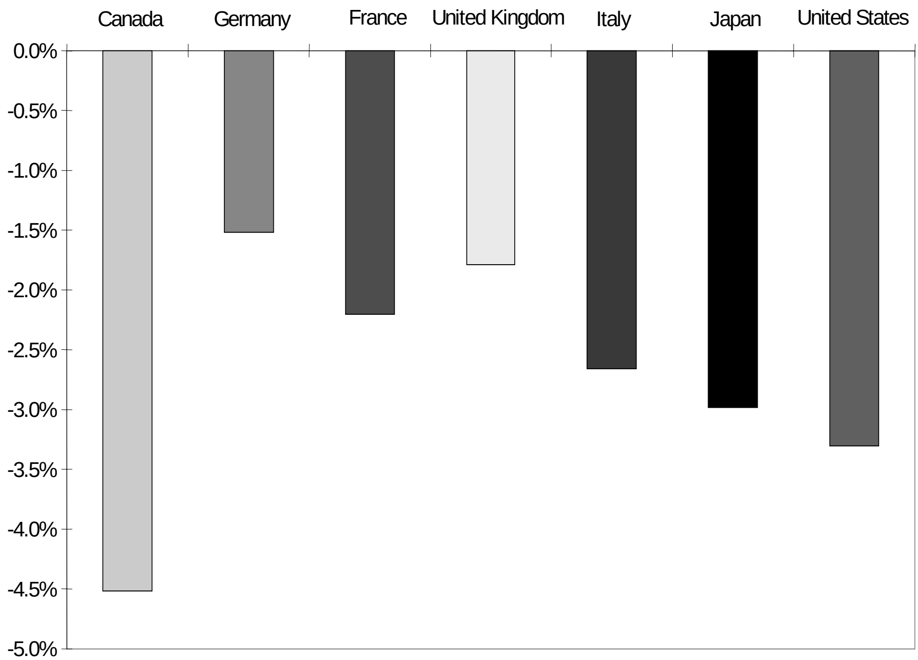


implied carbon tax) is smaller than in other OECD countries because the required percentage reduction in emissions is smaller, and both countries therefore, achieve trade benefits at the expense of other OECD countries.

France, Japan, and Italy experience less GDP loss than the U.S. and Canada because those three countries use less energy per unit of GDP and have lower growth in baseline emissions, than the latter two countries. Nuclear energy supplies more than a third of France's energy needs. This means that more than a third of France's energy is already a carbon free energy source. This produces two opposite effects on the costs of carbon limits. France has less scope to replace fossil fuels used for electric power generation with other fuels, and therefore must rely on more expensive options to curtail growth in emissions. In the baseline, France is assumed to continue to expand its nuclear power industry so that about one-third of baseline growth in energy demand is also satisfied from non-carbon sources. If, however, France were to move away from nuclear power in the baseline, then its costs would be greater than estimated.

Current energy prices in France, Japan, and Italy are much higher than in the U. S.

Exhibit 6: GDP Losses in 2030 from Reduction Proposals



and Canada therefore, it takes a large carbon tax to produce the same proportionate increase in delivered energy prices to bring about the required reduction from baseline consumption of fossil fuels. The required level of the carbon tax becomes so high that the price of fossil fuels (including their associated carbon taxes) equals the cost of the backstop fuel (a new, carbon-free energy source that is assumed to be available in unlimited quantities at a multiple of today's price for fossil fuels). In other words, the backstop fuel becomes cost-effective in the year 2015. If no backstop fuel existed, these countries would require carbon taxes that were two to three times more than those in the U.S. and Canada. Since the model assumes that each country produces its own back-stop fuel, the model underestimates the GDP loss in countries like Japan that are unlikely to do this. To address this issue, we made the price of Japan's backstop fuel 20 percent higher than that of the United States.

Trade effects play an important role in making Canada the most heavily impacted OECD country. Canada stands out as a country with a large ratio of exports to GDP, energy-intensive industries, a large share of trade with other OECD countries, and oil exports. This combination of trade factors, together with the high costs of reducing emissions, leads to larger harm for Canada than other OECD countries.

Developing Countries

The results for developing countries are mixed because of the offsetting income and substitution effects discussed earlier. The majority of developing countries suffer a loss in GDP under the two scenarios, but a small number benefit. Countries with significant energy exports are hurt the most, followed by countries whose particular situations make them less likely to benefit from the "substitution effect" and more likely to suffer from the "income effect" of emissions limits adopted in the OECD.

Under the Berlin Mandate, there are to be no additional commitments to reduce emissions on the part of developing countries. But the markets in the OECD to which these developing countries sell a large share of their exported goods will shrink, so that most developing countries would also be harmed by the adoption of emissions limits in the OECD. Under either proposal, developing countries would face losses on average of about ten percent as large as those experienced by the OECD. These losses would come about because OECD countries would demand fewer exports from developing countries, shifting the terms of trade against developing countries and causing a reduction in their gains from trade. In addition, imports from the OECD would become more expensive. Losses could exceed one percent of GDP for countries that are highly dependent on trade with the OECD and have little scope for benefiting from lower energy costs.

Developing countries that are not members of OPEC but do have significant oil exports suffer greater economic impacts than most developing countries. For example, under the Reduction proposal, Ecuador and Mexico experience declines in GDP of 1.6 percent and 1.0 percent, respectively, versus developing, non-oil exporting countries like China, which suffers a loss of only 0.05 percent in the year 2030. Furthermore, developing countries that are major oil importers, such as South Korea, benefit from the reduction in lower-energy prices and experience a slight increase in GDP from the two emissions abatement proposals.

