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The Use of Economic Instruments in Carbon Dioxide Mitigation: A Developing Country Perspective

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by Amrita N.Achanta, Mamta Mittal and Ritu Mathur

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Foreword

The relationship between international trade, environmental protection and sustainable development represents one of the most important, complex and encouraging policy dialogues since the 1992 Rio Summit. There, governments, industry, NGOs and public citizens agreed that in order for sustainable development to move from a general policy goal to specific operational commitments, core economic and environmental policies need to be integrated. The intersection of international trade and environmental policies represents a compelling opportunity to ensure that economic growth and development options stemming from increased trade liberalization, continue to act as a positive force towards environmental protection, and sustainable development.

The establishment of the World Trade Organization in early 1995 represents an historic coalition of national interests, moving towards a shared goal of an open, fair and non-discriminatory trading system. Similar evidence of international cooperation also continues in the environmental arena. In late 1994, for example, the world community met to review, revise and strengthen the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Convention on Biodiversity. In early 1995, governments met to review national plans related to climate change and global warming.

As the commitments of the Uruguay Round and the growing and constantly changing body of international environmental laws and measures are implemented at the national level, the potential for conflict between these two bodies of international law may increase. Our goal is to make certain potential conflicts are identified well in advance, that effective *preventative* measures are defined, and workable solutions are found. The record of the trade-environment debate clearly shows that the more both communities share perspectives and build confidence, the greater the potential that conflicts will diminish, and positive synergies between trade and environmental policies will take shape.

Elizabeth Dowdeswell
Executive Director

The Authors

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The Energy Research Institute (TERI)

The Tata Energy Research Institute was established in 1974, to address the immense and acute environmental and related problems facing mankind in the year ahead, related to (1) the gradual depletion of the Earth's finite energy resources, which are largely non-renewable, and (2) the existing methods of their use, which lead to increasing pollution. TERI is a multi-disciplinary institute, with a focus ranging from the global to micro levels. TERI has a research staff of over 300, and headquarters in New Delhi. TERI is addressing the larger task of showing to Indian society — and others — the path of sustainable development inasmuch as energy and environmental issues are concerned, by forwarding workable models that can be implemented at the grassroots level.

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Introduction

Economic instruments constitute one of a range of policy instruments used in the achievement of environmental protection. They could be defined as instruments that affect costs and benefits of alternative actions open to economic agents, with the effect of influencing behaviour in a way that is favourable to the environment (OECD, 1991). One of the aims of such instruments is to ensure that appropriate pricing will promote the efficient use of a particular resource. Currently, these instruments have been predominantly used in the OECD countries (the US, Sweden, Norway and Denmark having highest usage) and this experience forms the basis of this analysis of their potential use in developing countries, although some of the criticism relates to their current usage being inadequate to produce an incentive effect, and their primary goal being the generation of revenue. This last aspect is of particular significance in the developing country context, depending on what the value of the revenue to be collected is or whether the economic instrument is revenue neutral[1]. This paper examines the use of economic instruments in the protection of the global environment (particularly, global warming caused by enhanced carbon dioxide emissions), examining the potential impact on trade and welfare, from a developing country (LDC) perspective.

Such economic instruments are currently being used to tackle various environmental problems including air pollution and acid rain at the local level. Their use has also been proposed in multilateral environmental agreements such as the Montreal Protocol, the UN Convention on Long Range Transboundary Pollution and the Framework Convention on Climate Change (FCCC). In the case of some of these international agreements, their use is still being explored, given the need for global consensus on a multiplicity of issues. Of particular importance is the need to identify policy options in developing countries, in light of expected increases in LDC emissions of greenhouse gases (GHGs) arising from increased energy use.

Developing countries accounted for nearly 30 percent of global energy demand in 1990. This share is expected to rise to about 70 percent by the year 2050 (Commission of the European Communities, 1993). The Intergovernmental

Panel on Climate Change (IPCC) estimates that the share of primary energy demand of LDCs, under a high emissions (BAU-non interventionist) scenario, is likely to rise from 22 percent (in 1985), to over 60 percent in 2100 (IPCC, 1990). Further, many recent projections suggest that much of this growth in global energy demand will continue to be based on fossil fuels under a "business as usual" scenario. This is likely to aggravate both resource depletion and environmental pollution despite improved energy production and the development and adoption of cleaner combustion technologies. The selection of a growth trajectory for a LDC, aimed at containment of energy demand growth and environmental degradation, would depend upon the following variables and considerations:

* depletion of low-cost resources, supply disruption, or the nature and gravity of possible environmental constraints;
* economic, political, social, and behavioral changes; whether present nation states seek individual or more cooperative modes of development;
* whether more centralized or more dispersed solutions are sought in key sectors such as energy;
* whether existing institutional and administrative mechanisms prove to be sufficiently flexible and adaptive;
* numerous incremental and radical technological changes and interactions within and without the energy sector in fields as diverse as biotechnology, electronics, materials, photovoltaics, and telecommunications (Commission of the European Communities, 1993).

Today, there is increasing concern about the risks of global climate change[2] caused by anthropogenic emissions and rising atmospheric concentrations of GHGs. It is recognized that in the absence of policy action, i.e., non-intervention, worldwide emissions and consequently atmospheric concentrations of GHGs, in particular, carbon dioxide (CO^2), are set to increase significantly. Even though economic growth and the protection of natural and environmental resources are theoretically compatible goals, devoting resources to environmental protection renders them unavailable for the achievement of other development objectives. This is especially problematic for LDCs, where demands for rapid economic growth are compelling, and where the ability of business to afford environmentally sound production methods may be limited.

On the other hand, the argument that environmental protection in developing countries should be considered only after achieving their economic goals, reflects a short-term perspective. Thus, governments in such countries are under extraordinary pressure to identify policies that provide an acceptable level of environmental protection while minimizing cost and the degree to which they act as disincentives to economic progress. In light of this tradeoff, the identification of suitable policies requires an understanding of the nature of environmental problems, the economic impacts of alternative environmental policies, the institutional conditions and societal arrangements required for policies to be implemented effectively. This paper seeks to address some of these issues.

Outline of the paper

The paper is structured as follows. Prior to a discussion of the individual economic instruments (market based), a few selected global environmental issues sought to be addressed are briefly discussed, although the primary focus remains the usage of economic instruments in the reduction of global carbon dioxide emissions. Global environmental problems examined in Chapter 2 are: stratospheric ozone depletion;

acid rain; and climate change. Chapter 3 identifies some requirements of the FCCC, with emphasis on more traditional command-and-control approaches versus the market based approach. This section identifies general aspects of major economic instruments[3] (carbon taxes, energy taxes, ad valorem taxes and tradeable permits). Chapter 4 identifies issues arising from the potential application of various economic instruments, including implications for international trade, as well as global and domestic welfare, arising from unilateral/multilateral application. This discussion makes use of both economic theory and global and national macroeconomic modelling results. Chapter 5 focuses on developing country concerns arising from the use of economic instruments. Chapter 6 identifies current policy initiatives, either in place, or under consideration in the EC, the US and Japan. The criteria for the choice of the economic instruments at the international and national level are dealt with in Chapter 7. This and the other sections form the bases of the general policy options suggested in the concluding section.

2

Global Environmental Problems

Among the environmental problems being addressed in part through the use of economic instruments are: acid rain, stratospheric ozone depletion[4] and global warming. In these cases, the use of economic instruments has been limited to the national and regional level. The following discussion briefly outlines issues related to acid rain and global warming; for a discussion of ozone layer depletion, please see

"Protecting the Ozone Layer Through Trade Measures." (UNEP 1994).

Acid Rain Probleams[5]

The term "acid rain" was coined over one century ago by a British chemist, to refer to significant changes in the chemical composition of precipitation caused by air pollution pollution. There is a normal amount of acidity in rainfall, largely from the absorption of carbon dioxide and other natural background sources of acidity. Studies show that acidity in precipitation can be as much as ten times higher than normal background levels, because of airborne sulphur dioxide and nitrogen oxides. Global emissions of sulphur and nitrogen from the burning of fossil fuels resumed record high levels in 1991, following a drop in overall emissions in 1990. Each year, an estimated 70 million tonnes of sulphur dioxide are released into the atmosphere, together with an estimated 27 million tonnes of nitrogen (in the form of nitrogen oxides).

One of the many environmental consequences of increased levels of sulphur and nitrogen pollution is reflected in increased acidity of rainfall. Normal precipitation in most areas of the world is slightly acidic, with a pH of approximately 5.6. By contrast, rainfall with a pH of 4.0 and 4.5 in the eastern United States occurs frequently, while cloud droplets have had pH levels as low as 2.6 in the state of New York. One consequence of signifcant changes in acidity is reflected by recent studies showing that in more than 200 lakes of the Adirondack mountains of New York state, fish disappeared as early as 1982.

Overall, higher acidic pollution can create systemic, abrupt and severe changes in ecosystems. Impacts of acid rain are diverse at the regional level, reflecting differences in soil, bedrock characteristics which influence the capacity of an ecosystem to neturalize acidity. Generally speaking, however, acid rain has been shown to have a wide range of impacts, including: damage to vegetation by altering of natural soil cycles, lowering of soil nutrient levels, and accelerating the process of chemically wearing away soils; a significant decline in forest productivity, including evidence of severe forestry damages in Scandanavia, both western and eastern and central Europe and North America; evidence of severe acidification of lakes and rivers, and other impacts.

Major sources of acid rain are concentrated in the ore smelting or refining of sulphur-bearing metal ores, and the burning of fossil fuels for energy use. Accordingly, emission sources from ore smelters and power generating fossil fuel burning stations are largely concentrated to defined areas. However, the use of high-smoke stacks to disperse air pollution has contributed to the long-range, transboundary movement of acid rain.

In response to acid rain damages, estimated in monetary terms by the US National Academy of Sciences to exceed US$5 billion per year, the Clean Air Act amendments dealing with acid rain set a national ceiling of 8.95 million tonnes per year on SO^2 emissions from electric utilities. This has two phases, the first commencing in 1995 and the second in the year 2000. This visualizes the introduction of a nation-wide trading system (public auctioning of permits began at the Chicago stock exchange in March 1993), whereby existing utility operations subject to Phase One of the project would be granted allowances based on past fuel use and emission rates, as established in 1990. In the event of a plant's current emissions being below average emissions based on permit allocation, it could sell the surplus permits to the highest bidder. There is provision for auction or direct sale of up to 2.8

percent of the allowances made available to existing sources. Phase two requires existing utility plants with more than 25 megawatts, as well as all newly constructed plants to reduce SO^2 emissions reflecting 1.2lbs per million Btu (UNEP, 1993).

Further, due to the transboundary nature of the acid rain problem between Canada and USA, officials are believed to be reviewing a transboundary SO^2 emissions trading system, which would allow an expansion of the market for permits and savings associated with reduction of acid rain. Recent bilateral schemes regulating acid rain between Canada and the US have included economic instruments, notably tradeable emissions schemes. At the international level, ECE Convention on Long-Range Transboundary Air Pollution (1979) has been amended with increasingly strict protocols governing allowable emissions of sulphur dioxide. A key aspect of the ECE Protocol on the Reduction of Sulphur Emissions or Their Transboundary Fluxes includes commitments by governments to reduce sulphur emissions by at least 30 percent, using 1980 emission levels, by 1993. In June 1994, with that target not met, the Protocol was strengthened by governments, as well as made more flexible in implementation, to include two new stages:

(i) Emission ceilings ranging from 30 to 87 percent of 1980 emission levels have been set for each contracting Party to the Protocol, covering a flexible schedule covering the years 2000, 2005 and 2010. Governments have agreed to reduce sulphur deposition in Europe by 60 percent under this tri-part schedule;

(ii) New requirements are established for certain stationary combustion sources and for the sulphur content of gas oils.

Global warming

Increases in the atmospheric concentrations of greenhouse gases (GHGs), particularly carbon dioxide are predicted to lead to irreversible climate change. It is estimated that the earth's mean surface temperature may increase by 3°C by the end of the next century, with likely impacts on agriculture, forestry, natural terrestrial ecosystems, hydrology, water resources, oceans, coastal zones; and impact assessment work aims at refinement and quantification of the potential impacts.

The IPCC, in 1990 recommended a 60 percent reduction in carbon dioxide emissions in order for atmospheric equilibrium to be reached (IPCC, 1990). The FCCC commits the developed countries to adopt national policies aimed at returning GHG emissions to 1990 levels by the year 2000. At present there are no specific commitments of emission limits, specified for the developing countries, although this issue is likely to figure on future agenda, contingent on the developed world meeting commitments relating to financial assistance and technology transfer. Some nations within the European Community have already started applying national carbon and other related taxes.

The FCCC has as its objective "the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" {Article 2}. It further states that policies and measures[6] to combat climate change should be cost effective so as to ensure global benefits at the lowest possible cost {Article 3 (3)}. Article 3(5) states that measures taken to combat climate change, including unilateral ones, should not constitute means of arbitrary/unjustifiable discrimination or a disguised restriction on international trade. Other statements pertaining to trade concern the adverse effects of implementation of response measures on those LDCs vulnerable as a consequence of their high dependency on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products[7].

3

Use of Economic Instruments in Climate Change: CO^2 Stabilization/Reduction

The FCCC: CO^2 stabilization/reduction

According to the FCCC, developed country Parties and other Parties mentioned in Annex I aim to return individually or jointly to their 1990 levels of anthropogenic emissions of carbon dioxide and other GHGs not controlled by the Montreal Protocol by 2000 {Article 4(2)}. To date the OECD nations (included in Annex I countries of the FCCC) have accepted the goal of stabilization, and twenty two of the twenty three nations have adopted targets[8].

The goal of stabilization[9] at 1990 levels does not necessarily imply the prevention of increases in carbon dioxide concentrations in the atmosphere. While the rate of increase of carbon dioxide concentrations in the atmosphere may slow, the absolute level may still increase. Since the problem of enhanced greenhouse gas concentrations is of a transboundary nature, global cooperation is essential to mitigate these emissions. Multilateral cooperation would ensure a significant reduction in emissions, which is unlikely to occur if the effort was limited to a unilateral approach; and lead to the elimination of free riding. The absence of multilateral cooperation has also been associated with the potential for carbon leakages[10] apart from changes in sectoral comparative advantage.

