

EQUITY AND EFFICIENCY IN GLOBAL EMISSIONS  
MARKETS

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**T**HIS ESSAY examines the issues of equity and efficiency in the use of global environmental resources, with the atmosphere as a case in point. It shows a somewhat unexpected connection between the two issues in the context of international greenhouse gas emissions trading markets. Contrary to common wisdom, achieving a more even distribution of property rights to environmental assets is more than a matter of equity. Property rights also influence market efficiency. I show that a precondition for market efficiency is that more property rights in the global commons should be given to those regions that own fewer private goods. This connection leads to recommendations to implement the greenhouse gas emissions trading regimes authorized by the Kyoto Protocol to the United Nations Framework Convention on Climate Change (FCCC).<sup>1</sup> In order to ensure an efficient trading market, developing countries should be allocated proportionately more emissions rights than industrial countries. In

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<sup>1</sup> The recommendations in this essay were presented at the May 1994 Workshop on Joint Implementation organized with the support of GEF and the FCCC at Columbia University, New York, and in various FCCC meetings. In these recommendations I benefited from the discussions of several members of the Intergovernmental Negotiating Committee (INC) of the FCCC, who provided important insights: Minister Raul Estrada Oyuela, Chair of the INC/FCCC, H. E. Ismail Razali, Ambassador, Permanent Mission of Malaysia to the United Nations (UN), Mr. Xialong Wang, Third Secretary, Chinese Permanent Mission to the UN, Mr. James Baba, Deputy Permanent Representative of Uganda to the UN, and Dr. John Ashe, Counsellor, Permanent Mission of Antigua and Barbuda to the UN.

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addition, there is a need to create an International Bank for Environmental Settlements (IBES) as a self-financing institution that can obtain market value from environmental resources while preserving them. Emissions trading, the global reinsurance of environmental risks, and securitization of the earth's biodiversity resources are financial instruments that merge the interests of the private financial markets with international sustainable development policy. These instruments and institutions should help to redefine economic progress in a way that is compatible with a harmonious use of the world's resources and with equity among rich and poor nations.

### From industrial society to knowledge society

Since the Second World War, newly created institutions including the World Bank, the International Monetary Fund (IMF), and GATT, have led the world economy into an unprecedented period of industrialization, material expansion, and global commerce. These Bretton Woods institutions are creatures of the post-war reconstruction.<sup>2</sup> During this period economic progress has resulted in an ever-increasing use of energy and natural resources. A consensus is emerging that the main origin of the global environmental problems that the world faces today is the process of industrialization, which has been very resource-intensive. As the century turns, industrial societies' intensive use of the earth's resources has reached its logical limits. For the first time in history, economic activity has reached levels at which it can alter, in many cases irreversibly, the atmosphere of the planet and the complex web of species and ecosystems that constitutes and supports life on earth. Humans have the ability to destroy in a few decades much of the massive ecological infrastructure that supports the survival of the human species on the planet, the global habitat to which humans have adapted throughout the ages.

Industrial society's intensive use of the planet's resources is now under close scrutiny. At the same time, industrial society is in the process of transforming itself into a knowledge society, not a service economy as previously thought. To an increasing extent, humans can now achieve a new form of economic organization where the most important input of production is no

<sup>2</sup> See G. Chichilnisky, "The Greening of Bretton Woods," *The Financial Times*, 10 January 1996, and C. Bernandes, "Environmental Assets and Derivatives," 5 *Derivatives Week* No. 22 (3 June 1996).

longer machines, but human knowledge. Instead of burning fossil fuels to power machines, we could burn information to power knowledge. Information is a much cleaner fuel than coal or petroleum. This circumstance puts humans rather than machines at the center of economic progress.

The most dynamic sectors in the world economy today are not resource-intensive but knowledge-intensive: biotechnology and entertainment, software and hardware, communications and financial markets.<sup>3</sup> These sectors are friendly to the environment, use relatively few resources, and emit little carbon dioxide (CO<sub>2</sub>). They are the high-growth sectors in the US and in the most industrialized countries, and are developing rapidly in other regions of the world. Some of the most dynamic developing countries are making a swift transition from traditional societies to knowledge-intensive societies. Mexico produces computer chips, India's Bangalore is fast becoming one of the world's largest exporters of software (current exports are about \$2 billion), Barbados and Bermuda have recently unveiled a plan to become an information society within a generation. There is nothing new about such policies. These are precisely the policies followed by the Asian Tigers – Hong Kong, the Republic of Korea, Singapore, and the Taiwan Province of China – all countries which have achieved extraordinarily successful economic results over the last twenty years by relying not on resource exports but on knowledge-intensive products, such as consumer electronics. By contrast, Africa and Latin America have emphasized natural resource exports and have lost ground.