Major Oil Exporters

The economic impacts on most major oil exporting countries are fairly uniform. These countries experience larger GDP losses under the Reduction scenario than under the Stabilization scenario because the price of oil declines more in the latter scenario. There is a dramatic drop in each country's terms of trade because of each country's loss of revenue from its primary export, oil.

Countries that Benefit from Abatement Proposals

Within the non-OECD, there are some countries that might benefit if the OECD countries were to adopt either the Stabilization or Reduction proposals, including India, Jamaica, Jordan, Philippines, and South Korea. Jamaica prospers the most. It is an oil-importing developing country, that exports a very energy-intensive product, bauxite, to the OECD countries. Its potential benefits thus illustrate the necessary conditions for a gain in comparative advantage. Korea is also an oil importer, and it is a relatively wealthy country that has the industrial base to take advantage of lower costs in a broad range of internationally competitive industries.

These impacts are estimated assuming that capital flows freely into the developing countries to finance the conversion of their industries to take advantage of energy price differentials, and that the OECD countries do nothing to limit or offset imports of energy-intensive goods from countries not adopting carbon limits. As discussed below, trade protection by the OECD turns impacts on all developing countries negative.

Trade Protection Case

Under the carbon abatement proposals, many individual countries increase their non-energy exports because of their cost advantage over the OECD in markets inside and outside the OECD. However, the OECD may choose to protect some of its industries. To account for this possibility, CRA ran a trade protection case.

In the trade protection case, it is assumed that the OECD countries adopt some combination of measures to protect domestic industries against competition from countries that do not adopt carbon emissions limits. These policies could be overt, in the form of border adjustment taxes based on approximations of the carbon content of different imports, or more readily concealed actions to benefit industries facing such competition, such as tax subsidies or exemption from carbon taxes or other policies designed to reduce emissions. For the purposes of this analysis, these trade restrictions are implemented by limiting imports from non-OECD countries to baseline levels (a form of quotas). Under these assumptions, all developing countries face negative impacts, and the average loss in developing countries increases (ASIA and ROW) from 0.3 percent to 0.6 percent of GDP in 2030 under the Reduction scenario.

Conclusion

The bottom line of this research is that any significant reductions in greenhouse gas emissions will produce significant economic dislocations throughout the global economy, *even if* undeveloped nations are excluded or given a longer timetable to meet emission reduction goals. Excluding such nations from treaty commitments does not exclude them from the treaty's impacts, and it could trigger other policy changes that would have an even more deleterious effect upon the global economy.

Notes

[1] The Business-As-Usual scenario establishes a reference growth path over the

model's time horizon for emissions, energy production, and GDP growth rate.

[2] To meet the self-imposed limits, OECD countries must reduce their consumption of fossil fuels. As the economy grows and the demand for energy increases, the production cost within OECD countries increases since they must alter their mix of inputs to produce outputs and hence use less energy per dollar of GDP to manufacture goods. This increases the cost of producing both final and intermediate goods in the OECD. Non-OECD countries that use OECD-produced intermediate goods in manufacturing will see these price increases.

[3] Because of the IIAM's Armington structure, larger and larger price differences between imports and domestic goods are needed in order for a region to change its consumption mix between imported and domestically produced goods. The Armington elasticity helps determine how expensive it is for any country to substitute between domestically produced goods and imports from different regions. If the Armington elasticity were increased, the terms of trade for non-OECD countries would improve, but it would still be economical for these countries to import some goods from OECD countries.

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2. INTERNATIONAL IMPACTS: AN AUSTRALIAN VIEW

BRIAN FISHER

This paper is a summary of the latest Australian Bureau of Agricultural and Resource Economics (ABARE) research report on climate change policies, titled The Economic Impact of International Climate Change Policy.

The ultimate aim of the Berlin Mandate arising from the first Conference of the Parties to the United Nations Framework Convention on Climate Change was to negotiate greenhouse gas emission reduction objectives and policies for Annex I countries for the period beyond 2000. The deadline for an agreement on these objectives and policies is the third Conference of the Parties to the Convention to be held in Kyoto in December 1997. At this stage, however, the nature of any possible outcome from Kyoto remains very difficult to predict as many parties are still developing their proposals for international greenhouse gas emission limitation strategies.

The purpose in this report is to contribute analytical input to the international climate change policy development process by providing an assessment of the economic impacts of policies to reduce carbon dioxide emissions from fossil fuel combustion in Annex I (industrialized) countries between the present and the year 2020. The assessment is based on resulting from application of the MEGABARE model of the world economy.

MEGABARE is a model developed at the Australian Bureau of Agricultural and Resource Economics (ABARE). It contains 30 regions and 41 sectors or industries, with a particular emphasis on the energy sector. Using the model, it is possible to assess the impacts of climate change policies on international trade.

To date, much of the discussion on emission abatement has focused on the adoption of uniform emission reductions across Annex I countries. More recently, the potential role of tradable emission quota schemes in reducing the costs associated with emission abatement has become more prominent in the international climate change negotiations. Both uniform emission reduction regimes and tradable quota schemes are analysed and compared in this report.

