

How Regime Theory and the Economic Theory of International Environmental Cooperation Can Learn from Each Other

*Eric Neumayer**

Many environmental problems are truly international or global. They cannot be tackled by a single country alone. Hence international cooperation is needed for a solution. Although domestic environmental policy can use the enforcing power that sovereign nation-states ideally have within their territory, in general, international environmental policy cannot depend on a supra-national authority with enforcing powers. International environmental cooperation has to be accomplished in the context of anarchy.

Regime theory has long ago addressed the question of how cooperation can be achieved and sustained in a world divided into sovereign nation-states.¹ It has done so, not only in regard to the environment, but also with respect to many other issues, especially security, economics and finance. Independently from regime theory, and starting from around the early 1990s, a branch of international environmental economics called here the economic theory of international environmental cooperation—has engaged in substantial research on the subject as well. It has tackled the question that has traditionally occupied regime theorists most: “Why does cooperation emerge in some cases and not in others?”² Unfortunately, the regime theory literature that focuses on the environment is not inspired by the results from this research. Similarly, the economic literature on international environmental cooperation is to a great extent ignorant of the contributions from regime theory and does not consider how it could benefit from a better understanding of its findings.

Indicative of this mutual neglect is the fact that the works of Scott Barrett and Carlo Carraro—resumably the most prominent representatives of the economic theory of international environmental cooperation—are hardly cited in papers written by regime theorists. Usually, these papers do not mention or take any notice of the major results from the economic theory of international envi-

* I would like to thank three anonymous referees for helpful comments.

1. For an overview, see, for example, Haggard and Simmons 1987; Hasenclever, Mayer and Rittberger 1996.

2. Oye 1985b, 1.

ronmental cooperation. On the other hand, some of the work of the economic theorists do cite contributions from regime theory.³ However, reference is often only cursory, and major findings from regime theory are only occasionally integrated into model building. Furthermore, the citing of papers from regime theory in the economic literature of international environmental cooperation is the exception rather than the rule. Hence Carraro suggests that "the idea of 'issue linkage' was originally proposed by Folmer et al. (1993) and Cesar and de Zeeuw (1996) to solve the problem of asymmetries among countries,"⁴ when this proposition actually goes back to early contributions from regime theory and negotiation theory.⁵

In the next two sections, I show how regime theory could benefit from a better understanding of the basic findings from the economic theory of international environmental cooperation and vice versa. Then several examples are provided to illustrate how the two schools of thought could fruitfully engage in mutual learning from each other in order to achieve international environmental cooperation that is "wider" and "deeper."⁶

Oran R. Young praises the returns from inter-disciplinary research in international affairs when he refers to our entry into "a period of profound change in our thinking about governance in international society that offers an exciting new research agenda for students of international affairs and an opportunity to bridge the gap that has long separated the main streams of research in the fields of international relations, international law, and political science."⁷ Young does not include the economic theory of international environmental cooperation. One possible reason might be that there still exists a gap between the fields he mentions and the economic theory of international environmental cooperation. In a nutshell, it is the aim of this paper to convince readers that closing this gap is worthwhile.

1. Learning From the Economic Theory of International Environmental Cooperation

It would be beyond the scope of this paper to provide a complete outline of the economic theory of international environmental cooperation. Instead, I shall concentrate on those results that might be of special interest to scholars of regime theory. One of the major contributions of the economic theory of international environmental cooperation has been an elaboration of what the absence

3. For example, Cesar 1994; Cesar and de Zeeuw 1996; Batabyal 1996; Helm 1998; Ecchia and Mariotti 1998; and Barrett 1999.

4. Carraro 1997, 9.

5. See, in particular, Iklé 1964; Tollison and Willett 1979; Haas 1980; and Sebenius 1983.

6. International environmental cooperation is defined here to be "wider" if it includes more countries with responsibility for the environmental problem. It is defined here to be "deeper" if it increases the difference between the net benefits achieved by cooperation relative to the net benefits without such cooperation.

7. Young 1994, 12.

of a central authority in international affairs implies for the scope and depth of cooperation.

Before I come to this, it seems appropriate, however, to explain the assumptions upon which the economic theory of international cooperation is based. Arguably, the following four assumptions are the most important ones: first, it is utilitarian in that it assumes that all aspects of decision-making can be captured by utility-relevant costs and benefits and that agents maximize a utility function; second, it assumes that agents decide rationally, taking into account all available information; third, if it applies game theoretic analysis, which it often does, it assumes that there is a unitary actor; and, fourth, it assumes that the unitary actor is faced with a well-specified payoff matrix. Clearly, these assumptions are rather restrictive. However, they are often justified in order to construct a tractable model that results in testable propositions. As in other areas of the field, economists have never been very impressed by the low degree of realism of its assumptions as long as its propositions have performed well in tests. We will now look at some of the propositions from the economic theory of international environmental cooperation. We will see that at times the low degree of realism of its assumptions has led to significant shortcomings in its propositions.

Self-Enforcing and Renegotiation-Proof Agreements

The economic theory of international environmental cooperation has taken the idea of "cooperation under anarchy"⁸ very seriously and has developed the concepts of self-enforcing and renegotiation-proof agreements.⁹ What does this mean? As regards most international environmental problems, the affected countries are confronted with a basic Prisoner's Dilemma. The following situation is illustrative: all countries have an interest in reducing harmful emissions, and all countries are better off with international environmental cooperation, but each of them also has an incentive to free-ride on the others' efforts and to enjoy the benefits of abatement without incurring any of the costs of emission reduction. Therefore, international agreements normally have to deter external free-riding, that is, they have to deter countries that would benefit from emission reduction while remaining outside of the agreement. Equally, they have to deter internal free-riding, that is, they have to deter signatory countries from non-compliance with the requirements of the agreement. What is important is that the mechanism employed to achieve deterrence has to be self-enforcing in the sense that a recourse to an external enforcement agency is not feasible: No country can be forced to sign an agreement and signatories cannot be forced to comply with the agreement.

There exist many mechanisms that could potentially achieve such deter-

8. Oye 1985a.

9. The major contributions are Barrett 1990, 1991, 1994a, 1994b, 1997a, 1997b; Carraro and Siniscalco 1993; Botteon and Carraro 1997a; Endres and Finus 1998; and Finus and Rundshagen 1998a, 1998b. But see also the references in other notes below.

rence. Most of them, such as economic sanctions as well as a refusal to cooperate in other issue areas, depend on what has become known as issue linkage—a topic to which I will return. Assuming for the moment that issue linkage is impossible or undesirable, then the only variable left to a country is the amount of pollution it emits. Hence, the only mechanism left is to threaten not to undertake any emission reduction in order to deter external free-riding, or to decrease emissions by less than required by the agreement in order to punish non-compliant countries and to deter internal free-riding. This threat has to be credible in the sense that it is in the interest of the threatening country (or countries) to actually execute the threat whenever other countries try to free-ride. In other words, a threat cannot be credible if a country is worse off after executing the threat than it would be without execution. Non-credible threats cannot deter because potential free riders will anticipate that they could get away with free-riding without being punished. Moreover, an agreement that establishes such a mechanism to deter free-riding has to be renegotiation-proof. This means that the threat has to be credible also in the sense that the threatening country (or countries) must be better off actually executing the threat than refraining from execution and renegotiating a new agreement with the free-riding country (or countries). Agreements that are not renegotiation-proof cannot deter because potential free riders will anticipate that they could strike another deal after free-riding and could therefore get away without being punished.

