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DEFINING GLOBAL PUBLIC GOODS

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Weekends are great days for shopping—in cities like Manila, Nairobi, Cairo, Buenos Aires and London but also in many smaller towns and rural areas. People hustle through crowded bazaars and air-conditioned supermarkets with their baskets and carts filled with goods: bread, rice, vegetables, shoes and perhaps toys and sweets. Rarely, if ever, has someone been seen shopping for traffic lights. Yet few of our weekend shoppers could do without them. They would be stuck in gridlock traffic or unable to cross busy streets and highways. Without traffic lights, some might even have serious accidents on their way to the market. The reason nobody carries traffic lights in their shopping cart is that everybody expects to find them outside, as a public good. Inside the market, shoppers' attention is focused on private goods.

For their well-being people need both private and public goods. This chapter focuses on public goods, on the world outside the market places. First we introduce the concept of public goods and describe some of its main elements. Then we refine this generic definition and identify the distinguishing characteristics of *global* public goods, the main subject of this chapter and this volume. While there is a rapidly growing literature on the globalization of economic activity and its implications for public policy, not much attention has been paid to the notion of global public goods. Yet we know that domestically efficient economic activity and people's well-being require appropriate public goods. The question is, how does the expansion of economic activity across national borders affect the demand for public goods? In particular, does it entail a need for global public goods? To answer this question, it is important to understand the main properties and distinguishing features of international public goods, including regional and global public goods.

Global public goods must meet two criteria. The first is that their benefits have strong qualities of publicness—that is, they are marked by nonrivalry in consumption and nonexcludability. These features place them in the general category of public goods. The second criterion is that their benefits are

quasi universal in terms of countries (covering more than one group of countries), people (accruing to several, preferably all, population groups), and generations (extending to both current and future generations, or at least meeting the needs of current generations without foreclosing development options for future generations).¹ This property makes humanity as a whole the *publicum*, or beneficiary of global public goods.

PUBLIC GOODS: THE GENERIC DEFINITION

To understand what a public good is, it is useful to examine its counterpart, a private good, and to discuss what it means to have a market for private goods. In a market transaction a buyer gains access to a good (or service) in exchange for money or, sometimes, in exchange for another good. Buyers and sellers meet through the price mechanism, and if everything works in a textbook-perfect way, the economy can reach a state of maximum efficiency in which resources are put to their most productive uses. A key condition for a market transaction, however, is that the ownership or use of a good can be transferred or denied conditional on the offsetting exchange—the payment of its price. Thus private goods tend to be excludable and rival in consumption. A piece of cake, once consumed, cannot be enjoyed by others. With public goods, matters are different.

The main properties of public goods: nonrivalry in consumption and nonexcludability

The concept of public goods has its roots in 18th century scholarship. David Hume discussed the difficulties inherent in providing for “the common good” in his *Treatise of Human Nature*, first published in 1739. Some 30 years later Adam Smith analysed similar questions in his *Inquiry into the Nature and Causes of the Wealth of Nations*. We will not attempt to summarize the literature on the topic that has emerged since then. As Shmanske (1991, p.4) notes, it is “a literature so vast and varied that the mention of public goods brings to mind a dozen different issues, each of which brings along its own idiosyncratic model and relies on its own set of special assumptions”. Rather than offer an exhaustive summary, we will map out, in nontechnical language, the most important characteristics of public goods and clarify some of the key issues involved—notably those that help us understand the nature of *global* public goods.²

PURE PUBLIC GOODS. The ideal public good has two main qualities: its benefits are nonrivalrous in consumption and nonexcludable. To elaborate,

consider again the example of the traffic light. If one person crosses a street safely thanks to a well-functioning traffic light (and thanks to obedience on the part of the drivers facing the red signal), this does not distract from the light's utility for other persons. Hence the light's benefits are nonrivalrous in consumption. At the same time, it would be extremely difficult in political and social terms and quite costly in economic terms to reserve usage of the light for one person or group and to make all other people walk long distances to find a safe cross-way elsewhere. Thus the traffic light's benefits are nonexcludable, or excludable only at prohibitive costs. In fact, one could argue that as more people obey the light's signals, its benefits to each individual grow. This is because frequent use indicates broad public acceptance of the light's role in regulating traffic flows. Without such acceptance, its utility would be low and could even turn into disutility.

Strictly speaking, there is a market for traffic lights: they can be bought and sold, though perhaps not put in a shopping cart. But the traffic light *regime*—the lights, their shared meaning and the behavioural expectations they entail—is a public good.

Peace is another example of a pure public good. When it exists, all citizens of a country can enjoy it; and its enjoyment by, say, rural populations does not distract from its benefits for urban populations. A similar case can be made for law and order or good macroeconomic management (see Jervis 1988; Cowen 1992; and Mendez 1997).

IMPURE PUBLIC GOODS. Few goods are purely public or purely private. Most possess mixed benefits. Goods that only partly meet either or both of the defining criteria are called impure public goods. Because impure goods are more common than the pure type, we use the term “public good” to encompass both pure and impure public goods. As the discussion here and in other chapters of this volume shows, many of the implications of publicness remain salient even when a good is only partly nonrival or partly nonexcludable. Thus our general use of the term “public good” is a useful simplification.

In line with this definition, we suggest looking at “pure private” and “pure public” as the extremes of a public-private continuum. Even an activity such as consuming a nutritious meal, which at first glance seems to be highly private, upon closer examination has public benefits. A good meal adds to people's good health, and good health enhances their ability to acquire skills and to work productively. This, in turn, benefits not only them but also their families and society as a whole. The immediate benefits, however, are mostly private.

DEFINING GLOBAL PUBLIC GOODS

Impure public goods fall into two categories. Goods that are nonrivalrous in consumption but excludable are club goods (table 1; see also Cornes and Sandler 1996). Goods that are mostly nonexcludable but rivalrous in consumption are common pool resources (see G. Hardin 1968; Wijkman 1982; Stone 1993; Cooper 1994; Carraro and Siniscalco 1997; Dasgupta, Mäler and Vercelli 1997; and Sandler 1997). Public goods with an existence value are purchased not because they can be consumed but because people derive value from the knowledge that the good exists. Biodiversity would fall into this class of goods, as would the preservation of monuments and art. Merit goods are goods subsidized by the polity because their existence or their consumption (as in the case of art) is highly valued by the community (see Mead 1993 and Loomis 1996).

Externalities

Externalities arise when an individual or a firm takes an action but does not bear all the costs (negative externality) or all the benefits (positive externality; Stiglitz 1997) of the action. For example, educating women has positive effects on child survival and on slowing population growth. Releasing pollutants into a river, by contrast, can harm nature and human beings. Put differently, externalities are by-products of certain activities—spillovers into the public sphere. Cornes and Sandler (1996, p. 6) argue that public goods, notably pure public goods, “can be thought of as special cases of externalities”.

TABLE 1

Private and public goods

	Rivalrous	Nonrivalrous
Excludable	Private good	Network Club good (mostly nonrivalrous inside the club)
Nonexcludable	Good subject to congestion or depletion, yet accessible to all Some global commons (geostationary orbit)	Pure public good Existence value Some global commons (high seas, ozone layer)

Note: Public goods are in the shaded areas.

The foregoing discussion raises the question of what is positive and what is negative. For economists, positive and negative externalities are distinguished by their positive or negative utilities to third parties. Thus here we will reserve the term “public good” for goods and activities with positive utility, including positive externalities. If a public disutility is involved, we will use the term “public bad”.

While utility and disutility are commonly accepted notions, they ignore the issue of prioritization. At the local, national and global levels most judgments of what is desirable can only be the result of a political process, given the tremendous disparities in living conditions and value systems that exist within countries, let alone the world. Thus the measuring rod has to be found within existing policy consensus. For example, if society values knowledge, a library could be said to be a good with a high positive utility. Other communities, however, may prefer to spend resources on roads. Likewise, prioritization exists *de facto* in global policy-making. It has to be made transparent and participatory.

Supply problems of public goods

Because they are nonrivalrous in consumption and nonexcludable, public goods typically face supply problems, and so are often referred to as a case of market failure (see Bator 1958; Davis and Hulett 1977; and Malinvaud, Milleron and Sen 1998). They elicit patterns of behaviour that, from the individual agent’s viewpoint, are quite rational. Yet from a collective viewpoint—such as that of a local community, a nation or humanity as a whole—the result is suboptimal and can be disastrous. The two main problems affecting the provision of public goods are known in the literature as “free riding” and the “prisoner’s dilemma”.

THE FREE-RIDER PROBLEM. As noted, Hume first described the free-rider phenomenon in the mid-18th century. In his view, gaining the cooperation of a thousand citizens to jointly work for the common good would fail in the face of an individual’s incentive to “free himself of the trouble and expense, and . . . lay the whole burden on others” (Hume 1961, p. 478). Garrett Hardin reprised the problem in his famous essay “The Tragedy of the Commons”. In his formulation, shepherds sharing common pasture are “locked into a system that compels (each one) to increase his herd without limit” (G. Hardin 1968, p. 1244), thus leading to overgrazing and land degradation. Olson (1971, p. 113) argues that even altruism or common purpose would not overcome the powerful incentive to avoid contributing personal resources to common endeavours. People may fear that indicating an inter-

est, say, in better roads, will trap them into also having to foot the bill. Whatever the reason, the temptation to free ride, easy ride or simply not express one's preferences sends the wrong signal to suppliers. As a result supply and demand cannot reach an equilibrium, public goods are undersupplied and resource allocations are suboptimal.

Markets are good at providing private goods. For the provision of public goods, however, we need additional mechanisms such as cooperation. Yet as we will see in the following, cooperation is easier said than done.

THE PRISONER'S DILEMMA. In game theory the prisoner's dilemma describes a situation in which lack of information impedes collaboration between two prisoners (see R. Hardin 1971; Brams 1973; Riker and Ordeshook 1973; Kimber 1981; Conybeare 1984; and Oye 1986). The prisoners are held in separate cells and so are unable to agree on a common story in support of their defence. Thus each prisoner must independently reason through his or her best strategy for dealing with the police: deny the crime, or confess. The prosecutors, meanwhile, spell out the penalties as follows: if both prisoners deny the crime, they will each get a year in prison on a lesser charge that can be proven without a confession. If one confesses while the other denies, the one who collaborates will be rewarded with freedom, while the other will get five years in prison for the crime and for lying. If both confess, each will serve a reduced sentence of three years.

Prisoner A quickly realizes that no matter what prisoner B chooses (deny or confess), he is always better off confessing to the crime. If prisoner B denies the crime, prisoner A can get off with no punishment by confessing. If prisoner B confesses, prisoner A faces three years in jail if he also confesses the crime, and five years if he denies it. Thus prisoner A will confess. Prisoner B, facing identical choices, will also confess. The result: both prisoners will confess to the crime and will each serve three years in jail (table 2).

The prisoner's "dilemma" arises from the fact that both would be better off cooperating—by denying the crime—than defecting—by confessing. If they could maintain their silence, they could each serve one year rather than three. Lacking the ability to communicate, and thereby an opportunity to collaborate for mutual gain, they both lose out, serving a total of six years behind bars rather than just two. The four extra years of punishment represent the cumulative loss to the two prisoners resulting from their inability to create a cooperative outcome for themselves.

The prisoner's dilemma is of great interest to students of international relations and other areas of conflict and cooperation, because it represents in

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TABLE 2

The prisoner's dilemma

		Prisoner A	
		Denies	Confesses
Prisoner B	Denies	A and B each get 1 year	A gets 0 years B gets 5 years
	Confesses	A gets 5 years B get 0 years	A and B each serve 3 years

simple terms many real-life situations in which two or more parties face similar incentives to “defect” from cooperation unless mechanisms are established to facilitate communication and build trust. One real-life example is labour standards. In the absence of industry-wide negotiating forums, individual firms wishing to improve labour conditions would have to act in isolation. They would most likely be reluctant to improve work conditions, arguing that it would increase costs and jeopardize their competitiveness. The effect could be that no firm would improve work conditions. Indeed, under competitive pressures a perverse incentive emerges to lower labour standards even if many—or most—firms would prefer to raise their standards. Thus we see in a practical case how a lack of communication and ability to agree on a common strategy can lead to a suboptimal strategy—even though each firm acted rationally from its own point of view.

In a national context the solution to market failures and collective action problems is often to bring the state in to improve conditions for cooperation by, among other things, establishing new or clearer property rights, setting norms and standards or providing fiscal incentives. In some cases the coercive power of government produces socially optimal outcomes. In many other instances the state plays an essential catalytic role. Nevertheless, the supply of public goods also suffers from state failures, such as rent seeking on the part of policy-makers and bureaucrats, public expenditure biases in favour of influential population segments or political stalemate between competing interest groups (Olson 1971; see also Strange 1996 and World Bank 1997). Thus public goods often face a double jeopardy: market failure compounded by government failure. In such cases cooperation is often spurred by civil society advocacy on behalf of a public concern

(such as pollution control) or by the threat of an impending or actual disaster (such as a “tragedy of the commons”).

TAKING PUBLIC GOODS TO THE GLOBAL LEVEL

The assumption tacitly underpinning the discussion above, as with so many other discussions on the subject, is that public goods are national in character. Until recently this assumption could be sustained in many, if not most, cases. But today international, and particularly global, public goods are becoming more central to national and individual well-being. Within the class of public bads, examples include banking crises (which often have world-wide ripple effects), Internet-based crime and fraud, and increased risks of ill-health due to increased trade and travel but also due to the world-wide spread of such hazardous practices as drug abuse and smoking. Among public goods, a striking example is the rapidly growing number of international regimes providing common frameworks for international transport and communication, trade, harmonized taxation, monetary policy, governance and much more. In most if not all of these areas, policy questions that have traditionally been settled at the domestic level are now subject to international scrutiny and coordination.