Command and control approach vs market based instruments

The traditional command and control or regulatory approach identifies the best course of action to achieve an environmental goal and in accordance, makes particular forms of action or adoption of specific technologies mandatory. In this approach, polluters are required to adhere to standards, which are of four types: ambient quality standards which specify the characteristics of the receiving environment; emission standards which indicate the maximum allowable discharges of pollutants in the environment; process standards which specify the type of production process or emission reduction equipment that polluting plants must install; and product standards which define the characteristics of potentially polluting products. Some of the drawbacks of the regulatory approach include (i) the need and excessive reliance on effective enforcement, (ii) its limited ability to induce technological improvement (development of scrubbers being an exception), (iii) high administrative costs, among others.

Economic instruments provide market signals in the form of changed relative prices (taxation on certain products) and/or a financial transfer (payment or a charge). This economic incentive approach theoretically, allows more flexibility in attainment of the environmental goal by altering incentives available to an individual agent and relying on him to employ his information to identify the best means of meeting an assigned emission reduction target. In this manner, the best private choice[11] is made to coincide with the best social choice and the built-in flexibility helps in the achievement of the environmental goal at a lower cost[12] (this is anticipated in theory). In the case of a regulatory approach, lack of complete information (likely in market based instruments too) about emission control opportunities and other relevant parameters could reduce its efficiency. Economic incentive approaches seek to address this problem by putting in place a system of incentives (whether the incentive is successful would be dependent on its design) in which the concerned economic agents are better motivated to achieve environmental objectives at minimum cost.

In addition, economic incentive approaches which raise revenue (emission taxes or auctioned permits) for the regulatory authorities, replace that earned in traditional ways, which often distort resource allocation and produce inefficiencies in the economy. It is likely that more technological progress will occur by using economic incentive based approaches than under the command-and-control approach. This is because in the latter approach, the discovery or the development of an advanced pollution control technology by the regulatory authority will lead to the imposition of more stringent standards for the firms. In this event the polluters may conceal potential innovations. On the other hand, under a trading or marketable permits mechanism[13], innovating and reducing the level of emissions creates emission reduction credits (ERCs) for the firms, which can be sold. Hence, these economic incentive based approaches offer dynamic advantages.

Some other advantages of economic instruments:

* Automatic adjustment: emission levels automatically adjust to the tax (or price) - polluters lower their emissions until the marginal cost of abatement equals the tax rate, after which it is cheaper to pay the tax (or price) than abate.
* Resource conservation: By the use of pricing which reflects the social costs of environmental resources, an efficient use of resources is enhanced. This is especially important for developing countries, which rely heavily on natural resources.

The use of a market based approach[14], as opposed to imposition of stringent environmental controls, is especially relevant in the current context of a highly competitive global market place. However, the issue is not that of economic based approaches versus direct regulation. Increasingly, 'mixed systems' are coming into being whereby economic instruments complement regulation by providing additional incentives for pollution abatement. In some cases, economic instruments are the main policy measure instituted for environmental protection (e.g., waste water charges in France, Germany and Netherlands, air pollution in Sweden). In others, they constitute an optional tool and provide an opportunity for cost savings (tradeable permits in the United States).

Though the paper focuses on economic instruments this does not imply the absence of limitations. For instance, changes in energy pricing policies may have unforeseen effects based on numerous variables, including price-insensitivity, income distribution problems and lack of substitutability. Most importantly, their adoption may be constrained by the absence of empirical data on actual implementation in DCs. Other inadequacies of this approach relate to the absence of developed markets, existence of uncertainty and problems associated with the translation of theoretical considerations to the real world situation.

General aspects of implementing economic instruments

The combination of institutional (absence of secure property rights), market (environmental externalities) and policy failures (distortionary subsidies) lead to the underpricing of scarce natural resources and environmental assets (Schanzenbacher, 1995). This results in consumers and producers of these products and services not receiving the correct signals about the true scarcity of the resource or the damage they cause. This gap between the private cost of a product (production cost) and the social cost (including damage and depletion cost) causes incorrect signals. This gap is sought to be bridged, using economic instruments, which internalize all external costs to their sources, i.e. resources depleting and polluting commodities.

The economic theory underlying the use of economic instruments in environmental control is based on work done by Pigou, Coase, and Arrow, amongst others, and is outlined below. In economic theory, environmental pollution has been treated as an externality. Assuming a world of perfect competition, Pigou (1932) recommended that the generator of an externality be taxed (subsidized) by an amount that is equal to the social marginal net damage (benefit) that it creates. He showed that, under certain conditions, a Pigouvian tax can lead to an efficient allocation of resources.

Coase (1960), however, claimed that the adoption of a Pigouvian tax would result in a sub-optimal allocation of resources. According to Coase, control of externalities is an issue between the generator of the externality and the affected party. He proposed that in a world with zero transaction costs, and provided that rights are properly specified, bargaining between economic agents will lead to an efficient allocation of resources. However, in reality most transactions between polluters and victims are characterized by high transaction costs. This is particularly so in the case of climate change.

In the climate change context, transactions may not be limited to one-to-one negotiations involving individual (or small numbers of) polluters and victims (this is because global climate change caused by the greenhouse effect, is attributed to many anthropogenic activities and it is likely that the potential impacts are directed at specific individuals).

A third school of thought due to Arrow (1970) is based on the two theorems of welfare economics which are: first, under suitable conditions, all competitive equilibrium allocations are Pareto optimal, in the sense that no one can be made better off without hurting the welfare of some other agent; second, any arbitrary Pareto optimal allocation can be achieved as a competitive equilibrium under an appropriate choice of initial conditions. These theorems assume that markets exist for all possible commodities[15]. However, the existence of externalities implies the absence of certain markets. If a market could be established for all those commodities which are sources of externalities, then Pareto efficiency (or efficient resource use) would be restored. This implies that a polluter should be made to pay to each member of society who is adversely affected by the polluter's activity, an amount that is equal to the social value of marginal disutility suffered by the victim. Similarly, all members of society who are positively affected by the activity undertaken by an agent should pay this agent an amount that is equal to the social value of marginal utility enjoyed by the members.

The economic theory described above forms the basis of use of economic instruments in environmental protection. In environmental protection, and more specifically stabilization/reduction of carbon dioxide[16], the command and control approach or economic instruments could be used either in isolation or in combination with each other. The focus here is on the latter, and carbon taxes, energy taxes, ad valorem taxes, and tradeable permits have been singled out for detailed treatment, although it is likely that market based instruments may not be used in isolation; and neither are they being advocated as being superior nor mutually exclusive. While carbon taxes, energy taxes and ad valorem taxes, act on prices, in tradeable permits they act on quantities. Each of these instruments is dealt briefly below:

A. Energy taxes[17]

Energy taxes may be based on the energy content[18] of the fuels, or on the value of energy products embodied in the fuel (ad valorem energy taxes); rather than directly on the carbon content of carbon dioxide emitting fossil fuels. They are based on factors such as the heat supplied or the weight or volume of the fuel. Nevertheless, energy taxes on fossil fuels do indirectly penalize carbon emissions, though to a very different extent across different fuels and different countries.

B. Emissions taxes

An emissions tax is a tax per unit of emissions aimed at minimizing the total economic costs of achieving a given emissions target. Both static and dynamic efficiency gains can be achieved under an emissions tax. Static efficiency gains arise when polluters face different opportunities for emission control in the short run when factors of production and technological opportunities are fixed. Emitters will reduce emissions up to the point where the marginal cost of controlling emissions equals the tax rate and thus, marginal abatement costs will be equalised amongst polluters. Dynamic efficiency (cost minimisation over the long run when factors of production are variable) is also promoted as there exists a continuous incentive for the emitters to invest in research and development in emission abatement technologies in order to avoid the tax.

By using emissions taxes, the environmental costs of emissions as a result of any economic activity are 'internalised' at the level of the polluter i.e., the polluter bears the costs of implementing the pollution prevention and control measures. The revenues generated from such taxation may be recycled for energy system restructuring, may be used to reduce the negative impacts on economic activity caused by the introduction of the tax, or may be used for other purposes.

C. Carbon taxes

A carbon tax (levied on the basis of carbon content) on primary fuels, better targets carbon emissions[19] and is more effective than an energy tax which is not aimed directly at the carbon content of fuels. Since it is levied in proportion to the carbon dioxide emissions emitted by fuels when burned, it is a good proxy for a tax on the externality in question itself; if firms and individuals are required to pay for their carbon dioxide emissions, they will emit less. Such a tax (depending on the level) would stimulate users to substitute fuels with lower carbon content, such as natural gas, for high-carbon fuels such as coal. Model simulations of the US economy indicate that an energy tax could be between 20 and 40 % more costly, and an ad valorem tax 2 or 3 times more costly, than a carbon tax for equivalent reductions in emissions (Scheraga and Leary, 1992; Jorgenson and Wilcoxen, 1992). This is because an energy tax raises the price of all forms of energy, whether or not they contribute to carbon dioxide emissions, and would not create as much incentive to substitute lower emitting or non-emitting energy sources for high emitting energy sources.

i. National carbon tax

A carbon tax could be levied at the national or at the global level. The concerns ensuing from its application at the national level (which overlap partially with global concerns) are dealt with first. Various issues which need to be resolved prior to implementation may include those relating to technical, political, institutional, distributional aspects, among others.

Concerns about the adoption of a national carbon tax

Technical Issues

There are difficulties in devising and/or applying efficient rates (that would automatically achieve objectives). This is due to:

- lack of knowledge of abatement cost functions (and hence the difficulty in calculating an efficient tax rate);
- the difficulty of monitoring emissions (and hence the use of proxy variables like input or output);

- the difficulty of adapting rates to geographical conditions; and
- the need to adapt to inflation.

Political issues

- Opposition from environmentalists who interpret pollution taxes as 'purchasing the right to pollute';
- Opposition from industry as taxes impose a financial burden and may even result in losses in international competitiveness; and
- Opposition from influential industrialists who prefer regulations because the latter can be negotiated.

Institutional issues

Economic instruments require adapted institutional structures especially for enforcement and monitoring. This feature assumes significance in light of the potential for future extended participation.

Distributional Issues

Carbon/energy taxes are sometimes opposed on the grounds that they are regressive and may adversely affect low income groups. However, in most developing countries, taxes can be only partially shifted to consumers[20]. This means that a carbon tax would either be progressive or much less regressive than most people believe. Further, it is likely to be regressive only for some groups for which governments can take either ex-ante mitigation measures (e.g., reduced tax rates for certain income categories or industries) or ex-post compensation measures (lumpsum compensation payments). The second approach seems preferable as mitigation measures may reduce the incentive (for reducing carbon dioxide) effect created by the imposition of taxes. The Swedish proposal for a carbon tax, plans that the generated revenue would be distributed among the general population and the business community (Nieuwkoop and Walter, 1995). These distributional issues are especially important in developing economies where low income populations are very vulnerable to prices of basic commodities[21]. Also, the overall tax structure could be made even less regressive by using the carbon tax to reduce personal income taxes.

Revenue potential

The revenue potential of carbon taxes is extremely large. For some countries (China), such revenues could amount to about 2 percent of Gross Domestic Product (GDP). A case for carbon taxes on efficiency grounds alone rests upon introducing them in a revenue neutral manner, either as a replacement for corporate income taxes or fossil fuel subsidies. Alternately, the revenue generated[22] could be used to set up an State Environmental Fund as has been done in the Czech Republic. The disbursal of funds is focused on air and water protection.

Distortions in the economy

For any nation with energy subsidies, the first priority of the government must be the elimination of those subsidies which would improve the allocation of economic resources, reduce global carbon emissions and generate revenue that can be used in development projects. There are several types of subsidies, such as grants, soft loans and tax allowances, apart from implicit or "hidden" subsidies, e.g. when standards and/or prices of energy, water or other inputs are "artificially" low. Energy subsidies are especially prevalent in developing countries[23]. Subsidies represent a distortion, with resulting welfare costs, so that their removal can be welfare enhancing.

Economy-Wide Effects

The economic effects of a carbon tax are manifest throughout the economy. It would raise the price of energy, increase the cost of products produced by energy-intensive processes, reduce employment in energy sectors, increase employment elsewhere, and generate tax revenue. A carbon tax would raise fuel prices, particularly for coal[24]. Coal demand is likely to fall substantially (subject to availability of alternative resources), leading to a large decline in coal production[25]. Oil and gas output might also decline but by a much smaller percentage. Higher coal prices, in turn, would raise the cost of electricity. Consumers and firms would under this scenario, demand less electricity, which would slow productivity growth and capital formation. This would tend to reduce gross national product (GNP).

What actually happens to GNP, however, will depend very strongly on how the revenue from the tax is used. A carbon tax large enough to have a significant effect on emissions would raise ten to hundreds of billions of dollars annually. If this revenue were used to reduce distortionary taxes elsewhere in the economy, the impact of the tax on GNP would be much smaller. In fact, GNP might actually increase if the revenue were used to reduce taxes on capital.

Outside of the energy industry, the main result of the tax would be to increase the prices of electricity, refined petroleum and natural gas, each by a few percent. This could lead to two possibilities. First, higher energy prices would cause capital goods (which are produced using energy) to become more expensive, slow the rate of capital accumulation, and lower GNP in the future. Second, higher energy prices would be likely to discourage technical change in industries due to the involvement of energy use even in the process of technical change.

ii. Global Carbon taxes

A global carbon tax has been suggested by various members of the international community, as a policy option to combat climate change[26]. There are two types of global carbon taxes:

One, the international tax, in which the tax rate is uniform across the coalition (signatories) countries in order to ensure the cost effectiveness of the program to the coalition in aggregate. However, each coalition country is free to choose its own domestic carbon policy[27] (In the European Union, the member countries have agreed to stabilize emissions at 1990 levels by 2000, this is distinct from the above formulation in that they are free to chose their energy strategy and are not bound by a common carbon tax). Such a proactive approach[28] on the part of some nations (Scandinavian countries) ahead of others has necessitated the adoption of some safeguards (exemptions for energy intensive industries, so that international competitiveness is unaffected).

Two, a harmonized domestic carbon tax in which all coalition countries levy the same domestic carbon tax. Under the harmonized tax system, fixed lump-sum payments from rich to poor countries may be required in order to ensure participation of poor countries whereas under the international tax system, the agreement could specify what shares of the total international tax revenues would go to each participating country. These international financial transfers are proposed in the interest of global distributive equity. For all those coalition countries that would not be fully compensated, there is the domestic problem of burden sharing.