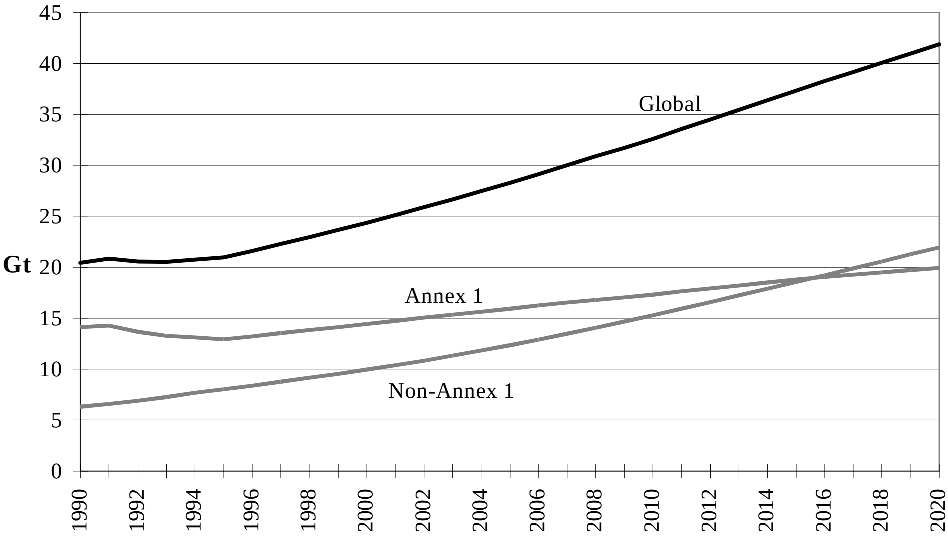
The assessment encompasses the production, expenditure and trade impacts of the emission abatement policies on developed and developing economies. It should be noted that no attempt is made to address the broader issue of assessing the over all costs of climate change itself compared with the costs of mitigation and adaptation.

Reference-Case Emissions Growth

Under the reference case scenario, global carbon dioxide emissions from fossil fuel combustion are projected to double over the period 1990 to 2020 (Exhibit 1). This growth will be driven to a large extent in the future by emissions growth in non-Annex I regions. Owing to their rapid projected growth, annual emissions from non-Annex I regions are projected to overtake Annex I emissions by 2016. By 2020 these regions are projected to be responsible for 52 percent of global emissions, compared with their 1990 share of around 30 percent.

Exhibit 1: Carbon dioxide emissions from fossil fuel combustion

Reference Case



Among the Annex I countries, high emissions growth rates (see Exhibit 2) are correlated with:

- high projected population growth rates, leading to increased energy demands;
- high current levels of dependence on energy sources other than fossil fuels such as hydroelectricity and nuclear power, both of which are expected to be disadvantaged compared with fossil fuel based electricity generation in the future; and
- a comparative advantage in emission intensive activities such as minerals processing.

The Implications of Uniform Emission Abatement Policies

A uniform targets approach to emission abatement requires each Annex I country to reduce its emissions to levels based on a uniform base period such as 1990.

Exhibit 2: Projected Annual Average Growth in Emissions, Population, Output and Emissions-Per-Person, 1990-2020: Annex 1 regions, reference case

	Emissions	Population *	Output (GDP)	Emissions per person
	%	%	%	%
Australia	1.63	0.94	2.31	0.68
New Zealand	2.20	0.34	2.43	1.86
United States	1.38	0.36	2.13	1.03
Canada	1.28	0.85	1.83	0.43
Japan	1.16	–0.07	2.52	1.22
European Union	1.12	–0.24	2.01	1.36
EFTA	1.10	–0.08	1.47	1.18
Former Soviet Union and Eastern Europe	0.85	0.22	1.34	0.63
Annex I average	1.34	0.29	2.01	1.05

***** MEGABARE projects lower population growth than some other recent studies. This can largely be attributed to the fact that neither of these other studies calculates population endogenously and they therefore do not take into account the full effects of any income changes on the population growth rate.

This contrasts with a differentiated targets approach, under which countries' individual economic and trade circumstances would be taken into account when their targets are set.

To illustrate the economic consequences of uniform emission abatement strategies, two alternative international climate change policies were simulated using MEGABARE:

- **Less Stringent Scenario**: Annex I countries reduce their carbon dioxide emissions from fossil fuel combustion to 1990 levels by 2010 and further reduce emissions to 10 per cent below 1990 levels by 2020; and
- **More Stringent Scenario**: Annex I countries stabilize their carbon dioxide emissions from fossil fuel combustion at 15 per cent below 1990 levels by 2010 and hold emissions at those levels in the period to 2020.

Neither simulation requires developing countries to restrict their emissions growth. This assumption is based on the stipulation in the Berlin Mandate that the current round of negotiations will not require developing countries to take additional measures to reduce their emissions at this time.

Impact on Emissions

The results in Exhibit 3 show that the more stringent emission reduction leads to moderately greater reductions in global emissions relative to reference case than the less stringent emission reduction over the medium term. However, over the longer term the difference between the impacts of the more and less stringent policies becomes increasingly small.

There are two reasons for this result. First, the share of Annex I emissions in global emissions is projected to decline, implying that emission reductions in Annex I regions alone will have an increasingly small impact on global emissions. Second, emission abatement action in Annex I countries is projected to encourage increased fossil fuel use and emissions in non-Annex I countries as fossil fuel intensive industries relocate to non-Annex I regions, where emission abatement targets do not apply. This process, known as “carbon leakage”, is projected to offset the impacts of emission reductions in Annex I countries on global emissions by around 12 percent in the less stringent scenario at 2020 and 14 percent in the more stringent scenario. This means that for every million tons reduction in emissions achieved by Annex I regions, emissions in non-Annex I regions rise by between 120,000 tons and 140,000 tons.

The limited impact of the assumed policies on global emissions highlights the need for all countries to become involved in emission abatement over the longer term if any significant and sustained reduction to global emissions is to be achieved.