The concept of being renegotiation-proof is more relevant and significant than might initially be apparent. The suggestion that cooperation under anarchy is possible is often implicitly or explicitly based on the Folk Theorem from game theory, which implies that full cooperation in an infinite or not obviously finite Prisoner's Dilemma can be sustained as a subgame perfect equilibrium if the discount rate is "sufficiently small" (the shadow of the future is "sufficiently long").¹⁰ One prominent supgame strategy that can achieve full cooperation as a subgame perfect equilibrium is the so-called trigger strategy. In a two-players' game, the trigger strategy is defined as follows: start with cooperation and continue cooperation until the other player defects, and after that defect forever. The problem with this and many other strategies is that they are not credible, because they are not renegotiation-proof. The player who is punished by "defection forever" has an incentive to suggest to the punisher to forget about the past and to start mutual cooperation anew. The punisher has an incentive, as well, to let bygones be bygones and to refrain from punishing forever. Hence the trigger strategy is vulnerable to renegotiation and cannot achieve mutual cooperation in a repeated Prisoner's Dilemma game. The players cannot get rid of the incentives for renegotiation because they cannot credibly commit to executing the "defect forever" threat. Renegotiation-proof equilibria are only a subset of subgame perfect equilibria, hence not all subgame perfect equilibria can be sustained via renegotiation-proof supgame strategies.

10. See, for example, Axelrod 1984.

Being renegotiation-proof is a far-reaching requirement. Not only does it rule out certain supgame-strategies, it also rules out other proposals on how to promote cooperation. Black, Levi and Meza, for example, have shown how a minimum participation clause in international agreements can in principle induce more countries to join the agreement.¹¹ In their model, there are only two options: either at least as many countries sign the agreement as specified by the minimum participation clause, or the agreement never comes into effect. This mechanism promotes participation as each country has to balance the benefits from free-riding against the benefits forgone if it does not sign the agreement and thereby contributes to increasing the likelihood that cooperation is inhibited once and forever. Also, the clause assures each participating country that at least as many other countries will cooperate as required by minimum participation, which helps to reduce the concerns of the cooperating countries about widespread free-riding. However, the problem with this device is that it is not renegotiation-proof. If the minimum number of countries required for the agreement to come into effect is not achieved the first time, the signatory countries can always renegotiate and lower the minimum participation clause. Alternatively, if the agreement does come into effect, the signatory countries have an incentive to revert to free-riding *ex post* and to break the agreement after it has come into effect. Indeed, the more successful the minimum participation clause initially was in increasing the number of signatories, the greater the incentive for a potential free-rider to break it afterwards.

The economic theory of international environmental cooperation has examined the implications for cooperation if countries are restricted to strategies that must be renegotiation-proof. If issue linkage is impossible or undesirable, then one basic result holds: a self-enforcing and renegotiation-proof agreement will either consist of only a small subset of affected countries, or, if many countries are parties to the agreement, then the gains from cooperation relative to the non-cooperative equilibrium are very small. In other words, large-scale cooperation will either not take place as only few countries sign the agreement, or, if it does take place, it is virtually irrelevant as the agreed-upon cooperation improves only marginally on what would have been achieved by unilateral action in the absence of the agreement. Cooperation is either narrow (instead of wide) or shallow (instead of deep).¹²

This result leads us to pessimistic expectations about solutions for the environmental problems for which international cooperation is most needed. To see this, note that in the case where the benefits from emission abatement are high and the costs are low (for example, ozone depleting substances), the basic result that cooperation will either be narrow or, if wide, will not be deep, does

11. Black, Levi and Meza 1993.

12. Cooperation can be wider and deeper if emission abatement is characterized by fixed costs, so that average costs are falling over a certain range of abatement, or if emission abatement creates positive technological externalities, so that abatement by one country reduces the abatement costs by other countries. See Heal 1994.

not matter much since countries have significant incentives to solve the problem unilaterally. The same might even be true if the benefits from abatement are relatively low, as long as the costs are low as well. Similarly, for the case where the benefits from abatement are low and the costs are high, from the perspective of the economic theory of international environmental cooperation, the basic result does not matter much: Even the full cooperative outcome would not do much about the environmental problem because of high costs. The case where the basic result is really relevant is the one where benefits from abatement are high, but so are costs (for example, greenhouse gas emissions). This is exactly the kind of case where a solution to the environmental problem would demand wide and deep cooperation most.¹³

The intuitive reason for this most basic result from the economic theory of international environmental cooperation is as follows: In order to deter free-riding, an agreement must specify that the non-free-riding countries increase their emissions relative to an agreement without free-riding in order to punish free-riders for not decreasing their emissions at all (external free-riding), or by not as much as requested by the agreement (internal free-riding). In order to deter, the damage to the potential free-rider caused by the increase in emissions must be greater than the potential benefit from free-riding. The wider and deeper cooperation is, the higher the benefit is from free-riding so that the damage to the potential free-rider must also increase in order to deter free-riding. The problem is, however, that the bigger the damage is to the potential free-rider, the bigger the damage is to the punishing countries themselves as well. This self-inflicted damage due to the emission increase limits the punishment that is available for free-rider deterrence. It must not hurt the punishing countries more than the damage caused by the free-riding. Otherwise it will not be credible as the potential free-rider knows that it is not in the best interest of the punishing countries to execute the punishment.

What is more, there must not exist any incentive for the punishing countries and the free-riders to renegotiate the agreement and strike another deal. For this condition to hold, the punishment must not be very high or else the damage to the free-riding country is big as is its incentive to renegotiate another agreement. Because of these twin reasons the credible punishment available cannot be very substantial which means that it cannot deter much free-riding. Because external free-riding can be deterred only to a small extent, free-riding is ubiquitous and the number of countries participating in an agreement is small. Alternatively, because internal free-riding can be deterred only to a small extent, the agreement cannot improve much relative to the non-cooperative equilibrium in order to keep the incentives for non-compliance small, if the number of signatories is large.

The consequences of the need for agreements to be self-enforcing and renegotiation-proof are challenging for regime theory with its belief in the possi-

13. Barrett 1991, 14f.

bility of wide and deep cooperation in spite of anarchy. But is it of any real-world relevance? This is a question that is difficult to answer. How do we know whether the gains from cooperation are small relative to the non-cooperative equilibrium? The fact that cooperation exists means that we cannot directly observe what the outcome would be without cooperation. And how do we know what the full cooperative outcome would look like? The few studies that have tried to gain evidence on this question by applying econometric techniques have supported basic findings from the perspective of the economic theory of international environmental cooperation; for example, James C. Murdoch and Todd Sandler suggest that the Montreal Protocol does not reduce ozone damaging chlorofluorocarbons (CFCs) by much more than the unilateral reductions that would have been made by the major producers based on their own selfish interest.¹⁴ Hence, the Montreal Protocol “may be more symbolic than a true instance of a cooperative equilibrium, since nations’ CFC reductions prior to the treaty taking effect appear to fit the predictions of a single-shot Nash equilibrium.”¹⁵ Similarly, Murdoch, Sandler and Keith Sargent find that, for the Helsinki Protocol limiting SO₂ emissions and for the Sofia Protocol limiting NO_x emissions, the cooperative gains are small relative to the non-cooperative equilibrium: “. . . nations achieved emission reduction levels and then drafted the treaty with these levels as targets.”¹⁶

Leakage

Another major area where regime theory could learn from the economic theory of international environmental cooperation is the aspect of leakage and how leakage exacerbates the problems of free-riding. An example of leakage is when a decrease in emissions by the participants to an agreement is counteracted by an increase of emissions by non-members. Such an increase can be a deliberate decision by the free-riding countries. Because the decrease in emissions by the participants lowers the marginal social damage of emissions by the non-participants, their non-cooperative Nash equilibrium emissions rise. These non-members will therefore usually find it in their own best interest to deliberately increase emissions. However, this is just part of the story. The other reasons why emissions of non-participants might rise are more subtle and can hardly be traced back to a deliberate policy by these countries to exploit the emissions reductions of others. To understand this point, take the example of carbon dioxide emissions. If a sub-set of all countries agrees to limit their carbon dioxide emissions, then production of carbon-intensive goods and services becomes relatively more expensive in these countries. Comparative advantage in these goods and services shifts to the non-participating countries who increase their

14. Murdoch and Sandler 1997.

15. *Ibid.*, 332f.

