

INTERNATIONAL COOPERATION AND THE INTERNATIONAL COMMONS

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I. INTRODUCTION

Efforts to sustain international cooperation invariably culminate in the signing of an international treaty, the success of which depends on the acumen of the individuals that negotiate it and the nature of the problem being addressed. But, while diplomats can make a difference, even the cleverest of diplomats cannot be relied upon to sustain first-best outcomes in all cases. Usually cooperation will be partial and there will be some loss in efficiency. International cooperation in these situations is analogous to domestic politics. Democracy may be the best system of government imaginable, but Arrow has taught us that we cannot rely on majority voting to sustain first-best outcomes every time.¹

In international relations, the novel constraint that prevents first-best outcomes from being realized is sovereignty. Since participation in an international treaty is voluntary, agreements that seek to sustain cooperation must be self-enforcing.² If the self-enforcement constraint bites with enough force (and this will depend on the nature of

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1. See, e.g., KENNETH J. ARROW, SOCIAL CHOICE AND INDIVIDUAL VALUES 2-3, 93-96 (2d ed. 1963) (describing the “paradox of voting” and providing some of the intellectual history of the idea).

2. Participation in an international treaty is voluntary in two senses. First, a state (country) is never obligated to participate in the negotiations of a treaty, nor sign or ratify the treaty. Second, despite the fact that a country that signs and ratifies a treaty becomes obligated to abide by its terms, a state may not be forced to comply with the commitments it has made, due to sometimes ineffective international police enforcement mechanisms. In this second sense, participation is voluntary because the state may choose to comply or not to comply.

the problem being negotiated), then we should not expect our diplomats to return home with the first-best treaty in their briefcases. Often, however, our negotiators could do better than the records indicate.

The problem is partly that our negotiators too often have a poor conceptual understanding of the task at hand. As will be explained later, they are not helped by the sometimes confused and disjointed literature, especially with regard to whether free riding is truly a problem in creating international agreements.³ There is also disagreement in the literature about whether compliance is a problem—and, in particular, whether “sticks” are needed to deter noncompliance. The purpose of this article is to try to make sense of the negotiators’ problem by discussing what makes international agreements work and how they can be made to work better.

This article begins by defining the international cooperation problem and distinguishing it from other problems requiring negotiation. Part III then discusses the general remedies to this kind of problem, and explains why judicial remedies cannot work for every cooperation problem. Part IV discusses specific remedies (*i.e.*, international treaties) to specific problems. Part V discusses whether compliance with international agreements is a problem or not, and Part VI distinguishes between compliance and participation. The article further distinguishes participation from free riding in Part VII and then in Part VIII it explains why, of all the problems, free-rider deterrence is the hardest to fix. Part IX distinguishes free riding from the related problem of trade leakage. Finally, the article summarizes what all of this means for our negotiators.

II. INTERNATIONAL COOPERATION AS A PRISONERS’ DILEMMA

Problems of international cooperation involving regional or global public goods, or regional or global commons problems, have characteristics that are crudely captured by the famous Prisoners’ Dilemma (PD) game.⁴ Examples of such international problems are the harvesting of migratory tuna, polluting of the Black Sea, protection of the ozone layer, conservation of biodiversity, and climate change mitigation. The focus of this article is concerned only with

3. See discussion *infra* Part VIII.

4. A description of this game may be found in any textbook on game theory. For a discussion relevant to the subject of this article, see TODD SANDLER, GLOBAL CHALLENGES: AN APPROACH TO ENVIRONMENTAL, POLITICAL, AND ECONOMIC PROBLEMS 26-34 (1997). In a PD game, pursuit of self-interest by each player results in a collectively unsatisfying outcome.

problems such as these, which, in their primitive forms, resemble the PD, or at least have aspects captured by the PD

The most important feature of the PD with respect to international public goods or commons problems is that the efficient outcome may *not* be sustainable by a decentralized or anarchic international system.⁵ For example, in the one-shot, single-round PD game, decentralization is fatal to the collective good.⁶ More generally, those outcomes that are welfare-superior (as compared to their anarchic counterparts) must be sustained by an enforcement mechanism of some kind. In particular, cooperation *can* be sustained for even the one-shot PD provided an agreement between the players can be enforced by a third party. However, there is no third party that can effectively enforce agreements between countries.⁷

