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NEW STRATEGIES FOR THE PROVISION OF GLOBAL PUBLIC GOODS: LEARNING FROM INTERNATIONAL ENVIRONMENTAL CHALLENGES

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New Strategies for the Provision of Global Public Goods: Learning from international environmental challenges[1]

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Abstract

The world of public goods has changed in the last quarter century. Many of the changes have their origins in massively increased human impacts on the biosphere, and in particular on important life support systems such as the carbon cycle, and on resources such as biodiversity, which operate as public goods that are privately provided. These goods have quite particular characteristics that may enhance the possibility of reaching durable international agreements concerning their provision. Adoption spillovers are important in this context: they can mitigate the normal free rider effect associated with public good provision. The private production of these public goods makes it natural to seek to use markets to manage their provision.

JEL Classification: H4, Q2, Q3.

[1] Forthcoming in *Global Public Goods: International Cooperation in the Twenty First Century*, edited by Inge Kaul, Isabelle Grunberg and Marc Stren, Oxford University Press, New York, 1999.

The world of public goods has changed radically in the last quarter of a century, rendering many text-book discussions and examples quite dated. It is, thus, timely to take a fresh look at both the *nature* of public goods and the *policy options* for managing their provision.

The first section of this chapter identifies some key trends in the changing world of public goods. It shows that increasingly public goods are privately produced—by private enterprise, as a result of privatisation, and by way of externalities, frequently negative externalities, as a result of a myriad of decentralised and independent decisions by numerous actors world wide.

The second section examines examples of mechanisms for the provision of this new type of privately produced public goods, placing special emphasis on market-based mechanisms. Given the growing importance of natural-resource issues in the category of global public goods, the examples come from the environmental field.

Two main messages emerge from the discussion:

Public goods, such as the reduction of greenhouse gas emissions, pose a new challenge: deciding who can—and should—produce the public good.

Creating new markets can be an effective and efficient means of meeting this challenge.

The changing world of public goods

Traditionally it has been assumed that public goods—such as law and order, defence, protection from extreme weather, essential social and economic infrastructure—are to be provided publicly by the public sector and for the public as a whole. Today we know that private initiative and private actions also play an important role. Why? Because the *nature* of public goods has changed, due to two major trends: privatisation and externalities.

Privatisation

Privatisation of previously state-provided public goods and services has been captured in the popular rhetoric of "rolling back the frontiers of the state." But the policy change goes far beyond rhetoric. Society's view of government in modern industrial economies—and in the developing—has changed radically. Many sectors previously under state management and ownership have been transferred to private ownership and management. These include the provision of water, power, telecommunications, transportation, broadcasting and in some cases medical services. Many economists had previously viewed these as involving a combination of public goods and natural monopolies: transport systems were viewed as public goods, and power suppliers as natural monopolies.

The change in social and political perspectives on these industries has many roots. Among them are changes in technology that permit smaller producers and potentially more scope for competition. It is no longer the case that a power plant, to be efficient, has to operate on a massive scale. Gas-fired turbine generators can compete with massive conventional power stations in meeting peak demands—and operate efficiently at output levels corresponding to the needs of small communities or individual factories.

Also important is our new understanding of network industries. A network industry typically consists of a physical network—railways, telecommunications channels, electric power cables—and a service that requires the use of this infrastructure. The last decade has seen a move to unbundling, to seeing the provision of the physical network and that of the related services as different businesses. Any power provider can use the grid to distribute its power, and any phone company can have access to the network of any other. It has always been the underlying physical network that has had the characteristics of a public good, requiring large-scale provision to be effective. Similar moves are under way with railways. Consider the UK rail system, with the track owned by RailTrack and train companies charged for its use. Together, these two trends—technological changes permitting efficient small-scale power generation, and the dissociation of distribution from production—permit substantial competition in the provision of power, changing the business radically. One effect: more competition in the provision of services.

Consider another example: broadcasting. It used to be impossible to exclude anyone in a broadcast's target area from receiving and using it. With no possibility of exclusion, and with no rivalry in consumption, broadcasting was a classic public good. But scrambling technologies have changed this. And if broadcasts are scrambled, only those who have paid for unscrambling technology can use them. There is still no rivalry in consumption, but there is perfect excludability. A public good has been privatised due to technological change—not in the legal or financial sense but in the strict economic sense.

Political factors have also contributed to the drive towards privatisation. Financing the provision of public goods or those provided by regulated natural monopolies has always posed a conceptual conflict between efficient pricing and breaking even. Efficient pricing has required marginal cost pricing and thus losses, although theoretical developments in the analysis of increasing returns make this an over-simplification (Heal 1998). The change in the role of the state has led governments to look favourably on an institutional framework in which breakeven appears to be assured—and moved the focus away from some of the traditional prescriptions for management of natural monopolies.

So, there is real substance behind the privatisation of traditional public goods and public sector activities. Changes in technology have made competition possible in some areas—and the goods or services excludable in others. In parallel, public concern with state spending has focused political attention on the financing of publicly provided goods, always a difficult point. As a result, the political balance has tipped in favour of privatisation.

The growing importance of externalities

The past two decades have seen a phenomenal increase in public concern about environmental public goods—by now the "quintessential" public good.