Concerns about the adoption of a global carbon tax

Efficiency

First, the climate change problem is a global problem and needs to be tackled on a global scale. Unilateral or regional action may not be enough to ensure a sufficient reduction in emissions. Second, there appear to be potentially major gains from international cooperation over unilateral action, for instance cooperation could lead to large cost savings achieved by placing greater weight on emission reduction in developing regions such as China, where the marginal costs of abatement would be low. However, it is anticipated that significant side payments from developed regions would be required to induce developing regions to cooperate (either via the Global Environment Facility or via joint implementation). Third, the absence of complete international coverage, could result in 'carbon leakage' by a movement of energy intensive industries away from participating countries to other nations. Hoel (1991) has shown that it is theoretically possible for such a policy to result in a net increase in world carbon dioxide emissions if non-participating nations have less efficient energy technologies. Such a partial coverage may also, by reducing world oil prices, induce an increase in production of energy-intensive goods in non-participating countries. For instance, if a carbon tax is adopted only in the OECD countries, a shift of energy intensive production to less developed countries may increase overall emissions (positive leakage). Further, an OECD carbon tax could reduce OECD oil demand enough to lower the world price of oil substantially. Lower world oil prices could in turn lead to a very large increase in oil demand by developing countries.

Equity

Ensuring sufficient participation internationally and hence an efficient outcome globally will require addressing distributional questions, including the issue of burden sharing. Furthermore, the issue of gainers and losers from a carbon tax cannot be separated from the issue of gainers and losers from climate change. If it is possible to establish the net gainers and losers then it is in principle possible to design a set of transfers which would maximize participation and be globally efficient and equitable. In order to ensure international distributive equity, the issues to be resolved are those relating to the distribution of tax proceeds, the point of application of the carbon tax, and others.

International competitiveness

It is often felt that international competition may make internalization of resource and environmental costs difficult because industries which internalize these costs to a greater degree than similar industries elsewhere may suffer a competitive disadvantage. That is, a firm or a sector that is taxed may suffer from a competitive disadvantage vis-a-vis competitors that are not taxed or not taxed as stringently (e.g Swedish exemptions/reimbursement to energy intensive sectors, as other member countries of the European Union are yet to take action). Such an exemption may in fact negate the effectiveness of such taxes, as these industries contribute substantial amounts of carbon dioxide. Instead of seeking such an exemption these industries may adopt measures like fuel-switching or improved efficiency. For this to occur the taxes must be imposed fully and be reflected in final prices, so that the necessary incentives to economize are given. The competitiveness issue is nevertheless one of concern, and is one reason why concerted international action has been called for.

Also the absence of action on the part of competing coalition members may discourage countries from levying a carbon tax if similar measures are not undertaken. This is exemplified by the proposal for the European Community's carbon/energy tax scheme, which bears a conditionality clause, stating that the tax will be implemented only if similar measures are implemented by the EC's main competitors, i.e., Japan and the US.

It is also important to analyze the impact of environment-related standards and regulations on international competitiveness with regard to developing countries. The need to comply with environmental product regulations in developed-country markets may sometimes result in obstacles to trade for developing country exporters (the case of the leather footwear industry in India), even when standards are internationally agreed-upon or when national standards are in accordance with the Most Favoured Nation (MFN) and national treatment requirements. This could be of relevance when the product standard is energy related, given that our current manufacturing processes are energy intensive (since product characteristics may be affected and come under the purview of the revised Technical Barriers to Trade Agreement). International cooperation is therefore needed to minimize the negative effects of environmental regulations on trading partners, particularly the developing countries and countries in transition[29]. An important question is how the special conditions and development needs of developing countries can receive adequate attention in the decision-making process. Negative effects on developing countries can also be prevented or reduced through increased transparency, early notification, and technical assistance[30].

Environment–development trade–off

Environmental protection may result in a slowing down of the growth-rate in economies (by discouraging energy intensive production, for example), at least in the short run. This may deter countries from adopting measures for environmental protection. For example, most OECD nations have now agreed that some sort of limit under the climate framework should be placed on carbon dioxide emissions. Many less developed nations however have shown reluctance to adopt any carbon dioxide policy that might reduce their economic growth. Schelling (1992) has suggested that this poses an insurmountable obstacle to a unanimous international policy. Thus, a likely outcome is that any global carbon dioxide policy would be incomplete: OECD nations would adopt a policy while developing nations would not.

Practical difficulties

Most global carbon tax regimes in practice appear unworkable, in view of the difficulties of getting nations to agree on (1) a common framework for determining the level and base of such a tax; and (2) institutional arrangements for tax collection and administration, as well as revenue distribution among nations. Some of the other concerns relating to the application of a global tax are mentioned in the section on developing country concerns.

The considerations influencing effectiveness
of carbon taxes

In practice, taxes/charges have been used primarily as revenue sources rather than as incentives to bring about behavioural change. They have been generally set at levels which are too low to deter polluting emissions. The increase in tax rates needed to achieve significant reductions in pollution are expected to be politically unacceptable. In addition, governments are reluctant to impose taxes/charges which might undermine industries' international competitiveness.

While relatively straightforward to implement administratively within the existing institutional framework, taxes and charges have the disadvantage that they leave considerable uncertainty as to whether environmental quality targets[31] will be achieved. Under a carbon tax regime, the effect on emissions is uncertain compared with a quantitative target which is imposed by some other means, for example using a regulatory approach. The issue of prices or quantities is an important one that is relevant in dealing with many environmental problems.

With a tax, the quantitative effect is indeed uncertain but the price, i.e. the cost of the policy is relatively well known and assured. With a quantitative target it is the cost which is relatively uncertain. Optimization requires a balancing of costs and benefits which means that it is not possible in advance to set the "volume" outcome before analyzing the costs and benefits of different degrees of abatement. This does not preclude a government or set of governments from establishing some objectives on emission-reduction, such as stabilization at current levels, and then trying to attain this target in a cost-effective manner. But the risk is that the cost of meeting the chosen objective will not match the estimated benefits so that there will be either excessive or insufficient abatement. Phasing in a carbon tax (as in the Swedish carbon tax) would have the advantage of allowing governments to work towards a quantitative objective which could be established over time as estimates of costs and benefits become better defined. Adjustments to the tax path could then be made in order to work gradually to establish an optimal degree of abatement.

Since there may be a high probability of error in setting the price control, of relevance in the use of this instrument (which is sensitive to price), quantity controls (such as a tradeable permits scheme) may be preferred over price controls. This is examined below.

D. Marketable or tradeable permits[32]:

The system of tradeable permits in the context of climate change, entails defining an overall target for emissions and then issuing permits to emit carbon to this level. Emissions trading can be applied in the context of any policy structure which is based on regulating emissions either directly (via emission standards) or indirectly (by making technology or input limitations mandatory). The participants in the trading scheme would have to hold permits equal to the value of their emissions (which are clearly quantifiable). However, if they prove insufficient, the permits would have to be bought or leased ('trading') from other participants (the need for a sufficiently wide market). The sum of these permits would equal the overall target or cap. Here the commodity being traded is the right to emit a particular pollutant in a specific region. The trade can take place within a plant, within a firm or amongst different firms.

Trading has been found to work better for large corporations, as transaction costs are sufficiently high and only large trading corporations can offset these costs and yet yield net gains. Other conditions required for implementation may include facilities for banking emissions over time; monitoring and enforcement requirements; and an effective information network across participants in the scheme and the government. Other issues to be decided upon, while devising a scheme of implementation are: at what level should the prices of permits be fixed?; should permits be auctioned or freely allocated ('grandfathering'")?; what is to be the basis for the initial allocation of permits?; how can transactions be most effectively managed and controlled?; how should one determine the optimum geographical scope of tradeable permits?

A critical issue in the operation of a tradeable permit system is how to allocate permits. While allocating permits two considerations are relevant, that of ensuring equity and acceptability to the participating countries (UNCTAD, 1995). Potential schemes which could form the basis of allocation schemes of permits are:

- levels of per capita emissions (based on the right of the individual to use the atmospheric resource;
- levels of emissions per unit of GNP (rewards economic activity but penalizes poor countries);
- size of population (based on equal per capita shares);
- extent of land area (encourages low population density);
- the principle of historical responsibility, whereby older emitters/firms would be allotted a greater share;

However, irrespective of the initial allocation of the permits, the subsequent trading leads to the participants' incurring minimum cost. Additionally, some rules need to be defined for trading the permits. The basic rationale for trading is that it reduces cost, because countries buying permits are able to meet their abatement expenses more cheaply, and those selling permits are compensated for their abatement expenses by revenues obtained from the sale of permits (UNCTAD, 1995). Emission reduction credits (ERCs) could be auctioned off to the polluter at the market clearing price, or created by the polluter as surplus reductions over a predetermined set of emission standards (since the latter approach favours older over newer emitters, it is referred to as 'grandfathering'). Either approach will ultimately result in a cost-effective allocation of the control responsibility among various polluters as long as they are price-takers, transaction costs are low, and emission reduction credits are fully transferrable because the after-market in which firms can buy or sell ERCs, rectifies any deficiencies of the initial allocation. This property of the tradeable permit system is very significant because it implies that under the right conditions, this initial allocation of emissions standards can be used to pursue distributional goals.

However, when firms are price setters, cost-effectiveness can be achieved only if the initial allocation of emission standards is such that it can achieve a cost-effective allocation even in the absence of any trading. Cost-effectiveness can be achieved even in the presence of price setting firms because the absence of trading prevents any firm from exploiting any market power. However, regulators need to have complete information on control costs for all polluters in order to achieve this allocation. Since this is not feasible, an active trading market will exist, offering the opportunity for price-setting behaviour.

The larger the deviation of the price setting source's emission standard from its cost-effective allocation, the larger the deviation of ultimate control costs from the least cost allocation. When the price setting source is initially allocated an insufficiently stringent emission standard, it can impose higher control costs on others by withholding ERCs from the market. On the other hand, when an excessively stringent emission control is imposed on the price setting source, it necessarily bears a higher control cost in order to reduce demand (and hence, prices) for the ERCs. Similarly, when transactions costs are high, the cost of consummating a transaction may exceed the potential benefits from it, thus eliminating the incentive to participate in trading.

Due to being quantity based, emissions trading offers opportunities to firms for leasing credits if the temporal pattern of emissions varies across sources. Such flexibility is not available in any other policy instrument for pollution control. If a firm has emission patterns that vary over time, then it can lease ERCs to another firm when its own emissions are below the allowable level, and recall them when required. Another advantage of leasing is that firms that are about to shut down can lease credits for the period till it shuts down. Under the regulatory approach, the firm would either have to shut down early (before the deadline for attainment of control) or install expensive pollution control equipment which would be rendered useless after the closure.

Another advantage of the emissions trading program is that since it can separate the two issues of which emission points are controlled and who pays for the reduction, emission control is attained at least cost. This has implications at both the national level and the international level. At the national level, regulating some firms is undesirable from a social standpoint, even though their marginal costs of control are lower. This is because of their financially precarious position and inability to pass on higher costs to consumers. To compensate for this, other firms have to control their emissions to a greater degree (at a higher marginal cost) leading to higher control costs. However, under a trading permits regime, the financially precarious firms can reduce emissions in order to create saleable ERCs, and would profit if the revenue earned from ERC sales exceeded the cost of control. The firms facing stringent controls would also benefit as buying ERCs may be cheaper than controlling emissions, and hence the overall regional control costs would fall. At the international level, trading will tend to transfer resources from the richer countries, where the cost of abatement is higher, to the poorer ones, where the cost is usually lower.

It is this reason that the tradeable permits system is most cost effective: that it is based on actions of buying and selling, in which participants aim to minimise their costs.

Tradeable permits have the advantage that they always encourage polluters to improve their performance, since they can then sell their unused production rights to others. Since production costs between firms vary widely in developing countries, potential gains from trading are likely to be large. These permits thus encourage the development and adoption of new technologies. However, the fact that they require well developed management structures and mechanisms, makes them unsuitable for most developing countries.

An effective trading system relies upon two different set of institutions. The first set involves market or quasi-market institutions and procedures that will provide information regarding the availability of entitlements for purchase, storing or 'banking' entitlements for further use or sale, and specifying the environment for transfer of entitlements. These market or quasi-market institutions must be complemented by a set of administrative institutions and procedures which create the environment within which market processes can operate efficiently. These include certification procedures for ensuring the homogeneity of transferred entitlements, monitoring procedures to attain compliance with the agreement, and enforcement procedures to deal with non-compliance (Tietenberg and Victor, 1994a).

In the actual working of a tradeable permit regime at an international level, emission entitlements for CO^2 among the signatory nations will depend upon the extent of abatement desired. If, for example, scientific evidence suggests the need for more drastic reductions, fewer entitlements could be granted (Tietenberg and Victor, 1994b).

The successful implementation of a transferable entitlement system requires the existence of a supporting set of institutions. Key functions performed by this supporting institutional structure are certification, monitoring and enforcement. Certification should be so designed as to offer flexibility in creating credits, and at the same time ensuring that the objectives are not compromised by that flexibility. Monitoring provides a basis for assessing compliance and helps in deciding whether stronger international action would be necessary.

At the international level, monitoring can be designed which relies heavily on self-reporting, which involves layers of veracity checks, which promotes transparency of behaviour through wide availability of collected data, and which is flexible.

Designing enforcement systems at the international level is difficult because international institutions are typically weak and international treaties rest on the assent of their parties. However, an economically and politically viable enforcement system can be crafted if:

(1) it relies heavily on domestic enforcement, especially by existing institutions,
(2) it establishes international standards for domestic enforcement,
(3) it incorporates veracity checks and international adjustments through agreed upon procedures for dispute resolution, and
(4) the principle of transparency is effectively incorporated.

In principle, there need be no difference between domestic carbon taxes and tradeable carbon permits from a distributional point of view. Moreover, what was earlier called recycling for carbon taxes exists to the same extent for a permit system. Tradeable permits may be grandfathered, in the short run, to (partly) compensate existing firms that may have not been sufficiently forewarned about the new policy. This choice corresponds to a tax scheme where, in a period of transition, all carbon tax revenues are redistributed to the firms that would have received free permits under a permit scheme.

Alternatively, after the period of transition is over, no compensation at all would be paid. This would amount to a tax system where the government kept the tax revenue (and used it for unrelated purposes) or a permit scheme where all permits were auctioned and the government retained the sales revenue.

Tradeable permits fix the level of control while taxes fix the marginal costs of control. Under a tradeable permit system, policy makers determine how much total pollution can occur (through the issuance of permits), but they do not and cannot set bounds on expenditures on pollution control. Taxes control the maximum amount that a firm may pay for each increment of emissions, but they do not dictate with certainty how much control will actually occur.