This is a basic point, but one that is routinely misunderstood. For example, it is sometimes noted that many problems are more akin to coordination games.⁸ Since efficient outcomes can be sustained in coordination games by an anarchical system, extrapolation implies that cooperation is not much of a challenge to the international system.⁹ While it is true that many problems resemble coordination games, the concern here is with problems that do not—problems that share the essential features of the PD. These problems are especially difficult for the international system to remedy.

One of the differences between the PD and coordination games is that, for the latter, players (here, countries) do not have dominant strategies: what is best for one country to do depends on what the others are doing.¹⁰ This is a common situation in international relations, but the coordination game is not unique in having this feature.

5. *See id.* at 132-43.

6. *See id.* Cooperation may be sustained, however, by using a strategy of reciprocity. *See id.* at 33-34, 132-34; *see also* ROBERT O. KEOHANE, *AFTER HEGEMONY: COOPERATION AND DISCORD IN THE WORLD POLITICAL ECONOMY* 75-78 (1984).

7. *See* SANDLER, *supra* note 4, at 32; Douglass C. North, *Dealing with a Non-Ergodic World: Institutional Economics, Property Rights, and the Global Environment*, 10 DUKE ENVTL. L. & POL'Y F. 1, 5 (1999). International institutions such as the International Court of Justice can pressure states to comply with treaty obligations. However, there is no institution empowered to intervene for the good of all and enforce compliance. *See* Scott Barrett, *The Problem of Global Environmental Protection*, OXFORD REV. ECON. POL'Y, Spring 1990, at 68, 69 (1990) [hereinafter Barrett, *Global Environmental Protection*].

8. In a coordination game, every party wants to do what the others are doing. *See* SANDLER, *supra* note 4, at 46-50.

9. *See* Carlisle Ford Runge, *Institutions and the Free Rider: The Assurance Problem in Collective Action*, 46 J. POL. 154, 155 (1984).

10. *See* SANDLER, *supra* note 4, at 49; Runge, *supra* note 9, at 161.

Indeed, in richer, more complex PD-like games, states do not have dominant strategies. For example, if the marginal damage from pollution is increasing, then as other states abate their pollution, it will pay for each state to abate its emissions less at the expense of the others.¹¹

Confusingly, some problems share features of both kinds of games. For example, participation in a treaty may resemble a coordination game, and yet the problem addressed by the treaty may be a PD. This kind of situation can result when trade sanctions are used to sustain cooperation in an international agreement. With sanctions imposed on non-signatories, every party prefers to participate if a significant number of others do as well. This resembles the coordination game. However, if the treaty also requires that the parties supply the public good, then this resembles the PD game.¹²

It is important to note, however, that there are features of the PD that are *not* important to my analysis. In the international relations literature, it is common to model the PD as being played by two states, each having a binary choice.¹³ These requirements can and should be relaxed. In a world of approximately 190 countries, it is a gross error to assume that all PD-type games are played by just two countries. Indeed, there is a huge qualitative difference between two-player and three-player PD games.

The ability of a treaty to sustain full cooperation depends on the nature of the problem. One dimension to the problem is the number of countries affected by the commons problem. It turns out that regional problems are easier to remedy partly because regional cooperation problems involve a small number of countries and partly because neighbors interact more frequently, allowing reciprocity to flourish.¹⁴

11. For a more in-depth discussion of the issue, see Scott Barrett, *Self-Enforcing International Environmental Agreements*, 46 OXFORD ECON. PAPERS 878 (1994). Other kinds of interdependencies are possible as well. For example, the marginal cost of abatement for each country could be decreasing in the abatement undertaken by others. Then, as others abate more, it will pay each country to abate its emissions by more, too. However, in this case, the underlying game would *not* be a PD. See Geoffrey Heal, *Formation of International Environmental Agreements*, in TRADE, INNOVATION, ENVIRONMENT 301, 308-19 (Carlo Carraro ed., 1994).