Here, I direct attention to privately produced public goods—many of which are, unfortunately, not "good" but "bad." Take carbon dioxide, the principal gas responsible for global climate change. It is quite stable, remaining in the atmosphere for about 60 years after emission. It mixes well, and within months, the carbon dioxide emitted in New York or Beijing will be diffused around the globe. The concentration of this gas in the atmosphere is thus rather uniform around the world, and the atmospheric concentration of carbon dioxide is a global public good.

How is all this CO_2 being produced? As a result of billions of decentralised and independent decisions by private households for heating or transportation, by corporations for these and other aspects, all outside the government's sphere. It can influence them—but only indirectly, through regulations or incentives. The same holds for other atmospheric pollutants. Sulphur dioxide is produced by the home heating and power generation choices of people the world over. Ozone-depleting chlorofluorocarbons are produced for use in household refrigerators and air conditioners. The loss of biodiversity results from myriad independent decision about changes in land use, which destroy previous habitats, and from decisions about pollution, including those that affect the climate. Farmers, ranchers, vacation home owners, suburban home owners—all have a direct impact on biodiversity through their life styles and land use.

The foregoing observations introduce a completely new element into the provision of public goods. For traditional public goods, three questions are to be answered:

- How much should be provided?
- How should this be financed?
- How can the state obtain the information to answer these questions?

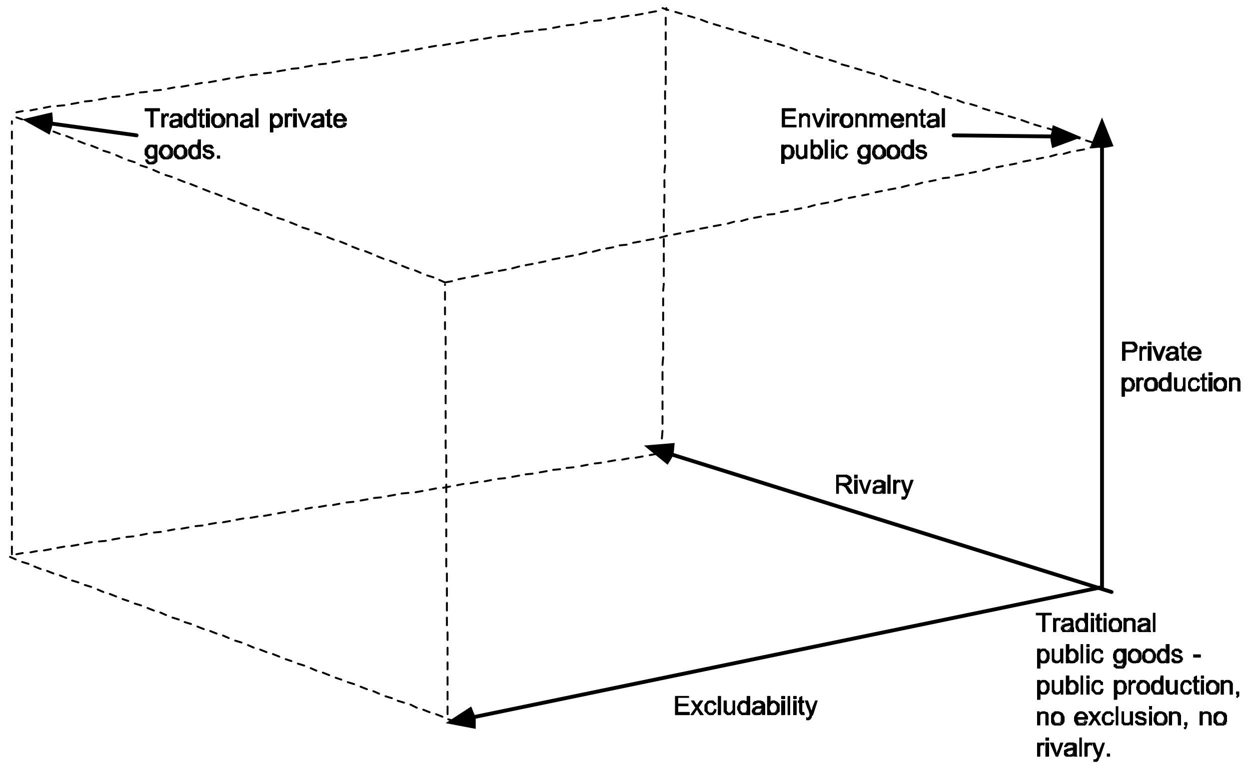
The last point relates of course to the famous free-rider problem. Anyone who is asked how much she or he is willing to pay for a public good—and who expects that their payment will be affected by the response—has an obvious incentive to give a response that understates the true preference. For privately produced public goods, however, we have to ask a fourth question:

- Given a desirable target level of production, how do we attain it, how is this target production to be divided between all of the potential producers?

For example, cutting back the emission of greenhouse gases takes a very specific and difficult form: which countries should cut back emissions, and how much? The same question will then be repeated within the country, and indeed probably within organisations and firms.

This new question—of how the production of the public good should be distributed among agents—interacts in surprising and interesting ways with the first trend of privatisation and the increasing use of markets.