This is not the place to examine why public goods and bads are going global; we leave that to other chapters in this volume. The important issue here is rather to rethink from a global perspective the characteristics of a public good—that is, its qualities of nonrivalry and nonexcludability. The main issue to clarify is what criteria we should use to identify a global public good. Of particular importance is the question of who should be the beneficiaries—the *publicum*—of a public good in order for it to qualify as global. This issue is important because we live in a highly divided and inequitable world where some actors are more influential than others in setting public policy agendas and where some goods, even supposedly public goods, are more easily accessible to some people than to others. Answering the beneficiary question and assessing the good’s scope of publicness will, furthermore, help in analysing—and correcting—supply problems. For example, it can provide clues to who might be free riding on whom and need incentives to cooperate. A concept of global public goods is crucial to effective public policy under conditions of increasing economic openness and interdependence among countries. As noted, the term “global public good” has not received much attention, despite the rapidly proliferating literature on globalization and its effects on national policy-making (see Kindleberger 1986; Streeten 1995; and Sandler 1998).

Identifying the global public

Despite the vanishing of the East-West divide in the late 1980s and increased economic openness and market integration, the world continues to be marked by sharp disparities and clear dividing lines. Thus it is no simple matter to determine the reach that a public good should have to qualify as global. Three divisions seem to be of special significance in our context—namely, the division of the world’s population into countries, socio-economic groups and generations.

COUNTRIES. Nation states form important core elements of the international community. Since the Peace of Westphalia in 1648, nation states have enjoyed formal policy sovereignty and played a key role in shaping human activity—economic, social, cultural and political—within their borders. For a variety of reasons and purposes, states (countries) form groups such as regional forums (for example, in Asia, Latin America, Sub-Saharan Africa or Europe), trade blocs (such as the North American Free Trade Agreement or South American Common Market, or Mercosur), defence alliances (such as NATO, the North Atlantic Treaty Organization), and clubs (such as the Organisation for Economic Co-operation and Development, G-7, or G-77).

Thus a first requirement for a global public good is that it covers more than one group of countries. If a public good were only to apply to one geographic region—say, South America—it would be a regional public good, and possibly a club good (that is, a good with excludable benefits).

SOCIO-ECONOMIC GROUPS. As trend analyses of human development over the past 50 years have shown, socio-economic disparities are growing both between and within countries (UNDP 1998). The rich are getting richer and the poor are getting poorer, not only in terms of income but also in many other respects, including access to knowledge, information and technology. Being rich or poor is not just a matter of being a citizen of a poor or a rich country. Rather, wealth and deprivation exist side by side in poorer and in richer countries. Hence, even though a public good has world-wide benefits in the sense of reaching all (or at least, a large number of nations belonging to different country groups), its benefits may be accessible only to better-off population segments, further marginalizing the poor.

The Internet, for example, entails such a risk because it has a high access price (the costs of a computer, a telephone line, and sometimes the subscriber fee for the Internet service provider). Similarly, global public bads, such as malaria or tuberculosis, if left unaddressed often hurt the poor more than the rich. This is because the poor may be unable to afford medical treat-

ment and protection or because the poor's only asset is often their health and physical strength. But the world is not only divided along income lines. Ethnicity, gender, religion, political affiliations and other factors also separate people. Hence for a public good to be global, its benefits must reach not only a broad spectrum of countries but also a broad spectrum of the global population.

GENERATIONS. The preceding two points suggest that ideally, humanity as a whole should be the beneficiary of global public goods. But an individual's life is limited. Thus it is important to specify which generation we have in mind when we say "humanity". The environmental movement has reminded us of the importance of a longer-term perspective. As argued in the Brundtland Commission's report, *Our Common Future* (World Commission on Environment and Development 1987, p. 43), sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition of sustainability applies not only to environmental debt (that is, irreversible damage to natural resources) but also to financial and other forms of debt. Any type of collective borrowing from the future raises questions of intergenerational equity.

Some authors, including Sandler in this volume, draw a distinction between intragenerational and intergenerational global public goods. As Sandler notes, we are often faced with trade-offs between these two types of goods. One of his examples is nuclear energy: it can increase the availability of energy for present generations, but in the long run it creates nuclear waste. Thus we believe that intergenerational spillovers should be included in the general definition of a global public good. Hence the third qualifying mark of a global public good is that it meets the needs of present generations without jeopardizing those of future generations.

The definition of a global public good suggested here is demanding. It describes the ideal type of a global public good. But as noted, a pure public good is rare—and so is a pure *global* public good. Bearing this in mind, a practical way of summarizing the foregoing discussion is to offer a maximal definition of a pure global public good and a minimal definition of an impure global public good. A pure global public good is marked by universality—that is, it benefits all countries, people and generations. An impure global public good would tend towards universality in that it would benefit more than one group of countries, and would not discriminate against any population segment or set of generations.

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In the same way we use the term “public good” to denote pure and impure public goods, we will use the term “global public good” to denote both purely global and impurely global public goods. The justification is again practical: both types of global public goods pose similar policy challenges. Chief among them is the issue repeatedly raised in the literature on international relations and cooperation: in the international sphere, where there is no government, how are public goods produced? (See Kindleberger 1986.)

Distinguishing global and nonglobal public goods

Our notion of global is not merely geographic—that is, global as opposed to local, national or regional. Rather, it is multidimensional, including, besides the geographic dimension, a sociological and temporal dimension. We have chosen this multidimensional definition to do greater justice to the complexities of the real world. The result, however, is a more complex definition. Thus it is useful to reflect not only on what a global public good is but also on what type of goods would not qualify.

Clearly, if a public good were to benefit only one country or region, it would not be global, but national or regional. Similarly, the security services that NATO provided during the Cold War for Western bloc countries were a public good for the alliance or, in more general terms, a club good. And if a multilateral investment guarantee scheme were to yield benefits exclusively for private international investors, it would be a world-wide club good, possibly even a private good—but not a global one according to our definition.

On the other hand, a poverty alleviation programme for Sub-Saharan Africa could be a global public good if, by meeting the needs of local populations, it were also to contribute to conflict prevention and international peace, reduce environmental degradation of potentially international consequences and improve global health conditions. By contrast, donations to disaster victims are a voluntary redistribution of private goods, from one owner to another, motivated primarily by empathy rather than by global concerns. Private transfers and public goods provision do not necessarily differ in a moral or ethical sense. They merely have different technical characteristics: (non)rivalry and (non)excludability.

All of this shows that it is important to guard against a hasty categorization of public goods as global or nonglobal. A decision on this issue requires careful assessment and impact analysis as well as a participatory policy dialogue among all concerned actors and beneficiaries.

A typology of global public goods

We have already distinguished between pure and impure global public goods. In what follows we will sort global public goods according to another criterion, namely, their place in the production chain. We suggest here a distinction between final and intermediate global public goods.

- Final global public goods are outcomes rather than “goods” in the standard sense. They may be tangible (such as the environment, or the common heritage of mankind) or intangible (such as peace or financial stability).
- Intermediate global public goods, such as international regimes, contribute towards the provision of final global public goods. Note that global public goods such as economic growth arise from a mixture of public and private inputs.

Again, this distinction has significant policy relevance. To illustrate, there is nothing intrinsically good about agreeing to reduce chlorofluorocarbons (CFCs). To achieve this objective—as an intermediate product—matters primarily in terms of the final good, an intact ozone shield. In general, the publicness of the final good matters most and may give rise to international collective inaction. Typically, global public goods are the results of many activities, private and public. The purpose of identifying intermediate global public goods is to highlight the area, or areas, where international public intervention may be needed to provide a particular global public good. To stay with the example of the ozone layer, the needed intermediate global public good could be an agreement such as the Montreal Protocol.

Perhaps the most important intermediate public goods are international regimes. Such regimes provide a basis for many other intermediate products with global public benefits—including, for example, international surveillance systems, international infrastructure or international aid programmes. International regimes take different forms that may be closely intertwined but that should nevertheless be distinguished:

- International agreements are statements of commitment typically setting forth policy priorities, principles, norms or standards as well as decision-making procedures and obligations.
- Organizations are bodies or mechanisms, usually resulting from international agreements, intended to, among other things, facilitate consultations and negotiations among member parties, monitor treaty compliance or provide other types of information, or undertake operational activities (for more details on international regimes, see Keohane 1984; Krasner 1986; and Ruggie 1993).

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Among international organizations, a distinction exists between those that support consultation and negotiation, those intended to provide vital information to states through monitoring and surveillance, and those dedicated to operational activities. A growing number of international agreements require operational follow-up at the country level.

International regimes cover an ever-growing range of activities, from transportation and communication to health, the environment, demographics, judicial systems, human rights and macroeconomic policy. While many global regimes are intergovernmental in nature, international civil society organizations and the private sector play an increasing role in international norm and standard setting as well as in international operational activities. Just think of international human rights organizations such as Amnesty International or Human Rights Watch, or humanitarian organizations such as the Red Cross or Médecins sans Frontières. Another example is the International Standards Organization (ISO), which is a public-private partnership.

The benefits of global regime building are enhanced predictability in international relations and transborder activities, which reduce the risk of conflict and misunderstanding. As a result transactions costs are reduced, encouraging cooperation and improving efficiency. In some cases international regimes help promote—or restore—universalism, such as the universal recognition of basic human rights, including women's rights.

Yet as Olson (1973, p. 873) notes, “the desire for peace . . . for orderly financial arrangements for multilateral trade, for the advance of basic knowledge, and for an ecologically viable planet are now virtually universal, yet these collective goods are only episodically or scantily supplied”. In the next section we offer some explanations for this inaction and undersupply of global public goods.

The supply problems of global public goods

Public goods are essentially defined by the existence of a provision problem; by their nature, they cannot easily be provided by the “invisible hand” of the market. Examining the issue of international trade from the public good viewpoint, Conybeare (1984, p. 7) notes that “in the public good game the degree of suboptimality is normally considered to be a function of the extent to which the qualities of publicness are present and of the number of beneficiaries”. As noted, global public goods can vary in their qualities of nonrivalry and nonexcludability. In this respect they are no different from any other public good. In terms of beneficiaries, however, most global public goods do vary from other public goods: their beneficiary groups are likely to be extremely large, often

reaching into the billions. As a consequence, the beneficiaries of global public goods are more diverse, including developing and industrial countries, poor and rich, and people of different cultures living in different ecosystems and coming from different historical backgrounds. Thus one has to expect that interests and concerns will vary and cooperation will not be easy to achieve due in part to differences in policy priorities and other preferences—perhaps often simply due to lack of information and mutual understanding and trust.

Certainly, billions of people do not negotiate directly with each other. In many instances their governments do it on their behalf, reducing the number of negotiating partners to about 185—still an unwieldy group for creating cooperative arrangements. But as Cooper and others (1989) and Putnam (1988) point out, intergovernmental negotiations are often two-tier processes. While negotiating with each other internationally, governments also have to consult with their diverse constituencies back home on emerging compromises or other proposals on the negotiating table. This requirement automatically increases the number of parties involved in any negotiation by a multiple. In addition, as various chapters in this volume demonstrate, intergovernmental negotiations increasingly come under close scrutiny from international civil society, so nongovernmental organizations (NGOs) are another factor to reckon with. So are the international organizations of business, such as the International Chambers of Commerce, as well as individual multinationals and other corporations. Given the large number of actors and beneficiaries and the tremendous uncertainty that results from their presence (in addition to the technical uncertainties that often surround issues under negotiation), one can expect collective action problems, such as free riding or prisoner's dilemmas, to abound.

Moreover, as explained by Martin in this volume, states internationally behave like private actors, motivated by national self-interest. This tendency raises the issue of who exists at the global level to cut the Gordian knot of collective inaction. At the national level that role is often assumed by the state, although state failures in this respect also occur domestically. Globally, however, the risk of "state" failure is systemic due to the absence of a global sovereign. This makes it all the more important to examine the role of nonstate actors in providing global public goods.

Despite these difficulties, which could potentially impede the supply of global public goods, there is an impressive—and growing—volume of international regimes as well as many other examples of successful international cooperation.

CONCLUSION

In today's rapidly globalizing world, people's well-being depends on striking a careful balance not only between private and public goods but also between domestic, regional and global public goods. Thus it is important to have a clear definition and understanding of global public goods.

We have defined global public goods as outcomes (or intermediate products) that tend towards universality in the sense that they benefit all countries, population groups and generations. At a minimum, a global public good would meet the following criteria: its benefits extend to more than one group of countries and do not discriminate against any population group or any set of generations, present or future.

Our discussion has shown that in a highly divided world, global public goods raise the familiar issue of how to ensure their provision, given that internationally there is no equivalent to a national institution of government. But global public goods also raise two other issues: Who defines the political agenda, and hence the priorities for resource allocations? And who determines whether global public goods are in fact accessible to all population groups? Both issues—prioritization and access—are important areas for further research and policy debate.

NOTES

The views presented here are solely those of the authors and not necessarily those of the institution with which they are affiliated.

1. This definition of the generational distribution of the benefits of global public goods draws on the definition of sustainable development provided by the World Commission on Environment and Development (Brundtland Commission) (1987).

2. An early description of public goods was made by economists Knut Wicksell and Erik Lindhal in the interwar period. Italian economists (such as Francesco Ferrara) in the 1850s and 1860s were forerunners. Many of these early classics were translated and introduced in Musgrave and Peacock (1959). For English-speaking readers, classic texts on public goods include Musgrave (1959), Samuelson (1954) and Buchanan (1968).