12. See generally Scott Barrett, *The Strategy of Trade Sanctions in International Environmental Agreements*, 19 RESOURCE & ENERGY ECON. 345 (1997).

13. See, e.g., ARTHUR A. STEIN, WHY NATIONS COOPERATE: CIRCUMSTANCE AND CHOICE IN INTERNATIONAL RELATIONS (1990) (providing multiple examples of the prisoners' dilemma).

14. This is a familiar insight, perhaps first drawn to our attention by Mancur Olson in 1965, but the mechanisms that support it have only recently been elucidated. See MANCUR OLSON,

Moreover, it is neither essential nor reasonable to assume that *all* choices are binary (even though it is sometimes analytically convenient to do so). For example, feasible pollution abatement can range from zero to one hundred percent. The important binary choice is between being a party and a nonparty to an international treaty (though even here there are gray areas).

III. GENERAL REMEDIES

States cooperate through treaties, and there are lots of them—close to 200 multilateral agreements and many more bilateral treaties.¹⁵ Treaties are specific remedies, however, and it might seem that there should be a more elegant and general remedy. For example, why not simply allocate rights, pursuant to the Coase Theorem, to all the earth's resources and let bargaining take care of the rest?¹⁶

Of course, to some extent, rights to the earth's resources—and to the resources of outer space—are allocated by international law.¹⁷ Customary law, for example, determines the limit of the territorial sea, while at the same time safeguarding the right to innocent passage. Moreover, the legal mechanism of international law has evolved to aid in our management of transnational natural resources. The extension of the territorial limit from three to twelve miles, for example, was motivated partly by the severe depletion of near-shore fisheries. Similarly, the 200-mile exclusive economic zone (EEZ) was created to bring ocean resources adjacent to sovereign territory under the control of municipal governments. Together, these measures have effectively nationalized most of the world's commercial fisher-

JR., THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS 53-65 (rev. ed. 1971) (1965); see generally Scott Barrett, *A Theory of Full International Cooperation*, 11 J. THEORETICAL POL. 519 (1999) [hereinafter Barrett, *Full International Cooperation*].

15. See Scott Barrett, *Economic Analysis of International Environmental Agreements: Lessons for a Global Warming Treaty*, in RESPONDING TO CLIMATE CHANGE: SELECTED ECONOMIC ISSUES 109, 137-44 (Org. for Econ. Co-operation and Dev. ed., 1991) (providing a list of agreements); but cf. David G. Victor, *Enforcing International Law: Implications for an Effective Global Warming Regime*, 10 DUKE ENVTL. L. & POL'Y F. 147, 151 & n.6 (1999) (providing his own count of multilateral environmental agreements).

16. See R.H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 2-8 (1960) (illustrating the classic invariance proposition). The Coase Theorem says that, irrespective of the initial allocation of rights, as long as rights are vested in one of the two parties, trade will ensure that the final allocation of resources is Pareto efficient, as long as there are no transaction costs. See *id.* Of course, Coase recognized that this general application of the theorem named after him is not possible, because in the real world there are positive transaction costs. See *id.* at 15 (stating that the assumption of zero transaction costs is "very unrealistic").

17. See IAN BROWNLIE, *PRINCIPLES OF PUBLIC INTERNATIONAL LAW* 258-86 (4th ed. 1990).

ies.¹⁸ Although straddling fish stocks and migratory species still pose a problem that necessitates international treaties, the above changes in property rights have removed certain problems from being managed within the constraints of self-enforcement. A good example is the Icelandic fishery. Iceland extended its claim to this resource from three to four miles in 1930; from four to twelve miles in 1958; from twelve to fifty miles in 1972; and from fifty to two hundred miles in 1975. Eventually, Iceland's claim was recognized for being compatible with the evolving custom regarding territorial limits. Consequently, Iceland has been able to deter foreign entry to this important fishery and manage the resource better.¹⁹

This type of allocation of rights, however, has limits. Countries that share a regional sea, for example, have little to gain from a 200-mile territorial limit. Having sole jurisdiction to a piece of a sea is of no help if the fish within it disperse evenly or if pollution that enters the sea mixes uniformly. Consequently, not every state has claimed an EEZ.²⁰ Such resources—including rivers that either border or run through different states, regional air sheds, and migratory animal species—often must be shared.