The lessons of history are clear. They dictate abandonment of reliance on resource exports as the foundation of economic development. Africa and Latin America must update their economic focus. Indeed, the whole world must shift away from resource-intensive economic processes and products. In doing so, fewer minerals (including fossil fuels) and other environmental resources will be extracted, and their price will rise. This is as it should be because today's low resource prices are a symptom of overproduction and inevitably lead to overconsumption and excessive environmental degradation.<sup>4</sup> In the future, resource producers will sell less but at higher prices.

<sup>3</sup> See G. Chichilnisky, "The Knowledge Revolution," *J. Int. Trade & Econ. Development* (1996) and *The New Economy* (London: IPPR, Spring 1997).

<sup>4</sup> See G. Chichilnisky, "Development and Global Finance: The Case for an International Bank for Environmental Settlements," keynote presentation at the Third Conference on Effective Financing, World Bank, 6 October 1995, Discussion Paper no. 10, UNESCO/UNDP-ODS (New York, 1996).

This is not to say that all will gain in the process. If the world's demand for petroleum drops, petroleum producers may lose unless they have diversified into other products and services that rely less on natural resource exploitation and have higher value. Many international oil companies (British Petroleum is a case in point) are investigating this strategy. The point is that nations cannot reliably develop on the basis of resource exports, and at the end of the day development based on knowledge-based strategies rather than natural resource-based stereotypes can make all better off. As the trend is inevitable, the sooner the transition is made, the better. Economic development means achieving more with less.

The question is how to promote the transition from an industrial, resource-intensive society to a much more environment-friendly knowledge society in the developing as well as the industrialized countries. New institutional arrangements, including international greenhouse gas emissions trading and the creation of an IBES, will be needed in order to facilitate this transition. The basic principles discussed in this essay apply very widely to the use of all environmental assets, including biodiversity, soil, and forests. However, the examples and data used here focus primarily on the use of the atmosphere of the planet through the emission of greenhouse gases, which are in large part derived from the burning of fossil fuels to generate energy.

#### **International cooperation and conflict in addressing climate change**

Widespread concern with ozone depletion, biodiversity destruction, and global climate change led to the 1992 Earth Summit in Rio de Janeiro. Over 100 nations agreed to work together to reduce the threat of global warming by signing the FCCC, which establishes a framework of cooperation that looks forward to binding international obligations for reductions of greenhouse gas emissions. At the same time that it embraced environmental protection objectives, the Earth Summit also emphasized the importance of achieving sustainable development. United Nations Agenda 21 has, as an explicit objective, a pattern of consumption oriented towards the satisfaction of basic needs.<sup>5</sup>

<sup>5</sup> The concept of development oriented towards the satisfaction of basic needs was introduced theoretically and developed empirically by the author in 1994, in the context of studies of sustainable development in five continents: G. Chichilnisky, "North-South Trade and the Global Environment," 84 (4) *Am. Econ. Rev.* 427-34 (1994). The Brundtland

In December 1997 the Third Conference of the Parties (COP3) to the FCCC in Kyoto took matters a great deal further. It reached for the first time an agreement for hard quotas from industrial nations by which they will decrease their emissions by an average of 5.2 percent by the period 2008–12, using as a baseline the level of emissions prevailing in 1990 (the developing nations are currently not subject to any emissions limitations obligations). At the same time that it limits industrial nations' emissions, the Kyoto Protocol provides four market-oriented "flexibility" mechanisms to help achieve these limits: pooling of commitments among industrial country Parties to achieve compliance jointly (Article 4.1); transfer among industrial country Parties of joint implementation project-based emissions reduction units (Article 6); the Clean Development Mechanism (Article 12); and emissions trading among industrial country Parties (Article 17). Of these, only the Clean Development Mechanism (CDM) incorporates both the industrial and the developing nations. It enables industrial countries to obtain credits against their Protocol emissions limitation obligations by investments, including investments by private firms, in projects in developing countries to reduce net greenhouse gas emissions.