To maximize the chances the permit market was competitive, in the scheme discussed by Hinchy, Thorpe and Fisher (1993): it was envisaged that there would be direct trading in permits between major emission sources within and across countries. However, for dispersed emission sources such as motor vehicles, transactions costs would probably be lower if governments made the initial purchase of permits. The costs of such purchases could be financed by taxes on motor vehicle users. These taxes would have to be set at such a level to attempt to ensure that aggregate motor vehicles emissions complied with the permits held. Taxes could be used in conjunction with other policies such as emission standards to attempt to achieve compliance. It may be that the problem of uncertainty about appropriate tax rates is present to some extent when the practical details of a tradeable permits scheme are considered. Nevertheless, the problem is not of the same magnitude as if there were total reliance on emission taxes.

Tradeable permit systems may be more susceptible to 'strategic' behaviour than tax systems. In order for a tradeable permit system to work effectively, relatively competitive conditions must exist in the permit (and product) market. The degree of competition will help determine the amount of trading that occurs and the cost savings that will be realized. Should any one firm control a significant share of the total number of permits, their activities may influence permit prices. Firms might attempt to manipulate permit prices to improve their positions in the permit market (say, by withholding permits and forcing others to cut production or keeping new entrants out). These risks would be reduced by: (a) using time-limited permits - that is, permits for emissions for a period of say five years, which might be in line with the design of an existing international tradable quota scheme; and (b) the government auctioning permits.

Tradeable permits appear to have some advantage over taxes when time and uncertainty are introduced into the analysis. Under a tax scheme, there would be a high level of uncertainty about investment in emission intensive activities with long payback periods such as coal fired power stations and research and development in technologies to reduce emissions. Such uncertainty would arise from uncertainty about the future nominal level of the tax and the impact of that tax given possible changes in relative prices, the absolute level of prices, and the level of economic activity.

A tradeable scheme can be designed to reduce uncertainty about the future in a number of ways. One approach would be to issue permits with different durations (Bertram, 1992) or for a set of future (for example, five-year) periods. Firms undertaking emission intensive investments with long payback periods would be able to reduce uncertainty about future costs by buying permits for the desired number of periods. The development of a forward or futures market for permits (that could be coupled with permits of different duration) would provide an even better mechanism to spread the risks associated with uncertainty about future policy toward emissions. Firms undertaking research and development into technologies to reduce emissions would be able to hedge the risks associated with the payoff from such technologies through operations in the futures market (Epstein and Gupta, 1990).

Similarly, firms investing in emission intensive activities would be able to hedge against the risks of future policy changes through futures markets operations.

Hence, permits may be somewhat more effective than taxes in achieving given emission targets. The lack of control over emissions with taxes could be a disadvantage. The frequent changes in taxes that may be required would add to the business uncertainty. Permits may be more susceptible to strategic manipulation than taxes but this problem can be reduced by scheme design. Permits appear to have a distinct advantage in creating the basis for a futures market that could enable a more efficient spreading of the risks about the future policy uncertainty.

4

Evaluation of Application Potential of Economic Instruments Based on Economic Theory and Modelling Results

While evaluating the potential for application of the various economic instruments in the context of climate change, it is important to consider potential implications on trade[34], GDP and Welfare, from a theoretical as well as modelling perspective. This would help facilitate an evaluation of how modelling results (both top-down and bottom up approaches) conform or depart from what is envisaged by theory. Such analysis are needed, to anticipate potential issues and policy responses. In this latter area, however, policy options inevitably raise questions as to whether modelling results can serve as a partial basis of policy prescriptions, or whether they instead are useful as general indicators of possible issues.

Model results noted in this paper may have either adopted a top–down or bottom–up approach. Variation amont them also occurs on the basis of:

(i) geographic scope-global or regional,
(ii) sectoral scope—energy, industry, services, transport, household, etc;
(iii) policy instruments assessed;
(iv) data—energy demand projections, fuel price scenarios, cost, and availability of technologies;
(v) level of forecasted emissions in the absence of environmental policies and the level of emission reduction required and
(vi) other features.

Some efforts have been made in both the Energy Modelling Forum and the OECD[35] to standardize the assumptions across models, to the extent possible. It still remains that the focus of individual global models may vary, in spite of their primary aim being that of simulating a carbon constraint. Issues of trade, GDP, and welfare are covered in a theoretical framework. This is followed by a description of the macroeconomic models, their results relating to trade implications, GDP, and welfare (wherever available), arising from the simulations using various policy instruments (at the regional and global level).

Trade Considerations

The FCCC is characterized by an absence of direct mention of trade provisions/trade restrictions[36] (in comparison to the Montreal Protocol) although there are indirect implications for trade. The presence of direct trade restrictions is likely to have implications for non-cooperating countries, as their presence is meant to deter free riders, get more countries to cooperate, and simultaneously prevent the treaty being undermined due to trade between cooperating and non-cooperating countries.

Concerns relating to trade[37], primarily relate to alterations in the terms of trade[38], if any; volume of trade, competitiveness, leakage of emissions from countries not part of the agreement; and impacts and implications of border tax adjustment policies on trade, primarily related to the levy of carbon taxes.

The first consideration is to detemine the extent of dependenvy of a region in terms of being energy importing or energy exporting. The latter (leakage) supplies the rationale for countries participating in cooperative action to reduce CO^2 emissions, the absence of participation leading to a compromise on the aim of reducing CO^2 emissions. As all models included in this study do not take into consideration trade, particularly at the international level in terms of full trade flows, or are limited to the bilateral level, the modelling results discussed include those of GREEN, Whalley and Wigle, and the Carbon Rights model.

Altered terms of trade (relative prices of imports and exports) could potentially occur as a result of the following circumstances. It is anticipated that producers of energy intensive goods would be forced by either enhanced costs of production or consumer preferences to shift away from the production of such goods (except in such cases when the resource availability dictates continued usage). Alternately, terms of trade could alter due to changed trade patterns arising from shift of carbon intensive activities to countries where they are not taxed at the same level, compromising the original policy of carbon dioxide mitigation to some extent.

In addition, revenues generated in the event of levy of a carbon tax, may influence the terms of trade depending on the point of application, i.e. on the fuel producer or the fuel user. In the former instance the exports prices would be raised and in the latter the import prices. This would assume importance in those countries having significant net trade flows in carbon products. However, the terms of trade between non energy goods are not generally so significant for individual countries. This is because both price changes and the degree of non specialisation are less extreme in markets for non-energy goods than in markets for energy-intensive goods.

This adjustment to the altered terms of trade may prove expensive, although it does not necessarily follow that such countries will suffer major losses of income as a result. If factors are mobile between sectors, industries are competitive and specialization is incomplete, then once adjustment has occurred, factor price will be equalised across sectors. This will ensure that all labour in the world experiences the same income shift independent of its initial industry of employment and regardless of previous output patterns.

In practice, factors are mobile and market structures are perfectly competitive in the long run. However, countries may fare differently because of their different factor endowments (and since labour and capital may be affected differently). Abatement will reduce the marginal product of capital and hence, with a constant capital stock, its rate of return.

However, in the long run, over which the capital stock is variable, rentals will return to their natural levels.

The terms of trade could also be altered due to the existing pattern of concentration of primary commodities in the export basket of DCs as opposed to manufactures in the developed world. The application of a carbon tax would enhance the cost of procuring these manufactures by the DCs.

Another potential effect of abatement could be to curtail the growth of trade in manufactures, as mentioned earlier. This might occur as prices of manufactures rose relative to those of services and non-tradeables, and also because protectionist barriers may be used to defend local producers from abatement costs. The post-war period has witnessed a rapid expansion in manufactured trade. If abatement policy curtailed such growth it could induce a decline in GDP. This in turn would affect trade patterns in general.

A change in competitiveness (whereby there are changes in price across all the country's goods) may occur under the following circumstances: (i) in the event of an uneven global abatement policy, i.e. only if abatement is restricted to some countries; or (ii) under an even abatement policy when participation is complete, and participants are differentially affected due to factors like prevalence of subsidies and varying growth paths of emissions, (in spite of a uniform carbon tax); or (iii) in the case of application of a border tax.

Taxation or other restrictions on a polluting industry which is engaged in international trade would make it more difficult for that industry to compete internationally. A country wanting to maintain stringent environmental standards has the following options to prevent loss of competitiveness of its domestic industry:

(1) levy import tariffs (border tax adjustment) to offset pol-

lution charges so that domestic producers will not be at a disadvantage compared to to competing producers of other countries without similar environmental regulation; and/or

(2) subsidise the cost of environmental protection with general revenues. Thus taxation would lead to the energy intensive industries in these countries suffering a loss in competitiveness, unless there are exemptions made to assist them[39].

Competitiveness across nations could be affected if economies have existing distortions that are addressed by abatement. Though eliminating existing distortions would improve world welfare, it would still imply additional adjustment for the sectors directly concerned, and this might get reflected in their international competitiveness[40]. Existing subsidies reduce the price of energy and hence, although their removal will reduce overall proportional abatement costs, a larger proportional abatement will be required.

On the other hand, if subsidies are permitting the use of local high-cost energy sources rather than cheap imports, the effects could be just the opposite.

Another aspect of competitiveness arises if abatement entails the imposition of rigid quantitative emission targets for each country. Then the implicit carbon tax is bound to differ between countries. Even if it was the same initially, differences would soon emerge as countries grew at different rates. Different tax rates imply competitiveness effects, and energy-intensive production would migrate to places where the emissions targets were loosest (i.e. where the tax was lowest).

If demand patterns remained unchanged this would affect international trade patterns and would result in the imposition of a carbon tariff. Another potential cause of a loss in competitiveness could arise from the application of a border tax[41], which could lead to a country's (including developing) products being subjected to a substantial increase in the price of the product. In addition double taxation, due to taxation in the country of origin and the country of destination could enhance price to the extent that it is non-competitive.

It is anticipated that the volume of world trade may fall because reduced fuel demand will tend to reduce fuel exports and hence final good imports. Moreover, since fuels are essentially Ricardian goods - goods in which comparative advantage depends primarily on natural resources it can be concluded that the fossil fuel exporting countries would be most affected.

The potential for carbon leakage[42] arises under various circumstances as discussed below, particularly in the scenario of unilateral abatement. Leakage could either be positive (increase in carbon emissions) or negative (decline in carbon emissions). The subject is of concern as it is felt that non-cooperating countries (to stabilization) increase emissions as a consequence of abatement undertaken by cooperating countries, although currently there does not appear to be any definite empirical evidence to support this concern[43]. This would result due to the comparative advantage such non cooperating countries would enjoy in the manufacture of energy intensive goods which would in turn lead to an increase in emissions (positive leakage).

According to the GREEN model (below), carbon abatement is likely to cause a reduction in energy demand in energy importing regions. This in turn would reduce income and economic growth for energy exporters leading to a fall in energy demand in these regions, and therefore a decline in carbon emissions (negative leakage). Some countries which do not impose a constraint may also have a negative leakage, which could be due to the adoption of efficient technologies. Alternatively, positive leakage may also be due to the non-participating countries having less efficient technologies to curb carbon dioxide emissions and this could strengthen the argument for technology transfer, which could reduce potential leakage.

The EC, which has proposed a European carbon tax, has incorporated some policy corrections for leakage, which are: (i) carbon tax + energy tax, (ii) exemption of certain energy intensive industries (although the underlying rationale is to reduce leakage, modelling of this scenario has shown no significant effect on leakage rates), (iii) tax package conditionality based on the other OECD countries adopting a similar policy.

In the case of tradeable permits, it is expected that they may not have significant implications for competitiveness, though they can constitute market barriers if they are not well designed. Verbruggen suggests that if the market for permits is not functioning well (due to indivisibilities and strategic behaviour), then less than the potentially available permits maybe supplied. Due to the emissions ceiling being fixed, expansion and new investments, particularly foreign investments, maybe blocked due to the lack of supply of permits. Also in the case of allocation based on grandfathering there may exist conditions of sheltering older/established firms and impediment of entry of new firms.

GDP and Welfare Concerns

The costs/benefits of abating GHG emissions can be measured in terms of various economic welfare indicators like real GDP, the change in household real income—Hicksian

equivalent variation[44] and the change in real domestic absorption[45]. Although global models like GREEN use all three preceding measures of welfare, most use the straightforward indicator of percentage change in GDP. This is so in spite of the uncritical use of GDP being increasingly questioned. Some of the concerns expressed relate to its use over a hundred-year period; the fact that even if consumption is proportional to GDP, welfare is not proportional to consumption; and that it is a partial indicator of welfare as it does not reflect changes in the terms of trade.
This last aspect assumes importance particularly in the case of oil producing countries.

The GDP implications arise from the (a) scale of the tax, (b) use to which the resources are put (refers to the option of the tax being revenue neutral, or return of revenue as a lump-sum rebate), (c) enhanced economic efficiency, (d) reduced balance of payments occurring due to reduced energy demand in energy importing countries.

Welfare implications arise from the distributive effects based on differential impacts on various income groups (carbon taxes considered regressive, in this context); and are associated with (a) efficiency gains from the removal of distortions (like energy subsidies), and (b) changes in the terms of trade, among other causes.

Apart from the above, a reduction in growth in the OECD arising from a carbon tax could force a reduction in aid flows to some extent. For OPEC[46] countries, a reduction in their earnings would not only limit their ability to give assistance, but some of them would actually require financial assistance. A number of them are already seriously indebted and undergoing painful adjustment processes. In fact, following the 1986 price fall, OPEC's official development assistance as a percentage of GNP has fallen substantially.

The changes in GDP predicted by various models are included below. The typical pattern across regions is for welfare losses to increase over time in line with the carbon tax.

Macroeconomic models

As mentioned above, the macroeconomy modelled could be either at an international or a national level. Some of the features included in our discussion relate to the assumptions made, the regions covered, use of policy instruments like carbon taxes, (at a regional or international level), and implications for trade, GDP, and welfare for the concerned regions. It must be noted that the results are not comparable due to the many underlying differences mentioned earlier), although some standardization exercises have been conducted by the OECD among others.

Global models are better able to assess the likely potential gains from international cooperation as opposed to unilateral action in reducing carbon dioxide emissions. They also strengthen the case for participation of major non-OECD countries, as is evident from the results from GREEN, which indicate that global CO^2 emissions would continue to grow after 2010. Global models discussed include (i) GREEN, (ii) the Carbon Rights Trade Model, (iii) the Global 2100 model and (v) the Whalley and Wigle model. The national model of the Indian economy is that by Ghosh (1990).