Figure 1. Characteristics of private and public goods



Before moving ahead, I will summarise some of what I have said about the characteristics of public goods in a diagram. Traditionally public goods have been seen as goods that are publicly produced and for which there is no rivalry in consumption and no excludability. Traditional private goods have been, and continue to be, the opposite. In figure 1, these three dimensions are shown as the three axes of a cube, with traditional public goods at one corner and private goods at the opposite one. In the example of scrambling broadcasting and thus making it excludable, though not rival, in consumption, a change in technology moved the service from the origin along the horizontal excludability axis. **[Geoffrey: Another example or two?]** Today we could find goods or services in almost any position in the cube, not just in the opposite corners.

Providing modern public goods

This section addresses the issue of how to manage the provision of modern public goods, notably privately provided public goods. Two mechanisms are reviewed: the creation of new markets for the right to pollute, and adoption spillovers.

Example One: Tradable pollution permits

As mentioned before, privately produced public goods raise the three standard questions on how much to provide, how to finance provision, and how to ascertain the information needed to answer the first two questions. They also raise the fourth question, a new one in the world of public goods: Who should produce how much of the total public good that ought to be provided?

I focus first on the fourth question, which in principle can be answered in several ways.

- One is the traditional command and control approach: take the total, divide it in some way among the possible producers, and instruct each of them that this is what they will produce. In the most common case of privately produced public goods—environmental pollution—this approach typically takes the form of deciding that there will be an X% reduction in the output of the pollutant and instructing everyone to reduce pollution by X%.

- A maximum level of pollution can be set, uniform across all agents, consistent with a target total pollution level.
- The pollution can be reduced by taxation, trying to pick a tax rate that will bring about just the desired pollution level.
- A market can be used to decide who produces how much, by allocating pollution rights and allowing them to be traded.

Standard arguments indicate that either of the last two approaches—taxation or permit markets—is more cost-effective than command and control. Cost-effective here means that a given abatement level is achieved at a lower total cost. Of the two cost-effective approaches, markets are a better way of attaining a given target total pollution level, for the obvious reason that we can pick the total volume of pollution permits to equal the target pollution level.

The idea of trading rights to pollute goes back at least to Dales (1968) and the 1970s, although it could be argued that it has origins in Coase (1960) or even in Lindahl's work on public goods (Foley 1970). For a general review of the issues, see Chichilnisky and Heal (1994b and 1999).

What issues does the use of markets raise in answering the "who produces" question for privately produced public goods? It is important to understand exactly how the market will work in this case. A total production level has been chosen for pollution, the total permissible pollution level. The next step is to allocate tradable rights to pollute—also known as tradable emission quotas—up to a total of the chosen total production target. These are divided among potential polluters according to a procedure chosen by the authority controlling the pollution.

To make this concrete, consider sulphur dioxide emission permits in the United States. The Environmental Protection Agency sets limits to the total emission of sulphur dioxide in a region, issues permits to emit SO_2 adding up to this limit, and then allocates these permits between potential polluters. Once this is done, the potential polluters are free to pollute up to the limit set by the permits that they have received—or to pollute less and sell the permits for which they have no need, or to purchase additional permits from other potential polluters and then pollute up to a level given by their initial allocation of permits plus their purchases. The incentive to cut back on pollution is provided by the fact that an unused permit can be sold: the higher the market price, the stronger the incentive.

The distribution of quotas

How would this work for a global public good, such as CO_2? In other words, what are its implications for the Kyoto agreement on greenhouse gas emission? To introduce a regime of tradable emission quotas, we have to create property rights where none previously existed. These property rights must then be allocated to countries participating in the CO_2 abatement program, in the form of quotas. Such quotas have market value, perhaps very great market value. The creation and distribution of quotas could therefore lead to a major redistribution of wealth internationally. This means that it is economically and politically important to understand fully the issues that underlie an evaluation of alternative ways of distributing emission quotas.

A clear precedent for this redistributive effect of international property rights can be seen in the Law of the Sea conference and the introduction of 200 mile territorial limits in the waters off a nation's coast. The limits established national property rights where none previously existed, and these rights could and frequently were distributed by governments to domestic firms. The property rights in offshore water thus effected a very substantial redistribution of wealth internationally.

There is no way to restrict countries' emissions of greenhouse gases without altering their energy use—and without altering their overall production and consumption patterns. The implementation of measures to decrease carbon emissions will thus have a significant impact on the ability of different groups and countries to produce goods and services for their own consumption and for trade. Because of this, the distributional impact of environmental policy—the choice of who will bear the adjustment costs—is of major import. Under a tradable quota regime, payment for the provision of a public good—in this case payment for an atmosphere containing less greenhouse gases—takes the form of bearing the economic costs of adjusting to the quota regime and its prices. This makes the analysis of environmental policy particularly difficult because distributional considerations are typically the ones where consensus is most difficult to achieve.

Distribution and efficiency

Market allocations are often recommended for their efficiency. This means that it is not possible to reallocate resources away from a market-clearing allocation without making someone worse off: there is no slack in the system. Market efficiency requires three key properties:

1. Markets must be competitive,

2. There must be no external effects—in the Pigouvian terminology private and social costs must be equal, and in the Coasian there must be property rights in the environment,

3. The goods produced and traded must be private.

The efficiency of market allocation is independent of the assignment of property rights. Ownership patterns are of great interest for welfare reasons, and different ownership patterns lead to different efficient allocations where traders achieve different levels of consumption and there are different distributions of income. But ownership patterns have no impact on market efficiency. The efficiency of the market independent of distribution is a crucial property underlying the organisation of most modern societies.