The flexibility mechanisms of the Kyoto Protocol are still in a somewhat embryonic form. The Conference of the Parties 4 (COP4) in Buenos Aires, in November 1998, attempted to achieve more definition. The agreement reached in Buenos Aires calls for a firm deadline to achieve this clarification within two years. In addition, the US signed the Kyoto Protocol in Buenos Aires and two developing nations, including the host of COP4, Argentina, declared their intention to participate voluntarily in the emissions trading provision. However these nations have little impact in terms of present or future emissions, and the unwillingness of developing nations to participate in emissions reduction commitments was reinforced in Buenos Aires by the largest emitters, such as India and China, and by the OPEC countries. Following Buenos Aires COP4, the need to achieve a solution that is attractive to both industrial and developing nations seems as compelling as ever.

Despite these steps towards cooperation, and the interest of all nations in dealing with the common problem of climate change, there are significant conflicts within the international community over the measures that

Report's definition of sustainable development is also anchored to basic needs: sustainable development satisfies the needs of the present without compromising the needs of the future. World Commission on Environment and Development, *Our Common Future* (1987), chapter 2, para. 1.

should be taken. Developing countries fear the imposition of restrictions on their growth in the form of emissions limitations that would curtail their use of their own energy and other national resources. Since most net greenhouse gas emissions currently originate and originated historically in the industrialized countries, whose patterns of development are at the root of the environmental dilemmas we face today,<sup>6</sup> the developing countries have consistently insisted that the industrial countries take the lead in reducing emissions. To a certain extent the Kyoto Protocol has met this requirement.

The members of OPEC are particularly concerned with the adverse effect of the Protocol limitations on their export markets if petroleum prices increase. A similar position is taken by other resource-intensive exporters, such as Australia. On the other hand, many industrialized countries fear excessive population growth, environmentally uncontrolled industrial growth, and sharply increasing energy consumption in developing countries and the environmental damage that they could bring. While recognizing their historical responsibility for excessive environmental resource use, they focus on a future in which global environmental problems could originate mostly in developing countries. Indeed, the future of industrialization is in the hands of the developing nations. Industrialization has led to the global environmental problems we have today. If the developing nations, with their much larger populations, were to retrace the steps of the industrial nations, the severity of the problems would increase several fold. Yet, the Bretton Woods institutions have traditionally advocated resource-intensive development policies in the developing nations. The traditional style of development, based on the intensive and extensive extraction of resources that are exported to and overconsumed in the industrial nations, has come to its logical end. It must be replaced by another form of development, the aspiration for which is reflected in "sustainable development" or "clean industrialization." This form of development can be promoted through the knowledge revolution as it evolves and is transmitted throughout the world economy. Nonetheless, the current and near-term negotiations for addressing climate change face a north-south divide. The road

<sup>6</sup> For carbon dioxide, the most important greenhouse gas, the breakdown is as follows: 60–70 percent of all emissions originate from industrial nations currently and about 70 percent historically, even though these countries contain about 25 percent of the world's population. Indeed, the 60 percent reduction in current emissions that many scientists believe may be required to have a substantial effect in lowering the risks of climate change can only come from decreasing the industrial nations' emissions: all developing nations together add up to only about 35 percent of emissions, and therefore nothing within their power could decrease emissions as required.

ahead is long and steep. International agreements are customarily adopted by consensus. How can this be achieved?

One essential step is to develop and eventually connect the various emissions trading mechanisms in the Kyoto Protocol in innovative ways in order to provide the transfers of technology and capital to developing countries that are crucial to break the historical link between carbon emissions and economic progress. The aim is to view the Kyoto Protocol's goals as part of the redefinition of the development strategies for developing nations, and trading mechanisms as a means to accomplish this objective.