A. The GREEN Model:

The GREEN (the GeneRal Equilibrium ENvironmental)[47] model developed by the OECD Secretariat is a multi-region, multi-sector, dynamic applied general equilibrium model with a time horizon extending to 2050. This quantifies the economy-wide and global costs of policies to curb CO^2 emissions. The model is characterised by disaggregated regional coverage with 12 regions represented, six of which relate to developing countries. The regions are China, India, Brazil, the Dynamic Asian Economies (Hong Kong, Philippines, Singapore, Republic of Korea, Taiwan, and Thailand), the Energy exporting LDCs (both OPEC and non-OPEC) and the Rest of the World (members included are Argentina, Pakistan, Israel, Syria, Chile, Morocco, and others). All regions are linked by trade flows so that the model is able to quantify the effects of policies to curb CO^2 emissions in one or more regions on trade flows and the terms of trade of all regions.

Imports from different regions are treated as imperfect substitutes, with the exception of crude oil which is assumed to be a homogenous good. This treatment of imports implies that each region faces downward sloping demand curves for its exports.

The simulation results with GREEN involve using carbon taxes[48] to achieve emission reduction targets; under two scenarios, either those in which only the OECD countries cooperate to reduce emissions or one in which all the countries participate. The effects of removing existing distortions in energy prices across regions are also examined, although these results are not included in this paper. In results pertaining to agreements by OECD countries to curb CO^2 emissions, based on announced commitments, revenue neutrality is assumed. Pertaining to the scenarios, the specific simulations are:

(1) OECD Stabilization in 2000, at 1990 emission levels; (2) OECD Stabilization in 2000 at 1990 emission levels using a mixed energy/carbon tax; (3) International agreement including the Non-OECD Regions;

Scenario One: OECD Stabilization in 2000, at 1990:

Emission levels of OECD countries stabilize their emissions in 2000, at 1990 levels, except for Japan (which is assumed to stabilize at a per capita basis). Stabilizing OECD emissions at their 1990 levels implies a significant cut, relative to the BaU path of 43 percent by 2050. It has a marginal impact on global emissions which are only 11 percent lower in 2050.

Leakage

In the absence of complete participation, there is a likelihood of increase in emissions in non-participating countries. Carbon leakages could be due to the rise in energy prices in participating countries, leading to the energy intensive industries in non-participating countries gaining in competitiveness. It could also result, if the restriction imposed by the agreement is sufficiently binding, leading to a fall in world prices, in turn leading to a rise in emissions.

The scenario indicates carbon leakages in the non-OECD countries, an emissions increase in the former Soviet Union, and decline in the energy exporting LDCs and China, in response to the cut in the OECD countries. The leakage is insignificant, peaking at 2.5 percent of the cut in OECD emissions in 2000, becoming slightly negative in 2010, turning positive again, and finally achieving a value of 1.5 percent in 2050.

A sensitivity analysis was carried out to assess whether this result of negligible leakages reacted to large changes in values of foreign trade elasticities. When the scenario included a much more severe constraint on the OECD, involving a cut of 80 percent over BaU, by 2050; the net leakage did not exceed 6 percent of the cut in emissions of the OECD.

Welfare

Regarding welfare, the achievement of the stabilization target imposes a small welfare cost on the OECD countries, from 2005. Prior to that they record small welfare gains as the improvement in their terms of trade arising from the cut back in oil imports more than offsets the efficiency losses due to the carbon tax. There is a decline in the terms of trade in the OECD as they substitute towards crude oil, adding to their welfare loss which reaches 1.3 percent by 2050. The largest welfare loss in 2050 is in Japan, followed by the EC.

The further reduction of emissions, has marginal welfare implications for the non-OECD countries, with the exception of energy exporting LDCs, which experience losses over most of the simulation period; the maximum real income loss being almost 3 percent below BaU levels in 2005, with the loss declining steadily after 2010, and a gain in 2050 as the substitution away from the carbon based synthetic fuel in the OECD, raises demand for crude oil.

The real GDP in the OECD is almost 1 percent below the baseline in 2050, with the greatest decline in Japan. Except for the energy exporting LDCs, the output effects in the non-OECD countries are marginal.

Scenario Two: OECD Stabilization in 2000 at 1990:
Emission levels using a mixed energy/carbon tax In this case, the EC stabilizes emissions at 1990 levels using a mixed energy/carbon tax, as proposed by the EC Commission. The proposed tax would be equivalent to $3 per barrel of oil (in 1993) reaching $10 per barrel in 2000, and would have an energy and a carbon content component in a 50:50 ratio. The Commission further decided that certain energy intensive industries and other sectors exposed to international competition, would be exempted until the ECs main trading partners took similar measures. Since no decision was taken regarding sectors to be exempted or level of exemption, the

simulation incorporated the application of the carbon tax on all sectors.

The carbon leakages induced by the EC proposal are moderate, peaking around 11 percent in 2000 and declining to zero in 2050. In the event that all the OECD countries take action to stabilize emissions, the leakages are greater, indicating that the majority of the OECD trade is intra-area trade. Positive leakages occur due to a shift in the production of energy intensive goods away from the EC to other OECD regions and certain non-OECD regions like the former Soviet Union, the CEECs, and RoW.

The economic costs to the Community (in terms of lower output and welfare) for the scenario of achieving stabilization in 2000, are very small. The real GDP is about half a percentage point below its BaU level in 2010 and the output loss rises slowly to 0.6 percent by 2050. After 2030, the EC suffers a terms of trade loss which aggravates its welfare loss. The EC tax also affects energy exporting LDCs, which record lower output and welfare due to the cutback on EC oil imports. Real output and welfare in the LDCs is one-fourth to half a percentage point lower than the BaU level over the period 2000-2050. The welfare loss reaches a maximum of 1 percent in 2010 before reducing due to a recovery in terms of trade.

Scenario Three: International agreement including the Non-OECD Regions:

The assumption is that OECD countries reduce emissions in 2010, to 80 percent of their 1990 levels and stabilise them thereafter; and non-OECD regions emissions were restricted to 50 percent higher than 1990 levels, by 2010 and stabilized thereafter. This would mean that there would be relatively larger proportion of reduction in emissions, relative to the BaU levels in non-OECD countries (-68 percent) by 2050 compared with a cut of 54 percent in the OECD countries.

Trade

Terms of trade gains occur in the OECD countries over most of the period. They peak around 2010 and decline slowly as the restrictions can be met by using back stop options instead of cutting down on oil imports. All the OECD regions record terms of trade losses as the carbon taxes induce them to substitute oil imports for the carbon-based synthetic fuel.

Most non-OECD regions suffer very small terms of trade losses or gains, except for energy exporting LDCs which experience sharp losses till 2030, in line with the decrease of world oil price relative to the BaU scenario. Their terms of trade recover after 2030 due to the shift away by the OECD countries from a carbon-based synthetic fuel towards imported oil. China experiences a growing terms of trade loss from 2030 as it responds to the carbon restriction by substituting oil imports for coal and the carbon-free synthetic fuel.

Welfare and GDP

The welfare loss of the OECD countries reaches 2 percent in 2010. Due to the backstops further lowering the costs of reducing emissions, between 2010 and 2030 this falls to 1 percent in 2030. This increases again after 2030 to reach the value of 2.1 percent in 2050 due to the increasing terms of trade loss in line with the increase in world oil price.

A very diverse set of impacts is faced by the non-OECD regions, energy exporting LDCs experiencing the largest losses, their real income being almost 10 percent below the baseline in 2030. In the period after 2030, there is a significant shift in the patterns of welfare gains and losses. The recovery of oil demand in the OECD countries and domestic supply shortages combine to produce an income shift in favour of the energy exporting LDCs, leading to a narrower welfare loss, of three and a quarter percent in 2050.

Among the non-OECD regions, China and India become the main losers due to their high carbon taxes, with their welfare losses reaching 8 and 4 percent respectively. Countries/regions like India and the energy exporting LDCs lose competitiveness in energy intensive industries to the benefit of RoW and the CEECs.

When a simulation of achieving a Toronto type agreement, using a pure energy tax or a mixed energy cum carbon tax, indicated that the output and welfare losses would be higher in comparison to that obtained using a carbon tax. Those regions which are either energy exporting LDCs or are dependent on imports of such fuels, suffer larger welfare losses when the emissions reduction target is achieved using an energy tax instead of a carbon tax. This welfare loss could be as high as 10 percent in 2050 with an energy tax, compared with a 3 percent loss under a carbon tax. China and India, which are large coal consuming countries, record smaller welfare losses under an energy tax.

B. Global 2100

This model developed by Alan Manne and Richard Richels analyzes the economic costs of limiting carbon dioxide during the 21st century. The regions included are the United States, Other OECD nations, USSR, China, and Rest of the World. The model is benchmarked for the year 1990 and the projections are for ten year intervals from 2000 to 2100.

GDP

In this model the economic costs of carbon reduction for the US, rise to 3 percent of the GDP and hold at this level for 2030-2100. For the rest of the OECD, it holds at about

2 percent of the GDP, the plateau being lower due to relatively larger undiscovered oil and gas resources, as well as due to the larger nuclear power industry. In the former Soviet Union and Eastern Europe, the GDP losses reach over 4 percent in 2030-2040 before stabilizing at 3 percent. For the Rest of the World, the losses are low through 2030, but reach 5 percent of GDP by 2100. China faces the largest losses, estimated at 8 percent of GDP by 2040 and rising to 10 percent by 2100.

Trade

This model is limited by the absence of modelling of trade, either in production or in energy resources, except for exogenously specified bounds on the willingness of each region to export or import oil. Neither does the model incorporate terms of trade. This may lead to an understatement of costs to the Rest of the World if adjustment occurs through consumption taxes imposed in the OECD.

C. Carbon Rights Trade Model

This model, known as the Carbon Rights Trade Model (CRTM), has been developed by Thomas Rutherford. It is a general equilibrium model whose time frame of analysis covers 1990 through 2100 in 10 year intervals. It features five regions of the world economy which are: the USA, other OECD countries, the USSR, China, and RoW.

Trade

Since the DCs output consists primarily of primary commodities in contrast to the OECD which specialises in manufactured products, the imposition of a carbon tax is likely to enhance the cost of manufactured goods, thus affecting the terms of trade for developing countries, with the exception of the newly industrialized countries.

An identification of the regional allocation of leakage, for a 2 percent per annum OECD cutback, showed that the RoW region constituted the main source of leakage in the first few periods. This is because in this model, RoW takes the role of OPEC price leader. As the OECD reduces oil imports, there is downward pressure on the international oil price. To sustain the international price, RoW severely restricts exports. This leads to a sharp fall in the RoW energy and the consequent leakage through both substitution and increased BMAT (Basic materials sector: steel, plastics, chemicals, glass, which are energy intensive) production.

The leakage rates are highest in the period 2000-2030 and are then negative later in the century. This is because the OECD carbon restrictions lead to lower levels of fossil fuel consumption and delayed extraction of relatively low-carbon oil and gas supplies in the RoW region. As a result, there is a significantly lower output of carbon intensive synthetic fuels in the RoW in the years 2060-2080 when the OECD unilaterally reduces carbon emissions.

GDP

The results using this recursively dynamic trade model show that the GDP losses for a 2 percent OECD reduction produces a long term GDP loss of 2.5 percent in the USA, 1.5 percent in other OECD countries, and of the order of 4 percent for other regions (non-OECD regions range from 3.5 percent for China to over 4 percent for RoW). In the OECD itself, the welfare costs are higher for the US as compared to other countries, due primarily to differences in composition of energy supplies in these regions.

D. Whalley and Wigle Model:

This general equilibrium model was developed to study the international incidence of carbon taxes. According to this model the world is divided into six regions, the EC, North America, Japan, other industrial market economies, oil exporters (OPEC countries and major non-OPEC, non-OECD energy exporters), and the Rest Of the World. It incorporates trade, production, and consumption of both energy and non energy products for these groups of countries. Projections are over the period 1990 to 2030. Each region is endowed with four non-traded primary factors of production: primary factors other than energy resources; carbon based energy resources; other energy resources; and sector specific skills and equipment in the energy intensive manufacturing sector. There are three internationally traded commodities: carbon based energy products, energy intensive manufactures, and other goods.

The three experiments conducted by Whalley and Wigle were designed to reduce carbon emissions by 50 percent from the baseline over a forty year period. The three instruments examined were a producer tax, a consumer tax, and an internationally levied tax with revenues redistributed according to population. The tax required to achieve the goal of 50 percent emissions is an average of $440 per ton of carbon.

Trade

This model shows the change in trade patterns under a carbon tax regime. Oil exporting regions stop the import of energy intensive manufactures and instead commence their export. Europe and Japan do the reverse (there is an increase in the relative scarcity of energy in these two countries, following the imposition of the tax). The authors do not simulate the model prohibiting changes in interregional trade.

Welfare

For the case in which all regions participate towards a 50 percent reduction from the baseline over a forty year period (through consumption cuts), all regions benefit except for oil exporters, this being due to a sharp deterioration in their terms of trade. North America experiences the largest loss (9.8 percent of GNP) as the generated revenue is primarily redistributed to developing countries. This redistribution allows the income of developing countries to rise by 1.8 percent in spite of global income falling by 4.2 percent.

In the case of unilateral consumption cuts of 50 percent, this leads to losses in the region concerned and benefits for all the other regions except oil exporters (approximately 18.7 percent GNP loss). The positive effects for non participants come not only from shared benefits in emission reductions, but also from terms of trade and other effects.

In the case of a production tax, the oil exporters experience gain (4.5 percent of GNP) as they are able to levy the tax on foreign oil consumers.

E. Ghosh's Model:

Although national models are not in a position to compare unilateral and multilateral policies nor to assess effects of different policies on world trade patterns, they provide a considerable amount of information on the industry level effects of global warming policies. The only national model (general equilibrium) included is one for India. Ghosh (1990), has developed a computable general equilibrium model (CGE) using empirical data for India, which simulates the use of different policy instruments, both market based and fiat based.

The economy modeled is an open, national economy and a price taker for imported commodities (while it engages in trade, its demand for imported aggregated commodity is small relative to world market demand). The international trade sector is included since it is an open economy. In this formulation, the internationally traded and domestically utilized commodity is considered to be the same, and the domestic prices of commodities is driven by world prices and tariff levels and is thus exogenous. In this approach, the good may be exported or imported not both.

In addition there is usually significant variation between domestic and world prices of commodities not due to tariffs alone. Countries also enter into two way trade in commodities of the same category.