16. Murdoch, Sandler and Sargent 1997, 298.

production of carbon-intensive goods and services. Similarly, some especially carbon-intensive industries might migrate from signatory to non-signatory countries. Also, the reduction in demand for fossil fuels due to the limitation of carbon dioxide emissions by the participants to the agreement will lower world fossil fuel prices, which increases demand for fossil fuels in non-member countries. All of these feedback mechanisms lead to an increase of emissions by non-participants quite involuntarily, that is, without the participating countries being able to blame the non-members for deliberately exploiting their emission reductions. How significant leakage would be depends on the underlying assumptions about the number of parties to the agreement, the level of emissions reduction, and the instrument used for emission reductions. Econometric estimates show that leakage could range from around 5 percent to 30 percent.¹⁷ In any case, leakage can potentially be quite an important obstacle for international environmental agreements and it would certainly pay regime theory to give more attention to the ways in which the benefits of international environmental cooperation can leak away.

One problem is how to distinguish leakage that is due to price effects and shifts in comparative advantage from free-riding proper. Another problem is that leakage is very hard to avoid. Peter Bohm suggests that participating countries could purchase or lease fossil fuel deposits in order to neutralize the price effects from lower demand, but this suggestion seems to be utterly unrealistic.¹⁸ Another theoretical possibility is to restrict imports of carbon-intensive goods from non-participating countries. As this would affect a wide range of goods, it would almost certainly clash with international trade regimes such as the World Trade Organization, however, and it is therefore not likely to be employed.

On the other hand, the existence of substantial leakage can also induce the formation of international environmental agreements with a large number of participating countries. This is because, all other things being equal, the return from large-scale cooperation is higher if leakage is a substantial problem. These two countervailing effects of leakage can imply that two equilibria exist: one with few participating countries, and the other with very many participants.¹⁹

Strategic Incentives

More generally, regime theory could learn from the economic theory of international environmental cooperation about the strategic effects of certain measures that appear to promote cooperation, but might indeed very well reduce cooperation. To give an example: side-payments and joint implementation measures are often thought of as being beneficial for international cooperation as they induce non-participant countries to engage in some form of emission reduction

17. For an overview, see Smith 1998.

18. Bohm 1993.

19. See Botteon and Carraro 1997a.

as well. The model of Michael Hoel and Kerstin Schneider suggest, however, that the very existence of these measures can represent a very strong strategic incentive for potential participants to stay out of the agreement so that they have to be "bought into it" later on.²⁰ Perversely, these unintended strategic side-effects can more than compensate for any cooperation gains side-payments and joint implementation measures can bring about. Furthermore, the model of Franz Wirl, Claus Huber and I.O. Walker shows that due to strategic incentives in joint implementation, cheating on both sides can be pervasive and the emission reductions achieved via joint implementation can be largely faked rather than real.²¹

2. Learning from Regime Theory

Regime theory covers a wide range of approaches towards the study of international regimes.²² It would be impossible to provide a complete overview here.²³ Instead, I shall use a number of topics to illustrate how the economic theory of international environmental cooperation could learn from regime theory.

The first issue deals with the coordinating function of regimes. Many scholars of the economic theory of international environmental cooperation point out that their models are characterized by multiple equilibria that differ on how much cooperation is achieved, and who gains by how much relative to others.²⁴ On this they could learn from regime theory on how regimes create "bargaining forums"²⁵ to coordinate the selection of certain equilibria.²⁶ Without explicitly referring to the regime theory literature, Michele Botteon and Carraro acknowledge the beneficial role regimes can play in stating that "how to move from one equilibrium to the other is a matter of coordination, which demands for new international institutions."²⁷ Similarly, Engelbert J. Dockner and Ngo Van Long implicitly refer to regimes when they state that "our results suggest that there are good reasons for negotiators to meet and communicate even if no contracts can be expected to be signed" and that "presumably preplay ne-

20. Hoel and Schneider 1997.

21. Wirl, Huber and Walker 1998.

22. Regimes should be understood here as "implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area of international relations." See Krasner 1983, 2.

23. See Haggard and Simmons 1987; and Hasenclever, Mayer and Rittberger 1996 for an overview of regime theory in general. For special reference to environmental regimes, see Young and von Moltke 1994 and Young 1998.

24. See, for example, Mäler 1991, 84f; Dockner and Long 1993, 15; Hoel and Schneider, 155; and Botteon and Carraro 1997a, 17. This point is also observed by regime theorists who employ game theory in their analysis. See, for example, Niou and Ordeshook 1994, 220; and Kydd and Snidal 1995.

25. Levy, Keohane and Haas 1993, 40.

26. Compare Morrow 1994. At least some economists seem to recognize this function of regimes at last See Ecchia and Mariotti 1998.

27. Botteon and Carraro 1997a, 17.

gotiations would lead to the choice of the most efficient strategy pair."²⁸ "Cheap talk," often denounced by economists as irrelevant because of its non-binding character,²⁹ becomes important once the existence of multiple equilibria and the necessity of a device for equilibrium selection is fully acknowledged. However, the presumption that the most efficient strategy pair will be chosen might well be wrong. The economic theory of international environmental cooperation could learn from regime theory that countries very often pay overwhelming attention to clearly perceivable distributional issues and are only a little concerned about the rather abstract notion of Pareto-efficiency that dominates economic reasoning.³⁰ Most of the relevant literature of the economic theory of international environmental cooperation implicitly assumes that international environmental agreements will end up on the Pareto-efficient contract curve. Regime theory in general does not share this misguided assumption.

The selection among different equilibria resembles a coordination game for which many of the traditional findings from the simple Prisoner's Dilemma literature are not valid anymore. As distributional issues come to the forefront, a long shadow of the future can have a detrimental rather than a beneficial effect on cooperation as it pays to hold out longer in the hope of reaching a distributionally more favorable equilibrium.³¹ The economic theory of international environmental cooperation could learn from regime theory to take into account the fact that countries are concerned about relative in addition to absolute gains and losses.³² Economics, with its preoccupation with efficiency, has not paid enough attention to relative distributional issues and has to catch up in this respect. A state might refuse to cooperate if it expects that its partners will gain relatively more from cooperation. What Joseph M. Grieco calls "state positionality"³³ plays more of a role in security matters than in environmental issues, but a good case can be made that states also pay attention to relative gains and losses as they concern natural resource exploitation and the costs of emission abatement.³⁴ Duncan Snidal has shown that if the number of states involved is large, relative gains maximization will not constrain the scope for cooperation to a great extent.³⁵ Nevertheless, it would pay economists to take state positionality into account in model building and examine how robust the results are. Similarly, economists have to pay more attention to how power in international relations determines who is allowed to play the game, who gets to

28. Dockner and Long 1993, 15 and 24. Characteristically for many contributions from the economic theory of international environmental cooperation, the papers by Botteon and Carraro and by Dockner and Long do not contain a single reference to the regime theory literature.

29. Which is exactly the reason why it is called "cheap."

30. Young 1989, 368f.

31. See Snidal 1985, 936; and Fearon 1998.

32. Compare Grieco 1988.

33. *Ibid.*, 499.