A second essential step is to establish what I call an International Bank for Environmental Settlements, or IBES. The emergence of global and environmental problems and their close relation to international trade and investment means that new institutional arrangements are needed to complement the Bretton Woods institutions. An institution such as the IBES proposed here is needed in order to implement the Kyoto Protocol and to help set up a cooperative process for industrial and developing nations in the achievement of its goals. The role of the IBES complements markets but goes much further than anything that unaided markets can achieve. The Bank will use as collateral the environmental assets of the planet, perhaps the most valuable of all assets known to humankind. Among other matters, it will facilitate the execution and settlement of the trading of environmental assets and related financial instruments within the global emissions ceilings stipulated by the Protocol.

**The economics of the global environment: the link between efficiency and equity in international greenhouse gas emissions trading systems**

The implementation of the various emissions trading regimes authorized by the Kyoto Protocol requires a measure of consensus about the policy instruments to be used and how they are deployed. These instruments share a novel and unusual characteristic. They trade rights to use the atmosphere of the planet, which are rights to use a public good: the quality of the earth's atmosphere is the same for all and cannot be chosen in different quantities for different people. Although different regions are affected differently, the concentration of greenhouse gases in the atmosphere is the same worldwide.

Another new aspect of this environmental problem is that emissions, although functionally related to a public good in the quality of the atmosphere, are not centrally produced by government, as are public goods like

law and order. In contrast with the classic case examined by Lindahl, Bowen, and Samuelson,<sup>7</sup> in which public goods are provided by governments, the public good that interests us here is privately produced. Indeed every person on the planet emits greenhouse gases through driving a car, heating their home, or consuming energy produced by burning fossil fuels. Reduction in these emissions will require changes in private behavior. Such changes can be induced by a variety of regulatory instruments, including emission caps and trading systems, adopted and enforced by governments, but the public good of atmospheric quality must ultimately be produced by private conduct. Emissions markets are therefore markets to trade *privately produced public goods*. Such markets are quite different from classical markets.

To understand the issues presented by these novel circumstances and develop appropriate policy, conceptual advances in economics and institutions are needed to address challenging questions such as:

What property rights regimes and market structures will lead to allocational efficiency?

How can an acceptable degree of equity in the global use of carbon be ensured?

How would market-based approaches for dealing with climate change have an impact on developing countries? Should developing countries have more property rights in the global "common," and if so, why and how?

Which institutional arrangements may be needed to support and regulate the trading, clearing, and settlement of emission rights and related assets, and to ensure the efficiency and integrity of the market?

To abate carbon emissions means, in the short term, burning less fossil fuel and producing less energy. This means less economic output in terms of conventional goods and services. Both industrialized and developing countries face significant abatement costs in the short run because current patterns of development are resource-intensive and it is costly to change them. Although the outcome of current practices is uncertain because we know relatively little about the impact of human activity on the environment of the planet, the risks we face are nevertheless sufficient to make it compelling that precautionary steps be taken now.

<sup>7</sup> See, e.g., A. Atkinson and J. Stiglitz, *Lectures in Public Economics* (Maidenhead: McGraw Hill, 1980).



As developed in Richard Stewart's chapter and in Chichilnisky and Heal,<sup>8</sup> an important argument for the use of emissions trading systems to limit net greenhouse gas (GHG) emissions is that it sets an overall ceiling to world emissions and within this ceiling it tends to equate marginal costs of abatement across countries so that it can improve the cost-effectiveness of emission reductions.<sup>9</sup> Regardless of how entitlements to emit GHG are initially allocated, trading will ensure that resources are allocated to the lowest cost GHG-reducing opportunities, wherever in the world they are located. For example, if abatement of carbon emissions costs less in developing countries, then trading would tend to ensure that a substantial amount of abatement would be carried out in those countries.<sup>10</sup> This approach would of course have limitations: the developing nations emit at most 40 percent of the world's emissions while scientific evaluations require a 60 percent reduction to make a dent in the climate change problem. Therefore in practice the environmentally appropriate reduction targets cannot be reached without a substantial reduction of emissions on the part of the industrial nations, which generate most emissions, as well.

The question of who should abate emissions first and by how much leads to the issue of who should bear the burden of decreasing their use of energy and potentially decreasing economic growth. Analysis points to the conclusion that under current conditions the industrial nations may have to abate first. This conclusion tallies with the views of 166 nations that agreed in the Kyoto Protocol to require emission reductions solely from Annex B countries, which are mostly industrialized countries. However the generally held view in industrial nations is, not surprisingly, that it would be more efficient for developing nations to abate first. To support this view it is argued that the costs of abatement are lower in developing countries, and thus more abatement can be achieved at a lower cost if the reduction in emissions takes place in those countries. The economic approach invoked to support this

<sup>8</sup> G. Chichilnisky and G. Heal, "Tradable Carbon Emissions: Principles and Practice," Report to Working Party No. 1 of the OECD (OECD Economics Working Paper, Paris, 1995).