Yet the efficiency properties that make the market so valuable for the allocation of private goods fail when the goods are public. With such goods it is not possible to separate efficiency from distribution. The public good nature of the atmospheric CO_2 is a physical fact, derived from the tendency of carbon dioxide to mix thoroughly and stably. This simple fact is completely independent of any economic or legal institutions. It has profound implications for the efficiency of market allocations, for efficiency and distribution are no longer divorced as they are in economies with private goods. Instead, they are closely associated. In economies with public goods, market solutions are efficient only with the appropriate distributions of initial property rights. Why?

When all goods are private, different traders typically end up with different amounts of goods at a market-clearing equilibrium, because of their different tastes and endowments. The flexibility of the market in assigning different bundles of goods to different traders is crucial for efficient solutions. But traders with different preferences should reach consumption levels at which economywide relative prices between any two goods are both (1) equal to the marginal rate of substitution between those goods for every trader and (2) equal to the rate of transformation between the two goods for every producer. This is an enormous task: it is a testament to the decentralised power of markets that this coincidence of values emerges at a market-clearing allocation.

When one good is public, however, there is a physical constraint: all traders, no matter how different, must consume the same quantity. This imposes an additional constraint, a restriction that does not exist in markets where all goods are private. Because of this restriction, some of the adjustments needed to reach an efficient equilibrium are no longer available in markets with public goods.

The number of instruments the market uses to reach an efficient solution—the goods' prices and the quantities consumed by all traders—is the same with private or public goods. But with a public good these instruments must now do more: at a market equilibrium the quantities of the public good demanded independently by each trader must be the same, no matter how different the traders are. As a result, in addition to equalising price ratios to every trader's marginal rates of substitution and transformation, an additional condition must now be met for efficiency. The sum over all traders of the marginal rates of substitution between the public good and any private good must equal the marginal rate of transformation between them—must also equal the relative price.

This condition emerges from the simple observation that one additional unit of the public good produced benefits every trader simultaneously, which is implied by the fact that all consumers consume the same amount.

The physical requirement of equal consumption by all therefore introduces a fundamental difference between efficiency with public goods and efficiency with private goods. All this must be achieved by the market in a decentralised fashion. Traders must still be able to choose freely, maximising their individual utilities, and therefore the previous condition of equating each trader's marginal rates of substitution and transformation to prices must still hold. Otherwise the market clearing allocation would not be efficient. In other words: with public goods the market must perform one more task.[1]

An additional task calls for additional instruments. Since the market with *n* private goods has precisely as many instruments as tasks, with public goods new instruments must be enlisted. Some of the economy's characteristics can now be adjusted to meet the new goals. The traders' property rights to the public good—their rights to emit gases into the atmosphere—are a natural instrument for this purpose, because they are in principle free and undefined until the environmental policy is considered. By treating the allocations of quotas as an instrument—by varying the distribution of property rights on the atmosphere—it is generally possible to achieve a market-clearing solution where traders choose freely to consume exactly the same amount of the public good. Market efficiency can be achieved with public goods, but only with the appropriate distribution of property rights. Again, distribution and efficiency are no longer independent.

Quota allocations: North-South aspects

The physical constraint of the public good is most acute when traders have rather different tastes and endowments, when they would naturally choose different consumption patterns and different levels of the public good. Tastes are often difficult to measure, but differences in endowments are measured more readily: national accounts often provide an adequate approximation. Income differences are very pronounced in the world economy, so it will be difficult internationally to achieve identical levels of demand for a public good—and correspondingly to attain market efficiency.

Think for simplicity of a world divided into a North and a South, the industrial and the developing. It is pretty obvious that endowments of private goods are much larger in the North than they are in the South; in a competitive market with private goods this naturally leads to very different patterns of consumption. The North-South dimension of CO_2 abatement is therefore likely to be an important aspect in the evaluation of environmental policy. While this point is widely understood in political negotiations between industrial and developing countries, it has not been clear until recent work that the political arguments have in fact an underpinning in arguments about economic efficiency.

Not only are distributional issues fundamental to achieving political good will and to building consensus. They are also fundamental in the design of policies that aim at market efficiency. Market efficiency is crucial in reaching political consensus: often negotiations advance by removing inefficiencies and so producing solutions potentially favourable to all. Proposing an inefficient solution means neglecting potential avenues to consensus—a strategic mistake in negotiations where the achievement of consensus is key.

The distribution of quotas among countries

From the previous arguments, it follows that a judicious allocation of quotas among countries must not be viewed solely as a politically expedient measure to facilitate consensus. Nor should it necessarily be viewed as an attempt to reach fair outcomes at the expense of efficiency, or at least independent of efficiency. The appropriate allocation of quotas within a given world total of emissions may be an instrument for ensuring that competitive markets can reach efficient allocations. The fact that it plays this role comes from the physical constraints that a public good imposes on market functioning.