Even if rights to such resources could be allocated (for example, the whole of an inland sea could be given to a single country), no simple rule will suffice to please all parties. Customary international law states that shared resources should be subject to "equitable utilization," but the law is silent on what makes for an equitable allocation.²¹ This ambiguity is inevitable, because what is equitable will depend on the specifics of a particular case and therefore must be decided by negotiation. On the other hand, while customary law is unable to allocate every environmental resource, it can nationalize some resources and focus the attentions of parties in the direction that negotiations should take.

18. Both the 12-mile territorial limit and the EEZ, which may extend up to 200 miles, are codified in the Law of the Sea Conventions. The territorial sea is an extension of a state's land mass with the exception that foreign vessels are allowed innocent passage. A state also has rights to its EEZ. However, other states have the right to fly over and lay cables in this territory. A state must actually claim an EEZ for it to be recognized in international law. See MALCOLM N. SHAW, *INTERNATIONAL LAW* 348-49, 359-63 (3ded. 1991).

19. See MARK KURLANSKY, *COD: A BIOGRAPHY OF THE FISH THAT CHANGED THE WORLD* 158-73 (1997).

20. See PATRICIA W. BIRNIE & ALAN E. BOYLE, *INTERNATIONAL LAW AND THE ENVIRONMENT* 116 (1992).

21. See *id.* at 127.

So, while at first blush, it might seem that allocating property rights and allowing Coasean bargaining to occur might be the general solution to global commons problems, this general remedy falls short. The desirable outcome promised by the Coase Theorem requires more than a full specification of property rights; it also requires *enforcement* by a third party. Even if the former requirement were satisfied, the latter cannot be, because third party enforcement of contracts (treaties) is not countenanced by the international system. This is the real problem and what distinguishes international from local commons problems.

IV. SPECIFIC REMEDIES

Of course, nothing prevents countries from negotiating an agreement in which rights are allocated—either an initial allocation, which may subsequently be redistributed by trading (as in the 1997 Kyoto Protocol), or a final allocation (as in the Rhine Chlorides Convention of 1976).²² The harder problem is figuring out how to ensure full participation in the agreement effecting an allocation and how to enforce an allocation. This is a widely misunderstood distinction. As evidenced by the Kyoto Protocol, the negotiators of this agreement were preoccupied with negotiating targets and timetables rather than enforcement or participation mechanisms. This was a mistake.²³ If effective enforcement mechanisms are omitted, and cannot be included subsequently, then the targets and timetables so painstakingly negotiated may not be met. If participation is narrow, the agreement may not enter into force; and even if it does enter into force, it may achieve less than anticipated.

Negotiating allocations is a challenge, but it is a problem for which solutions exist. Provided there is a total gain to cooperation, then with the help of compensating payments (side payments), states can negotiate an allocation that, when compared to the alternative of

22. See Scott Barrett, *Political Economy of the Kyoto Protocol*, OXFORD REV. ECON. POL'Y, Winter 1998, at 20, 29-30 [hereinafter Barrett, *Political Economy of Kyoto*]; DAVID G. LEMARQUAND, *INTERNATIONAL RIVERS: THE POLITICS OF COOPERATION* 108-18 (1977) (discussing the Rhine Chlorides Agreement). The Kyoto Protocol is an international treaty to reduce emissions of greenhouse gases. See Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, Conference of the Parties, 3d Sess., Agenda Item 5, U.N. Doc. FCCC/CP/1997/L.7/Add.1, *reprinted in* 37 I.L.M. 22 (1998) (not yet in force) (84 signatories and 22 Parties as of Jan. 20, 2000), *available at* <<http://www.unfccc.de/resource/docs/cop3/107a01.htm>>. The Rhine Chlorides Agreement seeks to reduce emissions of salts into the Rhine and allocates the costs among its parties. See Convention on the Protection of the Rhine Against Pollution by Chlorides, Dec. 3, 1976, 16 I.L.M. 265 (1977).