<sup>9</sup> See J. Coppel, "Implementing a Global Abatement Policy: Some Selected Issues," OECD/IEA conference on "The Economics of Climate Change," published in T. Jones ed., *The Economics of Climate Change* (Paris: OECD, 1993), and, in response, Chichilnisky's article in the same book as well as Chichilnisky and Heal, "Tradable Carbon Emissions."

<sup>10</sup> It is however an open question whether emission reductions are less expensive in developing nations, and if so under what accounting system, see Coppel, "Implementing a Global Abatement Policy," and Chichilnisky and Heal, "Tradable Carbon Emissions."

view arises from the standard theoretical position that efficient allocations require that marginal costs be equated throughout, and that accordingly, more abatement activity should take place in the lower cost regions.

The approach is sound when only the supply side is taken into consideration, but it neglects the fact that efficiency as usually defined involves both demand and supply.<sup>11</sup> When demand for environmental quality is taken into consideration, the standard approach is incomplete because it ignores the special character of public goods (such as reduced threats of climate change) that are privately produced. The implications of differences in wealth among nations alter the alignment of entitlements required to produce in an efficient manner the reduction in emissions needed to protect the climate system. Following Coase, the usual assumption is that it does not matter for purposes of efficiency how the initial set of entitlements to a joint resource is allocated; so long as those entitlements can be traded at low cost, an efficient allocation of entitlements and resource use will be achieved. As a result, the issue of property rights in emissions has until now been left to the political arena, with the understanding that it involves exclusively a transfer of wealth between countries, and has nothing to do with efficiency. The two issues, efficiency and distribution, have been seen as separate.

Recent advances in the economics of climate change,<sup>12</sup> however, have disclosed a new role for distributional issues: an appropriately equitable distribution of emissions rights is needed for markets to function efficiently.<sup>13</sup>

<sup>11</sup> The notion of efficiency used here is the standard notion of Pareto efficiency, under which a feasible allocation is *efficient* when there is no other feasible allocation that makes everyone better off.

<sup>12</sup> See G. Chichilnisky, "Economic Development and Efficiency Criteria in the Satisfaction of Basic Needs," 1(6) *Applied Mathematical Modelling* 290-97 (1997); G. Chichilnisky, G. Heal, and D. Starrett, "International Emissions Markets: Equity and Efficiency." Center for Economic Policy Research, publication no. 81 (Stanford University, Fall 1993).

<sup>13</sup> As stated above, a distribution is efficient (or Pareto efficient) if it cannot be improved so as to make one better off, or to make some better off and none worse off. Somewhat surprisingly, it can be shown (Chichilnisky, Heal and Starrett, "International Emissions Markets"; G. Chichilnisky and G. Heal, "Who Should Abate Carbon Emissions? An International Perspective," *Economic Letters* 443-49 (Spring 1994)), that a shift to an allowance distribution that is relatively more favorable to developing countries could make developed countries better off as well. This happens in two ways: by leading to a superior environmental quality that increases the welfare of industrial and developing nations, as well as by increasing the exports from industrial to developing nations thereby increasing industrial countries' economic growth. These results hold in a model of a market in which the utility of the traders depends on the consumption of private goods as well as on atmospheric quality.

The unexpected link between efficiency and equity emerges from an idiosyncratic economic property of markets for public goods such as the total biodiversity of the planet and the quality of the planet's climate. Like other public goods, such as the security provided by police forces, these global environmental goods are public goods in that their consumption is not rival. The benefit obtained by one person from atmospheric quality does not diminish the benefit obtained by others. This situation is unlike that in the case of private goods, where if one person obtains a car, the stock of cars available for others is reduced. But global public goods such as atmospheric quality are also different from many standard public goods because they are necessarily provided to everyone in the same quantity.<sup>14</sup> In this respect, they also differ from private goods, which afford an individual the opportunity to consume more or less of a given commodity quite independently of the others.