What remains to be determined, however, is the particular distribution of quotas is needed to ensure that the market solution will be efficient. Distributional issues are delicate points in any negotiation, and the fact that market efficiency is involved makes the point apparently more complex. In reality, however, it can be seen to improve the dynamics of the negotiation process. The reason is: the connection between distribution and efficiency means that an argument about distribution is not a zero sum game, as it would be if the division of a fixed total between competing parties is all that were involved. Because some distributions of quotas are efficient and others not, some lead to a greater total welfare than others and thus to an opportunity for all to gain relative to the other, inefficient distributions.[2]

Now, a conceptual overview of the problem. I work under the assumption that all countries have generally similar preferences for private goods and for environmental assets if they have comparable incomes.[3] This is of course consistent with different tradeoffs between private and environmental consumption in countries at different incomes. A second standard assumption is that the marginal utility of consumption decreases with income. This simply means that an additional unit of consumption increases utility less at higher levels of consumption than it does at lower levels: adding one dollar's worth of consumption to a person with meagre resources increases the person's well-being more that adding one dollar's worth to the consumption of a wealthy individual. I assume, too, that all countries have access to similar technologies and that their productive capacities differ only as a consequence of differences in capital stocks.

Under these assumptions, it is possible to show that the allocation of quotas may have to favour developing countries proportionately more than industrial countries if we seek market efficiency (Chichilnisky and Heal 1994a). This holds true for any total target level of emissions.

Is there generally a connection between the distribution of income and the level of emissions? To answer this, consider one more fact about preferences between private and public goods: that environmental assets are normal goods. This means that the amount one is willing to spend on environmental amenities or assets increases with one's income: the more we earn the more we spend on every normal good, including environmental goods.

The final general condition invoked by the analysis here requires perhaps more thought: that environmental assets are necessary goods. This simply means that while the total amount spent on environmental assets increases with income, the proportion of income a person is willing to spend on environmental assets decreases as their income level rises. This assumption has been corroborated empirically in every known study in the United States, Europe and Africa, though such studies typically involve contingent valuation techniques, which can have weaknesses.[4] The assumption can also be justified theoretically on the grounds that lower income people are more vulnerable to their environment than higher income people. They cannot afford to choose or modify their environment, while the former higher income people can. For example, a public park or access to potable water are environmental assets that have relatively more value to lower income people than they do to those who can afford to build their own park or arrange their own water access. People in lower income countries are known to be more vulnerable to global warming than those in higher income countries. My assumptions here are consistent with what has been established with remarkable regularity in most empirical studies: the income elasticity of demand for environmental assets is between zero and one (most studies find it to be about 0.3—see Kristrom and Riera 1996).

If these facts are correct, it is possible to establish that a redistribution of income towards lower income individuals or countries will generally lead to an improvement in environmental preservation. Why? Because when preferences are similar and the income elasticity of demand is less than one, a redistribution of income in favour of lower income groups implies that relatively more income will be allocated to the environmental asset. If traders choose freely, they will choose more preservation. In the case here, higher abatement levels are to be expected when more resources are assigned to the lower income groups of countries.

Example Two: Adoption Spillovers

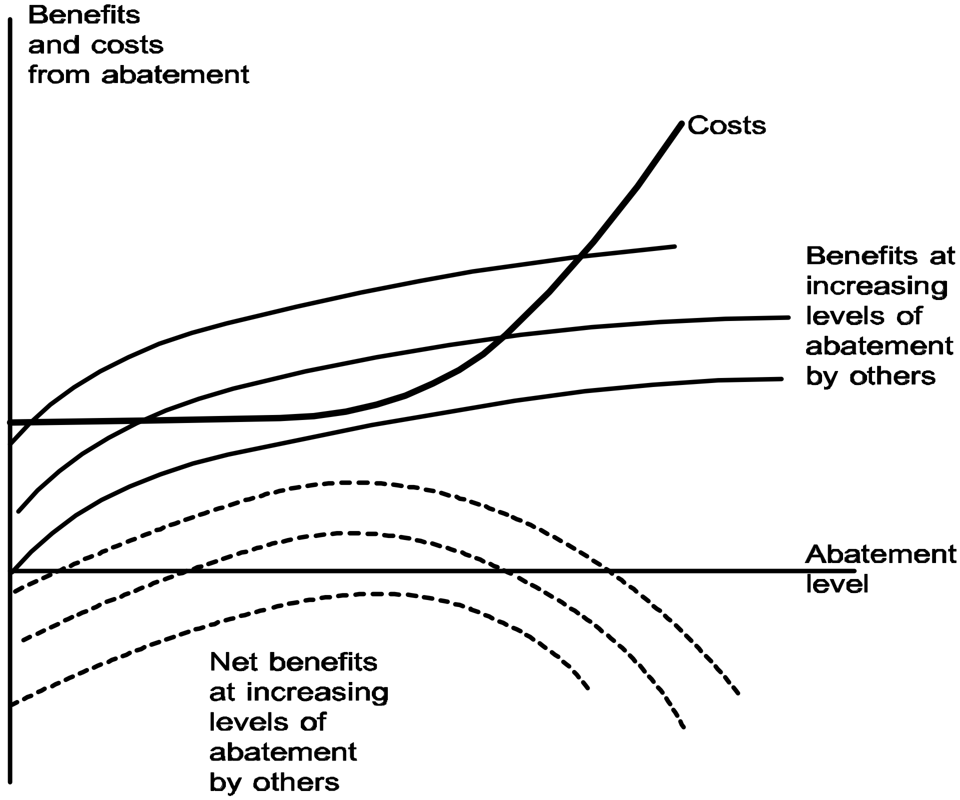
Environmental commitment markets have, in recent years, expanded in most countries, industrial and developing, as a result of governments adopting new legally binding environmental norms and standards. An example is unleaded gasoline in Germany and how the new gasoline policy in Germany affected—or produced spillover effects into—Italy.