23. See Barrett, *Political Economy of Kyoto*, *supra* note 22, at 20-21.

having no cooperation at all, makes every country better off. It may also be important that *coalitions* of countries have incentives to participate. Chander and Tulkens have shown that, in certain circumstances, at least one allocation exists that no coalition would want to reject (that is, an allocation that lies at the core of the game).²⁴

In general, negotiating allocations is a simpler problem as compared with enforcement. When an agreement must be enforced by credible mechanisms and where it is in the interests of the countries to actually carry out their threat when called upon to do so, compensating payments by themselves have virtually *no effect* on the outcomes that can be sustained.²⁵ This may come as a surprise to anyone familiar with the Montreal Protocol.²⁶ Research suggests that the side payments in this agreement mainly helped by “ratcheting up” the cooperation problem; that is, the agreement shifted the cooperation problem from reducing the emissions of industrialized countries to getting these countries to pay developing countries to reduce *their* emissions.²⁷ The binding constraint was not enforcing provision of the public good by rich countries. Rather, the binding constraint was enforcing provision of compensating payments by rich countries to make participation attractive to poor countries.²⁸

V. COMPLIANCE

There are a number of reasons to think that compliance with international agreements is not a problem, perhaps the most important being that the actual record of compliance is exemplary.²⁹ But what should we make of this? One interpretation is that compliance is enforced by the custom requiring states to comply with the treaties they

24. See Parkash Chander & Henry Tulkens, *The Core of an Economy with Multilateral Environmental Externalities*, 26 INT'L J. GAME THEORY 379, 399 (1997).

25. See Scott Barrett, *International Cooperation for Sale* (1999) (unpublished mimeo, Paul H. Nitze Sch. of Advanced Int'l Stud., Johns Hopkins Univ.) (on file with author) [hereinafter Barrett, *International Cooperation*].

26. The Montreal Protocol is an international agreement that reduces the production and consumption of substances that deplete the stratosphere ozone layer. See Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, 26 I.L.M. 1550 (1987) (entered into force Jan. 1, 1989) (banning trade in ozone-depleting substances between Parties and non-Parties). For a fascinating study of the negotiation of this agreement, see RICHARD ELLIOT BENEDICK, *OZONE DIPLOMACY: NEW DIRECTIONS IN SAFEGUARDING THE PLANET* (2d. ed. 1998).

27. For more on this issue, see Barrett, *International Cooperation*, *supra* note 25.

28. See BENEDICK, *supra* note 26, at 252-55.

29. See Abram Chayes & Antonia Handler Chayes, *On Compliance*, 47 INT'L ORG. 175, 176 (1993).

sign. Though the punishment for breaking with this customary law is not specified, it is real. A damaged reputation resulting from non-compliance can make it difficult for a deviant to enter into future agreements. Even a single deviation carries the risk of precipitating general erosion in law abidance, to the detriment of all states. This is one of the reasons why even states unaffected by an act of noncompliance may nonetheless take measures that have the effect of punishing a deviant.³⁰

This reasoning seems all the more compelling given that few treaties specify explicit punishments, or “sticks,” for noncompliance.³¹ It even invites the conclusion that treaty-specific “sticks” for non-compliance are not needed and may even be counterproductive.³² However, the same facts are open to a different interpretation. Perhaps countries only sign agreements they would be happy to comply with unilaterally, or perhaps compliance is not a problem because the obligations imposed on parties are so weak as to eliminate any incentive not to comply.³³ However, the analyses that support these opposing positions are incomplete. They either ignore the problem of enforcing participation or conflate the twin problems of noncompliance and nonparticipation. These are related but different problems and should be analyzed jointly.

VI. COMPLIANCE VS. PARTICIPATION

A country only needs to comply with a treaty to which it is a party.³⁴ Upon giving sufficient notice of an intention to withdraw from an agreement, a state is released from the legal obligation of having to comply. Therefore, if nonparticipation cannot be deterred, then compliance with an agreement becomes a moot issue. The deterrence of both nonparticipation and noncompliance are thus inter-linked.