The empirical simulations conducted include the use of fiscal policy instruments: import tariffs and other indirect taxes (excise and sales tax) focused on the outcomes of a single sector; and also assessed the use of tradeable permits. In the case of import tariffs, the "intermediates" sector is studied, which is a major energy user, having dense supply and demand linkages with almost all other sectors and is traded both ways. The import tariffs rate on GHGs energy intensive sources (coal and petroleum) were increased by 1 percent over 1984 rates (coal: 0.9 percent and petroleum: 11.9 percent). There are no imports of electricity or natural gas. The increase in import tariff rates on coal and petroleum did not affect the GDP, and there was a decrease in the Welfare Index of a sufficient order to further impact consumer welfare. There is a slight decrease in gross GHGs emissions.

This is due to the fact that the domestic prices of all commodities increase perceptibly, except for coal which decreases slightly. The highest increases occur in the case of petroleum, due to the fact that it has the highest initial level import tariff. There is a large increase in the imports of coal, agriculture, and food commodities, while there is an appreciable decline in the import of petroleum and durable and capital goods. In the case of industry, coal use increases marginally in all user industries, but this is accompanied by a decrease in the use of petroleum.

Thus the impact of the increase in import tariffs is higher for petroleum than for coal. Secondly, a significant fraction of the total petroleum use is based on imports in comparison to coal which is imported to a much lesser extent. As a result industries tend to substitute away from petroleum in favour of other energy sources, which in turn leads to a decline in emissions.

In addition, imports of petroleum decline, leading to little change in the government revenue. Substitution also occurs between imported and domestic varieties of petroleum, in favour of the latter. This is because the former is affected by the higher import tariffs.

In another simulation when "other indirect taxes" (i.e aggregated excise and sales tax on coal, petroleum and electricity) are increased by 1 percent of 1984 rates, there follows a fall in GDP and Welfare index of the same magnitude. There is also an increase in gross GHGs emitted by all sources. The increase in these taxes results in significant decreases in the domestic prices of each of the fossil energy resources and a decline in the domestic price of electricity.

There are large increases in the imports as well as exports of coal and petroleum. The exports are small in relation to domestic output. One consequence is the significant increase in the use of coal by the electricity sector, and larger percentage increases in coal usage by the intermediates, services, and transport sectors. There are also increases in petroleum use in the services and transport, agriculture and food, and intermediate sectors. There are changes in the pattern of use of electricity and natural gas, although these are not large.

Due to the overall increase in use of coal and petroleum, there is increase in gross GHG emissions. The increase in other indirect taxes, is akin to the application of an energy tax, where the impact on different energy sources would be in the same relative order, since calorific value happens to be in the inverse relative order of carbon content in the case of fossil fuels.

The simulations carried out show that the general equilibrium experiment using the import tariffs suggests that the use of this instrument may succeed in obtaining significant reductions in GHG emissions from the economy, with a reduction in consumer welfare. In the experiment involving the use of other indirect taxes, the results show that it may not be useful in reducing net GHG emissions in the economy. Additionally, there may be adverse impacts on GDP and consumer welfare.

Emissions standards achieve significant decreases in net GHGs emissions, with negligible changes in GDP and Welfare Index. They work through a major reduction in coal and natural gas use and a slight reduction in petroleum use.

In the case of auctioned tradeable permits, large decreases in net GHGs emissions are achieved, with a perceptible increase in the Welfare Index. This appears to work through an expansion of the forest sector and the associated offsets generation.

The use of a GHGs tax on positive net emissions of GHGs by industries accomplishes large reductions in GHGs emissions, with a significant increase in GDP and the Welfare Index.

F. Insights from the modelling results:

Though the results are not comparable across models due to: the variations amongst the models in terms of regional coverage, disaggregation level to which developing countries are considered, trade flow coverage or absence of trade coverage, substitutability of fuels, and the extent of validation, broad conclusions which may be drawn relate to (i) choice of policy instruments, (ii) determinants of the level of the carbon tax, including backstop technology adoption,(iii) significant costs to nations of carbon dioxide reduction, (iv) the need for multilateral cooperation in curbing CO^2 emissions (inclusive of non-OECD nations) in view of potential of leakage, and the continued rate of growth of GHG emissions in the absence of non-OECD country participation; (v) the issue of use of revenue generated from the tax, (vi) quantification of impact of adopted policy, on trade flows and terms of trade, for different regions is significant in the light of the FCCC {Article 4(8)}.

5

Developing Country Concerns[49] Arising Out of Usage of Economic Instruments in Environmental Control

Developing Country Concerns

Developing country concerns arise from two issues:

(i) the application of economic instruments for environmental protection in LDCs, and

(ii) direct and indirect effects on LDCs, of their application in the OECD countries.

There need not be a strict demarcation between the impacts arising from economic instrument usage elsewhere and that arising from national usage, as in the case of border tax adjustment, where it could be limited to the LDC applying the tax in order to protect the competitiveness of domestic industry; alternately it could impact an LDC, via the goods it exports (in the event of double taxation). Lowered competitiveness and market access of LDC goods (due to costs of adjustment of industry to standards), exchange rate manipulation, and impact on terms of trade (discussed earlier) could fall in the second category, of effects arising from application of economic instruments in OECD countries.

There remains resistance to the adoption (of economic instruments in environmental protection), if a conclusion can be surmised from a recent meeting at Tsukuba (IPCC, 1994) on the use of policy instruments, where several developing country participants felt it was unlikely that a global tax/tradeable permits regime would succeed in the context of climate change. Although this need not be representative of the stance of the developing world, some of their concerns may relate to (i) likely impacts on the aggregate economic activity, including costs of reduction measures (cost of adoption of environmentally sound technologies), (ii) situation arising from the removal of subsidies[50] on energy production and consumption (in India, done to protect interests of lower income groups), which would remove the distortions in energy markets, (iii) distributive implications of generated revenue (as taxes are predicted to have a greater impact on lower income groups, (iv) absence of well defined markets and adequate consumer preference for environmental goods and services, would hamper use of economic instruments, and (v) impact on competitiveness (border tax adjustment).

Additionally those developing countries, highly dependent on income generated from the processing, production, export (energy exporting LDCs), consumption of fossil fuels and associated energy intensive products, and those consuming fossil fuels with serious difficulties of switching fuels (India's predominant dependence on indigenous coal reserves) are likely to be more affected in the scenario of a global tax. It must be stressed that in spite of extensive theoretical work, modelling, and general recommendations, the absence of empirical data on instruments performance in the developing countries continues to act as a serious constraint to their adoption.

Any attempt to transpose their use from the OECD to the DCs should proceed with due caution. One of the peculiarities of DCs, which may find mention due to its implications in decisions relating to instrument choice, are the levels and patterns of energy usage. The per capita consumption of energy is considerably lower, apart from the sources of (substantial share of non commercial) energy being utilized. The latter would influence the substitution possibilities available in LDCs in comparison to the developed countries particularly at the domestic level (close relationship between income and fuel use).

In the case of industrial usage, there is likely to be similarity in both the developed and developing countries. Resource endowment would also play a critical role, particularly in the case of electricity generation where countries like India would continue to be largely dependent on indigenous coal reserves.

Nevertheless there are instances of use of economic instruments for environmental protection in developing countries. This has occurred in Thailand, several Latin American countries and to a lesser extent in India[51]. In the developing world, environmental taxes and charges have functioned principally as revenue sources rather than as incentives for behavioral change. Often, they have also led to strong political resistance or have been set at levels which are too low (suboptimal) to act as a major deterrent. Subsidies on pollution control investments or on less polluting inputs are more commonplace than taxes or charges.

Both Taiwan and Thailand have been inclined towards experimenting with the use of economic instruments for environmental purposes. They have been actively studying the introduction of pollution taxes. An Air Pollution Act allowing for a system of emission charges has been passed by the government in Taiwan in 1991. A proposal for air pollution control and energy taxes, to be levied on gasoline and industrial emissions, the revenues of which would be earmarked for environmental use, is also under consideration.

In Thailand, a pollution tax for the city of Bangkok is being assessed. In both these countries, the industrial structure is characterised by many small and medium-sized enterprises that tend to be geographically dispersed. The use of a regulatory approach would not be practical under such circumstances, in spite of both these countries having put in place a basic regulatory framework for defining environmental quality standards.

The Thai government subsidizes the purchase price of unleaded gasoline to make it competitive with leaded gasoline, with the subsidy on the former financed from a surtax on the latter. Unleaded gasoline accounts for nearly one fourth of the market in Bangkok. This price differential has led to the development of a thriving market for refitting of lead-burning engines to burn unleaded gasoline. This price incentive will soon be reinforced by a regulatory requirement that all new cars sold be equipped with catalytic converters, which in turn would further boost demand for unleaded gasoline.

Two additional causes for concern are the resultant implications of border tax adjustment (tax regimes vary across countries) and exchange rate manipulation which are elaborated below.

Border tax adjustment.

As previously noted, one of the trade concerns relates to the application of border tax adjustment (applied to US ozone depleting chemicals tax). In the event of border tax adjustment[52], an import into a particular country would be subjected to the same tax regime as the importing country and exports exempted (destination principle). The application of adjustment of internal taxes is optional. Countries have the right but not the obligation to impose the burdens borne by domestic products also on imported products.

This issue of tax adjustment is of concern because environmental taxes (belonging to the category of indirect taxes, i.e. process taxes) fall in the category of adjustable taxes. For instance, taxes on energy inputs or materials used in the manufacturing process are in this category. This could have implications for the energy intensive exports of DCs.

The provision of tax adjustment, is meant to protect the domestic market from foreign producers without a comparable tax provision and to allow exports to be competitive with those from other nations which have not adopted the tax. This could be detrimental to countries, including developing countries which have levied a tax on their exportable items[53]. In this case double taxation would occur[54], as the product would be subject to a tax in the country of export and the country of import, leading to the possibility of it being less competitive simply by virtue of having a higher price.

In addition, if there is taxation based on the content of carbon, a discriminatory situation could result. This situation could resemble the taxation according to alcoholic content for wines imported into Japan, where the imported wines with a higher raw material content are taxed higher than the domestic products containing lower raw material contents.

Exchange rate manipulation.
In the event of an international carbon tax, the currency of the tax would need to be determined. If, for example, it is set ad quantum in dollars, a problem is likely to arise due to the exchange rates of the various national currencies vis-a-vis the dollar which will inevitably vary over time. As a consequence, the countries would be required to periodically revise their national tax rates to keep them in line with standard rates set in dollars. On the other hand, if the common rate were defined in the various national currencies at a given date, variations in exchange rates could lead to substantial tax differences over time which might lead to a distortion of competition, necessitating a harmonization. Further non-convertibility of currencies raises the problem that tax rates cannot be easily compared (Bohm, 1991).

6

Current Policy Initiatives and Issues Under Debate

EC Strategy

As noted above, the EC strategy targets stabilization of CO^2 emissions in 2000 at 1990 levels. There are two approaches to meeting this goal, the first being the use of regulatory and voluntary measures aimed at improving energy efficiency at zero or low net costs. The second is the application of a fiscal initiative, the energy/CO^2 tax.

Some of the general principles are:

(i) the new tax is conceived as a combination of a CO^2 tax with a general energy tax where the energy component should not exceed 50 percent;

(ii) the tax would be phased in as of 1993, reaching its full size of US$ 10 per barrel of oil equivalent in the year 2000;

(iii) the tax rate would be the same for all Member States, although a safeguard clause is foreseen;

(iv) the revenues of the tax would accrue to Member States;

(v) a key characteristic of the new tax should be its revenue neutrality in order to avoid an increase in the overall tax burden within the Community;

(vi) a limited number of industries, which are heavy energy consumers and are exposed to strong international competition, will temporarily be (partly or totally) exempted in exchange for voluntary agreements to reduce CO^2 emissions as long as the Community's main competitors have not taken similar action. Non-energy use of energy products (e.g as raw material in the chemical industry) should be exempted as no CO^2 emissions are involved.

Some of the tax modalities which need to be resolved relate to the precise mix between CO^2 and energy components; and to coverage (production versus consumption). On the next page is a table showing the application of carbon, carbon dioxide, or related taxes in the OECD.

Table 1
Carbon, CO², or Related Taxes in OECD Member Countries

Country	Tax in Original Units for Main Products	Tax in $/TC¹	Fuels Covered	Effective Date	Exceptions
Denmark	Private DKr242/t of coal DKr0.10/kWh DKr320/t of fuel oil DKr270/m3 of heating oil DKr1.70/l of diesel oil Industry DKr121/t of coal DKr0.05/kWh DKr160/t of fuel oil DKr135/m3 of heating oil DKr0.85/l of diesel oil	Private 15.8 Industry 7.9	Private Coal Oil but not gasoline Electricity Industry Coal Oil but not gasoline Electricity	Private 15/5/92 Industry 1/1/93	For energy-intensive industry, refunds up to 100% if reasonable conservation projects have been carried through
Finland	Mk26/TC	6.4	Fossil Fuels	1/1/91	• Products used as raw material in industrial production • Fuels in overseas planes and vessels
Netherlands	Gld. 5.70/tonne CO² Gld. 0.44/GJ	12.5 for CO² only	Fossils fuels, including industrial fuel gas	1992	None except non-energy uses and international sea/air traffic

Table 1
Carbon, CO², or Related Taxes in OECD Member Countries

Country	Tax in Original Units For Main Products	Tax in $/TC[1]	Fuels covered	Effective Date	Exceptions
Norway	NKr 0.8/1 of gasoline NKr 0.3/1 of diesel oil and fuel oils NKr 0.8/m³ of natural gas Nkr 0.3/k of coal[2]	196 (gasoline) 66 (diesel) 196 (natural gas) 47-70 (coal)	Oil products, natural gas and coal[2]	1/1/91 Revised 1/1/92 except coal 1/7/92	• Fuels in all sea and air transport • Coal used as input to industrial processes
Sweden	SKr 250/t CO²	166	Fossil fuels	1/1/91	Cap on total energy intensive industrial CO² and energy taxes paid • Electricity sector • Int'l.sea and air traffic • Biofuels
	Residential SKr 320/t CO²	212	Fossil fuels	1/1/91	Same as above plus ethanol
	Industry SKr 80/t CO²	53	Fossil fuels		

Note:

TC = Tons of carbon, t = metric ton.

1. Sweden based on first quarter 1991 exchange rates; Norway and Denmark based on last quarter 1991 exchange rates; Finland and Netherlands based on third quarter 1992 exchange rates

2. Coal covered by tax only after 1/7/92

Sources: IEA/OECD (1992)

The European Union Summit held in December 1994, in Essen, is indicative of the tardy progress made on the proposal. At this meeting an agreement was reached to allow the member States to follow individual strategies on energy taxation instead of imposing common carbon tax based on a fuel's carbon content. The absence of a common position is of consequence as it would have assisted in the EC applying pressure on the US in terms of cuts in CO^2 emissions. It also has implications for the developing world, in terms of specific emission limits. Finally, the absence of consensus in the EC, is going to lower the likelihood of a protocol aimed at going beyond the Rio commitment to stabilize carbon dioxide emissions in the year 2000 at 1990 levels, being passed.