Unleaded gasoline was introduced in Germany before it was introduced in Italy. Many Germans drive to Italy as tourists, and in some regions their business is an important source of income. After the introduction of unleaded gasoline in Germany, Germans drove to Italy in cars requiring unleaded fuel, and their business was important enough that gas stations in the regions patronised by them installed facilities for serving unleaded gas, even though there was no market for this among Italian drivers. This required the establishment of facilities for the production and distribution of unleaded gasoline in Italy, which in turn required a considerable investment that historically has been one of the obstacles to the introduction of unleaded gasoline in any country. Because of this prior introduction to meet the requirements of German tourists, the incremental cost of requiring all vehicles to use unleaded gasoline in Italy was greatly reduced, making the eventual adoption of unleaded gasoline in Italy far easier than it would otherwise have been. This is a nice example of how the adoption of standards by one country has positive spillover effects to others and reduces their costs of adopting the same standards.

A second illustration of this point is more general. Emission abatement often requires the development and implementation of new technologies: in the case of unleaded gasoline, the main requirement was the development of vehicle engines that could deliver undiminished performance without lead additives. The mandating of unleaded gasoline in the United States forced all the world's main vehicle manufacturers to solve this problem, greatly reducing the costs and political obstacles to the later adoption of unleaded gas in other countries.

Both examples make an important general point: the more widely a standard is adopted, the less costly are subsequent adoptions. For global environmental public goods whose provision requires new technical standards, getting one or two large countries to make the move first can greatly facilitate the widespread adoption of the appropriate new standards. The Montreal Protocol illustrates this: the development of CFC-free refrigerants greatly reduced the opposition to this in industrial countries, and an agreement to transfer this new technology to developing countries then facilitated a worldwide agreement. In economic terms, the point is that there are big fixed costs to the provision of global public goods, and many of these fixed costs can be those for research and development. These R&D costs only have to be paid once: as the requisite technologies have to be developed only once. If one country does this, others need not. So the first to adopt confers benefits on others (see Sandler (forthcoming) for related points about the role of leader nations and the effect technology has on the stability of coalitions). To date, the United States has usually been the first mover in these agreements.