Markets allocate goods efficiently when the marginal rate of substitution among all goods for each individual is the same. Economic efficiency is achieved in markets for private goods because individuals adjust the amount that they consume of each to the point where the marginal utility derived from all goods consumed is the same. But matters become more complicated when atmospheric quality, which can only be enhanced by reducing the amount of private goods that would otherwise be produced, is included in the picture. In this situation, efficiency requires that the marginal rate of substitution between private goods and the public good of climate quality be the same for each individual.<sup>15</sup> This is difficult to achieve. There are large differences in average wealth among poor and rich nations. From the viewpoint of human welfare, what counts for purposes of efficiency is not the dollar value of the cost of abating greenhouse gas emissions in order to produce climate quality, but rather the opportunity cost of that dollar value in terms of the utility that it can provide. The marginal utility of income decreases with income. The more income we have, the less our utility increases with the additional dollar. Accordingly, the utility that a poor person would derive from spending a dollar to consume more private goods rather than better atmospheric quality is significantly greater

<sup>14</sup> Because the impacts of climate change may vary regionally, atmospheric quality is not absolutely uniform, but it is reasonable to assume uniformity for purposes of this analysis.

<sup>15</sup> Marginal rates of substitution must all be equal across markets, and must equal the marginal rates of transformation in those markets.

than the utility that a rich person would obtain from the same increase in private goods. Thus, even assuming that poor and rich persons have the same preference for atmospheric quality, poorer people would, other things being equal, prefer to consume relatively more private goods than to reduce such consumption in order to enjoy enhanced atmospheric quality, while wealthier people would prefer to consume relatively fewer private goods and have better atmospheric quality. Yet atmospheric quality is the same for all individuals, rich or poor, who consume it. In this circumstance, efficiency will not be achieved by equalizing the marginal monetary costs of limiting greenhouse gas emissions and of producing private goods, for example, through a market in emission rights, unless all countries and their populations have the same marginal utility of income, which they do not.<sup>16</sup>

For example, suppose that the marginal opportunity cost of abating a ton of carbon is \$1 worth (in market terms) of private goods of output in India and \$2 of private output in the United States. Standard efficiency analysis dictates that the abatement should occur in India, where the monetary cost is less. Yet, the real loss of utility from abatement in India can be much higher than in the United States because devoting \$1 of resources to improving climate quality rather than producing private goods can have a major impact on the welfare of the average citizen of India, while devoting \$2 less in the United States to the same goal has only a small impact on the average citizen. From the viewpoint of economic welfare, it may be preferable to abate in the United States. Thus, a focus on the dollar cost of abatement alone, while ignoring the distributional dimensions of the issue, will not ensure an efficient outcome. Requiring even proportional abatement from all countries in proportion to their emissions would thus be a regressive measure, because it would impose a relatively heavier burden on the poor. In addition to thwarting efficiency in producing climate quality, regressive measures of this sort can cause problems because environmental degradation and poverty are closely connected. Anything that worsens poverty is likely to lead to further environmental degradation.<sup>17</sup>

<sup>16</sup> See Atkinson and Stiglitz, *Lectures in Public Economics*. The rule is typically that the sum of marginal rates of substitution equals the marginal rate of transformation when the government produces the public good. See Chichilnisky, Heal, and Starrett, "International Emissions Markets," for the case where free international trade in permits is allowed. The answer is the same.

<sup>17</sup> For example, a policy that lowers the price of wood and therefore the income of harvesters can lead to more, rather than less, extraction of wood. Since the purpose of taxing the price of wood is to discourage extraction of wood, by decreasing the income of the

One possible solution to the problem of achieving efficiency in the production of the public good of climate quality is directly to transfer wealth from wealthier to poorer countries, through bilateral or multilateral assistance programs, in order to equalize their wealth and hence their marginal utility from private consumption. Such transfers, however, are not realistic on the scale that would be required.<sup>18</sup>

Another, potentially more realistic, solution is to distribute the burden of greenhouse gas abatement so as to equalize the marginal rate of substitution between atmospheric quality and private goods among rich and poor countries. This can be achieved by allocating relatively more emission allowances to poorer countries, which can use those allowances to obtain more private goods either by producing them domestically and using these allowances to cover the emissions increases caused by increased productive activity or by selling them to wealthier countries in exchange for private goods.<sup>19</sup> Under general conditions, the proportion of income dedicated to greenhouse gas emissions abatement should increase with the level of income; this goal can be achieved by an appropriate allocation of emissions allowances.