34. List and Rittberger 1992, 93f.

35. Snidal 1991a, 1991b.

move when, and how power can be used to change the payoff matrix of the game.³⁶

More generally, the economic theory of international environmental cooperation could learn from the institutionally rich analysis of regime theory on the various functions regimes provide and how they foster international cooperation. Economists could profit from a better understanding of how regimes can enlarge the shadow of the future in making interaction more durable and more frequent³⁷ and how earlier mutually advantageous experience with regimes induces prospective partners to be more cooperative in the building of new regimes—an aspect that Keohane circumscribes as the reputational aspect of regimes.³⁸ The analysis of the economic theory of international environmental cooperation would be enriched by a recognition of how regimes provide ongoing negotiating processes that reduce transaction costs³⁹ and how they help to make transfers and linkages by clustering issues.⁴⁰ The same holds true for a recognition of how regimes provide monitoring and verification services⁴¹ as well as implementation review mechanisms.⁴² It can learn from regime theory how important regimes can be in strengthening the domestic capacity of weak governments to comply with an agreement via a transfer of technical assistance and general aid.⁴³

The economic theory of international environmental cooperation could also benefit from a better understanding of how important a participatory approach towards international agreement making and procedurally fair rules are for bringing about cooperation. For example, substantially the same bargaining outcome that is accepted by a party if it feels sufficiently involved in the bargaining process can be rejected if the party feels that it has been treated unjustly.⁴⁴ The importance of procedural fairness holds especially true when participants, as David Lewis Feldman observes, “do not bargain from pre-established positions, but, in many cases, enter into negotiations precisely to learn more about a problem.”⁴⁵ An understanding of this aspect will also allow the economic theory of international environmental cooperation to comprehend why at times individual leadership in negotiations, and an exogenous crisis or shock, such as a nuclear power accident or satellite pictures showing a hole in the ozone layer, are important in bringing about international cooperation.⁴⁶ Connected to this,

36. Compare Krasner 1991.

37. Axelrod 1984, 129.

38. Keohane 1984, 94.

39. This beneficial aspect has to be balanced against the fact that an ongoing negotiation process often lets a considerable amount of time pass by before the environmental problem is eventually tackled. See Susskind 1994, chapter 1.

40. Milner 1992.

41. Levy, Keohane and Haas 1993, 402f.

42. Young and Demko 1996, 233.

43. Levy, Keohane and Haas 1993, 405.

44. Young and Demko 1996, 232 and 238f.

45. Feldman 1991, 379.

46. Young and Osherenko 1995, 230ff.

the economic theory of international environmental cooperation could learn from the weak cognitivist or epistemic community branch of regime theory how important a consensus community of scientists can be for bringing about negotiations and shaping state actors' interests⁴⁷ and how regimes help states to re-evaluate their interests.⁴⁸ How international networks of scientists can serve as catalysts and facilitators for regime formation has mostly been ignored by the economic theory of international environmental cooperation.

The finding from Young and Gail Osherenko that states tend to agree on uncomplicated formulas and across-the-board or equal relative emission cuts, even if efficiency is sacrificed, could teach economists that complicated formulas for the allocation of the burden of abatement such as those in the models of Parkash Chander and Henry Tulkens, that can theoretically achieve efficiency, are hopelessly unrealistic and would never be agreed upon in real negotiations.⁴⁹ As originally pointed out by Thomas C. Schelling, states look for "focal points" or "salient solutions" in international bargaining, not for highly complex formulas.⁵⁰ Some initial steps in building more realistic models have already been undertaken. The models of Alfred Endres and Michael Finus and Finus and Bianca Rundshagen explicitly assume that players agree on uniform solutions for all participants in a game of incomplete information.⁵¹ They rationalize this assumption in suggesting that uniform solutions appear to be "fair" to all participants and have low transaction costs, while an agreement on differentiated solutions would take more time. Also, the models assume that negotiating partners agree on the "smallest common denominator" solution at the end of the bargaining process. This is because no country can be forced to sign the agreement, hence the uniform solution cannot go beyond what the "bottleneck country" is willing to do.⁵² Both assumptions are frequently observed characteristics of international environmental agreements and represent an important step towards making the economic theory of international environmental cooperation conform more with the reality of international bargaining on environmental issues.

The already mentioned study by Murdoch and Sandler⁵³ provide one concrete example of how regime theory might contest some of the empirical evidence that proponents of the economic theory of international environmental cooperation invoke in support of their propositions. From a regime theoretic perspective, this study suffers from at least two major shortcomings: first, even if the reductions agreed upon in the Montreal Protocol correspond with what

47. Young and Osherenko 1995, 237; and Mayer, Rittberger and Zürn 1995, 415. See, for example, Haas 1989, 1990a, 1990b, 1992a, 1992b, 1995.

48. Levy, Keohane and Haas 1993, 398.

49. Young and Osherenko 1995, 233; and Chander and Tulkens 1995, 1997.

50. Schelling 1960.

51. Endres and Finus 1998; and Finus and Rundshagen 1998b.

52. It is assumed that transfer payments are not feasible.

53. Murdoch and Sandler 1997. I am grateful to an anonymous referee for drawing my attention to this example.

Murdoch and Sandler predict as a Nash equilibrium, it might be misleading to call these “voluntary” as they might have been undertaken in anticipation of the restraints an international environmental agreement such as the Montreal Protocol would impose on nation-states. Thus, Murdoch and Sandler are likely to underestimate the importance of international negotiations for bringing about these emission reductions. Second, and connected to the last point, it seems inappropriate to only look at the Montreal Protocol without looking at its various amendments that made emission reduction obligations more stringent. Even if the Montreal Protocol can be interpreted as codifying emission reductions that nation-states would have undertaken anyway, it is much more doubtful whether the same could be said of the increasingly stringent amendments to the Protocol.

Another example is the similar finding in the already mentioned study by Murdoch, Sandler and Sargent on the Helsinki and Sofia Protocols.⁵⁴ If international environmental cooperation is not particularly deep here, this might have much more to do with the fact that it brought together countries with hugely different value systems at or shortly after the height of East-West tensions rather than with the problems related to the agreements being self-enforcing and renegotiation-proof. Given these differing value systems, both Protocols might therefore be interpreted as a very successful example of regime formation in the face of enormous obstacles to negotiation, rather than as evidence that the requirements to be self-enforcing and renegotiation-proof will invariably prevent international environmental cooperation from becoming deep.

3. Achieving Wide and Deep Cooperation: Prospects for Mutual Learning Opportunities

So far I have tried to demonstrate how one school of thought can learn from the findings of the other. In this section, I shall present several examples of how regime theory and the economic theory of international environmental cooperation could fruitfully learn from each other. All the topics that I refer to here are part of ongoing projects by either regime theory or the economic theory of international environmental cooperation. However, it is the aim of this section to show how both streams of research might gain from cross-fertilization.

Compliance

One such example is the question of why states comply with international agreements and what this implies for the problem of free-riding. Abram Chayes and Antonia Handler Chayes have tried to show that non-compliance with the requirements of an agreement is the exception rather than the rule in the prac-

54. Murdoch, Sandler and Sargent 1997.

tice of international relations.⁵⁵ If non-compliance occurs, it is often due to insufficient managerial capacity, rather than a deliberate decision to free-ride on others' efforts. Chayes and Chayes conclude from their findings that the "free rider problem has been overestimated."⁵⁶ This conclusion is highly contested, however. George W. Downs, David M. Rocke and Peter N. Barsoom have argued that the marginality of non-compliance is due to "the fact that most treaties require states to make only modest departures from what they would have done in the absence of an agreement."⁵⁷ The economic theory of international environmental cooperation strongly supports their argument. From that perspective, free-riding is a great problem as it is the impotence to deter free-riding on a large scale that limits the gains to be achieved from cooperation. Once the agreement has been reached, free-riding is no longer a major problem, but if free-riding had not been such a major problem in the first instance, another agreement with much deeper cooperation could have been reached. Indeed, because, implicitly and in effect, external free-riding is an extreme version of non-compliance, once free-riding has been deterred, non-compliance is no longer of concern.⁵⁸ Thus, the conclusion by Chayes and Chayes does not follow from their findings if one takes the stage of agreement making into account as well. On the other hand, the economic theory of international environmental cooperation could learn from regime theory that sometimes perfect compliance by "weak" governments is not even the outcome that "strong" governments expect. As Levy, Keohane and Haas observe, regime standards are often set higher than many countries with weak environmental preferences either want to comply with or countries with weak administrative capacity can comply with.⁵⁹ This is because high regime standards serve other functions as well, such as generating political concern in "weak countries" and setting normative goals for them, communicating the intensity of preferences among regime members, and legitimating technical aid or outright transfer payments that might otherwise be denounced as bribes or blackmail.