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INTERGENERATIONAL PUBLIC GOODS

Strategies, Efficiency and Institutions

TODD SANDLER

We live in a “brave new world” where allocative decisions on public goods today can have consequences that cross political and generational boundaries. Although the international aspects of public goods have received much attention in recent years, particularly with respect to environmental activities,¹ intergenerational public goods have received relatively scant attention.² An intergenerational pure public good (bad) provides benefits (costs) that are nonrival and nonexcludable within and among generations. For example, a genetically engineered medicine that cures cancers can benefit people worldwide during the discovering generation’s lifetime and for generations to come. Similarly, lost biodiversity can have adverse global consequences for today’s generation and all subsequent generations. Other intergenerational public goods include eradicating disease, curbing global warming, limiting ozone shield depletion, preserving culture, restraining ethnic conflict and developing cultural norms. For ethnic conflicts, atrocities committed by one generation can create hatreds that fuel conflicts for generations to come, as evident in Bosnia, Kosovo, northern Ireland, parts of the Middle East and some areas of Africa. Cultural norms and laws that promote cooperative behaviour within or among generations can have immense intergenerational benefits.

Although it is tempting to apply standard remedies for transnational public goods problems to transgenerational public goods, it is not necessarily effective. For example, fostering greater transnational cooperation can exacerbate intergenerational inefficiency if this cooperation leads to an even larger provision of an activity that benefits the current generation at the expense of future generations (John and Pecchenino 1997; Sandler 1978). Thus the expansion of nuclear energy through international cooperation improves the welfare of contemporaries but creates an even greater nuclear

waste containment problem for future generations. Similarly, foreign aid intended to develop a country's natural resources so as to alleviate poverty—such as World Bank financing of dams in South America—can result in enormous losses to biodiversity, limiting opportunities for future generations. This last example concerns sustainable development, associated with the preservation of natural capital so as to maintain the opportunities of future generations.³

Other aspects that distinguish remedies for transnational public goods from those for transgenerational public goods involve bargaining, strategic interactions and institutional design. For intergenerational public goods the natural sequencing of generations has profound implications for the design of institutional structures and the kinds of strategizing that can occur among concerned parties. An earlier generation might, for example, exploit a first-mover's advantage, placing more of the burden for an intergenerational public good on the next generation. The sequencing of generations can affect the bargainers' threat points, associated with a failure to reach an agreement. When institutions are designed to correct for market failures tied to transgenerational public goods, the calculation of net linkage gains depends on the outcome in the absence of an agreement. This status quo point also represents the participants' well-being that must be improved if an institutional arrangement is to make everyone better off. A rich array of strategic interactions exists for intergenerational public goods because collective action problems can arise within nations, among nations, among generations or among both nations and generations.

This chapter has five main purposes. First, it presents a taxonomy of public goods with benefits spanning generational or national boundaries. Second, it describes the implications for economic efficiency of a variety of public goods that affect nations or generations. Third, it explores the strategic aspects of intergenerational public goods. Fourth, it offers design principles for institutional arrangements, intended to address concerns about the allocation of transgenerational public goods. Fifth, the analysis is applied to specific cases of intergenerational public goods throughout.

A number of policy insights derive from this analysis. At the national level, decision-makers are unlikely to achieve optimal levels of these public goods. If intergenerational awareness of public goods spillovers is only encouraged within a country, then that country's well-being may actually deteriorate as others free ride on its enhanced far-sightedness. Thus cooperation and increased awareness of spillovers must have both an international

and an intergenerational dimension for all nations to gain. If institutions are properly designed to provide these intergenerational public goods, then the extent of policy-makers' awareness on both dimensions must be anticipated. Simple club arrangements can efficiently allocate resources for intergenerational public goods with excludable benefits. Markets can operate reasonably well for intergenerational public goods that display a large share of nation-specific or generation-specific benefits. When intervention is needed, supra-national structures must be designed to account for associated transactions costs and benefits. Loose or unstructured linkages, which conserve on transactions costs, should be tried first.

A PUBLIC GOODS TAXONOMY

The creation of a taxonomy for public goods that provide benefits across nations or generations poses choices about which attributes of those goods to highlight. Two distinctions are essential for intergenerational public goods—namely, between intragenerational and intergenerational spillovers of benefits and between regional and global spillovers of benefits. The spatial dimension of the public good determines the relevant decision-makers—for example, the executive branch for national public goods, a regional social planner (that is, a hegemon) or individual nations for regional public goods and a world body or regional collectives for global problems. If no further attributes are considered, the resulting 2 x 2 classification scheme is identical to that of Sandler (1997, pp. 67–68). Curbing global warming fits the intergenerational category because greenhouse gases (such as carbon dioxide) have long residency in the atmosphere; it also fits the global category because atmospheric heating affects temperatures world-wide. In contrast, managing a terrorist incident is apt to yield only localized public benefits to the current generation.

This earlier taxonomy can now be extended. Although nonrivalry and nonexcludability can themselves be associated with a whole continuum of categories, a useful approach is to focus on, say, four types of public goods that affect the need for and form of institutional structures to correct for market failures. To expand the 2 x 2 taxonomy to 16 categories, I list pure public goods, impure public goods, club goods, and public goods possessing joint products. For its range of recipients, pure public goods provide benefits that are both completely nonrival and nonexcludable, whereas impure public goods yield benefits that are partially rival and/or partially nonexcludable. If,

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say, congestion detracts from the good's benefits available to others, then these benefits are partially rival. An important subclass of impure public goods consists of club goods, which possess partially rival benefits that can be excluded. At a national level, clubs provide an opportunity for members to allocate resources privately to a public good without government intervention. Similarly, nations can form a club to share an excludable public good without the need for a supranational government structure. Thus the International Telecommunications Satellite Organization (Intelsat), a private consortium with nations and firms as members, operates as a club to share a communications satellite network that carries most international phone calls and television networks. A fourth class includes public good activities that yield two or more outputs that vary in their degree of publicness. For example, "tied" foreign aid can, by financing a developing country's infrastructure or fostering its people's well-being, yield public benefits to the recipient and to the world at large. Because the aid is tied to the interests of the donor country, the donor is expected to obtain one or more country-specific benefits from providing its donation. If, for example, a donor is granted military bases on the recipient's soil, then both a security and foreign interest benefit are conferred on the donor.

The 16-cell taxonomy is provided in table 1, complete with four examples of each type. Intragenerational and intergenerational public goods are distinguished by regional and global spillovers, as well as by the four classes of public goods. Insofar as the suppression of a forest fire provides regional purely public benefits to just a current generation, it is placed in the top left-hand cell along with groundwater pollution that can be cleansed within a generation's lifespan. Flood control and animal disease control are also instances of regional pure public goods.

In the pure public column, the cleanup of ocean pollution provides global spillover benefits to the current generation. Weather forecasts of El Niño represent a global public good because this phenomenon affects large portions of the earth. These forecasts are intragenerational because such weather phenomenon are short-lived. Other, more localized weather forecasts would be regional. Atmospheric monitoring stations and the World Court represent additional intragenerational public goods. Insofar as the World Court is open to all nations to hear disputes for settlement, it provides nonexcludable benefits world-wide. The court's ability to resolve a dispute between one set of nations does not limit its ability to address additional disputes between others, so its benefits are also nonrival.

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TABLE 1

Taxonomy of public goods based on good's characteristics

		Pure public
Intragenerational	Regional	<ul style="list-style-type: none"> • Forest fire suppression • Groundwater pollution cleanup • Animal disease control • Flood control
	Global	<ul style="list-style-type: none"> • Ocean pollution cleanup • Weather forecasts • Monitoring stations • World Court
Intergenerational	Regional	<ul style="list-style-type: none"> • Wetland preservation • Lake cleansing • Toxic waste cleanup • Lead emissions reduction
	Global	<ul style="list-style-type: none"> • Ozone shield protection • Global warming prevention • Disease eradication • Knowledge creation

Some public goods may fall into more than one category depending on how they are defined. Intergenerational, regional pure public goods include wetland preservation, lake cleansing, toxic waste cleanup and curbing of lead emissions, whereas intergenerational, global pure public goods involve stemming the thinning of the ozone layer, curbing global warming, eradicating disease and creating knowledge. All these examples provide nonrival benefits that are nonexcludable. The removal of a pollutant provides benefits to everyone residing in the region of spillovers. Within this spillover area, everyone receives the benefits from the cleanup. If the impact of the pollution removal is sufficiently long-lived, it can benefit future generations.

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Impure public	Club	Joint products
<ul style="list-style-type: none"> • Waterways • Rivers • Highways • Local parks 	<ul style="list-style-type: none"> • Common markets • Crisis management forces • Electric grid • Information networks 	<ul style="list-style-type: none"> • Peacekeeping • Military forces • Medical aid • Technical assistance
<ul style="list-style-type: none"> • Electromagnetic spectrum allocation • Satellite transmissions • Postal service • Disease control 	<ul style="list-style-type: none"> • Canals • Air corridors • Internet • Shipping lanes 	<ul style="list-style-type: none"> • Foreign aid • Disaster relief • Drug interdiction
<ul style="list-style-type: none"> • Acid rain reduction • Fisheries protection • Hunting grounds protection • VOC emissions reduction 	<ul style="list-style-type: none"> • National parks • Irrigation systems • Lakes • Cities 	<ul style="list-style-type: none"> • Peacekeeping • Flood control • North Atlantic Treaty Organization • Cultural norms
<ul style="list-style-type: none"> • Overuse of antibiotics • Ocean fisheries • Antarctica protection • Revolution making 	<ul style="list-style-type: none"> • Transnational parks • Geostationary orbits • Polar orbits • Barrier reefs 	<ul style="list-style-type: none"> • Tropical forest preservation • Space colonies • United Nations • Poverty alleviation

In the impure public good column, examples range from waterways that allow for the local transport of goods and services to the overuse of antibiotics that affects the well-being of current and future generations. For all the impure public goods listed, crowding or congestion reduces the quality of services available to users as overall utilization increases. As more vessels ply a waterway, transit time increases. Noise and interference characterize congestion for the electromagnetic spectrum because increased utilization requires that smaller bandwidths separate users. For antibiotics, an intertemporal form of congestion occurs when greater utilization of antibiotics today raises the likelihood that surviving bacteria will develop an immunity, decreasing the future effectiveness of the antibiotics. Acid rain is impurely public because

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its dispersion is based on a spatial rivalry—that is, the further a country is from the source of the sulphur or nitrogen oxide emissions, the less of these emissions are deposited on that country's soil (Murdoch, Sandler, and Sargent 1997; Sandnes 1993). A similar phenomenon applies to the emission of volatile organic compounds (VOCs). By causing long-run degradation to the environment, acid rain and VOCs have intergenerational effects. Because exploitation of fisheries and hunting grounds can result in smaller species populations or even extinction, use of these goods also implies intergenerational consequences.

Table 1 lists 16 club goods. For these club goods an exclusion mechanism can charge a toll to users so as to internalize the crowding costs associated with a unit of utilization. If the toll is to achieve efficiency, then the toll must equal the marginal crowding costs that another visit or unit of utilization imposes on the membership. Users' total toll payments equal their visits times the toll per visit; visitors with a strong preference for the club good will visit more frequently and pay higher total payments. Regional club goods include goods—common markets, crisis-management forces, electric grids, national parks, highways—whose users are region specific. In contrast, global club goods—the Panama Canal, straits, air corridors, the Internet, polar orbits—are shared by countries world-wide. The distinction between intragenerational and intergenerational club goods has to do with the nature of congestion and whether there is an intergenerational consequence to utilization. For intergenerational club goods, congestion takes both the standard form, in which utilization today detracts from the consumption experience of current users, and an intertemporal form, in which utilization today affects the quality of the club good for current and future users. The latter form of rivalry is known as depreciation due to utilization (Sandler 1982).

Consider a national park. Once visits surpass a park's carrying capacity—that is, its limit for withstanding use and being able to regenerate to its natural state by the next period—its environment begins to deteriorate. As another example, an irrigation system may build up silt through use, resulting in reduced efficiency or depreciation due to utilization. Yet another global intergenerational club involves the sharing of geostationary orbits some 22,300 miles above the equator, at which altitude a satellite orbits the earth in sync with the earth's rotation, so that the satellite remains stationary over a point on the earth's surface. When placed in this orbital band, only three satellites are required to provide point-to-multipoint service throughout the earth

(except at the poles). Congestion takes the form of atemporal signal interference and the possibility of collisions, which may involve discarded and functioning satellites that drift up to 100 miles. Leaving discarded satellites in orbit, a standard practice, poses an intertemporal crowding externality. Intergenerational club goods can be managed efficiently by a collective of members, called an *intergenerational club* (see below).

The last column in table 1 indicates public goods in which an activity gives rise to two or more jointly produced outputs as benefits. Thus a country's military forces may provide purely nation-oriented goals of civil defence and terrorism crisis management while also deterring aggression at home and against a country's allies. Deterrence is purely public to all allies. Similarly, disaster relief yields a world-wide public benefit by helping a country in need; this relief may also contribute to the providing nation's standing in the world community. If an intergenerational benefit is derived, the good is placed in the two bottom cells of the column. Peacekeeping may give intragenerational or intergenerational benefits; hence its placement in two cells. When peacekeeping inhibits the acquisition of hatred that can be passed from one generation to the next, an intergenerational public good is achieved. Similarly, foreign aid or poverty alleviation may, by improving the health of a country's people, benefit current and future generations. Preserving tropical forests provides intergenerational public benefits on a global scale because of carbon sequestration and biodiversity. Flood control can give more localized joint products that are partly intergenerational in character if a dam is long-lived. By providing scientific discoveries, space colonies may produce global intergenerational benefits. Cultural norms that foster the cooperative provision of public goods may also yield benefits to current and future generations.