Figure 2. Benefits increase when others abate

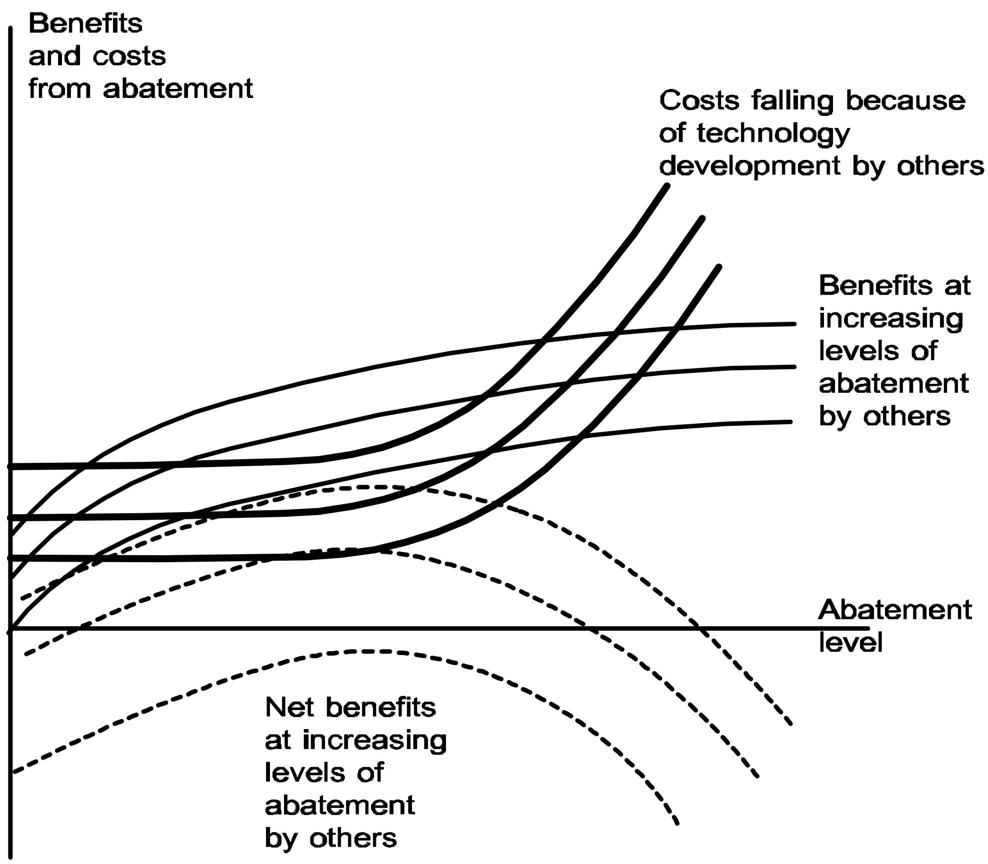


How do these considerations apply to the Kyoto protocol and the associated moves to reduce the emission of greenhouse gases on a global scale? Will a key technological breakthrough facilitate widespread progress, as in phasing out CFCs or lead additives? There are probably two strategic developments here: the development of clean vehicle engines, and the commercialisation of renewable energy sources. Japanese and German vehicle manufacturers are pressing hard on the development of fuel-cell technologies for cars, and British Petroleum and other energy companies are allocating rapidly rising R&D dollars to renewable energy sources, mainly photovoltaic. The introduction of really strict CO_2 emission standards by a few large economies could act as the catalyst to push these ventures to commercial viability—and start the process of widespread adoption.

There is another element to the role played by early adopters of a standard required for supporting the provision of a global public good. This additional effect interacts with reducing fixed costs. If some countries abate emissions of greenhouse gases, this confers benefits on the non-abating countries and moves upwards the curve relating their benefits from abatement to the level of abatement and the costs they incur to abate. They now accrue positive benefits even when incurring no abatement costs, so that their cost-benefit relationship no longer goes through the origin. Figure 2 illustrates this.

As a consequence of abatement by others, the net benefits from adoption in follower countries increase at all cost levels, and the maximum net benefit may increase from negative to positive (figure 2). The net benefit curves have to be interpreted carefully. They show net benefits as a function of abatement at positive abatement levels, but at zero abatement the net benefit is always positive and given by the vertical intercept of the benefit curve. Why? Because even at zero abatement, a follower country benefits from the abatement activities of others. So the graph of net benefits versus abatement level for follower countries has a discontinuity at zero. Net benefits for these countries are positive at zero abatement because of benefits from the actions of others and the absence of abatement costs, but they jump down as soon as abatement begins because of the fixed costs incurred.

Figure 3. Costs fall when others develop the technology



As other countries increase their abatement and move the benefit curves up, the fixed cost of abatement may also fall due to technological innovations as explained above. Figure 3 shows clearly how this combination of circumstances can lead to a situation where the optimal abatement level for individual follower countries viewed on its own is positive. There will be no tendency in such situations to opt out of an abatement agreement totally and free ride on others.

In sum: there are reasons to be guardedly optimistic about the possibility for durable agreements to support the provision of international public goods. Precedents are encouraging (though some are tragic), and features of the problem suggest a self-interest in cooperation can emerge as costs fall following early investments by some countries.

Coalition formation and international politics

Management of global public goods, including the creation of market-based mechanisms, implies global actions and global agreements. What is the nature of these agreements, and how can the international community relate to them?

To be effective, international agreements have to be attractive to all participants, because participation cannot be enforced, at least not in the way compliance with domestic laws can be enforced. The Montreal Protocol on Substances that Deplete the Ozone Layer has been effective because it is in the interests of all key players, and was carefully crafted to be so (Barrett 1999). The remaining negotiation for the Kyoto protocol has to achieve the same outcome, and make this protocol in the interests of developing and industrial countries. Crafting stable agreements of this type is generally challenging. But features of the global public goods problems can, if properly exploited, help in attaining of consensus on their provision.

Conventional wisdom runs quite counter to this, asserting that the free-rider problem is particularly destructive at the international level. The point here is that each country has an obvious incentive to let others cut back emissions of global pollutants and bear the cost, while enjoying a share of the benefits. Precisely because a better global environment is itself a global public good, each country can benefit from improvements wrought by others at no cost to itself. There is thus a sense in which its best course is to encourage others to go ahead and contribute to a better environment but not joining them. This brings the benefits but not the costs of improvement.

This rather cynical analysis misses the mark empirically: as of 1990 there were about 150 international environmental treaties, and the number is still growing (Barrett 1994). Many are regional rather than global, but the issues are the same. Not all of them came into existence purely because of the altruism of their members: there has to be an element of self-interest, which the free-rider argument misses. Indeed, there seem to be two factors that help bring these treaties into existence and hold them together.

One has to do with the fact that the parties to these treaties are all members of a continuing international community in which they have interacted regularly for many years and expect to continue doing so. These interactions cover many areas, not just global or regional public goods: they cover security, trade, aid, and many other issues. Analytically this means two things. One is that the countries involved in these agreements are picking moves in repeated games—that is, in strategic interactions that will continue indefinitely. The second is that the strategy spaces in these games are not restricted to moves concerning global public goods: the strategy spaces are much more rich, and contain many other dimensions. They include trade strategies, technology transfer strategies, security strategies, and many more.