Unilateral Action

As another example for mutual learning opportunities, consider the issue of unilateral emission abatement by one country. Game theoretic models of Hoel and of Endres and Finus show how unilateral emission abatement by one country can be detrimental to the environment because it can lower the abatement incentives of other countries in a potential future agreement.⁶⁰ This result holds

55. Chayes and Chayes 1995.

56. *Ibid.*, 19f.

57. Downs, Rocke, and Barsoom 1996, 380.

58. See Barrett 1998a, 328f.; 1998b, 36.

59. Levy, Keohane, and Haas 1993, 404.

60. Hoel 1991; and Endres and Finus 1998.

true only under certain restrictive assumptions, however. For example, countries are supposed to know exactly what their payoffs are, and to maximize their own payoffs with the exception of the unilaterally acting country. Regime theory could learn from the economic theory of international environmental cooperation how important it is to trace the perverse strategic effects that a well-intended action can have under certain conditions. At the same time, the economic theory of international environmental cooperation could learn from regime theory that these very same conditions that give rise to their model results need not hold in reality. In real-world international bargaining, countries do not know their exact payoffs and unilateral action by one country can be regarded by potential participants to an agreement as a constructive, confidence-building step towards regime building. Unilateral action can help overcome a deadlock in negotiations by pushing ahead and demonstrating that a country is credibly committed to cooperation and, possibly, also by proving to potential partners to an agreement that emission abatement is less expensive than commonly believed.

Rules, Norms, and Conventions

Maybe the highest return from mutual learning is likely to stem from exploring how wide and deep cooperation in international environmental affairs can be achieved. This is the fundamental question that has to be tackled. There is no convincing answer yet, but there are some attempts to show how the problems related to self-enforcing and renegotiation-proof agreements can, at least, be mitigated.

Schmidt, for example, proposes that the deposition of securities at third parties—for example, at international institutions—or the exchange of “hostages” could increase the credibility of countries making threats. The idea is that these deposits or hostages are automatically lost if countries do not execute their threat to punish free-riders. In principle, threats that were not credible before can be made credible with such a device if the deposit or hostage is appropriately specified. The problem with this proposal, however, is that the deposit or the exchange of hostages is itself not renegotiation-proof. A country that stands to lose its deposit could always engage in negotiations with the agency holding the deposit to strike another deal and avoid the loss. Equally, countries can always engage in negotiations with each other to get their hostages back.⁶¹

Another attempt derives from the idea that behavior is not fully determined by utility maximization; it is also governed by rules and norms. Hoel and Schneider show in a game theoretic model how deeper cooperation is possible if countries are inhibited from free-riding excessively because they follow the social norm and convention that free-riding is undesirable.⁶²

61. Schmidt 1998, 22.

62. Hoel and Schneider 1997.

Yet another attempt sticks to the assumption of utility maximization, but includes more items in the utility function than usual. Carsten Schmidt, for example, uses the idea that countries might refrain from free-riding for fear of being blamed as opportunistic. In other words, the reputation of being regarded as a responsible member of the international community of nation-states represents an important factor in the utility function of state actors.⁶³ But where do these norms and conventions come from and why do states not simply break them if they run counter to their own selfish interests, as realism would have it?⁶⁴ Why do countries not want to be blamed as opportunistic? Here, regime theory can provide initial steps for a better understanding. Both Snidal and Litfin argue that once international regimes have come into existence, they gain, to some extent, an independent life on their own.⁶⁵ They change actors' expectations, they change the rules of the game, they make actors' decisions transparent, they initiate further steps and push issues forward—in short, they start to constrain state behaviour. After the establishment of regimes, the states that created the regime are no longer free to do as they please.⁶⁶ States get accustomed to cooperation, and successful interaction in one regime makes the establishing of the next one more likely. The strong cognitivist branch of regime theory, as it is called by Andreas Hasenclever, Peter Mayer and Volker Rittberger,⁶⁷ even argues that successful regime building induces the participating states to develop a collective identity that helps them to sustain cooperation even in situations where one or the other state would otherwise defect.⁶⁸ But we need to better understand how these transformations come about and why sovereign nation-states are willing to agree in the first instance on mechanisms that constrain their very sovereignty later on. Therein lies the real challenge to both regime theory and the economic theory of international environmental cooperation individually and to both of them together.

Because states, to some extent, pay attention to fairness, that provides another promising way to mitigate the negative impact that the requirements of being self-enforcing and renegotiation-proof have on the scope and depth of cooperation. Fairness here means two things. First, players behave cooperatively if others behave cooperatively, even if, strictly speaking, it is in their selfish interest to free ride on others' cooperation. This aspect means that the problem of free-riding is less pronounced than if states were not concerned with fairness. Second, players are willing to punish defectors, even if, strictly speaking, it is in their selfish interest to refrain from punishment. This aspect means that free-

63. Schmidt 1998, 32.

64. Compare Bernauer 1995, 354.

65. Snidal 1996, 127; and Litfin 1997, 181f.

66. The Montreal Protocol, for example, has a clause that allows a tightening of the agreement if it is approved by an overall two-third majority and a simple majority of both developed and developing countries. The international whaling commission provides a similar example with its combination of majority voting and the allowance for countries to object to certain decisions.

67. Hasenclever, Mayer and Rittberger 1996.

68. See, for example, Wendt 1992, 417; 1994, 388–391.

riding can be deterred to a greater extent, as punishment can be more severe than dictated by the selfish interest of the punisher. Certainly, considerations of fairness encounter limits. If the incentives to free ride become overwhelming, then players defect even if the others maintain cooperation. Similarly, if the harm inflicted upon oneself due to punishing a defector becomes too severe, the potential punisher has to let the defector get away without punishment. But if considerations of fairness play some role in international bargaining, then deeper cooperation becomes possible. This is confirmed by a model of Tim Jeppesen and Per Andersen, who use the pioneering work by Matthew Rabin.⁶⁹ The challenge is to better understand why and to what extent states take considerations of fairness into account and what factors promote these considerations, as well as what factors lead to their disregard.

Issue Linkage

Another mechanism to promote cooperation—and one that has long been recognized—is issue linkage.⁷⁰ Issue linkage strengthens the incentives for mutual cooperation by linking games with an asymmetric payoff structure.⁷¹ Issue linkage functions best if one set of players has a strong interest in cooperation in one issue, but not in another one, whereas another set of players has the opposite preference structure. Hence, in order to promote cooperation, issue linkage depends on countries being asymmetric in their preferences and, in some sense, the more asymmetric countries are, the better are the prospects for issue linkage. The aspect just considered looks at issue linkage as a means to transform mutual cooperation into the common interest of all players—something that is often already implicitly assumed in regarding the problem of international environmental cooperation as a Prisoner's Dilemma.⁷²

But issue linkage can also be used if the underlying game is a Prisoner's Dilemma right from the start, and it can mitigate the problems related to being self-enforcing and renegotiation-proof for this game. Barrett shows how linking an international environmental agreement with trade can promote cooperation.⁷³ Trade sanctions are a more credible threat to deter free-riding than an increase in emissions because, according to Barrett, trade sanctions mainly harm the free-rider, whereas the emission increase considerably harms the punisher as well.⁷⁴ Hence, with trade sanctions, free-riding can be deterred more effec-

69. Jeppesen and Andersen 1998; and Rabin 1993.

70. The pioneering contributions are Tollison and Willett 1979; Haas 1980; and Sebenius 1983.

71. See Folmer et al. 1993, 315. Cesar and de Zeeuw 1996 show how full cooperation can be achieved via issue linkage even with the requirement to be renegotiation-proof.