US Strategy[55]

The US stand has been positioned on the absence of scientific uncertainty and consequent costs of mitigation, to warrant the adoption of a specific emission target by a specific date. The position of the US negotiators was to keep total greenhouse gas emissions constant at 1990 levels by 2000. The scientific finding of CFCs being neutral in their global warming potential, has affected their stand of increased carbon dioxide emissions being compensated by the phasing out of CFCs. In 1993, the US announced the Climate Change Action Plan, which aims to achieve 1990 levels by 2000.

Japan

The Japanese Government has also adopted the goal of stabilizing per capita carbon emissions by 2000, at 1990 levels. The plan known as the "New Earth 21" is being coordinated by the Ministry of International Trade and Industry. It envisages an initial focus on scientific research and sets some objectives for successive decades (for example, development of renewable energy and carbon fixation and reutilization technologies by 2000-10, and enhancement of ocean carbon sinks by 2020-2030, among others).

7

Choice of Policy Instrument: International and National Scenarios

International Scenario

The choice of the policy approach at the multilateral level, aimed at reducing carbon dioxide emissions would depend significantly on the international agreement reached amongst the signatories of the FCCC. At the tenth meeting of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (held in Geneva, 22 August-2

September 1994) a German draft protocol aimed at reducing emissions of Annex I countries by the year 'x' individually or jointly by 'y' percent, failed to find acceptance.

However there was consensus on the need for additional measures to limit GHG emissions. Future refinement of commitments relating to technology and financial transfer on the part of developed countries may, however, be linked to commitments on the part of developing countries in terms of rate of growth of emissions. Alternatively, once national emission targets are set, the mechanism of joint implementation may be used to achieve these targets.

Though the criteria while deciding on the choice of the economic instruments are numerous, a few are further elaborated upon. They include environmental or ecological effectiveness, economic efficiency, equity, administrative feasibility and cost, acceptability, international extendability, compliance with national energy policies, and effects on competition, among others[56]. Achieving ecological effectiveness in this case would refer to the ability of the instrument to reduce annual CO^2 emissions to the targeted level. Economic efficiency can be defined as the achievement of optimal allocation of resources both in terms of pollution and expenditure on avoiding pollution. This would mean achieving the desired reduction of CO^2 emissions at minimal cost.

If the instrument only achieves a reduction in energy usage and does not induce a substitution amongst fuels, it would be considered inefficient. Instruments also differ in their acceptability to the main target groups. They may also differ in their administrative feasibility and cost, which includes implementation and institutional structures; and in the costs of monitoring. The feature of international extendability would take into account the flexibility of the instrument's ability to allow future additions of countries committed to curbing carbon dioxide emissions. One feature affecting extendability is the robustness of the instrument to changes in currency exchange rates.

Four other aspects to be considered in instrument choice deserve mention: First, the necessity for compliance with the national energy policies must be considered, given the extent of impact on the energy industry. Second, it is important to study and consider the prior performance of the instrument in other countries before deciding on the instrument. Third, avoidance of unfair competition and international trade distortion on introduction of the chosen economic instrument is a concern. Finally, it is important that the chosen instrument meets the other fiscal objectives of the Government, although ultimately it is the political feasibility of the policy approach which plays a decisive role[57].

In spite of the number of suggestions submitted for enabling the selection of the appropriate instrument, the best choice would be to approach CO^2 abatement policy as a sequential decision process in which choices are made for short time horizons and re-evaluated periodically in the light of new information and circumstances.

Prior to discussing in greater detail some of the criteria applicable in developing countries, it is important to acknowledge both the DCs right to sovereignty and their obligation not to damage the environment of other nation states. The requirement that countries cooperate with each other in the case of global environmental problems is balanced by their right to sovereign control over natural resources under the Principle of Common but Differentiated Responsibility.

When implemented correctly, economic incentives can achieve environmental objectives at substantially lower costs than regulatory approaches. The successful use of economic instruments in developing countries requires that a number of conditions be met (OECD, 1993)[58].

The most important are:

a) the agency responsible for environmental policy must have the technical knowledge to formulate and implement economic incentives, and polluters must have the knowledge needed to respond appropriately;
b) the legal structure must define property rights adequately and establish the authority to implement and enforce incentives systems;
c) there must be reasonably competitive markets so that economic incentives are effective;
d) the responsible government agency must have the financial and administrative capacity to initiate, monitor and enforce incentive programmes; and
e) the application of economic incentives must be politically feasible.

Economic incentives that meet these five conditions reasonably well have a chance of success. Ideally, as well, the incentives should be effective, efficient, and flexible.

National scenario: India

The first question that arises while debating on the use of economic instruments in environmental protection (and specifically climate change) is its significance in relation to developmental concerns, which would need to be addressed in the short term. In the current scenario the feasibility of using economic incentives in isolation is unlikely. Some of the reasons are the existence of an informal sector, presence of market distortions and existing subsidies[59]. It is likely that they would need to be complemented by direct regulatory intervention.

Though no specific recommendations can be made in the choice of a policy instrument (given the extent of information, including that available in the form of the model of the Indian economy), some of the general options which could be considered are discussed below. A brief overview of the energy sector (including pricing) is critical prior to discussing issues arising from the possible policy options.

Of the total availability of energy sources, indigenous production and imports account for approximately 84 percent and 16 percent of the total energy consumption. Included amongst its commercial energy endowments are large deposits of coal, a high potential for hydro and nuclear power, and significant reserves of natural gas. India's petroleum reserves are limited but it has potential for extensive use of renewable energy resources. In the Indian context, coal and oil are the two most important commercial fuels consumed. The industrial sector is the largest consumer of commercial energy, within the economy.

A significant component of the total energy consumption (in rural and poor urban households) is biomass based, which does not enter the formal market economy. Both increased household incomes and urbanization cause shifts in usage from biomass fuels to commercial fuels like kerosene.

Currently, the commercial energy prices are administered by the Government and usually do not reflect full opportunity costs. In addition, no consideration is taken of the possibility of interfuel substitution while arriving at these prices (policy pronouncements support this objective). Coal prices are lower than the costs of coal production (this has been changing recently) and also that of fuel oil. For coal, pricing addresses only pithead costs, and with no controls on the delivered price of coal. For crude oil, price setting takes into consideration exploration and development costs and conditions in the international crude market. Consumer prices are fixed on the basis of political and equity considerations (as mentioned earlier in respect of kerosene and electricity pricing), with differences amongst states being largely due to differential retail tax levies.

Mathur (1991) has suggested the implementation of an integrated energy pricing policy, which would aid in reflecting the real costs of various fuels to the economy, including depletion costs; encourage energy conservation with a graded tariff structure; promote fuel substitution and renewable energy sources by introducing mill pricing; and incorporate environmental costs in energy prices. This is expected to lead to improvements in the quality of energy supply due to easing of financial constraints on energy suppliers; encouragement of energy conservation measures driven by the enhanced energy costs; and promotion of interfuel substitution, such as coal by natural gas and biomass by other renewables.

Recently, the Report on the Strategy for Rational Pricing of Energy (TERI, 1994) made some observations:

(i) Changes in consumption are contingent upon the availability of alternative fuels. In the past petroleum has acted as a "swing fuel" in the face of supply constraints of coal and electricity. Such supply constraints are expected.

(ii) It is possible to bring about directional changes in the fuel mix for any particular end-use. However, if economic costs will also be recovered, this would entail increase in prices in sectors where consumer subsidies are very large.

(iii) Any exercise of rational price integration would involve rationalization of current tax and subsidy structure in energy pricing. The ideal situation would be to totally eliminate rent and subsidy so that the consumer prices reflect the resource costs. At least a gradual movement towards such a situation would be inescapable, if any rational price integration is to be adapted.

India is in the process of addressing this concern of rational energy pricing in the case of electricity (private investment in power generation has quickened this necessity) and hydrocarbons. A committee of Public Sector oil companies has suggested the complete dismantling of all administrative prices in the hydrocarbon sector (Economic Times, 1994).

Returning to the issue of choice of an economic instrument India has experience in usage of fiscal incentives for environmental protection and no prior experience with tradeable permits, carbon taxes or energy taxes. Since the adoption of an economic instrument would involve a tradeoff between the environment and the economy, some concerns are voiced. The adoption of a energy tax and not a carbon tax is likely to cause less welfare losses, due to our heavy dependence on coal. A carbon tax would affect the prices of coal (substitution between fuels would appear restricted, due to high indigenous availability of coal), prices of thermal based power generation (coal based) and the availability of power to industries which are energy intensive.

The impact of the application of each of these economic instruments and its interaction with the existing regulatory framework needs further detailed study at the sectoral level. This would facilitate a gradual or phased adoption of such instruments and the addressing of distributional concerns. Another pointer from previous national experience reveals the likelihood of failure of broad policy instruments. Given the high transaction costs involved in the adoption of energy efficient technologies, industries must be helped to make the transition.

Thus there exists a definite need for consideration of the sectoral implications and encouragement of adoption of energy efficient and environmentally sound technologies[60]. The current trends in energy prices and setting of standards (performance and technological standards in production and process technologies involving energy consumption) are steps in the right direction.

8

General Policy Options

It is clear that multilateral cooperation beyond the OECD countries (including the developing world) is necessary in order to achieve a reduction of carbon dioxide emissions. This would reduce the likelihood of free riding and leakage (or alternatively lead only to a moderate reduction in global emissions), which could in turn affect the efficacy of the FCCC. While noting the fact that Annex I nations have been unable to resolve the issue of specific commitments, it would be advisable for national governments to go ahead and place on the policy agenda a mix of instruments.

The country's developmental and social compulsions must be kept in mind while simultaneously adhering to internationally agreed commitments. This could be based on national studies which address the specific elements of the country's situation, as well as an assessment of the sectoral implications of economic instrument use.

It is not possible at this stage to make concrete suggestions regarding the choice of an economic instrument, in the LDC context as requirements would vary across countries. The genuine concerns identified during this exercise, need to be addressed while putting such a system in place. One of the primary considerations in these nations would be that it should have the smallest adverse distributional effect and may include an element of tradeability. The latter's incorporation would lessen welfare losses in total, apart from welfare losses borne by each country entering future agreements.

It would also be in the spirit of the FCCC, which addresses LDC concerns relating to impact of response measures on such economies that these countries requirement of financial assistance to alleviate welfare costs, arising from such reduction measures and direct impacts of climate change are met.

Endnotes

1. Introduction

1. In the EC, the carbon tax is assumed to be revenue neutral.

2. Emissions from anthropogenic activities are substantially increasing the atmospheric concentrations of greenhouse gases: carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide. These increases will enhance the greenhouse effect, resulting in an increase in the earth's mean surface temperature. This is expected to also cause a rise in sea level and other changes across ecosystems.

3. Ecolabelling schemes refers to the use of labels in order to inform the consumer that the labelled product is environmentally more friendly to other products in the same category. Despite being voluntary schemes they could act as a non-tariff barrier to goods from developing countries. The costs of compliance and testing procedures required for compliance to these schemes may also be a deterrent. Ecolabelling schemes in the German textile sector have required adjustment in the Indian export oriented textile industry.

The instrument itself has not been considered in the context of climate change, due to its voluntary nature; though ecolabelling criteria could in the future impinge on energy intensive processes of production.

2. Global Environmental Problems

4. <u>Stratospheric ozone depletion</u>

The Montreal Protocol of 1987 and its subsequent amendments (1990, 1992, and 1994), aims to protect the stratospheric ozone layer. It limits the production and consumption of specific chlorofluorocarbons (CFCs) and halons which are believed to have a role in depleting the ozone layer. The depletion of this layer is linked to an increase in ultraviolet radiation, which is linked to an increased incidence of skin cancer, cataracts and suppression of the immune system. Plants and aquatic organisms are also adversely affected. The US has issued chlorofluorocarbon production and consumption allowance trading for compliance with the Montreal Protocol to which it is a signatory. For a discussion of the environmental causes and effects of ozone layer depletion, please see UNEP, "Protecting the Ozone Layer Through the Use of Trade Measures," 1994.

5. This account of the problem in the United States is based on McCormick (1989).

6. By September 21, 1994 signatories from industrialized countries are required to submit both inventories and plans on how they plan to return to 1990 emissions levels (CO^2 and other GHGs not controlled by the Montreal Protocol) by 2000.

7. See footnote 36 for details.

3. Use of Economic Instruments in Climate Change: CO^2 Stabilization/Reduction

8. Turkey is the only nation to have not adopted a target. All of the twenty two except Canada and Australia are in terms of carbon emissions only. The Netherlands has adopted two targets, one for carbon dioxide and the other for all GHGs (OECD/IEA, 1992).

9. The first formulation of a carbon emission limitation goal was at the 1988 UNEP/WMO Climate Conference, at Toronto, aimed at the reduction of CO^2 emissions by 20 percent of the 1988 levels. Although several countries have adopted such goals they differ in the actual target (reduction/stabilization, the target year, the reference year, degree of commitment (varied from official declarations to those of intent), conditionality (national targets would be implemented consequent to other countries taking similar steps) and sectors covered (usually applicable to the entire economy but could be restricted to the energy sector). Apart from the national targets of the European Community, a joint Council of the EC's Energy and Environment Ministers declared, on 29 October 1990, that the EC and Member States plan to take actions aimed at stabilizing total CO^2 emissions by the year

2000, at 1990 levels (Commission of the European Communities, 1992).

10. This is discussed elsewhere under trade related concerns, in the section on evaluation of potential application of economic instruments, based on economic theory and modelling results.

11. The choice at the level of the individual.

12. However, if the real world operating environment is taken into account, the potential cost savings from the use of economic incentives are less than those expected from the application of 'ideal' economic incentive approaches (i.e. considered only in a theoretical framework).

13. Tradeable or marketable permits are environmental quotas, allowances or ceilings on pollution levels that, once initially allocated by the appropriate authority, can be traded subject to prescribed rules. Such reductions in emissions by agents, can lead to the accumulation of emission reduction credits (ERCs), which are tradeable.

14. Economic instruments can be defined as instruments that affect costs and benefits of alternative actions open to economic agents. There are two broad groups of economic instruments: market based and on-market based economic instruments. Market based instruments include all instruments and incentives that work by a change of product or factor prices, e.g. taxes, pollution charges, and tradeable permits. Governments attempt to alter price signals to ensure that emitters face direct cost incentives to control emissions, leading in turn to the generation of revenue. An example of a non market based economic instrument is a land reclamation bond (OECD, 1991; and Schanzenbacher, 1995).