INTERGENERATIONAL PURE PUBLIC GOODS: SPILLOVER AWARENESS

To provide a flavour of the allocative efficiency problems posed by an intergenerational public good, a simplified model is sketched in which there are two regions, $r = 1, 2$, with three generations, $j = 1, 2, 3$, in each region. Each generation lives for one period so that, in the initial analysis, there are no overlapping generations within either region. The set of people in the j th generation of the r th region is denoted by Ω_{jr} . As an intergenerational public good, good q is produced by each region in period 1 and then lasts for three periods. In the first and subsequent periods a private good, y , is produced and fully consumed during the period of production; thus the private good has no

intergenerational aspects. Initially, the public good is only allowed to be produced in period 1.

The modelling details are presented in appendix 1. In essence there are three ingredients in the model: a utility function for each individual, a constraint requiring consumption of private goods in each period to equal production of private goods, and a multiperiod, multiregional production possibility constraint. The utility functions represent individuals' tastes for the private good and the intergenerational public good, while the production possibility constraint indicates how much of each good can be produced with available resources at different points in time.

An efficiency criterion is required if the allocative aspects of an intergenerational public good are to be investigated. The concept of intergenerational Pareto efficiency (IPE) is employed and corresponds to a position from which it is not possible to improve the well-being of any person at any point in time without harming some other person in the current or some other generation (Page 1977; Sandler and Smith 1976). The intergenerational Pareto efficiency criterion applies the Pareto principle over time and space because it accounts for all relevant periods. In particular, intergenerational Pareto optimality requires the maximization of the i th individual's utility subject to the constancy of all other individuals' utility in the relevant regions and generations.⁴ In addition, the production transformation function and the private good production-consumption constraints must be satisfied. To attain intergenerational Pareto efficiency, the provider of the intergenerational public good must account for the marginal benefits that the long-lived public good confers on people in the current *and* future generations in *both* regions (see appendix 1). Thus spillovers of public good benefits to other regions and future generations must be taken into account. Moreover, the required sum of these marginal benefits over regions and generations must be equated to the marginal costs associated with producing the public good in period 1. A similar condition holds for any region that provides the public good. This full awareness of spillovers is labelled *awareness rule 1* (AR1) and serves as an ideal benchmark. Such a far-sighted decision is anticipated only if some centralized social planner—such as a collective serving the two regions' interests—made the allocation decision while taking into account benefit spillovers over space and time. If more regions or generations were affected by the public good, then the marginal benefit must be summed over all relevant regions and generations.

Alternative awareness rules

When the allocative decision about the intergenerational public good is made at the regional or national level, the decision-maker is unlikely to account for the benefit spillovers conferred on other regions and future generations. At least three reduced levels of awareness are possible. First, an interregional social planner or institution can account for interregional spillover benefits but not for intergenerational benefits. In this case awareness rule 2 (AR2) would equate the marginal benefits of only the current generation in the two regions to the marginal costs (see appendix 2).⁵ Insofar as AR1 includes more marginal benefit terms than AR2, AR2 implies a lower level of provision because a smaller aggregate marginal benefit is equated to marginal production cost. AR2 corresponds to a myopic supranational institution that is aware of the interregional consequences of the public good decision but is ignorant of the intergenerational consequences.

The next two awareness rules are the most relevant and indicate the provision decision for the intergenerational public good being made by a decision-maker in each region. In this scenario the regional planners or national governments are only interested in the Pareto principle as it applies to their people, so there is no concern for residents outside the region.⁶ A third level of awareness has the regional social planners ignoring interregional spillovers while accounting for intergenerational spillovers, so that the marginal benefits are summed only over the region's own current and future generations before being equated to the marginal costs for the public good. For simplicity we assume that regional marginal costs for the public good equal the multi-regional marginal costs in AR1, so that a provision comparison can be easily made between AR1 and AR3. Given the smaller number of marginal benefit terms in AR3 relative to AR1, the intergenerational public good is underprovided relative to the ideal. This follows because interregional spillover benefits are ignored.

The fourth level of spillover awareness, AR4, proves to be the most likely result, in which both interregional and intergenerational spillovers are ignored by the regional social planners. When AR4 applies, the provision level for the intergenerational public good is the smallest of the four rules in which only the current generation's gains in the providing region matters.

Diagrammatic representation

To apply a standard graphical apparatus to intergenerational public goods (Cornes and Sandler 1985; Sandler 1992), I assume that the regional planner's

welfare is solely dependent on current residents' utility levels.⁷ In figure 1 two (production) constrained iso-welfare contours for region 1's social planner are displayed as curves II and $I'I'$ for the case where AR4 applies so that each region looks out for just its own first generation. Production of q takes place in both regions, so that $q = q^1 + q^2$ and residents of either region derive a marginal benefit from either region's provision of the public good. For a given level of q^2 , say q_0^2 , AR4 is satisfied along curve II at point A , where the slope is zero.⁸ Iso-welfare curve $I'I'$ represents a higher level of well-being for region 1 insofar as it receives a greater level of q^2 spillins for each level of its own provision of q^1 . If the spillins are q_1^2 , then AR4 is satisfied along $I'I'$ in figure 1 at point B , where the iso-welfare contour again attains a zero slope. The curve connecting the zero-sloped points on the various iso-welfare contours for different spillin levels from region 2 is the Nash reaction path, N_{AR4}^1 , for region 1. This reaction

FIGURE 1

Nash reaction path for region 1

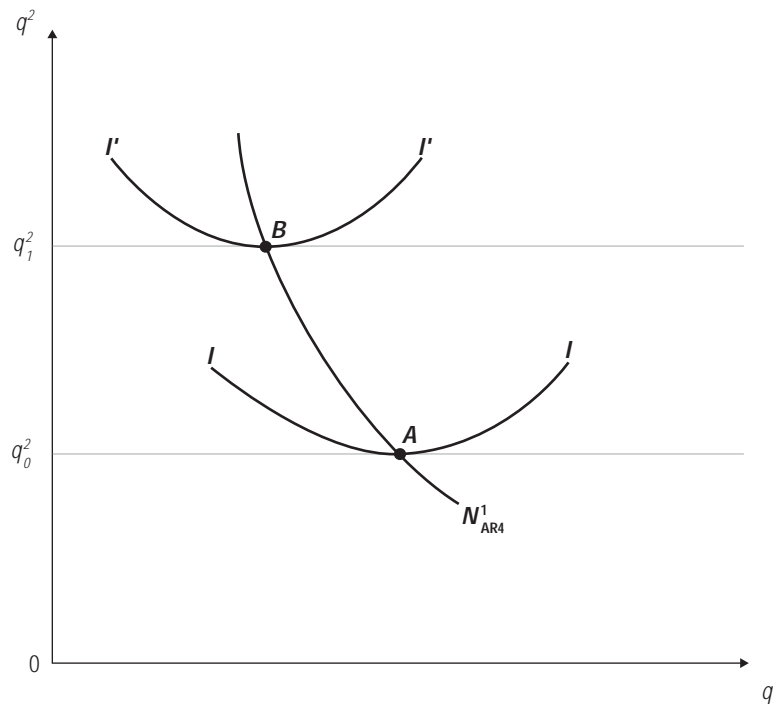
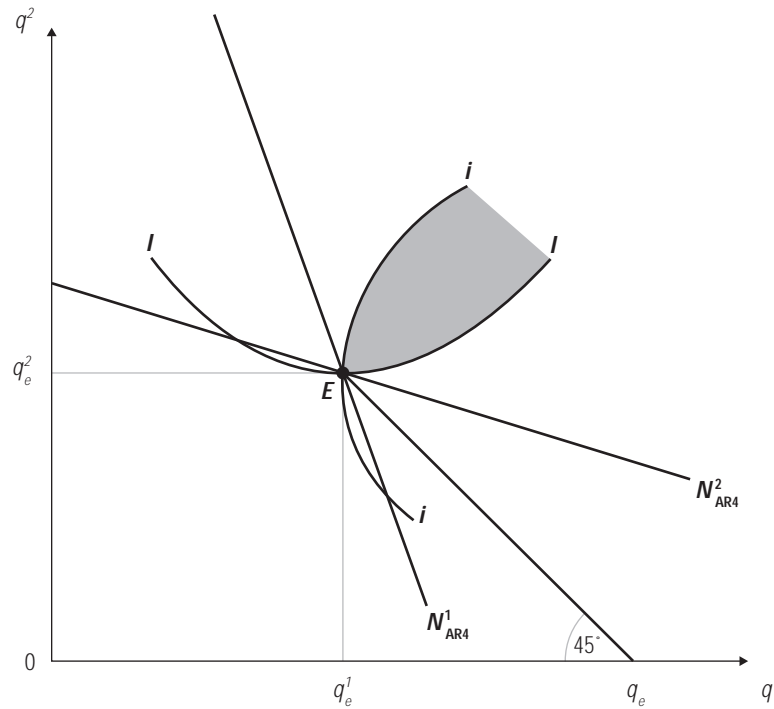


FIGURE 2

Nash equilibrium for two regions



path is typically downward sloping, indicating that as region 2 provides more of the intergenerational public good, region 1 provides less as it free rides on region 2's provision.

Region 2's iso-welfare contours have their bottom points oriented to the q^2 axis. One such curve, ii , is depicted in figure 2. Similarly, region 2's Nash reaction path is derived by connecting these infinite-sloped points—see N^2_{AR4} in figure 2. Region 2's Nash reaction path is also negatively sloped, indicating that region 2 reduces its provision of the intergenerational public good as region 1 increases its provision.⁹ If both regions abide by AR4, then a Nash equilibrium results at point E in figure 2 with region r providing q^r_e for $r = 1, 2$. If we draw a 45 degree line from point E to the q^1 axis, then the intercept of this line, q_e , is the total multiregional provision level. To the north-east of point E the shaded region between the respective regions' iso-welfare contours

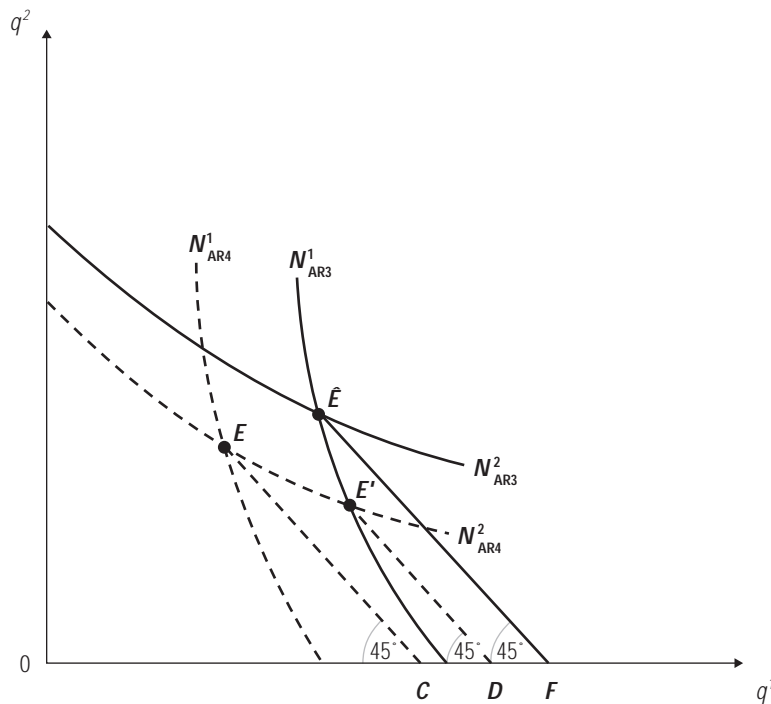
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indicates allocations where both regions' welfare can be augmented. The strategic interaction associated with AR4 leads to a Pareto suboptimal outcome at E from which both regions' welfare could be improved if they both accounted for the spillins conferred spatially and temporally.

Suppose that region 1 assumes a more far-sighted view towards its future generation and accounts for intergenerational public good spillovers by satisfying AR3. Further suppose that region 2 continues to satisfy AR4. By abiding by AR3, region 1 includes more marginal benefits in its calculation when deciding its level q^1 for each level of spillins of q^2 . As a result region 1's provision of the intergenerational public good will be greater for each level of q^2 . This increased intergenerational awareness results in a rightward shift of region 1's Nash reaction path from N_{AR4}^1 to N_{AR3}^1 in figure 3. After this shift the new equilibrium is at E' where the overall level of the public good has

FIGURE 3

Increased intergenerational spillover awareness



increased from $0C$ to $0D$, so that unilateral far-sightedness augments the overall level of the intergenerational public good. Region 2 is clearly better off because it contributes less to the public good but consumes more of it owing to increased spillins. Region 2's iso-welfare curve (not depicted in figure 3) through point E' is a greater welfare level than the iso-welfare curve through point E . A welfare comparison for region 1 is more troublesome because the iso-welfare contours associated with N_{AR3}^1 and point E' are different than those associated with N_{AR4}^1 and point E , insofar as the underlying social welfare function for the planner in region 1 has changed. The smaller is region 2's free riding on region 1's increased provision, the more likely that region 1 may also benefit from its increased concern for its future generations. Region 1's enhanced intergenerational spillover awareness could lose its net welfare if region 2's reaction path were sufficiently steep, so that region 1 loses sizable spillins from the other region's strategic response.