Noncompliance will only be deterred if the act of noncompliance is punished. However, although it is easy to threaten to impose a huge punishment for noncompliance, it is harder to make such a

30. For a game-theoretic demonstration of this, see Michihiro Kandori, *Social Norms and Community Enforcement*, 59 REV. ECON. STUD. 63 (1992).

31. See Victor, *supra* note 15, at 150 n.3.

32. See ABRAM CHAYES & ANTONIA HANDLER CHAYES, *THE NEW SOVEREIGNTY: COMPLIANCE WITH INTERNATIONAL REGULATORY AGREEMENTS* 29-33(1995); Victor, *supra* note 15, at 163-64.

33. See George W. Downs et al., *Is the Good News About Compliance Good News About Cooperation?*, 50 INT'L ORG. 379, 380, 383 (1996); Victor, *supra* note 15, at 152-57.

34. See SHAW, *supra* note 18, at 579.

threat credible, because punishing noncompliance usually harms the countries that carry out the punishment as well. For example, larger deviations offer larger rewards to the deviant and so can only be deterred by the threat to impose stiffer punishments. Unfortunately, the larger the punishment, the greater the cost of enforcement to the countries called upon to punish the deviant.³⁵

Consider the largest, credible deviation that needs to be deterred. This involves a participant (and would-be deviant) choosing the same provision level that it would choose if it were a nonparticipant. Detering such a deviation requires a large punishment. But if the required punishment is credible, then this unilateral deviation can be deterred. Furthermore, any smaller act of noncompliance can be deterred by smaller punishments, and small punishments are more credible. Thus, if an agreement can deter nonparticipation at the margin, then it will easily be able to deter noncompliance at the margin. Once nonparticipation has been deterred, noncompliance will be deterred free-of-charge.³⁶

If this reasoning is correct, then the compliance problem needs to be interpreted differently. “Sticks” will be needed to enforce compliance, as well as to enforce participation. Indeed, there should be a natural connection between these punishments. As explained below, nonparticipation in the Montreal Protocol has been deterred by the *threat* to impose trade sanctions against nonparties. Although the compliance mechanism in this treaty was left unspecified, when Russia threatened noncompliance, the parties to this remarkable treaty threatened to punish Russia by restricting trade. The threat was more implicit than explicit, but it worked all the same.³⁷

VII. PARTICIPATION VS. FREE RIDING

It is a rule of international law that participation in a treaty is voluntary.³⁸ Indeed, having the right to choose between participating or not is one of the most important aspects of statehood. We are accustomed to thinking of free riding as being manifest in nonparticipation. However, this reasoning can be misleading.³⁹ It is possible for countries to negotiate by consensus, for every country with a stake in

35. See Barrett, *Full International Cooperation*, *supra* note 14, at 522.

36. See *id.* at 533-37.

37. See BENEDICK, *supra* note 26, at 280-86.

38. See SHAW, *supra* note 18, at 561-64.

39. See Scott Barrett, *Consensus Treaties* (1999) (unpublished mimeo, Paul H. Nitze Sch. of Advanced Int'l Stud., Johns Hopkins Univ.) (on file with author).

an outcome of an agreement to be a party to it, and yet for free riding to remain a problem. In a consensus treaty, free riding is manifest in every party providing too little of the public good. This occurs because participation cannot be enforced if provision levels are larger, and deviations from an agreement specifying larger provision levels require larger punishments that are not credible. Moreover, countries may be better off by *choosing* to negotiate by consensus. A consensus treaty is especially appealing when the total cost of public good provision falls as the level of participation increases (as would be true of climate change mitigation). In the debate between having a “narrow but deep” versus a “broad but shallow” treaty, this logic commends the latter for this kind of problem.

There are certain forces that push in the direction of a consensus treaty. One is the customary law requiring countries to cooperate (though not requiring that they *be* parties to an agreement, let alone that they undertake efficient provision).⁴⁰ Another is the desire on the part of countries to conform, or to behave as others behave.⁴¹ The results noted above show that full participation may result despite these influences.