72. Another mechanism to make mutual cooperation the interest of all affected parties is outright transfer payments. The record of international environmental agreements seems to suggest, however, that countries prefer issue linkage to transfer payments.

73. Barrett 1997b. For an excellent discussion of economic instruments for sustaining international environmental regimes more generally, see Heister et al. 1997.

74. A necessary condition is, however, that the trade sanctions are executed by a certain minimum number of countries and not just by one country alone. See Barrett 1997b, 347. Indeed, cooper-

tively as a more substantial punishment becomes credible, so wider and deeper cooperation can be achieved as a self-enforcing and renegotiation-proof equilibrium.⁷⁵ A similar mechanism is employed in the models in Carraro and Domenico Siniscalco and Botteon and Carraro.⁷⁶ International environmental cooperation is linked to joint efforts into research and development. The idea is that in contrast to emission abatement which benefits potential free-riders as well, research and development can be considered a club good which benefits the participants of an agreement only. Hence potential free-riders have an incentive to join the agreement if the gains from joint research and development exceed the gains from free-riding on the other countries' emission abatement.

These arguments seem to suggest that issue linkage is a very promising means to promote international environmental cooperation. One must not disregard the many problematic aspects of issue linkage, however. Indeed, the early contributions from regime theory, while praising issue linkage as a means to foster cooperation, have at the same time stressed the problems of linkage. Robert D. Tollison and Thomas D. Willett, for example, emphasize the increase in transaction costs that can result from issue linkage.⁷⁷ James K. Sebenius' influential and insightful discussion of issue linkage points out that issue linkage can make mutual cooperation less, rather than more, likely if divisive issues are linked and a joint settlement is required.⁷⁸

As concerns the employment of trade sanctions to bring about international environmental cooperation, all depends on one's implicit view of the benefits from trade. Many proponents of trade liberalization would object to the suggestion, implicit in Barrett's analysis, that trade sanctions do not harm the sanctioning party to a great extent. Indeed, they would object to the very idea that trade liberalization is a Prisoner's Dilemma where all gain from mutual liberalization, but every player gains even more if only the other players open their markets for trade. Many liberal international economists would instead maintain that it is always in a country's best interest to open its market no matter what other countries do.⁷⁹ If this view on trade liberalization is correct, however, then trade sanctions are not necessarily a credible threat to deter free-riding and cannot promote cooperation to a large extent. The challenge is to find specific trade areas for which sanctions hurt the free-riding countries substantially more than the cooperating countries. Also, if trade sanctions are actually executed against free-riders, then there is the risk that these countries might retaliate in imposing sanctions as well, and that cooperation in other issue areas might collapse.

Another problem with international environmental agreements employ-

ating countries that fail to execute trade sanctions against free-riders might themselves face trade sanctions.

75. Sanctions are cheaper than transfer payments as they do not impose any costs as long as the deterrence of free-riding is successful.

76. Carraro and Siniscalco 1995, 1997; and Botteon and Carraro 1997b.

77. Tollison and Willett 1979.

78. Sebenius 1983.

79. See, for example, Bhagwati and Hudec 1996.

ing trade sanctions is that they can potentially clash with existing, and quite powerful, international trading regimes such as the World Trade Organization (WTO). The Montreal Protocol on the banning of ozone-depleting substances is the major agreement so far that has included the threat of trade sanctions, both against the substances themselves, as well as against goods produced with the help of these substances.⁸⁰ Participation in the Protocol is by now almost universal and trade sanctions were never actually employed, which might partly explain why no member to the WTO has ever challenged the trade clauses in the Protocol. There seems to be a consensus among scholars, however, that the Protocol's trade incentives have been very important.⁸¹ But major doubts remain as to whether the Protocol is compatible with the obligations under the WTO regime.⁸² The same holds potentially true for future agreements. How future international environmental agreements that employ trade sanctions to deter free-riding can be made compatible with the WTO and other trade regimes is a major topic for fruitful research.⁸³

As international environmental cooperation is linked to joint research and development efforts, problems arise if there are diminishing returns to these efforts, because then it can be optimal to exclude some countries from the linked agreement even though they should be participants to the agreement based on the environmental perspective alone. In some sense, this is the opposite problem to free-riding and it can damage rather than promote environmental cooperation under certain conditions.⁸⁴ A more fundamental problem with this form of linkage is that it remains unclear why countries have not long since realized the mutual gains from joint research and development efforts independent of the problem of international environmental cooperation. In other words, why do countries wait until the free-riding problems in an international environmental agreement necessitate linkage in order to reap the excludable benefits from joint research and development?

All the mentioned problems of issue linkage notwithstanding, it could form a major object for common research using both regime theory and the economic theory of international environmental cooperation. The question is how the problems of linkage can be reduced and how linkage can be employed such that it best promotes international environmental cooperation. In this respect, Stephan Kroll, Charles F. Mason and Jason F. Shogren have provided an interesting finding that deserves further attention.⁸⁵ In laboratory experiments, they have studied the question of whether issue linkage is likely to promote cooperation more if the linkage is implicit (two games played simultaneously in a

80. Other agreements with major trade implications are the Convention on International Trade in Endangered Species of Wild Fauna and Flores, and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

81. See, for example, French 1994, 62; Brack 1996, 55; Barrett 1997b, 346; and OECD 1999, 4.

82. See Brack 1996; and OECD 1999

83. See Neumayer 2000.

84. See Carraro and Siniscalco 1998, 567; and Botteon and Carraro 1997b.

85. Kroll, Mason and Shogren 1998.

parallel institutional framework) or explicit (a linked game played in a joint institutional framework). They have found that the participants in their experiments were much more likely to cooperate in the joint than in the parallel framework. It would be interesting to explore whether this finding is robust and whether it is relevant outside the laboratory as well. If so, then this finding would clearly call for explicitly linking issues in one single negotiation rather than holding parallel but separate negotiations at the same time—under the condition that transaction costs are not substantially higher for explicit issue linkage.

Conclusion

This paper has tried to show that both regime theory and the economic theory of international environmental cooperation have a lot to gain from reciprocal learning. Regime theorists first coined the metaphor of “cooperation under anarchy,” but regime theory can learn from the economic theory of international environmental cooperation about the adverse consequences for cooperation that follow from the requirements associated with international environmental agreements being self-enforcing and renegotiation-proof, as well as from emission leakage and “perverse” strategic incentives. The economic theory of international environmental cooperation, on the other hand, can benefit from a better understanding of the myriad roles regimes play in promoting cooperation and it can learn from the institutionally rich analysis of regime theory.

Learning from the other school of thought is important, but it is merely a first step and it is somewhat one-sided. Examples were provided where the two can fruitfully learn from each other; for example, the consequences of unilateral action on international cooperation, why nation-states comply with international agreements, and what this implies for the problem of free-riding. The most interesting question, however, is one that each school of thought has long since examined on its own: how can cooperation in international environmental affairs become wider and deeper? The focus should be on two things: first, on the role regimes play in developing social norms, conventions and considerations of fairness that limit free-riding, and second, on the role of issue linkage, especially with respect to trade sanctions.

The question is, of course, whether mutual learning is possible at all, and whether it would diminish the relative strengths of both regime theory and the economic theory of international environmental cooperation. For example, would the inclusion of some of the insights from regime theory not diminish the elegance and explanatory power of the models employed within the economic theory of international environmental cooperation? Admittedly, this is a possibility that cannot be dismissed offhand. It is beyond the scope of this paper to explore the limits of mutual learning opportunities here. However, in principle, I can see no reason why mutual learning would be impossible or counter-productive. After all, as mentioned, some economists like Endres, Finus

and Rundshagen have already successfully integrated insights from regime theory about the prevalence of fairness considerations and uniform solutions into their model building. Conversely, scholars of regime theory who have employed game theory in examining what influence free-rider incentives, punishment costs and insider-outsider dynamics have on the emergence and effectiveness of regimes have certainly advanced regime theory. To make my point clear, this paper has stressed and possibly at times even over-emphasized the differences between the economic theory of international environmental cooperation and regime theory. To some extent at least, the two schools of thought are at times not quite as far apart in their methodological and conceptual framework as might have been suggested here. However, it remains true that even in these cases explicit notice of the other school of thought is rarely taken.