A better scenario occurs if region 2 also becomes more aware and also abides by AR3. If this were to occur, then region 2's Nash path would shift to N_{AR3}^2 in figure 3 and the equilibrium \hat{E} would result, where the overall level of provision is $0F$, which exceeds $0D$. The distribution of provision burdens at \hat{E} relative to E depends on the relative rightward shifts of the Nash paths. The most likely scenario is that both regions will contribute more and be better off than at E . Because satisfying AR3 does nothing to internalize interregional spillovers, as required by AR1, the equilibrium at \hat{E} does not result in intergenerational Pareto efficiency. Accounting for these interregional spillovers may require some form of supranational linkage between the regions.

FURTHER STRATEGIC INTERACTIONS

The analysis is now extended to investigate strategic behaviour both within a region and between regions for the provision of an intergenerational public good. Again just two regions are assumed, now labelled East and West. We further assume that in the East the young are expected to serve and carry on the wishes of their parents. In contrast, the parenting (earlier) generation often displays a responsibility for the next generation in the West region, and in so doing demonstrates a good deal of future-generation awareness. Thus the East and West labels distinguish between a region with backward-oriented responsibility and a region with forward-looking altruism. Within both regions there are two generations in which the first lives for two periods, $j = 1, 2$, and the second lives only for period 2. Thus generation 1 overlaps in time with generation 2.

The model

A sketch of the underlying model is given from the viewpoint of the East or backward-oriented region. Each generation is now represented by a single individual to simplify the presentation; the reader is invited to view this representative individual as a social planner for his or her generation. Once again a private good (y) and an intergenerational public good (q) are assumed, in which y_E^j denotes the i th Eastern generation's consumption of the atemporal private good in period j and q_E^j denotes the i th Eastern generation's provision of the intergenerational public good in period j . The first Eastern generation's multiperiod utility,

$$1. \quad V_E^1 = V_E^1 [u_E^{11} (\bullet), u_E^{12} (\bullet)]$$

depends on the generation's single period utility functions during its lifetime. Eastern generation 2's multiperiod utility contains only $u_E^{22} (\bullet)$. In period 1 Eastern generation 1's consumption of the intergenerational public good is $q_E^{11} + q_W^{11}$ or the provision amount in the first period in both the East and West, where q_W^{11} is determined from abroad. In period 2 generation 1's consumption of the public good is $q_E^{11} + q_E^{12} + q_E^{22} + q_W^{11} + q_W^{12} + q_W^{22}$ or the provision amount in the first and second periods in both the East and West. The first and second generations are constrained by a multiperiod transformation indicating the ability of each generation to trade off production of the two goods.¹⁰

Each generation chooses its y 's and q 's to maximize its multiperiod utility function subject to its transformation function.¹¹ At the Nash solution the first generation has no incentive to provide the intergenerational public good in period 2, so q_r^{12} is zero in both the East and West. This follows because the marginal benefits derived from the intergenerational public good provision in period 1 is always greater than those from provision in period 2 because period 1 provision benefits the provider for two periods rather than one period. When making a multiperiod allocative decision, generation 1 foresees this consideration and provides the public good immediately, thus supplying just the private good in the second period.

Strategic considerations

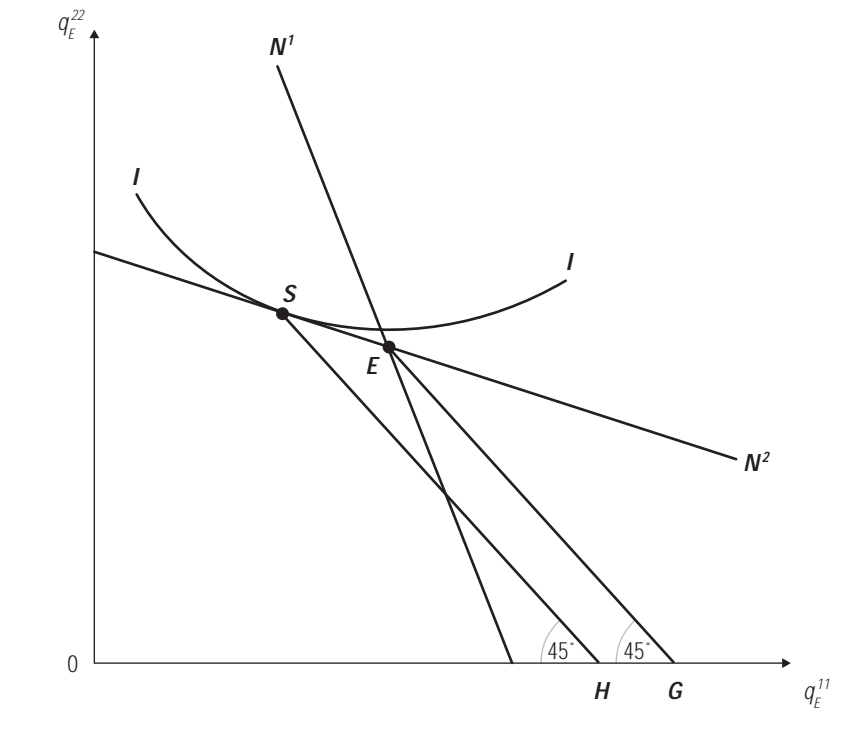
If regional spillovers are taken as given, then strategic behaviour in the East involves the decision to provide q_E^{11} by generation 1 and q_E^{22} by generation 2, given q_W^{11} and q_W^{22} . This can be represented by the standard reaction paths based on the transformation-constrained iso-welfare curves for generations 1 and 2 in the East. In figure 4 q_E^{11} is placed on the horizontal axis and q_E^{22} on

the vertical axis. Nash path N^1 connects the zero-sloped points on generation 1's iso-welfare contours for different levels of q_E^{22} as anticipated to come from generation 2 in the second period of generation 1's lifetime. Also in figure 4, N^2 denotes generation 2's reaction path to spillins of q_E^{11} . These Nash reaction paths assume that the level of interregional spillins from the West are fixed; an increase in these Western spillins would shift both Nash reaction paths leftward as spillins from abroad substitute for the region's own provision. A decrease in these interregional spillins would have the opposite effect.

If each generation in the backward-looking region or East acts according to its Nash reaction path, then the equilibrium is at E in figure 4, where OG represents the aggregate two-period provision of the public asset. The sequencing of the generations allows for an alternative strategic response known as *leader-follower* behaviour (Sandler 1992; Cornes and Sandler 1996),

FIGURE 4

Eastern intergenerational strategizing



in which the first generation acts as the leader and the second as the follower. The leader knows that the follower, who goes second, will take the leader's provision amount as given; hence the follower continues to abide by its Nash reaction path. The leader, however, treats the follower's public good provision, q_E^{22} , as dependent on the leader's choice of q_E^{11} relative to the follower's Nash reaction path. Consequently, the leader attempts to achieve its greatest iso-welfare curve along generation 2's Nash reaction path. In figure 4 the leader-follower equilibrium in the East is S , where iso-welfare curve II is tangent to N^2 . At S the aggregate multiperiod level of q_E has fallen from $0G$ to $0H$ as the first generation exploits its first-mover advantage and forces the second generation to assume a larger burden for the intergenerational public good. Generation 1's iso-welfare curve through S is higher than the one (not shown) through point E ; the opposite is true for generation 2's welfare.

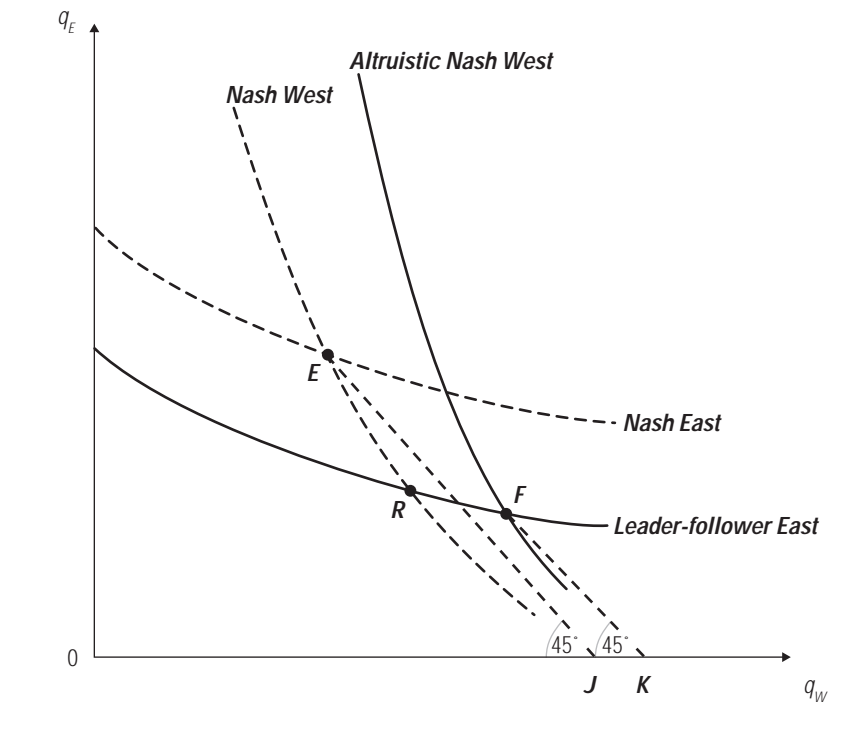
Regions that have very different views of the responsibilities that one generation has for the next may have profound effects on the manner in which resources are allocated to intergenerational public goods. This insight may partly help explain why industrial countries have more strongly supported environmental treaties, such as the Kyoto Protocol on global warming, while some developing countries have been hesitant.¹² Given its generational orientation, the East is apt to engage in a leader-follower strategy. In contrast, the West is anticipated to use a Nash strategy based on altruism to its future generation, much like the AR3 case encountered in the previous section. Figure 5 represents the strategic interactions and their consequences on the East and West; the provision of the intergenerational public good in the West is on the horizontal axis and the provision in the East is on the vertical axis. The dotted Nash West and East curves serve as benchmark cases and indicate the intergenerational response in each multigenerational region for alternative levels of spillins from the other region. In essence these paths depict the equilibrium aggregate quantity (for example, $0G$) of $q_E^{11} + q_E^{22}$ from figure 4 for alternative levels of q_W ($= q_W^{11} + q_W^{22}$), and hence shifts of N^1 and N^2 . Each increase in q_W would cause curves N^1 and N^2 in figure 4 to shift to the left and down, so that equilibrium E would move to the south-west, implying a reduced provision of q_E ($= q_E^{11} + q_E^{22}$). As a result the Nash reaction curves relating q_E and q_W in figure 5 are negatively sloped for both the West and East as drawn.

In figure 5 the leader-follower reaction curve for the East is also negatively sloped, because an increase in q_W also displaces the equilibrium S to the south-west in figure 4, thus reducing q_E . Because the aggregate amount

of q_E associated with leader-follower behaviour is always less than that of the Nash equilibrium in the East, the East's leader-follower curve must be below its Nash curve in figure 5. If the West adheres to its Nash path while the East abides by its leader-follower path, then the equilibrium would be at point R , where the aggregate level of the intergenerational public good is less than level OJ of the Nash equilibrium. The East would shift more of the burden for the public good onto the West owing to these regions' different dispositions to future generations. This burden-shifting tendency between the East and West is worsened if the West displays altruism towards future generations, analogous to a switch from AR_4 to AR_3 , so that the Nash curve in figure 5 shifts to the altruistic Nash West curve. If this occurs, the equilibrium at F for the two solid paths would result in a greater overall level of q because OK exceeds OJ . At F the West picks up much of the burden for the

FIGURE 5

East-West intergenerational strategizing



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intergenerational public good. If the shifts were larger, a corner solution on the horizontal axis could follow with the East riding free. Whether or not the overall level of q increases at F relative to E hinges on the relative shifts of the two paths. The greater is the shift in the Nash West path relative to the leader-follower East path, the more likely it is that the aggregate level of q will increase.

These differences in intergenerational responsibilities imply that countries in a forward-looking region are more apt to supply such things as disease cures, environmental protection and research breakthroughs. Based on these results, sustainable development is predicted to be more difficult to maintain in backward-oriented countries than in forward-looking countries. Even more disturbing is the realization that efforts by some countries to achieve sustainable development, an intergenerational public good, may encourage other countries to reduce theirs.

JOINT PRODUCTS

Many different joint product scenarios are possible. Again consider the basic model of two regions (East and West) and three nonoverlapping generations, each of which lives for one period. Wherever possible the same notation is maintained. An intergenerational public activity (q) is assumed to yield a generation-specific and region-specific benefit (x) and an intergenerational pure public benefit (z). That is, good x benefits only the generation of the region supplying activity q during the generation's lifetime, while the benefits of good z spill over to the other region and generations. Further suppose that activity q is only supplied in the first of three periods. The joint product relations are

$$2. \quad x^{lr} = \alpha^r q^r, \quad r = E, W,$$

and

$$3. \quad z^r = \beta^r q^r, \quad r = E, W,$$

where α^r and β^r are positive constants representing how many units of the respective joint products are derived from each unit of activity q^r . The total amount of the intergenerational public good experienced by an individual in any generation is

$$4. \quad Z = z^E + z^W = \beta^E q^E + \beta^W q^W.$$

During period 1 the utility function of individual i in region r is

$$5. \quad u^{ir} = u^{ir}(y^{ir}, \alpha^r q^r, \beta^E q^E + \beta^W q^W), \quad r = E, W, \quad i \in \Omega_r,$$

where I have substituted for x^{Ir} and Z based on equations 2, 3 and 4. Individuals in generations 2 and 3 have only the private good y and the intergenerational public good Z in their utility functions because they do not supply activity q . The rest of the model is analogous to that described in the second section. As before, the multiperiod production trade-off is between the private good and the public activity.