VIII. FREE RIDING

Since noncompliance can be deterred, and full participation can be sustained, we are left with the conclusion that *the* problem of international cooperation is the deterrence of free riding. However, although free riding has long occupied the attention of scholars in both international relations⁴² and economics,⁴³ its importance is too often minimized. Some even dismiss free riding as irrelevant, believing that most issues only require coordination or that free riding cannot be a problem since international agreements often generate full participation.⁴⁴ Economists sometimes make assumptions that have the effect of shooting the problem dead. For example, in some papers, it is deemed reasonable for agreements to be enforced by punishments

40. See BIRNIE & BOYLE, *supra* note 20, at 83.

41. See Michael Hoel & Kerstin Schneider, *Incentives to Participate in an International Environmental Agreement*, 9 ENVTL. & RESOURCE ECON. 153, 155 (1997).

42. See e.g., KEOHANE, *supra* note 6; Robert O. Keohane, *Reciprocity in International Relations*, 40 INT'L ORG. 1, 12-13 (1986); Robert Axelrod & Robert O. Keohane, *Achieving Cooperation Under Anarchy: Strategies and Institutions*, 38 WORLD POL. 226, 234-38 (1985).

43. See, e.g., SANDLER, *supra* note 4; Barrett, *Global Environmental Protection*, *supra* note 7.

44. See Runge, *supra* note 9, at 157.

that are not credible or for countries to make commitments not to withdraw from an agreement.⁴⁵

There is a much deeper reason for thinking that free riding is not a problem. The folk theorems of repeated games tell us that if the players in PD games are sufficiently patient and if they can expect to meet again in the future, then any feasible outcome can be sustained (as a sub-game perfect equilibrium) by the anarchic international system.⁴⁶ However, the notion behind such an equilibrium is inappropriate to the study of international cooperation because it assumes that the parties to an international agreement cannot renegotiate. In reality, they can and indeed they often do renegotiate. The Montreal Protocol, for example, has been renegotiated several times in the last ten years.

If you relax this constraint and allow parties to renegotiate agreements, then the usual folk theorem result ceases to hold when the number of players in the PD game exceeds two. When there are three or more players, it may not be possible to devise a self-enforcing treaty capable of sustaining full cooperation.⁴⁷ Some kind of second-best fallback must be accepted instead.

Moreover, this result depends on the payoff functions for these players. It matters, for example, whether the benefit of abatement is increasing or decreasing. The parameter values for the relationships can also matter. An important yet depressing result is that cooperation is often harder to achieve when the gains that can spring from it are largest. This is because it is precisely under these circumstances that stiff penalties are needed to deter free riding. Stiff penalties, as mentioned previously, are often not credible.

IX. FREE RIDING VS. LEAKAGE

How can credibility be augmented in order to deter non-participation? It is natural to turn to the success of the Montreal Protocol for inspiration. This agreement, it will be recalled, relies on

45. See, e.g., Chander & Tulkens, *supra* note 24, at 379; Carlo Carraro & Domenico Siniscalco, *Strategies for the International Protection of the Environment*, 52 J. PUB. ECON. 309 (1993).

46. For a more in-depth discussion of the topic, see Barrett, *Full International Cooperation*, *supra* note 14.

47. See generally Barrett, *Full International Cooperation*, *supra* note 14.

trade sanctions to deter non-participation.⁴⁸ Could this mechanism be replicated for other international treaties?

Before answering this question, three related observations need to be made. First, the Montreal Protocol sanctions may violate the rules of the Global Agreement on Tariffs and Trade (GATT) and thus be subject to challenge under the World Trade Organization (WTO).⁴⁹ As of yet, this is not a legal problem, because no country has complained to the WTO about the Montreal sanctions. However, it is pretty obvious that the sanctions violate the principle of non-discrimination. It seems inevitable that some kind of deal will need to be negotiated in the future to reconcile WTO principles with the need to sustain environmental agreements.