15. This does not hold true because of the nonexistence of relevant markets in the context of climate change.

16. There is also an ongoing debate as to whether these instruments are effective at the global level or local level.

17. Taxes are unrequited payments which go to the general budget; whereas charges are payment for which the payer receives a benefit in return in proportion to the amount paid. In this paper the two terms have been used interchangeably (Potier, 1995).

18. Energy content refers to calorific value (lower heating values, if IPCC guidelines are followed); whereas carbon content is based on the elemental carbon contained in the fuel.

19. Given that carbon emissions contribute nearly three fourths of the long-run warming potential of the greenhouse gases.

20. The reason for this is that, there is generally some combination of the following elements creating a situation where taxes can be only partially shifted to consumers.

- If there is a significant degree of foreign direct investment from countries where investors are allowed foreign tax credits against domestic liabilities, then a significant tax burden could be passed on to foreign treasuries, producers, and consumers.
- If price controls apply, producers often cannot pass the tax on to consumers in terms of higher prices.
- With binding import quotas or rationed foreign exchange, a tax would reduce the excess profits made by the privileged class.

21. The price of firewood in India has registered a 400% increase between 1983 and 1985. This has been particularly severe for the lowest income group as energy forms the bulk of their expenditure (37% of total non-food expenditure goes towards energy in the lowest income class in comparison to 9% in the highest income class). TERI (1994b).

22. Some of the sources of revenue are air pollution charges, wastewater charges, solid waste disposal charges, charges for the withdrawal of ground water, and penalties imposed by the Czech Environmental Inspection Agency for legal violations.

23. The World Bank estimates that developing countries spend more than $250 billion annually to

subsidize energy (World Bank, 1994).

24. Coal is affected strongly for three reasons. First, coal emits more carbon dioxide than oil or natural gas per unit of energy produced. Thus, the absolute level of the tax per unit of energy content is high on coal than other fuels. Second, the tax is very large relative to the base case price of coal for purchasers, in contrast, oil is far more expensive per unit of energy, hence in percentage terms its price is less affected by the tax). Third, the demand for coal is relatively elastic. Most coal is purchased by electric utilities (in the US), which can substitute other fuels for coal when the price rises (this may not be true in India as more than 65% of the thermal power generation is coal based; and the shift may not be easy). Moreover, the demand for electricity itself is relatively elastic, so when the price of electricity rises, demand for electricity (and hence demand for coal) falls substantially.

25. In India, for the year 1991/92, domestic production of primary commercial energy was 165 mtoe (which included 68% coal, 18% of oil, 10% of natural gas and the rest electricity); and import was 37 mtoe (mainly oil) TERI (1994b). Coal and oil remain the two main commercial fuels used in the Indian economy. Apart from these, traditional fuels meet approximately 40% of the country's energy needs (primarily in the domestic sector). The production, conversion and distribution of all commercial energy is mainly with organizations of the State and Central governments. Apart from electricity all other energy sources are administered by the Central Government. Electricity pricing is done by the State Electricity Boards and varies between consumer categories.

26. The idea of a global carbon tax and/tradeable permit regime was considered a non starter at the round table session on implementation in developing countries (IPCC, 1994). It was also expressed that a binding global regime may be implemented 20-50 years from now.

27. This is what has been suggested in the European proposal for a common energy/carbon dioxide tax, where all member States would have a common tax rate (with some safeguard clauses). This has been discussed further in the section on current policy initiatives and issues under debate.

28. In the Swedish carbon dioxide tax, which has been effective since 1991, has the following elements (Nieuwkoop and Walter, 1995):

(i) tax levied on all fossil fuels (petrol, diesel, heating oil, natural gas and coal) based on carbon content (the tax rate has been fixed with concerns relating to distortion of international trade, costs of industrial adjustment, and losses/gains across sectors, in mind;

(ii) Tax to be introduced gradually, in three stages, in SKr per tonne of carbon dioxide emitted (aware that consumers and companies would take time to adapt);

(iii) Tax to be levied on imported fossil fuels and domestic production;

(iv) Exemptions in air and sea traffic, wood and other biomass, non-energy use of fossil fuels and export of fossil fuels;

(v) Reimbursement of energy-intensive sectors (aimed at protection of energy intensive export industries);

(vi) Exemption of electricity and district heating as long as they are not produced from fossil fuels). In Sweden hydropower produces approximately 60 percent of the electricity, the remaining is nuclear.
The revenue generated is expected to go towards reducing the existing taxes, and also directly distributed to the households. A part of the revenue has been earmarked for subsidizing environmental and energy saving measures. The exemption/reimbursement of energy industries (done from the viewpoint of protecting international competitiveness, and preventing any relocation of industry) is likely to defeat the ecological effectiveness of the tax since these industries produce large amounts of carbon dioxide emissions.

29. The recommendations to the Commission on Sustainable Development, made by the workshop on

Economic Instruments for Sustainable Development, mentions the need for case studies to assess the implications of economic instruments on cost savings, distribution and competitiveness and their relationship to regulatory frameworks [(Proceedings (Chairman) Report: Workshop on Economic Instruments for Sustainable Development, 1995)].

30. The example of technical assistance to Indian industry is by the Indo-German Export Promotion Project which assisted Indian manufacturers adjust to the ban on Pentachlorophenol (PCP) use in the leather industry by Germany by (i) making them aware of the ban; (ii) identifying alternatives to PCP; (iii) establishing modern testing facilities to detect PCP in leather goods (Wiemann, J., et al., 1994).

31. Unlike in the OECD, these environmental quality indicators need not be clearly defined in many developing countries.

32. The concept of tradeable permits has been used in the US, in several instances. Its use in the acid rain program (discussed earlier),in the lead free petrol scheme, and in the control of ozone depleting substances, have been briefly outlined.

When lead free petrol was introduced in the United States, a permit scheme was put in place which allowed refiners who reduced lead levels below those required in one quarter of the year to bank credits for subsequent quarters. These credits could also be transferred from one refiner to another. Those refiners who could not immediately meet the required levels bought these credits - they thus obtained more time to comply and were also saved the expense of legal action. Another instance of the adoption of a tradeable scheme, in the US is for ozone depleting chemicals. Its success, owing to various reasons, has been limited. This permit scheme was supplemented by a taxation on ozone depleting chemicals, which has proved effective. The first component, the tradeable permit system allowed a tight control of quantities emitted and the second, the tax system generated revenues.

33. This approach favours older emitters over newer emitters, and hence is known as 'grandfathering.'

4. Evaluation of Application Potential of Economic Instruments Based on Economic Theory and Modelling Results

34. It is important to clarify that not all the models are uniform in the consideration of trade, as they range from consideration of full trade flows to the absence of trade considerations.

35. The OECD model comparisons project.

36 . Further, the FCCC states in Article 4(8) relating to commitments, that the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on

(a)...

(h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; Also in Article 4 (10), it is stated that the Parties shall, in accordance with Article 10, (relating to the subsidiary body on implementation) take into consideration in the implementation of the commitments of the Convention the situation of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change. This applies notably to Parties with economies that are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives

37. The blockage of the European Community car-

bon/energy tax proposal is attributed among other reasons to the German stand that it would stand to lose from a purely carbon based levy, due to its major share of electricity being carbon based. It would be at a disadvantage in comparison to countries like France where electricity is derived from other sources.

38. According to Jha, V. (1995), environmental policy tools implemented at a sufficiently high level to obtain a relevant incentive effect will necessarily affect production and consumption decisions and thus trade flows.

39. As recommended in the EC case.

40. This is substantiated by a study of the impact of environmental standards and/ecolabels in the OECD countries, on the Indian leather footwear industry. Some of the costs incurred to meet the standards of eliminating PCP, relate to cost of eliminating PCP and laboratory testing of chemical inputs, among others. Bharucha (1994) estimates that the incremental costs to be incurred to conduct the basic tests set under the ecocriteria would lead to a 30 percent increase over the present export price of leather footwear. This is expected to make Indian shoes uncompetitive with shoes from China, Pakistan, Bangladesh, Indonesia and Thailand, who are India's major competitors. This could have a significant impact since 84 percent of our leather products and leather manufactures; and 57 percent of our leather footwear are destined for the OECD market.

41. The definition of border tax adjustments as applied in the OECD "is that they are any fiscal measures which put into effect, in whole or in part, the destination principle (i.e. which enable exported products to be relieved of some or all of the tax charged in the exporting country in respect of similar domestic products sold to consumers on the home market and which enable imported products sold to consumers to be charged with some or all of the tax charged in the importing country in respect of similar domestic products)".

42. Carbon leakages are predicted to occur when (a) there is rise in energy prices in participating countries, and the energy intensive industries of non participating countries gain in competitiveness; and (b) restriction imposed by agreement is sufficiently binding, leading to a decline in world prices, and a rise in emissions.

43. There exists the possibility that the imposition of national carbon quotas would stimulate a major relocation of world industry. This issue is important, because greater mobility of industry (or carbon leakage) would reduce the global costs of a given set of carbon quotas by allowing greater adjustment but would also redistribute those costs. A major determinant of the extent of redistribution is the extent to which industries confer surpluses on their countries of location, which in turn depends on market structure, factor market institutions, tax policies etc. It is not always that such migration is harmful to the host country. Further, imposing carbon quotas would itself change competitive conditions and would induce strategic behaviour (Ulph, 1990). Also, if relocation were to become a major phenomenon, the institutional framework for capital flows and profit repatriation would come under such pressure.

44. Hicksian Equivalent variation has been defined as the increase in income a consumer would need before the imposition of a carbon tax to allow him to reach the welfare level he actually achieves after the change.

45. This is the sum of household consumption, government consumption, investment and stock changes.

46. Nigeria, Algeria, Venezuela, Islamic Republic of Iran, Iraq, S Arabia, Kuwait, UAE, Libya and Qatar.

47. This account depended on information available in Burniaux J.M., et al., (1992a).

48. The carbon tax is an excise tax expressed as a fixed absolute amount of US dollar per ton of carbon emitted by each fossil fuel. Since it is based on the fuel's carbon content, it effectively functions as a tax on

carbon emissions inducing energy conservation and fuel substitution. It is applied at the consumer end in this case.

5. Developing Country Concerns Arising out of Usage of Economic Instruments in Environmental Control

49. Surprisingly, though very few of the current global models take into consideration the LDCs as a whole or individually. More often than not, they are treated as a Rest-of-the World (ROW) category, which attempts to categorize them broadly in a uniform block. Moreover, whenever they have been taken into consideration, they have not considered biomass, a major form of non-commercial energy and a major component of LDC energy use.

50. One estimate (Shah and Larsen, 1991) indicates that carbon reductions from subsidy removal would be in the range of 9 percent of global emissions, for subsidising countries other than the erstwhile Soviet Union. The subsidies represent a distortion, with resulting welfare costs, so their removal can be welfare enhancing for the subsidising countries.

51. In the case of Indian industry, some of the fiscal incentives offered are (i) a depreciation allowance of 50 percent is provided on devices and systems, installed by manufacturing units to control pollution; (ii) a provision for a rebate of 70 percent in the cess levied on water use if the industry concerned has installed equipment for treatment of sewage or effluent; (iii) a concession on excise duty is provided for manufacturing goods used for pollution control;(iv) a concessional custom duty is levied on notified equipments and spares for pollution control; and finally, (v) financial institutions have the provision of extending soft loan facilities for installation of pollution control equipment.

52. GATT does not specify which taxes are adjustable, though it has been agreed that simple product taxes and taxes on inputs physically incorporated are adjustable (Charnowitz, Year unknown).

53. In this case an environmental standard or quantitative limit on emissions introduced in the exporting country may not be taken into account and the product may still be subjected to a border tax adjustment.

54. There are no requirements under GATT that border adjustment rules on imports and exports be symmetric (i.e. importing country applies an environmental tax on imports and the exporting country, with an identical tax rebates it). The absence of symmetry, i.e. if the country applies its environmental tax to its exports and the importing country also taxes the product, this could constitute a case of double taxation.

6. Current Policy Initiatives and Issues Under Debate

55. This section is based on Cline (1992). Global Warming: The Economic Stakes and the US Climate Change Action Plan, 1993.

7. Choice of Policy Instrument: International and National Scenarios

56. The criteria are based on OECD (1991); and Heister J.et al., (1992).

Additionally, in the case of developing countries, the choice of instrument should be such that it preserves the cost effectiveness advantage of economic incentives and also is acceptable to industry and government. Certain criteria therefore need to be kept in mind (OECD, 1993): First, the aim of the instrument should be to achieve a desired, specific, monitorable, and verifiable environmental quality. This desired ambient environmental quality standard should be attained through the most cost-effective means to ensure lowest cost to the economy (including monitoring and enforcement costs to regulatory agency also output reduction and pollution control costs to the industry). Second, the policy instrument should be self financed and equitable i.e. the incidence of pollution charge should be shared between the producer & consumer in a proportion determined by the elasticity of demand for the product. Third, the policy instrument should minimize the overall competitiveness of the industry. Finally, the policy should be stable and predictable and should allow for adjustment during the transition period.

57. In the EC, political feasibility (including influence of coal producing regions in Germany and other member states) yielded the hybrid tax.

58. A number of these conditions are not met in reality leading to 'market failure' as opposed to 'government failure'.

59. A better understanding of subsidies in the energy sector is obtained by examination of pricing in the petroleum sector TERI (1994a). The prices of those fuels used by the poorer sections of society and fertilizer industry (kerosene, light diesel oil, furnace oil, naptha for fertilizer industry and liquefied petroleum gas (LPG) for domestic use) are increased in smaller steps, and with longer time lags than other products. The price of high speed diesel (HSD) has been kept lower than most other petroleum products as it is used for public transport and road based freight movement. Kerosene is priced lower than the import cost. Considering that India imports about 33 percent of the kerosene consumed, the subsidy on kerosene, HSD and LPG (domestic use) constitutes a heavy financial burden, which is covered up by markups of other petroleum products, petrol, aviation fuel, naptha and furnace oil for non-fertilizer use.

60. The Indian Government is currently encouraging energy conservation and the use of energy efficient technologies via its technology policy and other related policies. Some of the measures include the provision for 100% depreciation of energy efficient equipment in the first year, mandatory reporting of energy use statistics in the annual reports of industrial units, subsidies for energy audits and reduced customs duty on selected control equipment for managing energy use.

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