In the providing generation and region the decision-maker for the intergenerational public good is anticipated to concentrate on the benefits derived by the current generation in just his or her own region. This behaviour implies that the weighted sum of the marginal benefits for the two jointly produced outputs is equated to the marginal costs of activity q .¹³ The weights on the marginal benefits reflect the productivity of q in providing the region-specific and the region-wide outputs of x and Z , respectively, as given in equations 2 and 3. If the intergenerational activity is, say, more productive in yielding x than Z , then these region-specific benefits are emphasized to a greater extent when determining how much q to produce. The providing generation fails to account for the benefits that its provision of q supplies to the other region and future generations, leading to suboptimal provision. However, the greater is the generation-specific benefits derived from q , the more motivated is the generation to provide the public activity and the less the need for intervention.

Next, suppose that activity q gives rise to region-specific benefit x that also lasts for three generations. When acting alone, the first generation is still anticipated to focus on its gains from activity q , and, in so doing, ignores intergenerational benefits conferred through both x and Z . This means that unlike previous analyses of joint products, the appearance of provider-specific benefits may worsen suboptimality if temporal spillovers arise with respect to these latter benefits and are also ignored. In calibrating the extent of suboptimality, one must calculate the providing generation's sum of benefits from the public activity as a share of the total benefits received by both regions and all generations.¹⁴ As this share increases towards one so that the providing generation receives most of the gains, the current generation has greater incen-

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tives to supply the public activity. Altruism towards future generations can also increase the providing generation's perceived marginal benefits, thus motivating it to account for future generations' spillovers.

The presence of joint products means that increased interregional cooperation through supranational structures may worsen the misallocation of resources. Consider a scenario in which each region receives region-specific private benefits and a jointly produced interregional public bad from an activity. Further, suppose that the private benefit affects only the current generation, while the public bad influences current and future generations. For example, the production of nuclear energy benefits the current generation but gives rise to wastes that place current and future generations world-wide at risk. Similarly, the burning of fossil fuels warms the current generation but adds to the accumulation of greenhouse gases, which may harm current and future generations world-wide. If a supranational link forms that furthers the interests of the current generation in the cooperating regions, then the cooperation-induced increased provision of the public activity adjusts for the current generation's interregional externalities, while increasing the negative externalities to future generations. With joint products, external effects concern regions, jointly produced outputs and generations. When negative externalities are present, agreements and linkages that attend to just one or two of these external-effects dimensions may worsen resource allocation relative to no agreement whatsoever. Some standard remedies may no longer apply when joint products possess alternative temporal characteristics.

INTERGENERATIONAL CLUBS

When forming a supranational structure to correct for market failures involving two or more regions, regional policy-makers must consider the transactions costs that accompany any mode of allocation. If these transactions costs are less than the transactions benefits attributable to an allocative mechanism that augments efficiency, then the institution may be warranted (Sandler 1997). Institutional arrangements that economize on transactions costs stand a better chance of being viable. One such institutional arrangement is a club, which can be formed when the public good's benefits are excludable at costs less than the allocative benefits achieved by matching tastes and user fees. Depending on the shared good, club participants can be firms, nations or individuals. For intergenerational club goods the required toll must account for crowding and depreciation losses that a visit imposes at the margin on cur-

rent and future members. Depreciation due to utilization arises when a current visit affects the quality of the club good now and into the future. Users who visit more frequently pay more in total tolls but pay the same toll per visit.

Thus clubs are able to account for differences in tastes by monitoring visits and charging for each visit based on the associated costs imposed on the membership. If, for example, a visit causes a great deal of depreciation for current and future users, then the toll must be sufficiently high to reflect these losses. Visitors who visit early in an intergenerational club good's lifetime may have to pay relatively large fees for any resulting deterioration of the club good, insofar as any depreciation will affect a large number of subsequent generations and members. As the intertemporal component of the toll rises, individuals will be dissuaded from visiting, thus preserving the good. Toll proceeds are earmarked to maintain and to provide the club good, passed among the generations of members. If the tolls are properly designed, then tolls can finance the club good without the need for outside intervention. Clubs can be owned and operated by members (such as sovereign nations) for their own well-being.

One generation of members can reimburse an earlier generation's investment through equity shares, sold as the club good is transferred between generations. The value of these equity shares depends on the residual value of the club good. If a generation were myopic and ran down the club good's value through depreciation and collected tolls that did not reflect this depreciation, then the myopic generation would receive less in payments to support its retirement when the club asset is traded to the next generation (Sandler 1982). In such a club arrangement the current generation's actions are tied to the future consequences, thus motivating it to far-sighted behaviour. If the club investment were instead raised by debt, then the club's ability to repay its loan would depend on it collecting sufficient tolls to offset any depreciation through maintenance. The ability to refinance the loan between generations depends directly on the residual worth of the shared good—the collateral on which the debt is drawn. When a generation behaves myopically, less money can be raised during refinancing, and hence that generation is made to shoulder the burden of its short-sightedness. In fact, any form of leveraged financing of the club good would provide incentives for the current generation to collect the proper tolls. Intergenerational clubs represent a “private” means for a collective to internalize intergenerational externalities in the form of crowding and depreciation due to utilization.

As an example of an intergenerational club good, consider the Great Barrier Reef off the coast of Queensland, Australia. Visitors to the reef can

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be charged a user fee that reflects a visit's crowding effects and its long-run impact on the health of the reef. If these tolls are properly managed to internalize the externality to current and future generations, the visitation rate will be duly restricted to address the intergenerational concerns. The same arrangement can be applied to protect transnational parks (such as game reserves) and historical monuments (such as the Taj Mahal or the Egyptian pyramids). The management of tropical forests for ecotourism can also benefit from the application of club theory. Even population decisions and traffic control in cities can be decided with the help of the theory of intergenerational clubs. Perhaps the ultimate example of an intergenerational club is "spaceship earth", where membership is the world's changing population.

In passing an intergenerational club asset from an old generation to a new generation, the selling of the asset to the next generation helps determine pension assets. These pension revenues will be higher if a generation properly looked after a club good, thus providing motivation for far-sighted behaviour.

OTHER INSTITUTIONAL CONSIDERATIONS

When exclusion is not feasible, as in the case of some purely public intergenerational goods, a club arrangement is not an institutional alternative. For chlorofluorocarbon (CFC) reduction the resulting protection of the ozone layer yields benefits that cannot be withheld from nonpayers, now or into the future. Supranational structures (such as international organizations or treaties) intended to correct for the market failure associated with intergenerational public goods must adjust for a number of considerations. First, they must include an intergenerational perspective if the interregional linkage is to address both the spatial and temporal externalities. This intergenerational perspective may be fostered by including overlapping generations of young, middle-aged and old among the decision-makers (John and Pecchenino 1997). As the lifetimes of generations are lengthened by better medicine and nutrition, more generations will overlap at any one time and this can support greater intergenerational awareness.

Second, there is a need for long-lived institutional structures that can take and maintain an intergenerational perspective. Churches, for example, have been particularly adept at passing down religious doctrines from one generation to the next. A common concern (for example, the fear of hell) united generations and drew them together in a similar pursuit. As culture these

church doctrines represent intergenerational public goods. To be effective these institutions must be sufficiently flexible to allow for evolution as generational tastes change over time.

Third, effective institutions for providing intergenerational public goods must supply the current generation with a sufficiently large share of the benefits so that they are properly motivated to act. Finally, there is less need for a formal institutional arrangement when the current generation's share of the public good's benefits is sufficiently large. If the institutional structure providing the public good can remain "loose" or unstructured, then this will economize on transactions costs. A structure is loose if there is no need for an enforcement mechanism, decisions are unanimous, meetings are infrequent and participants' autonomy is preserved (Sandler 1997). By economizing on transactions costs, these structures can then be viable because transactions benefits do not have to be very large to justify the institution.

In the case of ozone depletion, the benefits to the current generation and its immediate descendants were sufficiently large to balance the associated costs, so the current generation initiated drastic cuts in CFC use. The Montreal Protocol and its subsequent amendments to curb CFCs required little in the way of enforcement insofar as nations viewed the associated net benefits from participating as positive. Meetings on the protocol were infrequent and ad hoc. For acid rain the spatial weights relating emissions to depositions meant that the lion's share of a country's emissions befouled its own territory. This realization provided the right incentives to frame a treaty to curb sulphur emissions. If, analogously, a sufficient temporal share of the benefits from providing an intergenerational public good is specific to the current generation, then this bodes well for an action being taken. Any action that can increase the current generation's perceived share of the gain from providing an intergenerational public good will motivate its provision.

While the current generation's share of the benefits appears large from curbing CFC emissions, for which the immediate health threat from enhanced ultraviolet radiation exposure is experienced today, this is not necessarily the case for global warming, for which the adverse effects might not be noticeable for decades. This suggests that the global warming problem does not have the appropriate incentives from an intergenerational viewpoint to ensure proper action. Efforts to resolve uncertainty regarding the benefits associated with an intergenerational public good may increase the current generation's perceived share of benefits by more adequately identifying the immediate gains from an action and, as a consequence, motivate action.

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Finally, consider the promotion of sustainable development where efforts are made to maintain the opportunities provided to the next generation (Solow 1986; Toman, Pezzey and Krautkraemer 1995). If the current generation is to form far-sighted transnational agreements, then it must perceive a high share of the resulting benefits. When today's generation has a better understanding of the losses associated with its decisions, its awareness of the ensuing benefits and costs can be fostered. This awareness can be furthered by instituting a change in national income accounting so as to include depreciation to the natural capital stock. Efforts to educate the public about the environmental consequences of today's actions can promote altruism to future generations and, consequently, should bolster sustainable development.

CONCLUSION

The strategic interaction between generations differs from that within generations. If an intergenerational public good yields benefits that spill over borders and generations, then policies designed to correct for just spatial transnational externalities may worsen the misallocation of resources. This is especially the case if the public activity provides positive near-term benefits and negative long-run costs. Moreover, the natural sequencing of generations gives the present generation a potential first-mover advantage. In a suggestive interregional example, a backward-looking region is depicted as abiding by a leader-follower model in which the current generation relies on the next generation, while a forward-looking region is represented as adhering to Nash behaviour with the current generation applying altruism towards future generations. The final outcome is that the forward-looking region assumes a larger burden than the backward-looking region for providing intergenerational public goods—an outcome that bodes poorly for environmental treaties involving world-wide pollutants.

Actions to increase the perceived share of the intergenerational public good benefits going to the current generation will motivate it to provide the good. Transnational linkages that achieve far-sighted solutions are facilitated if efforts to promote intergenerational awareness are successful for all participants of the linkage. Policies that increase the awareness of only some participants will result in lopsided outcomes where the burden of the intergenerational public good is shouldered by the far-sighted nations. If institutional linkages for providing intergenerational public goods can be kept loose or unintegrated, then transactions costs are economized, and this promotes the institution of the linkage. This looseness can be achieved if the

current generation within each participant perceives significant generation-specific benefits.

Much research remains to be done on intergenerational public goods. For example, more work is needed on the issue of discounting (Doeleman and Sandler 1998). A more complete analysis is also required for representing strategic behaviour among generations. Yet another extension would examine the role of income redistribution policy between and within generations as a means for promoting public good provision.

APPENDIX 1

BASIC MODEL

This appendix describes the basic model used in the second section of the chapter. An individual's utility function is depicted as

$$1a. \quad u^{ijr} = u^{ijr}(y^{ijr}, q), \quad i \in \Omega_{jr}, j = 1, 2, 3 \text{ and } r = 1, 2.$$

Each of these utility functions is assumed to be strictly increasing, quasi-concave, and twice differentiable. The total quantity of the private good produced during period j , denoted by Y_j , must equal the amount consumed during the j^{th} period, so that

$$2a. \quad Y_j = \sum_{r=1}^2 \sum_{i \in \Omega_{jr}} y^{ijr}$$

for $j = 1, 2, 3$. In equation 2a the y^{ijr} terms represent the i^{th} individual's consumption of the private good during period j in region r . These individual consumption amounts are summed over the individuals alive during period j in a given region and then over the regions for each period. The multi-regional, multiperiod production of the private good is

$$3a. \quad Y = \sum_{j=1}^3 Y_j$$

or the sum of the production amounts in the three periods. A multiperiod transformation constraint for the two-region economy indicates how a given amount of resources can be transferred between the two production activities:

$$4a. F(Y, q) = 0,$$

where the multiperiod supply of resources is suppressed. This function is strictly increasing and strictly convex in its arguments to assure that first-order conditions are sufficient for a maximum.

For intergenerational Pareto efficiency the associated Lagrangean expression, L , is:

$$L = u^{111}(y^{111}, q) + \sum_{r=1}^2 \sum_{j=1}^3 \sum_{i \in \Omega_{jr}} \lambda^{ijr} [u^{ijr}(y^{ijr}, q) - k^{ijr}] - \sigma F\left(\sum_{j=1}^3 Y_j, q\right),$$

where the sum over i in the second term on the right-hand side excludes the first individual. The λ 's and σ are undetermined Lagrangean multipliers, while the k expressions are constant levels of utility. Maximization of the Lagrangean with respect to the y^{ijr} expressions and q yields the first-order condition in (AR1), after simplification to eliminate the Lagrangean multipliers:

$$AR1. \sum_{r=1}^2 \sum_{j=1}^3 \sum_{i \in \Omega_{jr}} MRS_{qy}^{ijr} = MRT_{qy}.$$

In equation AR1 the MRS expressions represent the marginal rate of substitution of the intergenerational public good for the private good. The marginal rate of substitution is the ratio of marginal utilities of the two goods and indicates the *marginal benefit* or value, in terms of the private good, that an individual derives from the intergenerational public good. From left to right, the superscripts on the MRS correspond to the individual, the period and the region. On the right-hand side of equation AR1 the marginal rate of transformation (MRT) of the public good for the private good denotes the ratio of marginal costs of the two goods.