Because of space restrictions, this paper could only sketch some of the major findings from both schools and outline the topics for which the mutual learning opportunities are greatest. All these topics have long since been examined by each school separately, and in this respect this paper has not proposed any new topic for studying. I hope, however, that this exploration has convinced readers that if scholars from both schools of thought took more notice of each other and aspired to learn from each other's findings, this would lead to more comprehensive analyses and better understanding. With these come better policy advice for policy-makers tackling international environmental problems.

References

- Axelrod, Robert M. 1984. *The Evolution of Cooperation*. New York: Basic Books.
- Barrett, Scott. 1990. The Problem of Global Environmental Protection. *Oxford Review of Economic Policy* 6 (1): 68–79.
- _____. 1991. Economic Analysis of International Environmental Agreements: Lessons for a Global Warming Treaty. In *Responding to Climate Change: Selected Economic Issues*, 109–149. Paris: OECD.
- _____. 1994a. Self-enforcing International Environmental Agreements. *Oxford Economic Papers* 46 (5): 878–894.
- _____. 1994b. The Biodiversity Supergame. *Environmental and Resource Economics* 4 (1): 111–122.
- _____. 1997a. Heterogeneous International Environmental Agreements. In *International Environmental Negotiations: Strategic Policy Issues*, edited by Carlo Carraro, 9–25. Cheltenham: Edward Elgar.
- _____. 1997b. The Strategy of Trade Sanctions in International Environmental Agreements. *Resource and Energy Economics* 19 (4): 345–361.
- _____. 1998a. On the Theory and Diplomacy of Environmental Treaty-Making. *Environmental and Resource Economics* 11 (3–4): 317–333.
- _____. 1998b. Political Economy of the Kyoto Protocol. *Oxford Review of Economic Policy* 14 (4): 20–39.
- _____. 1999. A Theory of Full International Cooperation. *Journal of Theoretical Politics* 11 (4): 519–541.

- Batabyal, Amitrajeet A. 1996. An Agenda for the Design and Study of International Environmental Agreements. *Ecological Economics* 19 (1): 3–9.
- Bernauer, Thomas. 1995. The Effect of International Environmental Institutions: How We Might Learn More. *International Organization* 49 (2): 351–377.
- Black, Jane, Maurice D. Levi, and David de Meza. 1993. Creating a Good Atmosphere: Minimum Participation for Tackling the “Greenhouse Effect.” *Economica* 60 (239): 281–293.
- Bhagwati, Jagdish N., and R.E. Hudec, eds. 1996. *Fair Trade and Harmonization: Prerequisites for Free Trade?* Cambridge, Mass.: MIT Press.
- Bohm, Peter. 1993. Incomplete International Cooperation to Reduce CO₂ Emissions: Alternative Policies. *Journal of Environmental Economics and Management* 24 (3): 258–271.
- Botteon, Michele, and Carlo Carraro. 1997a. Environmental Coalitions with Heterogeneous Countries: Burden-Sharing and Carbon Leakage. FEEM Working Paper. Milano: Fondazione Eni Enrico Mattei.
- . 1997b. International Environmental Negotiations and Coalition Stability in Environmental Negotiations with Asymmetric Countries. In *International Environmental Negotiations: Strategic Policy Issues*, edited by Carlo Carraro, 26–55. Cheltenham: Edward Elgar.
- Brack, Duncan. 1996. *International Trade and the Montreal Protocol*. London: Royal Institute of International Affairs.
- Carraro, Carlo. 1997. The Structure of International Environmental Agreements, FEEM Working Paper. Milano: Fondazione Eni Enrico Mattei.
- Carraro, Carlo and Domenico Siniscalco. 1995. Policy Coordination for Sustainability: Commitments, Transfers, and Linked Negotiations. In *Economics of Sustainable Growth*, edited by Ian Goldin and Alan Winters, 264–288. Cambridge: Cambridge University Press.
- . 1993. Strategies for the International Protection of the Environment. *Journal of Public Economics* 52 (3): 309–328.
- Cesar, Herman, and Aart de Zeeuw. 1996. Issue Linkage in Global Environmental Problems. In *Economic Policy for the Environment and Natural Resources*, edited by Anastasios Xepapadeas, 158–173. Cheltenham: Edward Elgar.
- Chander, Parkash, and Henry Tulkens. 1995. A Core-Theoretic Solution for the Design of Cooperative Agreements on Transfrontier Pollution. *International Tax and Public Finance* 2 (2): 279–293.
- . 1997. The Core of an Economy with Multilateral Environmental Externalities. *International Journal of Game Theory* 26 (3): 379–401.
- Chayes, Abram, and Antonia Handler Chayes. 1995. *The New Sovereignty: Compliance with International Regulatory Agreements*. Cambridge, Mass.: Harvard University Press.
- Dockner, Engelbert J. and Long, Ngo Van. 1993. International Pollution Control: Cooperative Versus Noncooperative Strategies. *Journal of Environmental Economics and Management* 25 (1): 13–29.
- Downs, George W., David M. Rocke and Peter N. Barsoom. 1996. Is the Good News about Compliance Good News about Cooperation? *International Organization* 50 (3): 379–406.
- Ecchia, Giulio, and Marco Mariotti. 1998. Coalition Formation in International Environmental Agreements and the Role of Institutions. *European Economic Review* 42 (3–5): 573–582.

- Endres, Alfred, and Michael Finus. 1998. Renegotiation-Proof Equilibria in a Bargaining Game Over Global Emission Reductions: Does the Instrumental Framework Matter? In *Game Theory and the Environment*, edited by Nick Hanley and Henk Folmer, 135-164. Cheltenham: Edward Elgar.
- Evans, Peter B., Harold K. Jacobson, and Robert D. Putnam, eds. 1993. *Double-Edged Diplomacy: International Bargaining and Domestic Politics*. Berkeley: University of California Press.
- Fearon, James D. 1998. Bargaining, Enforcement, and International Cooperation. *International Organization* 52 (2): 269-305.
- Feldman, David Lewis. 1991. International Decision Making for Global Climate Change. *Society and Natural Resources* 4 (4): 379-396.
- Finus, Michael, and Bianca Rundshagen. 1998. Renegotiation-Proof Equilibria in a Global Emission Game when Players are Impatient. *Environmental and Resource Economics* 12 (3): 275-306.
- . 1998. Toward a Positive Theory of Coalition Formation and Endogenous Instrumental Choice in Global Pollution Control. *Public Choice* 96 (1-2): 145-186.
- Folmer, Henk, Pierre v. Mouche, and Shannon Ragland. 1993. Interconnected Games and International Environmental Problems. *Environmental and Resource Economics* 3 (4): 313-335.
- French, Hilary F. 1994. Making Environmental Treaties Work. *Scientific American* 271 (6): 62-65.
- Grieco, Joseph M. 1988. Anarchy and the Limits to Cooperation: A Realist Critique of the Newest Liberal Institutionalism. *International Organization* 42 (3): 485-507.
- Haggard, Stephan, and Beth A. Simmons. 1987. Theories of International Regimes. *International Organization* 41 (3): 491-517.
- Hasenclever, Andreas, Peter Mayer, and Volker Rittberger. 1996. Interests, Power, Knowledge: The Study of International Regimes. *Mershon International Studies Review* 40 (2): 177-228.
- Haufler, Virginia. 1995. Crossing the Boundary Between the Public and Private: International Regimes and Non-State Actors. In *Regime Theory and International Relations*, edited by Volker Rittberger and Peter Mayer, 94-111. Oxford: Clarendon Press.
- Heal, Geoffrey. 1994. Formation of International Environmental Agreements. In *Trade, Innovation, Environment*, edited by Carlo Carraro, 301-322. Dordrecht: Kluwer.
- Heister, Johannes, Ernst Mohr, Frank Stähler, Peter-Tobias Stoll, and Rüdiger Wolfrum. 1997. Strategies to Enforce Compliance with an International CO2 Treaty. *International Environmental Affairs* 9 (1): 22-53.
- Helm, Carsten. 1998. International Cooperation Behind the Veil of Uncertainty. *Environmental and Resource Economics* 12 (2): 185-201.
- Hoel, Michael. 1991. Global Environmental Problems: The Effects of Unilateral Actions Taken by One Country. *Journal of Environmental Economics and Management* 20 (1): 55-70.
- Hoel, Michael, and Kerstin Schneider. 1997. Incentives to Participate in an International Environmental Agreement. *Environmental and Resource Economics* 9 (2): 153-170.
- Jeppesen, Tim, and Per Andersen. 1998. Commitment and Fairness in Environmental Games. In *Game Theory and the Environment*, edited by Nick Hanley and Henk Folmer, 65-83. Cheltenham: Edward Elgar.
- Jervis, Robert. 1988. Realism, Game Theory, and Cooperation. *World Politics* 40 (3): 317-349.