Exhibit 3: Global carbon dioxide emissions from fossil fuel combustion under uniform emission reduction scenarios

Emissions rate in gigatons

Reference Case

Global Economic Impacts

The emission reductions are estimated to impose losses in real gross national expenditure in both Annex I and non-Annex I regions (Exhibit 4). At a global level, gross expenditure and output are projected to be around 0.8 per cent below reference case levels by 2020 under the less stringent scenario and 1.1 per cent below, the reference case under the more stringent scenario.

Exhibit 4: Change in GNE at 2020 relative to the reference case due to emission reductions in Annex I regions

	Less Stringent	More Stringent
Annex I	-1.0%	-1.5%
Non-Annex I	-0.5%	-0.2%
Global	-0.8%	-1.1%

Annex I Impacts

Owing to significant differences in economic structures and trading patterns, uniform emission abatement targets do not lead to uniform economic costs between Annex I regions (see Exhibit 5). For example, the projected economic costs for Australia, Norway, New Zealand, and Japan are many times higher than those projected for the other Annex I regions. The magnitude of the burden increases for the more ambitious emission abatement target. Japan experiences high costs because Japanese industries have already taken major steps to improve energy efficiency and reduce fossil fuel use. Further action to reduce emissions by significant amounts in Japan would imply further structural adjustment to the Japanese economy, carrying large costs. In the case of Australia, which supplies large shares of the world's coal and processed minerals products, emission abatement activities would entail major structural adjustment in industry, with high economic costs.

At a sectoral level, there are significant reductions in the outputs of coal, oil and gas as Annex I countries shift away from fossil fuel use to meet their emission abatement targets. Coal, which is the most emission intensive fuel experiences the largest output fall, followed by gas and oil (see Exhibit 6).

Significant declines in output are also experienced in the chemical, rubber and plastics and iron and steel industries of most countries. Nonferrous metals production in Australia, which is based on coal fired power generation, also experiences a significant output fall, relative to the reference case.

Exhibit 5: Net present value of GNE losses due to uniform emission reduction, 2000-2020, Annex 1 regions

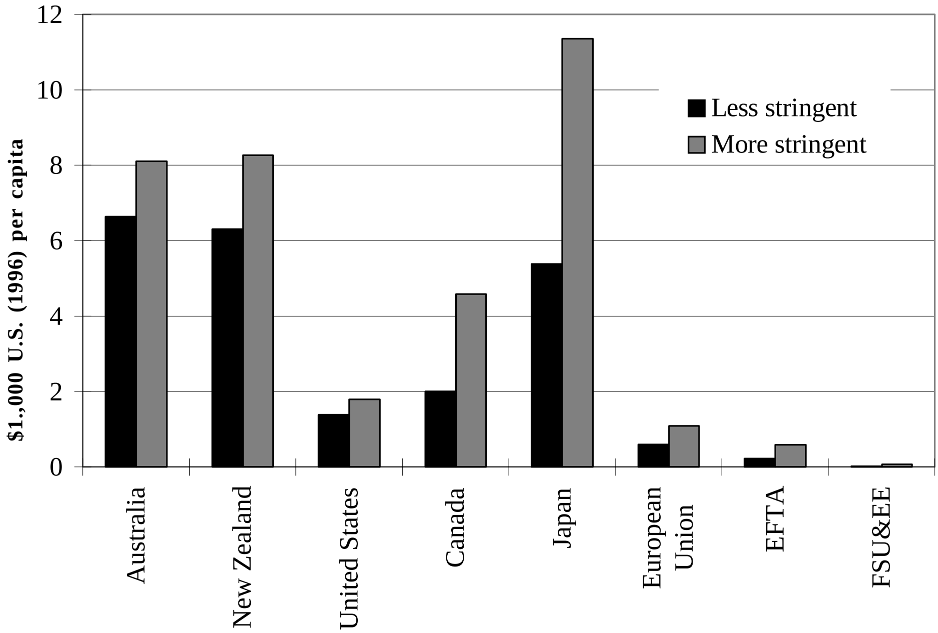


Exhibit 6: Change in global primary energy use at 2020 relative to reference case levels due to emission reductions in Annex 1 regions

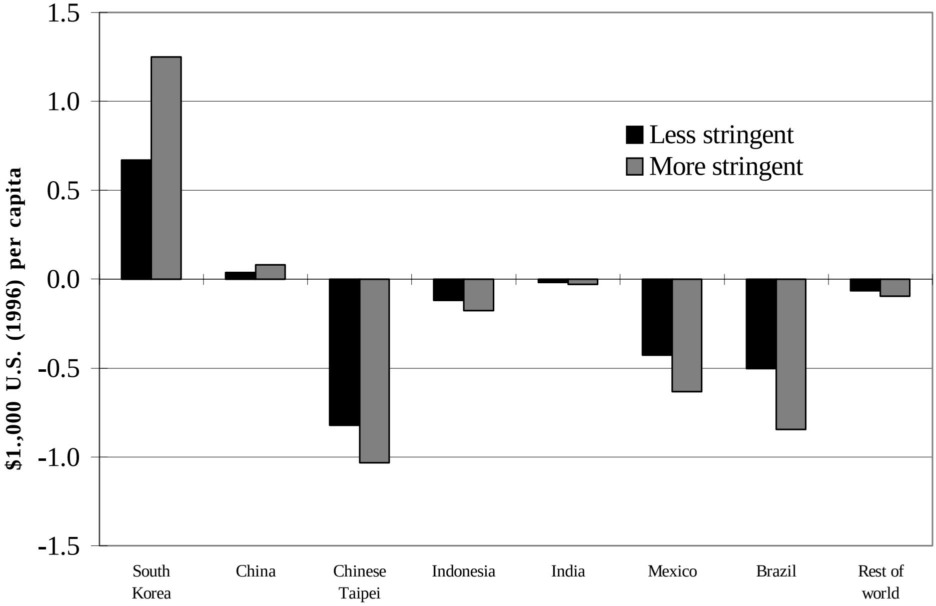
	Less stringent scenario %	More stringent scenario %
Coal	–41.0	–41.8
Oil	–5.9	–6.3
Gas	–26.6	–30.3

Non-Annex I Impacts

A key factor driving economic growth in non-Annex I countries is the increased integration of non-Annex I countries into the global economy through trade and investment linkages. These linkages are likely to be affected when Annex I countries undertake emission abatement, with consequent economic impacts.