APPENDIX 2

AWARENESS RULES AR2, AR3, AND AR4

The three additional awareness rules are as follows:

$$\text{AR2. } \sum_{r=1}^2 \sum_{i \in \Omega_{1r}} MRS_{qy}^{ir} = MRT_{qy},$$

$$\text{AR3. } \sum_{j=1}^3 \sum_{i \in \Omega_{jr}} MRS_{qy}^{ijr} = MRT_{qy}^r, \quad r = 1, 2$$

$$\text{AR4. } \sum_{i \in \Omega_{1r}} MRS_{qy}^{ir} = MRT_{qy}^r, \quad r = 1, 2$$

where Ω_{1r} is the current generation in region r for AR2 and AR4. The superscript on MRT denotes the region.

NOTES

1. On transnational public goods, see, for example, Barrett (1993), Bryant (1995), Cornes and Sandler (1996, chapters 17–18), Helm (1991), Murdoch and Sandler (1997), Runge (1993), Sandler (1992, 1996, 1997, 1998) and Sandler and Sargent (1995).

2. The following papers consider intergenerational public goods: Amsberg (1995), Bromley (1989), Doeleman and Sandler (1998), John and Pecchenino (1994, 1997), John and others (1995) and Myles (1997).

3. Recent articles on sustainability include Buiter (1997), Doeleman and Sandler (1998), Howarth (1997) and Toman, Pezzey and Krautkraemer (1995). Solow (1986) distinguishes three types of capital: humanmade, human and natural. For weak sustainability the overall capital stock must be maintained, so any reduction in natural capital must be compensated by an increase in the other kinds of capital. In contrast, natural capital stocks cannot decline when satisfying strong sustainability.

4. This criterion applies a zero discount rate so as to treat benefits to each generation equally. For very long-lived projects this implied that the discount factor of unity is in the spirit of Heal's (1997) call for proportional discounting that places more value on future benefits.

5. The underlying Lagrangean is the same form as that in appendix 1 except that only the utility levels of the first generation are held constant.

6. The transformation function is now region specific and denoted by $F^r(Y^r, q^r) = 0$, where Y^r represents the multiperiod production amount for the private good and is summed over the three periods. Thus Y^r is the multiperiod sum of Y_j^r , which equals the sum of y^{ijr} over just the j th generation, while q^r is the intergenerational public good in period 1 in region r .

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7. The underlying social welfare function is assumed to be utilitarian, which consists of a simple sum of the relevant individuals' utility functions.

8. In figure 1 the slope of an iso-welfare curve for region 1 is

$$\left(MRT_{qy}^1 / \sum_{i \in \Omega_{11}} MRS_{qy}^{i11} \right) - 1.$$

If this equation is set equal to zero, then AR4 results.

9. In figure 2 the Nash path for region 2 is drawn flatter than the 45 degree line, while the Nash path for region 1 is drawn steeper than the 45 degree line. If both goods are normal with a positive income elasticity less than one, then these slopes result and the Nash equilibrium is unique and stable (Cornes and Sandler 1996).

10. The first generation's multiperiod transformation is denoted by

$$F_E^1(y_E^{11} + y_E^{12}, q_E^{11} + q_E^{12}) = 0,$$

while the second generation's transformation function is given by

$$F_E^2(y_E^{22}, q_E^{22}) = 0$$

11. The Lagrangean for Eastern generation 1 is

$$V_E^1[u_E^{11}(y_E^{11}, q_E^{11} + q_W^{11}), u_E^{12}(y_E^{12}, q_E^{12} + q_E^{22} + q_W^{11} + q_W^{12} + q_W^{22})] - \sigma F_E^1(\bullet),$$

and the Lagrangean for generation 2 is

$$V_E^2[u_E^{22}(y_E^{22}, q_E^{11} + q_E^{12} + q_E^{22} + q_W^{11} + q_W^{12} + q_W^{22})] - \psi F_W^2(\bullet).$$

12. Income disparity between the East and West also explains some of the differences in environment-supporting behaviour, but the strategic differences introduced here represent influences that go beyond income disparity to explain alternative environmental policies.

13. This condition is

$$\sum_{i \in \Omega_{1r}} (\alpha^r MRS_{xy}^{ir} + \beta^r MRS_{zy}^{ir}) = MRT_{qy}^r, \quad r = E, W.$$

14. The intergenerational optimality condition for full awareness is

$$\sum_{j=1}^3 \sum_{i \in \Omega_{jr}} \alpha^r MRS_{xy}^{ijr} + \sum_{r=E, W} \sum_{j=1}^3 \sum_{i \in \Omega_{jr}} \beta^r MRS_{zy}^{ijr} = MRT_{qy}^r.$$

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THE POLITICAL ECONOMY OF INTERNATIONAL COOPERATION

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Over the past 15 years the field of international relations has produced a great deal of work on international cooperation and international institutions. This work has immediate relevance for conceptualizing a new era and a new approach to international development cooperation. Once we understand development cooperation as a problem of providing global public goods, our attention is immediately drawn to the problems of strategic interaction and opportunistic behaviour that confront states as they attempt to cooperate in the pursuit of mutually beneficial goals.

Drawing on public goods models and related concerns, the literature on international cooperation identifies strategic problems that states must overcome if they are to cooperate effectively—and how international organizations can facilitate state efforts to cooperate, primarily through the provision of information. This chapter summarizes the central claims of political science about the conditions for international cooperation and the roles of international organizations and nonstate actors in helping states achieve the benefits of cooperation. It concludes that the most useful functions of international organizations involve the provision of information about state preferences and behaviour—particularly about standards and causal knowledge.

THEORIES OF INTERNATIONAL COOPERATION

Since the early 1980s the field of international relations has largely been dominated by debates about the concept of international cooperation (Oye 1986). Stimulating this theoretical innovation were developments in the new institutional economics and game theory, which used ideas of self-enforcing agreements, opportunistic behaviour and lack of legal obligation that nicely characterize the international arena (Keohane 1984). The modern literature on international cooperation departed from earlier liberal, or “idealist”, conceptions of cooperation in important ways. It attempted to show that, even

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making fairly pessimistic assumptions about state interests and intentions, we could identify conditions under which states would find it beneficial and possible to cooperate with one another. The literature has specified conditions that should facilitate cooperation and the various types of information needed. Examination of the need for information has drawn theorists' attention to the role of international organizations, considered in more detail below.

Theories of international cooperation made a big leap forward by accepting the assumption that states are self-interested and have conflicts of interest with one another. Theorists accepted the challenge of showing how cooperation might nevertheless emerge—and even show some stability. The key set of articles in this area is the volume edited by Kenneth Oye (1986), *Cooperation under Anarchy*. The emphasis on anarchy was an especially important part of the research agenda because it ruled out the possibility that cooperation would be enforced by outside agents. As Oye explains, “nations dwell in perpetual anarchy, for no central authority imposes limits on the pursuit of sovereign interests” (1986, p. 1). The statement that international relations is an anarchical realm simply means that agreements among states will last only if they are self-enforcing. International organizations may play a major role, as elaborated below, but it is a mistake to conceive of this role as direct enforcement of agreements. International organizations, if they have any enforcement powers, have only minimal capability to force states to do anything they do not want to do. Instead, organizations assist cooperation by creating the conditions that make agreements self-enforcing.

Before going into the specifics, it is important to stress one of the main premises of these studies. From their perspective, international institutions are not seen as a form of world government, as a failed attempt at world government or as a precursor to world government. Nor are international institutions conceptualized as sitting above states, handing down mandates to them and enforcing agreements. “World government”, in fact, has little if anything to do with what political scientists see as the functions that international institutions can perform. Instead these institutions are seen as actors that acquire authority and powers only as the result of acts of delegation by their member states.

For the most part, delegated powers consist of various kinds of information provision, such as monitoring, setting standards and distributing scientific expertise. Enforcement of international agreements nearly always continues to be decentralized in the hands of member states rather than the

organization itself. Some international organizations, such as the World Trade Organization and European Court of Justice, are increasingly involving themselves in dispute resolution. But even with these functions organizations are properly seen as assisting states in resolving their cooperation dilemmas, rather than acting as an authoritative enforcer of rules and norms. By providing guidance on how to interpret international agreements and the specifics of state behaviour, dispute resolution is properly seen as one more type of information provision.

The basic model of state interests adopted by the new literature on cooperation is that of the prisoner's dilemma. The prisoner's dilemma captures the logic of mixed motives, in which states can gain from reaching cooperative agreements but also confront incentives to renege on these commitments. In games with a definite, foreseeable termination, the prisoner's dilemma logic leads inexorably to defection, with actors unable to achieve potential gains from cooperation. But when a prisoner's dilemma game is repeated indefinitely, actors can adopt strategies of reciprocity that allow them to reach cooperative, and mutually beneficial, equilibria. Reciprocity consists of such strategies as tit-for-tat, where cooperation is met with cooperation, and defection with defection. Theories of international cooperation define cooperation as mutual adjustment of state policies to achieve outcomes that all prefer to the status quo (Keohane 1984). Cooperation is clearly differentiated from harmony, in which states pursue policies that other states prefer without any explicit mutual adjustment. Because prisoner's dilemma situations present states with incentives to renege on cooperative arrangements, they make the distinction between harmony and cooperation particularly clear and compelling.

Drawing on the logic of the prisoner's dilemma, theorists have identified generic conditions for international cooperation. The basic issue here is what allows strategies of reciprocity to operate effectively. Fundamental to their success is reliable information about various aspects of the situation, including others' actions and intentions, their beliefs, the relevant standards of behaviour and the relationship between actions and outcomes (that is, causal knowledge). Strategies of reciprocity require that states can monitor one another's behaviour and retaliate when others fail to live up to their commitments. Poor monitoring capacities, resulting in "noise" in observations of state actions, can quickly undermine the practice of reciprocity and so the possibility of stable cooperation. Axelrod (1984), in an experimental setting, shows how small mistakes in monitoring actors' behaviour in a prisoner's

dilemma can quickly lead to feuds and cycles of retaliation, making the achievement of cooperation highly problematic. Poor information of any type can undermine the use of reciprocity to sustain cooperation, making information provision one of the keys to successful international cooperation. For this reason the rest of this chapter focuses on how international organizations and other actors can provide various types of information, thus facilitating international cooperation.

As discussed below, the prisoner's dilemma is not the only appropriate model for international cooperation. But it is extremely important in drawing attention to the mixed motives that states face—and to certain generic obstacles to international cooperation. It is also a fruitful model in that it concentrates research on the question of reciprocity, a common strategy for maintaining cooperation in international relations. Cooperative behaviour requires the establishment of conditions in which strategies of reciprocity can work effectively, particularly conditions of good information.

THE ROLE OF INTERNATIONAL ORGANIZATIONS

According to contractual theory (see, for example, Krasner 1983; Keohane 1984; and Goldstein 1996), states often face problems like the prisoner's dilemma, in which individually rational behaviour gives rise to outcomes that leave all unhappy. In economics such a situation is called market failure because a properly functioning market should prevent suboptimal outcomes. In international relations this situation has been called a game of collaboration, drawing attention to the fact that states must collaborate to reach their own, individually specified goals (Martin 1992; Snidal 1985; Stein 1983).

The motivation behind institutional creation and maintenance is to allow states to reach the Pareto frontier, the set of outcomes at which no more joint gains are available. At the Pareto frontier any gain to one state by definition results in losses for others. Reaching the Pareto frontier in a prisoner's dilemma requires good information about the situation and the other players. One way to think about what information does is to conceive of it as removing or making transparent the walls that separate the prisoners from one another. Freed from these walls, they can learn about each other's intentions and actions, agree on standards of behaviour and learn about the relationship between their actions and outcomes.

Keohane (1984) spells out how international institutions can help states overcome collective action dilemmas. He argues that market failure should

not occur if transactions costs are negligible and property rights are clearly defined. As he explains, “the Coase theorem could be interpreted...as predicting that problems of collective action could easily be overcome in international politics through bargaining and mutual adjustment” (Keohane 1984, p. 86). Under these conditions states should be able to make and maintain mutually beneficial agreements. But in international politics transactions costs are high and property rights are often poorly defined. Thus states often may fail to overcome collective-action problems because of fear that others will renege on deals, because they are unable to adequately monitor others’ behaviour or learn about others’ preferences or because they act opportunistically since punishment mechanisms are inadequate.

Institutions enter the picture at this point—to allow states to overcome such problems and reach mutually beneficial agreements. The primary function of institutions in this framework is to allow strategies of reciprocity to operate efficiently (Keohane 1986). Institutions perform this function by providing information about others’ preferences, intentions, behaviour, standards of behaviour and causal knowledge. Thus in contractual theory the primary effect of institutions is an efficiency effect, in that they allow states to reach agreements that are closer to the Pareto frontier. Institutions, in this rationalist model, do not modify underlying state interests. Instead, by changing the informational environment, they change state strategies in such a way that self-interested states find it easier to cooperate reliably with one another.

A similar conclusion has been reached in the literature on common-pool resources. One finding of this literature is that cooperation is facilitated when users of a common-pool resource can monitor each other’s compliance with joint rules at a reasonable cost. In other words, information about compliance becomes central to the resolution of common-pool resource dilemmas—as is the case in such real-world examples as conserving global whale populations, controlling the trade of endangered species and protecting regional marine environments.