These two facts—repeated interaction and a complex strategy space—are important. A very basis result in the theory of games tells us that there is much more scope for cooperative and mutually beneficial outcomes in strategic interactions that are repeated rather than once-off (Heal 1976 and Myers 1997). For example, if a prisoners' dilemma game is played once, the outcome for rational players is the inefficient one. But if it is repeated indefinitely, the efficient solution should emerge.[5] The complexity of the strategy space also helps. Another result in the theory of games tells us that efficient outcomes are more likely in games with high-dimensional strategy spaces.

What are the implications of this for managing the provision of international public goods? Relatively simple: it helps to have a functioning international community that cooperates in many different areas and that includes all countries likely to be involved in the provision and management of the public goods. Then we have the benefits of repeat interaction—and of having many different dimensions to negotiating strategies. If in addition, a fair and equitable outcome can be projected and realised, then, as stressed by Rao in this book, all countries will feel that they are a part of a repeated game, a repeated strategic interaction, and they will have an interest in the long-run viability and stability of the international community. This is very clearly an argument against excluding countries from full participation in the international community as a way of exercising leverage over them.

Conclusion

The world of public goods, having changed, is still changing. Many goods that were traditionally provided publicly have been privatised. Although publicly provided in the past, they are not necessarily strictly public goods, but often have an element of publicness through limited excludability or limited rivalry. For them, there has been a tendency to distinguish between the infrastructure, often a network, and the services provided on top of it. Privatisation has tried to introduce competition in the provision of services that use the network—and to regulating the network provider.

In a distinct development that also involves the use of markets in the regulation of public goods, we have moved to a regime in which policy concerns focus on public goods that are privately produced. A growing tendency with such goods is to use the market to answer the “who will produce” question. This is associated with the growth of markets for emission permits and pollution rights.

Managing the provision of global privately produced public goods raises interesting questions, which are currently on the agenda of the Framework Convention on Climate Change and the governments and agencies that want this to work. Many sceptics have focused on the free-rider issue and the prisoners' dilemma implicit in the efficient provision of public goods. This seems inappropriate, for it misses the context in which all of this occurs. There is an international community. The countries involved are a part of this. And they are involved in many negotiations on a wide range of issues. In addition, there are adoption spillovers: the first adopter of policies to provide more of the global public good makes the task easier for those who come later.

These observations define a natural role for international diplomacy, with two parts. One is to fully involve countries whose cooperation is critical in the international community on a continuing equitable basis and in many different ways. The second, related to the adoption spillovers discussed earlier, is for the international community to encourage key actors to play a pump-priming role by making early moves towards adopting new policies and standards, reducing the costs to those that will follow. Given the crucial role of early movers in establishing frameworks and technologies and in demonstrating feasibility, there may be a case for designing systems under which they will eventually recover some of the costs of being first, perhaps in the form of a type of intellectual property right.

References

Barrett, Scott. 1994. “Self-Enforcing International Environmental Agreements.” *Oxford Economic Papers* 46: 878-94.

__________. 1999. “Montreal v. Kyoto: International Cooperation and the Global Environment.” This volume.

Chichilnisky, Graciela and Geoffrey M. Heal. 1994a. “Who Should Abate Carbon Emissions? An International Viewpoint?” *Economics Letters* 44: 443-449.

__________. 1994b. “Markets for Tradable Carbon Dioxide Emission Quotas: Principles and Practice.” A report to OECD. Washington, DC: OECD.

__________, eds. 1999. *Environmental Markets*. New York: Columbia University Press.

Coase, Ronald H. 1960. “The Problem of Social Cost.” *Journal of Law and Economics* 3: 1-44.

Dales, John H. 1968. *Pollution Property and Prices*. Toronto, Canada: University of Toronto Press 1968.

Foley, Duncan K. 1970. “Lindahl's Solution and the Core of an Economy with Public Goods.” *Econometrica* 38 (1) 66-72.

Heal, Geoffrey M. 1976. “Do Bad Products Drive Out Good?” *Quarterly Journal of Economics* 90(3):499-502.

__________. 1998. *The Economics of Increasing Returns*. The International Library of Critical Writings in Economics. Edward Elgar. 1998.

Kristrom, Bengt and Per Riera. 1996. “Is the Income Elasticity of Environmental Improvement Less Than One?” *Environmental and Resource Economics* 7: 45-55.

Martin, Lisa L. 1999. “The Political Economy of International Cooperation.” This volume.

Myers, Norman. 1997. “The World's Forests and Their Ecosystem Services.” In Gretchen C. Daily, *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, DC: Island Press.

Sandler, Todd. Forthcoming. “Global and Regional Public Goods: A Prognosis for Collective Action.” *Fiscal Studies*.

ENDNOTES

[1] A Lindahl equilibrium provides extra instruments for this task, namely extra prices, by considering personalized prices for public goods. Redistribution of endowments can substitute for the extra prices in a Lindahl equilibrium.

[2] Although I cannot develop this point here, this is true even in a strictly second-best context where the total emission level being distributed between countries is not one associated with an efficient pattern of resource use overall. The connection between efficiency and distribution has long been known to be close in second-best policy choices.

[3] By this I mean only that their income and price elasticities of demand are of the same order of magnitude. I am ruling out radically different valuations of private goods and the environment.

[4] This has now been documented in a large number of studies in many different countries. A good reference is the recent paper by Kristrom and Riera (1996).

[5] Martin (1999) makes the same point from a political science perspective.