Among the non-Annex I regions, South Korea and China are projected to experience economic benefits under both emission reduction scenarios as these countries benefit from the phenomenon of carbon leakage or, more particularly, from their increased competitiveness in emission intensive production processes relative to Annex I countries (see Exhibit 7).

Exhibit 7: Net present value of GNE changes due to uniform emission reduction, year 2000-2020, Non-Annex 1 regions



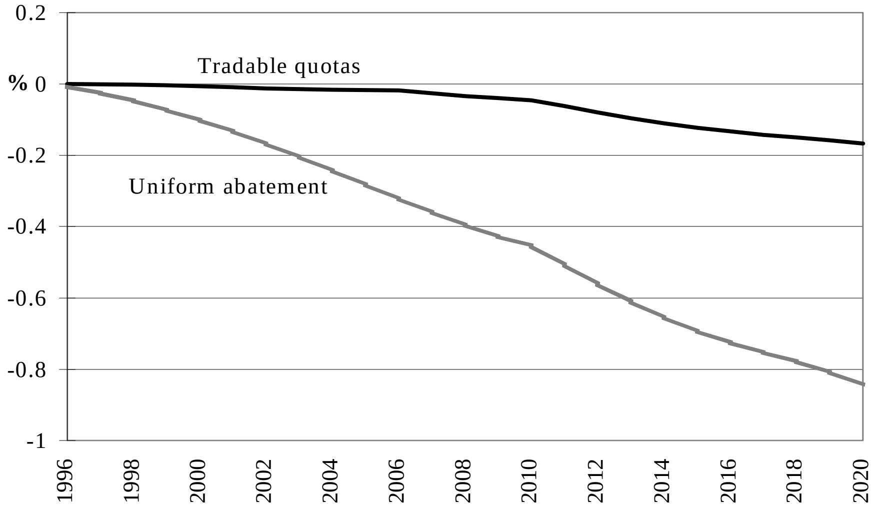
The remaining non-Annex I regions are projected to experience economic costs due to adverse trade and investment outcomes. For example, Mexico and Indonesia export fossil fuels to Annex I regions and, therefore, experience a decline in export demand for these commodities. Further, the declining world price of these commodities contributes to a decline in export earnings. These countries also import fossil fuel intensive manufactures from Annex I regions, the prices of which rise due to the emission abatement efforts in Annex I regions. These price increases are passed on to consumers in Mexico and Indonesia, further contributing to the economic costs experienced by them.

Least-Cost Approaches and Tradable Emission Quota Schemes

Strategies that impose smaller economic costs on the international community, and which lead to outcomes that are perceived to involve a more equitable sharing of these costs are much more likely to lead to effective global efforts to limit emissions than strategies that impose high and unequal costs on countries. A tradable quota scheme has the potential to allow carbon dioxide emissions to be reduced by the same amount as uniform abatement policies but at a lower cost to the international community (see Exhibit 8).

The process of trade leads to greater emission abatement in low cost locations such as the former Soviet Union and Eastern Europe than would have been the case under the uniform targets approach alone. This region receives a substantial compensation for undertaking the emission reductions in the form of revenue from

Exhibit 8: Change in global GNE over time relative to the reference case under grandfathered tradable quotas and uniform abatement



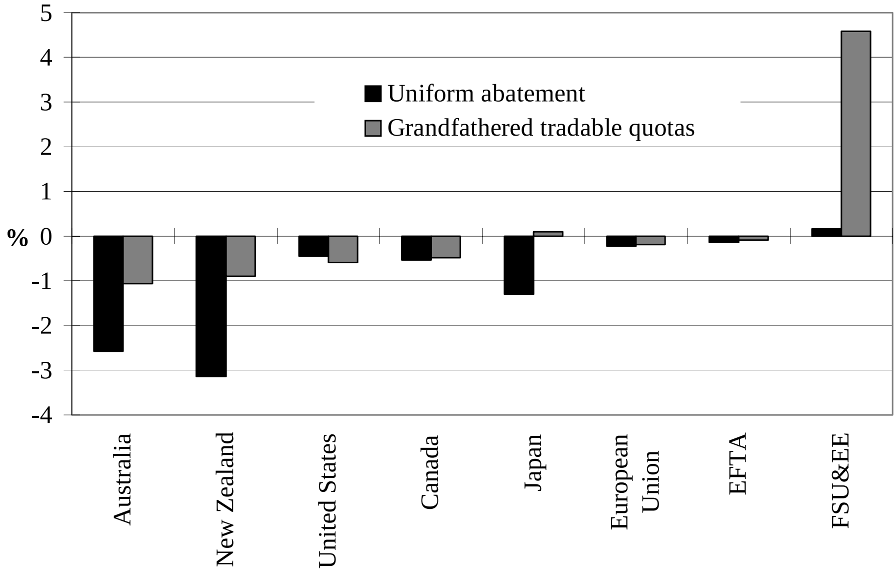
emission permits sold to other regions.