Some authors have responded to contractual theory by pointing out that collaboration problems are not the only impediments to cooperation facing states. States also face distributional, coordination and bargaining problems (Krasner 1991; Fearon 1998). All these problems revolve around disputes over where states will find themselves on the Pareto frontier—not the less contentious question of how to reach the Pareto frontier. In any institutionalized pattern of cooperation there are a number of ways to cooperate, and many may not be readily distinguishable from one another in terms of efficiency

(that is, they are all on the Pareto frontier). States that agree to coordinate their exchange rates will disagree on precisely what the appropriate parities are; states that cooperate with one another in a military alliance will disagree on precisely how much each should contribute to mutual defence.

Initial studies of international regimes argued that such coordination problems were easier to solve than collaboration problems—and that regimes had little to contribute to their resolution (Stein 1983). But this argument has come under serious attack. Bargaining problems can be just as devastating to prospects for international cooperation as can collaboration problems. In addition, bargaining problems are resolved under different conditions. Fearon (1998) has shown, for example, that while a long shadow of the future may enhance the prospects of finding mutually beneficial agreements, it also intensifies bargaining problems because any deals struck will have consequences that reach far into the future. Only coordination problems with no distributional consequences—a rare category—will lend themselves to quick resolution. In other cases states will delay, make threats, hide or distort information, and generally engage in all the time-honoured techniques of statecraft that make international politics a fascinating yet grim business.

How do bargaining problems get resolved? Krasner (1991) follows the traditional realist line, arguing that a straightforward exercise of state power determines which of the possible outcomes gets chosen. The most powerful state simply chooses the outcome it prefers; other states have little choice but to go along. Power is not the only possible solution to the bargaining problem. Garrett and Weingast (1993) point to the role of focal points in resolving coordination problems. The concept of a focal point dates back to Schelling (1960) and initially referred to solutions that had an “obvious”, natural ring to them: meeting at Grand Central Station if two people become separated in New York City, or dividing the benefits of cooperation 50-50.

Garrett and Weingast extend the notion to include “constructed” focal points, those intentionally chosen and promoted by international actors. They concentrate especially on the European Court of Justice, arguing that its choice of the norm of mutual recognition as a method to complete the internal European Union (EU) market is an important example of a constructed focal point. They claim that the court’s ability to establish focal points explains why it has been so influential in European integration, even though it lacks (at least until recently) enforcement power.

So, using the constructed focal point analogy, analysts have found that international institutions can operate to resolve coordination problems. This

analysis of bargaining and coordination is important because it reinforces the central argument of this chapter that information is essential to international cooperation. Bargaining is about choosing one among a number of sustainable solutions to a problem, and states will generally disagree about which of these solutions they prefer. As analysis of bargaining problems evolves to consider notions such as focal points, we discover that bargaining problems are largely information problems. By constructing a focal point, which generally involves setting a standard, organizations can provide the information needed to allow states to overcome bargaining problems, as the European Court of Justice did when specifying mutual recognition as the path to completion of the internal EU market. This provision of focal point or standard-setting information can potentially be undertaken by powerful states (or even firms) rather than by international organizations. But because other states will always be suspicious of the motives of the powerful states, relying on organizations to set standards and identify focal points is often more effective, as members of the European Union have discovered.

In sum, rationalist approaches to international institutions assume that states turn to institutions in an attempt to solve cooperation problems. These cooperation problems are defined by patterns of state interests. In this perspective institutions change patterns of state behaviour not by changing fundamental state goals but by changing strategies and beliefs—by influencing the informational environment. They provide information about others' preferences, behaviour and intentions. They also provide information about means-ends relationships—how particular policies will lead to different outcomes. Such causal knowledge is essential, for example, to understanding how the choice of a particular exchange rate regime will affect key macroeconomic variables. Equilibria in rationalist models are defined by a combination of beliefs and strategies (Morrow 1994), and institutions operate directly on both.

The cases discussed in other chapters in this book illustrate many of the general arguments made here. The chapters on distributive justice, for example, make more concrete the discussion of bargaining and the importance of information in resolving bargaining problems, as distributive justice and bargaining both refer to the distribution of the benefits of cooperation. Sen (in this volume) and Rao (in this volume) analyse equity as a global public good, and Kapstein (in this volume) discusses how concepts of distributive justice were integrated with the international system developed after the Second World War. As the foregoing discussion of bargaining suggested, concerns

about equity can impede the creation of international institutions and be addressed by well-designed institutions.

We can also see a growing consensus that failure to assure a relatively equitable distribution of benefits from cooperation can prevent, or at least greatly delay, the creation of cooperative mechanisms. While legal scholars, sociologists and philosophers tend to trace this fact to deeply embedded norms of fairness, political scientists focus more on bargaining incentives and the desire of actors to increase their share of any benefits produced. If lack of equity prevents the creation of cooperative mechanisms that could benefit all, equity comes to take on some characteristics of a public good. These arguments about distributive justice suggest that we should turn our attention to how international organizations can operate to enhance the equitable distribution of the benefits of cooperation.

In many cases considered in this book, such as environmental issues, compensation of losers from agreements may be key both to increasing effectiveness and to enhancing equity. But providing compensation to those who lose in the short term from international agreements raises a host of strategic problems, most having to do with gaining access to high-quality information. The losers have incentives to exaggerate their losses, thus increasing their claim on compensation. Meanwhile, those who must provide the compensation face incentives to minimize the calculations of losses, and to find excuses not to come through with promised resources.

International organizations can step in to alleviate these strategic dilemmas in several ways. They can provide expert analyses of the claims of losers for compensation—say, by evaluating the extent of economic losses from participation in international agreements. Organizations can also set standards for contributions to provision pools and publicize information about states that fall short of their obligations in this respect. The discussion of equity and distributive justice thus clarifies some of the kinds of information that are necessary if states are to resolve bargaining and coordination problems—and highlights the role that international organizations can play in providing such information.

The chapters in this book on environmental agreements, by Barrett and by Heal, also provide concrete examples of the strategic problems that states face in attempting to cooperate with one another and how lack of information can impede cooperation. Technology and the creation of markets for rights to pollute will greatly alleviate the difficulties in increasing provision of environmental goods, as these chapters show. But reliance on technology and markets

alone is unlikely to put international organizations out of the business of helping to protect the environment. Even if technology facilitates the conclusion of global accords, temptations to fall out of compliance with these accords will persist. Poor countries in particular will be concerned about the costs of turning to new technology and may be tempted to ignore the terms of environmental agreements, especially if they believe that their compliance will go unnoticed and unrewarded (or that cheating will go unpunished). This is the classic problem of incomplete information considered by theories of international cooperation, and leads in a straightforward way to the proposition that international organizations can be valuable in monitoring compliance with international agreements and publicizing this information. Such monitoring is likely to be perceived as less intrusive than monitoring by other states.

Similarly, relying on tradable rights to pollute can work as an effective solution only if information about compliance with permit limits is widely available. One problem that has plagued the implementation of tradable permit systems is precisely the difficulty of monitoring whether participants in the schemes are exceeding their limits. Theories of cooperation strongly suggest that this is precisely the kind of situation in which assigning monitoring functions to international organizations (or, in some cases, to nonstate actors) can improve the welfare of all by limiting the extent of cheating. Environmental cooperation illustrates the demand for monitoring and reliable information about whether states are complying with international agreements—and the potential role of international organizations in providing this information.

NONSTATE ACTORS: NGOs AND EPISTEMIC COMMUNITIES

The problem of development cooperation increasingly requires that states interact productively with nonstate actors. These actors can facilitate development cooperation or, in the worst case, significantly interfere with the pursuit of global public goods. Nongovernmental organizations (NGOs) and epistemic (or expert) communities provide various kinds of information that are relevant to the pursuit of collective goals. NGOs also have important effects on agenda setting and the evolution of public attention to global goals (Sen in this volume). A focus on the information provision functions of international organizations leads us to the question of whether some types of information could be provided as effectively by other types of actors, such as NGOs and epistemic communities.

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Nonstate actors should be viewed as complements to international organizations rather than as substitutes for them. While nonstate actors can and do provide vital information to facilitate cooperation, the tasks of filtering, sorting, publicizing and authenticating this information properly fall to international organizations. The issue, from this perspective, is to find ways for these actors to work together, complementing one another's strengths rather than looking to put one another out of business.

First, consider the rapidly expanding role that NGOs play in global politics. NGOs have moved well beyond the nationally based groups of the early 20th century. Increasingly, they are transnational in organization, membership and objectives (Keck and Sikkink 1998). Working as advocacy networks, they shape agendas, publicize events throughout the world, raise public awareness and issue reports on compliance with international standards of behaviour. Because NGOs are typically built on a foundation of strongly held principles and have networks at the grass roots and throughout many countries, they acquire legitimacy and persuasiveness in their approach to global problems. As Sen (in this volume) notes, some nongovernmental groups transcend individual or even national interests to promote universal—global—interests. In the short term the greatest contribution of these groups to the provision of global public goods may be in their activities of publicizing failures to comply with international norms, such as human rights or environmental norms. In the longer term they can make an even more significant contribution by changing public attitudes towards such issues, as they did on slavery and women's rights.

A concept closely related to that of NGOs is epistemic communities (Haas 1992). Like NGOs, epistemic communities are advocacy networks. But they add an element of scientific or expert knowledge, specializing in knowledge-based advocacy. They thus provide what I have called causal knowledge. The activities of epistemic communities in environmental issues are especially notable. As scientific knowledge about environmental topics evolves and epistemic communities reach a consensus on how human activity changes the environment, this knowledge is filtered through to domestic politics, national governments and international negotiations. Like NGOs, epistemic communities provide information and, over the longer run, change public attitudes. Their distinctive contribution, and one that is growing, may be their ability to have a direct impact on international negotiations on issues of global concern. Experts present at negotiations on the environment or on economic issues can greatly influence the negotiations and the framework for interna-

tional agreements. One institutional question is whether such representation is most effective in constructing efficient, well-designed international agreements if experts play only an informal, advisory role, or if they are given a more formal place at the negotiating table.

To make these arguments about NGOs and epistemic communities more concrete, I turn to public health. Zacher (in this volume) concentrates on one aspect of global public health, the provision of information about the incidence of infectious disease. Two strategic problems seem central here: the provision of reliable information about disease and the willingness of governments to publicize outbreaks of infectious disease in their territories when such revelations might have negative economic consequences. Zacher emphasizes that multiple sources of information, such as the Internet, are becoming available.

At first glance this may suggest that the provision of information does not face a supply problem and that international organizations have little value to add in information provision, contrary to the major lesson of theories of international cooperation. But the availability of multiple sources of information does not automatically solve the information provision problem. It is entirely possible that some nongovernmental sources are biased or prone to error. Multiplication of information providers could, in practice, result in proliferation of noise and inaccurate information, rather than the high-quality information that states need to adequately address public health threats.

This analysis suggests that it may make more sense to conceive of the role of international organizations as one of filtering available information rather than directly providing it. When reports of infectious disease surface, it could be extremely valuable to the international community to have an expert, unbiased, reliable actor who could assess these reports and provide some indication of their likely accuracy. International organizations are likely to be better placed than states to perform this filtering.

If international organizations took on this filtering, they would contribute to resolution of the second strategic problem—getting governments to reveal information about disease in their territories. Governments may be dissuaded from issuing preliminary reports of disease by the fear that these would be publicized by the Internet and media outlets, without allowing for experts to come in and first establish the accuracy of the reports. Being able to turn, perhaps discreetly, to an unbiased expert body could greatly enhance the willingness of legitimately worried governments to report disease outbreaks in a timely and open manner.

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As the information about the disease example suggests, private actors and international organizations have offsetting strengths and can usefully work together to enhance international cooperation. NGOs have the advantage of being close to the ground, spread around the world and tied together in networks. They are highly important, therefore, in providing rapid, initial information about such problems as the outbreak of infectious disease. Epistemic communities, in contrast, work on a smaller scale, providing scientific information that enhances the ability of actors to develop strategies that will achieve their desired outcomes.

International organizations generally cannot compete with NGOs in having grass-roots access—or with epistemic communities in having direct access to the latest scientific knowledge. But they do have the advantages of high visibility and a level of authority that comes from the powers delegated to them by their member states. Thus they can vitally complement the activities of private actors even where NGOs and epistemic communities are highly engaged. As in public health, they can filter information from NGOs; as in the environment, they can structure the input of epistemic communities to international negotiations. In addition, where cooperation requires direct monitoring of government activities—for example, to ascertain compliance with formal international agreements—there seems little substitute for the authoritative activities of international organizations. They have a legitimacy not achieved by private actors, and thus are the best placed to engage in potentially invasive monitoring of governments' behaviour.

CONCLUSION

Studies of international cooperation and public goods combine theoretical and empirical analysis of the conditions for self-interested actors to cooperate with one another in a stable, sustainable manner. One does not need to assume that actors are altruistic or idealistic to explain why they might cooperate with one another. All one needs to do is demonstrate that all can benefit from cooperative endeavours. But analysts then need to confront obstacles to cooperation. Resolution of these problems requires high-quality information about states' preferences, actions and intentions, about relevant standards of behaviour, and about causal or scientific knowledge. In all these areas, international organizations are designed to provide, either on their own or in collaboration with NGOs and epistemic communities, the relevant information.

As the practice of international development aid moves away from the traditional donor-recipient model to more multilateral, cooperative models, these generic obstacles to cooperation will increasingly come to bear. As we move into an era where development is conceptualized as a problem of providing global public goods rather than as a direct transfer of resources, the structure of future development cooperation institutions will change. One of the key lessons is that international organizations can substantially facilitate the pursuit of global cooperative goals, often through the provision of high-quality, reliable information about the characteristics and actions of states.

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