The Program on Information and Resources of Columbia University has carried out computer simulations based on a model that incorporates the factors summarized here and on a different model, the OECD Green model, modified to incorporate the possibility of trading emissions permits between the countries. These modeling exercises have confirmed the results discussed above; the most efficient model runs, in terms of minimizing the loss of economic welfare that abatement of GHG emissions induces, are those in which the distribution of permits favors the developing countries.<sup>20</sup>

harvesters the tax could achieve the opposite effect from that which is intended. See, e.g., *World Development Report* (World Bank, 1992); G. Chichilnisky, "North-South Trade and the Global Environment," 84(4) *Am. Econ. Rev.* 427-34 (1994); G. Chichilnisky, "Trade Regimes and GATT: Resource Intensive vs. Knowledge Intensive Growth," *J. Int. Comp. Econ.* 147-81 (1994).

<sup>18</sup> Paid transfers, such as those which occur within international markets, need not equate the marginal utility of consumption across trading regions.

<sup>19</sup> See Chichilnisky and Heal, "Who Should Abate Carbon Emissions?"

<sup>20</sup> Those readers interested in the details of these models and the modeling results should review the references to the economic literature. See Chichilnisky, "Economic Development and Efficiency Criteria"; Chichilnisky and Heal, "Who Should Abate Carbon Emissions?"; Chichilnisky, Heal, and Starrett, "International Emissions Markets"; G. Chichilnisky and G. Heal, "Economic Returns from the Biosphere," 391 *Nature* (February 1998).

### **An International Bank for Environmental Settlements**

An IBES could be created in order to promote sustainable development, environmental protection, and global equity among nations. The existing Bretton Woods institutions are not currently discharging these functions and are not well equipped to do so.

An IBES could perform a number of important roles in structuring and facilitating efficient and equitable international greenhouse gas emissions trading markets. Since more sophisticated market structures are required to trade emissions, an institution like an IBES with the role of regulating the markets and ensuring their integrity is needed. In promoting the development of CDM trading between developed and developing countries, an IBES could operate under the aegis of the Executive Board established under Article 12 of the Kyoto Protocol to implement the CDM.

The Bank could serve as a forum for recording environmental accounts that could be used to monitor the successes and failures of implementation. It could fulfill the role of a clearing and settlement institution. It could also determine which type of instruments will be traded – for example, derivative securities (options, futures) – and how. The Bank could offer credit enhancements for the carbon emissions permits sold by adding credit-worthiness to contracts sold, and perhaps by ensuring that the counterpart to each contract is the Bank rather than another country or corporation, as is the case in the commodities clearing house. The Bank could regulate the relationship between primary and secondary markets, a matter of great importance in ensuring market liquidity. It could run open market operations and, in general, have an impact on borrowing and lending rates.

The trading of emissions rights should not conflict with humanitarian aid or other international aid flows. An IBES should provide more access to capital for development. It should have the role of ensuring fair markets and equal access to information and to trading. It should also ensure market integrity and depth. Deals should be structured so that they can be reversed without undue penalty to the traders of countries, especially developing countries, which may revise their priorities in the future. In order to ensure fair prices for developing countries, it may be desirable for the Bank to establish a market rate of interest on emissions permits in a market open only to industrialized countries and then to pay this rate on deposits from developing countries.

The trading of GHG emissions rights should not compromise the future

ability of developing countries to change their development strategies. In order to achieve this objective, emissions rights could be *loaned*, instead of or in addition to being *sold*, with the lending and borrowing managed by the Bank. The key aspect of a loan rather than a sale of emissions rights is that developing countries need not be concerned about unforeseen long-term consequences of an irreversible transfer of their emissions rights to other countries, nor need they be concerned that they will make irreversible deals today at prices that will subsequently look unreasonable. Lending rather than selling these rights avoids many uncertainties faced by developing countries entering into an emissions abatement agreement. Lending rates can also be regulated by the IBES.