While trading reduces the global costs of emission abatement, the costs do not fall evenly among Annex I countries. The results in Exhibit 8 show the percentage changes in GNE at 2010 when countries' emission are allocated on the basis of historical emission levels (also known as "grandfathering").

The results in Exhibit 9 indicate that, compared with the uniform targets result, countries such as Japan and New Zealand (where marginal abatement costs are projected to be the highest under uniform targets) experience the greatest benefit from the shift to grandfathered tradable quotas. Australia, on the other hand, continues to experience trade related losses owing to reduced demand for its coal exports and, as a result, it continues to experience a greater GNE loss than the other Annex I regions relative to business-as-usual.

A key result is that the United States experiences a greater loss in GNE under the grandfathered approach than under the uniform targets approach. This occurs for two reasons. First, the United States does not experience as great a reduction in marginal emission abatement costs from the move to tradable quotas as do countries such as Japan and New Zealand. As a result, the gains to fossil fuel using industries in the United States are not as great as those for industries in many other Annex I regions. Second, the significant reduction in marginal emission abatement costs in other Annex I regions relative to that for the United States reduces the competitiveness of U.S. industry compared to the situation it faced with uniform targets. Consequently, the terms of trade (or the rate at which U.S. exports can be exchanged for imports) decline relative to the uniform targets outcome. This leads to a substantial trade related loss in GNE for the United States that outweighs the relatively small benefits from reduced marginal emission abatement costs.

Exhibit 9: Change in GNE at 2010 relative to business-as-usual under uniform abatement and grandfathered tradable quotas



Kyoto in December

In the very long term, the United Nations Framework Convention on Climate Change will be judged to have been effective if a balance has been achieved between the net damages from climate change itself and the economic costs imposed as a result of emission abatement and adaptation. One of the necessary conditions for such a balance is that all the major emitters are part of an agreement to reduce greenhouse gases. This type of participation will be encouraged only if emission abatement actions undertaken by signatories are equitable and least cost.

A demand for simplicity by some parties to the convention has led them to insist on uniform abatement targets that lead to an unequal allocation of economic costs among Annex I countries. Such an approach does not lay the long term foundation for an agreement that will be implemented wholeheartedly, that will provide a mechanism for signing on developing countries to undertake future commitments, or that will form the basis for introduction of innovative new policies such as tradable emissions quotas.

An emission trading scheme has the potential to be the least cost approach to meeting the challenge of reducing emissions at the international level. The initial allocation of emission permits could be used to compensate countries (at least to some extent) for the costs of meeting emission abatement targets. A negotiated settlement on intial allocation of permits would provide one mechanism to encourage participation in the international emission abatement process.

3. ECOLOGICAL IMPERIALISM: THE PROSPECTIVE COSTS OF KYOTO FOR THE THIRD WORLD

DEEPAK LAL

At Kyoto, Third World countries are going to face their first serious confrontation with the growing ecological imperialism of the international green movement, which has already succeeded after Rio in getting the developed countries to agree to reductions in carbon emissions to control the so-called greenhouse effect. These Annex I countries were the only ones to have agreed to limit their emissions, but there are already signs that they will now also seek to get emission targets imposed on the non-Annex I countries, that is mainly the Third World. This is partly due to the so-called "carbon leakage" problem, whereby with the limits on emissions from developed countries, production of carbon-intensive goods shifts to the developing world. Along with the emissions associated with the acceleration in growth rates of two of the largest Third World countries — India and China — it is expected that by 2010 the Third World will account for almost half the global emissions compared with less than one third today.

At the recent Earth summit, so-called "Rio plus-5," the U.S. government failed to endorse the European Union's proposal for a 15 percent reduction of greenhouse emissions below 1990 levels in industrialized countries by 2010. Instead, the White House issued a statement on June 26 stating that the Kyoto accord must include "language that makes it clear" that developing country obligations under the pact will increase over time "and will include binding targets." The U.S. also committed itself to foreign aid to developing countries to deal with these emissions of $1 billion over five years — a derisory sum as we shall see.

Effects on Third World Development of CO_2 Abatement Policies

As David Montgomery has shown, even the implementation of the emission limitations on industrialized countries called for in the Berlin mandate will have deleterious effects on many Third World countries — of the order of one percent of GDP. This is because of the income and terms of trade effects arising from the reduction in developed country growth rates that the Berlin mandate will induce. A few countries, mainly major oil importers, could gain from the lower energy prices (particularly for oil) that would result.

But these imminent indirect losses in Third World GDP and growth will be dwarfed by the much larger direct losses that will result from any Kyoto pact which commits developing countries to a reduction in their own emissions. The IPCC (1996) provides a survey of various model-based estimates of the GDP losses in various regions of the world under two scenarios: 1) a reduction in the rate of growth of emissions in each region by two percent per annum, and 2) a stabilization of emissions at 1990 levels in each region. Amongst the various non-developed country regions, the losses in GDP are large. particularly for China, for which losses range from 4 to 13 percent GDP loss in 2019 over the business as usual scenario.

Given the great uncertainty surrounding the estimates of the costs of abating greenhouse emissions, particularly in developing countries, it is perhaps better to keep a ball-park figure that Schelling (1992) has derived from the various model estimates made until that date. To delay the doubling of CO_2 emissions by four decades will cost roughly two percent of gross world product in perpetuity. While this might appear a trivial cost for developed countries, it is not for many poor countries. More seriously, any limits to their use of fossil fuels for development in the near future poses serious threats to their possibility of developing at all.