Second, if a trade sanction works well, then it will never need to be implemented. If the threat to impose the sanction is credible, and if the sanction is big enough to deter “cheating,” then cheating will never occur. Sanctions, therefore, will never need to be imposed.

Third, it can only be acceptable to impose sanctions against free-riders, as opposed to nonparticipants. Some countries may damage the environment but have no interest in protecting it. The threat of sanctions may make these countries reduce their emissions, but such an outcome would not necessarily be “fair.” In the Montreal Protocol, compensating payments to pay for the compliance costs of developing countries help to make the threat to impose sanctions in this agreement “fair.”⁵⁰ This is one important reason why the use of “sticks” often needs to be accompanied by the use of “carrots” (or compensating payments).

However, trade sanctions are not the easy answer to most environmental problems. One reason is that trade sanctions will not always be credible. Like other strategies of reciprocity, trade sanctions may harm the countries that impose them as well as those who receive them. Trade sanctions are credible for the Montreal Protocol mainly because of the worry about “trade leakage”—that, as some countries reduce their production and consumption of ozone-

48. See Scott Barrett, *Montreal v. Kyoto: International Cooperation and the Global Environment*, in GLOBAL PUBLIC GOODS: INTERNATIONAL COOPERATION IN THE 21ST CENTURY 192, 211-13 (Inge Kaul et al. eds., 1999) [hereinafter Barrett, *Montreal v. Kyoto*].

49. See DUNCAN BRACK, INTERNATIONAL TRADE AND THE MONTREAL PROTOCOL 81 (1996). On the topic of whether the provisions of the Kyoto Protocol regarding allocation and trading of emission allowances may be subject to challenge under the WTO, see Annie Petsonk, *The Kyoto Protocol and the WTO: Integrating Greenhouse Gas Emissions Allowance Trading into the Global Marketplace*, 10 DUKE ENVTL. L. & POL'Y F. 185 (1999).

50. See Barrett, *Montreal v. Kyoto*, *supra* note 48, at 210-11.

depleting substances, output and usage will simply shift to non-participants. Ironically, although leakage exacerbates free riding in the sense that it frustrates *unilateral* efforts to provide a public good, it also contains the ingredient needed to deter free riding in a multilateral agreement.⁵¹

Another reason is that for some environmental problems—climate change mitigation being the most obvious—sanctions might need to be applied very broadly. The production of all goods and services results in emission of greenhouse gases. To reduce leakage, some kind of border tax adjustment would probably be needed. But this would be impractical. It is virtually impossible to work out, for *each* traded good, the emissions resulting from its manufacture. Importantly, though the Montreal Protocol threatens to impose sanctions on trade in products made using ozone-depleting substances, such an action has not been taken and has not proven necessary.⁵² For climate change, it would seem essential, and yet the consequence may be a threat to the multilateral trading system. This would be an unhappy tradeoff. Ozone depletion and climate change mitigation are different problems, and cannot be solved using a one-size-fits-all treaty.⁵³

X. CONCLUSION

All the answers to global commons problems have certainly not been settled. However, a useful theory should prompt us to ask the right questions. The negotiators in Kyoto, for example, should have started by asking what kind of agreement on climate change mitigation could be enforced. Only after this question was answered should they have negotiated allocations or other policy actions. In this way, they could be sure that the obligations in the treaty could be enforced and that the required level of participation would be reached. Instead, the Kyoto negotiators lavished more attention on the setting of emission limits with little thought given to participation and enforcement. The unfortunate consequence may be an agreement that fails to enter into force or that fails to be sustained after having entered into force. Ultimately, the issues addressed in this article will have to

51. See generally Scott Barrett, *The Credibility of Trade Sanctions in International Environmental Agreements*, in TRADE, GLOBAL POLICY, AND THE ENVIRONMENT 161 (World Bank Discussion Paper No. 402, Per G. Fredriksson ed., 1999).

52. See BRACK, *supra* note 49, at 81.

53. See Barrett, *Montreal v. Kyoto*, *supra* note 48, at 192-94.

be faced—either in subsequent conferences among the parties or in renegotiations of the agreement.