Developing countries are likely to want to lend emissions rights for limited periods until their needs for such rights are clarified, whereas industrialized countries are likely to want to borrow for longer periods. The IBES and other institutions managing this market would match these positions by "borrowing short and lending long" in the traditional manner of financial intermediaries. In exchange for the risk involved, they would charge a borrow-lend spread. Commercial capital and international financial institutions, private or public, would undoubtedly be attracted to such an operation. The IBES should facilitate securitizing carbon emission reductions from new technologies and products, so as to attract investments from global capital markets and generate self-funding mechanisms to finance such technologies and products, thus fostering clean industrialization and advancing the knowledge revolution in developing nations.<sup>21</sup>

Joint implementation and other project-based credit trading schemes are bilateral agreements and a natural extension of the economic practice of barter trading. However, bilateral trading is typically inferior to multilateral trading through open, transparent, and widely accessible markets, where all parties have access to all possible deals that could in principle be made. Bilateral trading eventually leads to multilateral trading. Yet a widely expressed concern is that during the development of multilateral markets, the price may turn against the developing countries. Initially, developing countries will typically be sellers of permits when prices are lower. If they buy permits later in order to industrialize, they may be paying much more

<sup>21</sup> See G. Chichilnisky, "Technology Transfer and Emissions Trading: A Win-Win Approach to the Kyoto Protocol," United Nations Foundation Grant to Columbia University's Program on Information and Resources (September 1998).

for the same permits that they initially sold. Selling a country's rights to emit is the same as selling its rights to industrialize. There is a chance that the first buyer could reap unfair "rents" or "bargains" over later buyers. A response to this concern is to implement a strategy for "leapfrogging" into multilateral trading sooner rather than later and attempting to establish fair trading practices, such as uniformly distributed price information and other practices that are widely adopted in the most successful markets, in order to ensure equal access to information and trading opportunities, efficiency, market integrity, and depth. An IBES could play a key role in implementing this strategy.

The IBES can also promote efficiency and equity by playing a similar market-making role with respect to environmental assets other than the global atmosphere. For example, it has been established that at present most forests are destroyed in order to produce minerals or to grow agricultural products for sale on the international market.<sup>22</sup> The right financial mechanisms are needed to realize their value without destroying them. The IBES could help developing countries, which own most of the forests and biodiversity on the planet, to obtain economic value from these assets without destroying them. This may include securitization of commercial applications of biodiversity, such as the Merck-INBIO deal in Costa Rica. An analogy is provided by traditional mortgages, in which assets (such as buildings) serve as collateral for obtaining financial value from the asset (the building) without destroying the asset itself. This may require institutional arrangements for organizing, executing and monitoring the trading of emissions permits, loans on them, and associated derivative instruments. An IBES could also promote securitizing the world's watersheds, in order to attract private funding for the conservation of clean water resources.<sup>23</sup> It could similarly promote securitization of the planet's biodiversity, and global reinsurance of environmental risks.<sup>24</sup>

### Conclusion

This essay has examined the issues of equity and efficiency in the use of global environmental resources. A somewhat unexpected connection arises

<sup>22</sup> See Chichilnisky, "North-South Trade and the Global Environment."

<sup>23</sup> See Chichilnisky and Heal, "Economic Returns from the Biosphere."

<sup>24</sup> See G. Chichilnisky and G. Heal, "The Future of Global Reinsurance," *J. Portfolio Mgmt.* (August 1998).



between the two issues in the context of international greenhouse gas emissions trading markets: achieving a more even distribution of property rights to environmental resources can influence market efficiency. Because atmospheric quality is a privately produced public good, achieving market efficiency may require that more property rights in the global commons should be given to those regions that own fewer private goods. Accordingly, in implementing the greenhouse gas emissions trading regimes authorized by the Kyoto Protocol, proportionately more emissions rights should be allocated to developing nations than to industrial countries. In order to carry out such policies, I have suggested the creation of an IBES, a self-financing institution that can obtain market value from environmental resources without destroying them. Emissions trading, the global reinsurance of environmental risks, and securitization of the earth's biodiversity resources are financial instruments that merge the interests of the private financial markets with international sustainable development. These instruments and institutions could help redefine economic progress in a way that is compatible with harmonious use of the world's resources and equity among rich and poor nations.