For as economic historians have emphasized, it was not until the Industrial Revolution that mankind found the key to intensive growth — a sustained rise in per capita income—which, as the example of the West and many newly industrializing countries have shown, has the potential of eradicating mass structural poverty — the scourge which in the past was considered to be irremediable (*pace* the Biblical saying that the poor will always be with us). For in the past, most growth was extensive — with output growing in line with (modest) population growth (Reynolds, 1983). As pre-industrial economies relied on organic raw materials for food, clothing, housing and fuel (energy), whose supply in the long run was inevitably constrained by the fixed factor, land, their growth was ultimately bounded by the productivity of land. For even traditional industry and transportation — depending upon animal muscle for mechanical energy, and upon charcoal (a vegetable substance) for smelting and working crude ores and providing heat — would ultimately be constrained by the diminishing returns to land that would inexorably set in once the land frontier was reached. In these organic economies (Wrigley, 1988), with diminishing returns to land conjoined with the Malthusian principle of population, a long run stationary state where the mass of the people languished at a subsistence standard of living seemed inevitable. No wonder the classical economists were so gloomy!

But even in organic economies there could be some respite, through the adoption of market "capitalism" and free trade defended by Adam Smith. This could generate some intensive growth as it would increase the productivity of the economy as compared with mercantilism, and by lowering the cost of the consumption bundle (through cheaper imports) would lead to a rise in per capita income. But if this growth in popular opulence led to excessive breeding the land constraint would inexorably lead back to subsistence wages. Technical progress could hold the stationary state at bay but the land constraint would ultimately prove binding.

The Industrial Revolution led to the substitution of this organic economy by a mineral-based energy economy. It escaped from the land constraint by using mineral raw materials instead of the organic products of land. Coal was the most notable, providing most of the heat energy of industry and with the development of the steam engine virtually unlimited supplies of mechanical energy. Intensive growth now became possible, as the land constraint on the raw materials required for raising aggregate output was removed.

Thus the Industrial Revolution in England was based on two forms of "capitalism," one institutional, namely that defended by Adam Smith — because of its productivity enhancing effects, even in an organic economy — and the other physical: the capital stock of stored energy represented by the fossil fuels. The latter which allowed mankind to create, in the words of E.A. Wrigley:

> [A] world that no longer follows the rhythm of the sun and the seasons; a world in which the fortunes of men depend largely upon how he himself regulates the economy and not upon the vagaries of weather and harvest; a world in which poverty has become an optional state rather than a reflection of the necessary limitations of human productive powers. (Wrigley, 1988, p. 6)

The Greens are, of course, against both forms of "capitalism" — the free trade promoted by Smith, as well as the continued burning of fossil fuels — leaving little hope for the world's poor.

Costs of Global Warming to Developing Countries

The IPCC (1996) surveyed the studies which have tried to estimate the costs to different regions from a doubling of CO_2 . There are differential benefits with some regions gaining and others losing. Most of these studies have focused on the effects on agriculture and the rise in sea levels. The most extreme estimates of the damage to agriculture are Cline's (1992). But in view of his debate with Mendelsohn and Nordhaus (1996) and Cline (1996) on the effect of climate change on American agriculture, where Mendelsohn and Nordhaus convincingly defend their view that "moderate global warming and carbon dioxide accumulation is likely to benefit American agriculture," it would seem that we also need to dismiss Cline's "gloomy prognostications" (Mendelsohn and Nordhaus, p. 1314). The best estimates of the aggregate effects on agriculture of global warming are that it will be favorable (see Beckerman, 1995; Nordhaus, 1991). Moreover, as Schelling (1992) has emphasized, industrialization and urbanization — the two great forces of economic progress in this century — have made making a living in developed countries virtually climate proof. The same process of economic growth will do the same in developing countries. Whilst the fact that millions have voluntarily moved from colder northern to warmer southern climates in the U.S. shows that even a sudden rise in temperature will not lead to a more drastic change in their local climates than is involved in this voluntary migration.

On the rise in sea levels, again these represent distributional effects.[2] Even if the projected rise in sea levels, which along with so many of the scientific predictions is now estimated to be much less than originally predicted, leads to the erosion of many coastal areas, this is in itself no worse than what is happening normally through sea-erosion. (see Beckerman, 1995). Of the costs to the Netherlands, Bangladesh and various Pacific islands, the costs of adapting to the changes in sea level are trivial compared with the costs of a global limitation of CO_2 emissions to prevent global warming. One constructive suggestion in case there are serious worries about the poor developing countries threatened with these prospective costs is for the U.S. and other donors to put the foreign aid money they are currently committing to persuade developing countries to reduce their carbon emissions, into a trust fund to be paid out for adaptation by the victims of sea-level rises in these countries if the worst does come to pass.

The Costs and Benefits of Avoiding a Climatic Catastrophe

This will not satisfy the Greens, who will say that we cannot wait for the scientific uncertainties surrounding the greenhouse effect to be resolved before taking action.[3] For if there is even and infinitely small chance that doing nothing now could lead to Apocalypse, then analogous with Pascal's wager on the existence of God, we must act now to stop global warming — even though this action may in time be shown to be futile.

But even if we take the Green fear of a small probability of an apocalyptic greenhouse effect — which all the current evidence shows is even on the worst assumptions unlikely to be apocalyptic (see Lal, 1990, 1994; Beckerman, 1995; Ridley, 1995) — is current action to curb greenhouse gases rational as an insurance policy? Fortunately, a sophisticated cost/benefit study which quantifies the various alternative scenarios and the uncertainties surrounding both the extent of the likely climatic effects of the increase in greenhouse gases following from continuing economic growth — not least its acceleration in countries like China and India which contain the bulk of the world's poor — as well as the effects of this climate change on the economies of different regions of the world is now available (see Nordhaus, 1995). Nordhaus considers seven alternative policies for dealing with climate change:

> the first is . . . "laissez-faire" . . . in which there are no controls on greenhouse gasses . . . The second is the "optimal" policy, a scenario in which [greenhouse gas emissions] controls are set so as to maximize the discounted value of the utility of consumption. The third is a scenario in which we wait 10 years to implement policies so that our knowledge might be more secure. The fourth and fifth policies are ones that stabilize emissions — one at the 1990 rate of emissions and the other at 80 percent of the 1990 emissions rate. The sixth proposal is to undertake geo-engineering, while the final approach is to curb emissions sufficiently to slow climate change and eventually stabilize climate. (p. 79)

His results for the best guess case are:

> among these seven [policy options] the rank order from a purely economic viewpoint is geo-engineering, economic optimum, 10 year delay, no controls, stabilizing emissions, cutting emissions by 20 percent, and stabilizing climate. The advantage of geo-engineering over other policies is enormous. (p. 96)

These results are fairly robust and are not changed markedly by the introduction of “uncertainty and realistic constraints on the resolution of uncertainty” (p. 186).

There are two points worth noting about these results. First, the geo-engineering option, which according to a U.S. National Academy of Sciences survey could be implemented “at relatively low costs” (Nordhaus, op cit., p. 81), involves various options including “shooting smart mirrors into space with 16 inch naval rifles or seeding the oceans with iron to accelerate carbon sequestration” (Nordhaus, ibid). But as Nordhaus notes, these technological fixes are opposed by environmentalists “because of the grave reservations about the environmental impacts of the geo-engineering options” (ibid). Whether these reservations are rational is not discussed. (My suspicion would be they are not.)

Second, the ten year delay and laissez-faire alternatives dominate the various alternatives about stabilizing emissions, the policy alternative endorsed by the Rio conference, and adopted enthusiastically by the United Kingdom and the European Union. Moreover the optimal policy implies a reduction in greenhouse gas emissions from their laissez-faire level of 21.96 billions of tons of carbon equivalent in 2075 to 19.01 billions of tons of carbon equivalent (a mere 13 percent reduction from laissez faire). And the gain from this policy over laissez-faire is only an 0.06 percent annual increase in world annual consumption! By contrast all the alternatives of stabilizing emissions involve losses of from eight to 1.5 percent of world annual consumption.[4] Given the political difficulties in implementing the optimum solution (see Swanson), and the trivial gains to be thereby secured, the only rational conclusion is that the only sensible policy on climate change is to let well alone — that is laissez-faire![5]

But suppose given the eco-fundamentalism sweeping the West that it insists at Kyoto on a limitation of greenhouses emissions from the Third World. The latter has made clear (not least at the latest Earth Summit) that it would only be willing to consider this if the West is willing to pay for its dubious eco-morality. If the earlier estimates of a ballpark figure of the costs of such abatement as about two percent of gross world product in perpetuity is correct, this will mean that developed countries would have to be willing to commit themselves to official transfers about four times current aid flows to developing countries in, perpetuity.

This is, however, unlikely to offer much comfort to the poor of the Third World. As a statistical study by Mosley (1987) concluded “foreign aid appears to redistribute from the reasonably well-off in the West to most economic groups in the Third World except the poorest.” (p.23) Nor has aid promoted growth. Thus a recent study by Boone (1994) found that the effect of aid on growth was often negative. Foreign aid cannot therefore be expected to make up for the poverty alleviation that would occur with rapid growth based on industrialization which uses fossil fuel. To deny this is moral hypocrisy. To subserve some uncertain Green ideal at the cost of leaving the Third World mired in poverty is morally wicked.

Moreover, even if we ignore the patchy record of the effectiveness of foreign aid in alleviating poverty and promoting growth , the likelihood of such transfers finding political acceptance in the aid fatigued climate of Western democracies is remote. This would then open up the real danger of an era of direct or indirect imperialism, to discharge a green variant of the nineteenth century's white man's burden. For one little noticed aspect of the attitudes that underlie greenery is its implicit misanthropy (see Lal, 1995), whose close cousin is racism. Burgeoning third-world populations, polluting the atmosphere and degrading its natural resources and habitats for plants and insects, can easily be turned into the enemy on Spaceship Earth.

Notes

[1] This paper is based on Lal (1990), (1995), (1996).

[2] As I had argued in Lal (1990), the externality associated with global warming looks more like a Pareto-irrelevant pecuniary externality, in which there is in effect a worldwide redistribution of agricultural resources. It is also akin to the pecurniary externalities associated with for instance the development of synthetic fibers which adversely effected the incomes of natural fibre producers. As is well known [see Buchanan and Stubblebine (1962)], pecauniary externalities are Pareto-irrelevant and do not require any countervailing action.

[3] Balling (1992) provides the most balanced assessment of the uncertainties. Also see Houghton (1994) for a summary of the IPCC's views.

[4] See Nordhaus, op. Cit., Table 5.1 and p. 83. The impact on annualized value of consumption for the world in billions of dollars per year is 11 for the optimum; 10 for the 10 year delay; 0 for laissez faire; 224 for geo-engineering; and -283 for stabilizing emissions at 1990 levels; -501 for stabilization at 80 percent of 1990 emission levels; and -1639 for stabilizing climate at max of 1.5 degrees C increase. These number can be compared to an annual consumption rate of approximately $20,000 billion in the 1990-99 period of Nordhaus' model.

[5] Nordhaus and Yang (1996) have produced a regionally more disaggregated model of coping with climate change. Again they find "the stakes in controlling global warming are modest in the context of overall economic activity over the next century."

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Exhibit1: Percentage Change in Carbon Emissions for the OECD and World Reduction Proposal