- Krasner, Stephen D. 1983. Structural Causes and Regime Consequences: Regimes as Intervening Variables. In *International Regimes*, edited by Stephen D. Krasner, 1–21. Ithaca: Cornell University Press.
- . 1991. Global Communications and National Power: Life on the Pareto Frontier. *World Politics* 43 (3): 336–366.
- Kroll, Stephan, Charles F. Mason, and Jason F. Shogren. 1998. Environmental Conflicts and Interconnected Games: An Experimental Note on Institutional Design. In *Game Theory and the Environment*, edited by Nick Hanley and Henk Folmer, 204–218. Cheltenham: Edward Elgar.
- Kydd, Andrew, and Duncan Snidal. 1995. Progress in Game-Theoretical Analysis of International Regimes. In *Regime Theory and International Relations*, edited by Volker Rittberger and Peter Mayer, 112–135. Oxford: Clarendon Press.
- Levy, Marc A., Robert O. Keohane, and Peter M. Haas. 1993. Improving the Effectiveness of International Environmental Institutions. In *Institutions for the Earth: Sources of Effective International Environmental Protection*, edited by Peter M. Haas, Robert O. Keohane and Marc A. Levy, 397–426. Cambridge, MA: MIT Press.
- List, Martin, and Volker Rittberger. 1992. Regime Theory and International Environmental Management. In *The International Politics of the Environment*, edited by Andrew Hurrell and Benedict Kingsbury, 85–109. Oxford: Clarendon Press.
- Litfin, Karen T. 1997. Sovereignty in World Ecopolitics. *Mershon International Studies Review* 41 (S2): 167–204.
- Mäler, Karl-Göran. 1990. International Environmental Problems. *Oxford Review of Economic Policy* 6 (1): 80–108.
- McGinnis, Michael D., and John T. Williams. 1993. Policy Uncertainty in Two-Level Games: Examples of Correlated Equilibria. *International Studies Quarterly* 37 (1): 29–54.
- Meyer, John W., David John Frank, Ann Hironaka, Evan Schofer, and Nancy Brandon Tuma. 1997. The Structuring of a World Environmental Regime 1870–1990. *International Organization* 51 (4): 623–651.
- Milner, Helen. 1992. International Theories of Cooperation Among Nations. *World Politics* 44 (3): 466–496.
- Morrow, James D. 1994. Modeling the Forms of International Cooperation: Distribution Versus Information. *International Organization* 48 (3): 387–423.
- Murdoch, James C., and Todd Sandler. 1997. The Voluntary Provision of a Pure Public Good: The Case of Reduced CFC Emissions and the Montreal Protocol. *Journal of Public Economics* 63 (3): 331–349.
- Murdoch, James C., Todd Sandler, and Keith Sargent. 1997. A Tale of Two Collectives: Sulphur Versus Nitrogen Oxides Emission Reduction in Europe. *Economica* 64 (254): 281–301.
- Na, Seong-lin, and Hyun Song Shin. 1998. International Environmental Agreements Under Uncertainty. *Oxford Economic Papers* 50 (2): 173–185.
- Neumayer, Eric. 2000. *Investment, Trade and the Environment*. London: London School of Economics.
- Niou, Emerson M.S., and Peter C. Ordeshook. 1994. “Less Filling, Tastes Great”: The Realist-Neoliberal Debate. *World Politics* 46 (2): 209–234.
- OECD. 1999. Trade Measures in Multilateral Environmental Agreements: Synthesis Report of Three Case Studies. Joint Working Party on Trade and Environment, COM/ENV/TD(98)127/FINAL. Paris: OECD, available online at: <http://www.oecd.org/ech/docs/envi.htm>.

- Oye, Kenneth A., ed. 1985a. *Cooperation Under Anarchy*. Princeton: Princeton University Press.
- . 1985b. Explaining Cooperation Under Anarchy: Hypotheses and Strategies. In *Cooperation Under Anarchy*, edited by Kenneth A. Oye, 1-24. Princeton: Princeton University Press.
- Petrakis, Emmanuel, and Anastasios Xepapadeas. 1996. Environmental Consciousness and Moral Hazard in International Agreements to Protect the Environment. *Journal of Public Economics* 60 (1): 95–110.
- Porter, Gareth, and Janet Welsh Brown. 1991. *Global Environmental Politics*. Colorado: Westview Press.
- Putnam, Robert D. 1988. Diplomacy and Domestic Politics: The Logic of Two-Level Games. *International Organization* 42 (2): 427–460.
- Rabin, Matthew. 1993. Incorporating Fairness into Game Theory and Economics. *American Economic Review* 83 (5): 1281–1302.
- Raustiala, Kal. 1997a. Domestic Institutions and International Regulatory Cooperation: Comparative Responses to the Convention on Biological Diversity. *World Politics* 49 (4): 482–509.
- . 1997b. States, NGOs, and International Environmental Institutions. *International Studies Quarterly* 41 (4): 719–740.
- Roberts, J. Timmons. 1996. Predicting Participation in Environmental Treaties: A World-System Analysis. *Sociological Inquiry* 66 (1): 38–57.
- Schmidt, Carsten. 1998. Incentives for International Environmental Cooperation: Theoretic Models and Economic Instruments. Working Paper. Konstanz: University of Konstanz.
- Sebenius, James K. 1983. Negotiation Arithmetic: Adding and Subtracting Issues and Parties. *International Organization* 37 (2): 281–316.
- Smith, Clare. 1998. Carbon Leakage: An Empirical Assessment Using a Global Econometric Model. In *International Competitiveness and Environmental Policies*, edited by Jonathan Köhler, 143-165. Cheltenham: Edward Elgar.
- Snidal, Duncan. 1985. Coordination versus Prisoners' Dilemma: Implications for International Cooperation and Regimes. *American Political Science Review* 79 (4): 923–942.
- . 1991a. International Cooperation Among Relative Gains Maximizers. *International Studies Quarterly* 35 (3): 387–402.
- . 1991b. Relative Gains and the Pattern of International Cooperation. *American Political Science Review* 85 (3): 701–726.
- . 1996. Political Economy and International Institutions. *International Review of Law and Economics* 16 (1): 121–137.
- Sprinz, Detlef, and Tapani Vaahtoranta. 1994. The Interest-Based Explanation of International Environmental Policy. *International Organization* 48 (1): 77–105.
- Susskind, Lawrence E. 1994. *Environmental Diplomacy: Negotiating More Effective Global Agreements*. Oxford: Oxford University Press.
- Tollison, Robert D., and Thomas D. Willett. 1979. An Economic Theory of Mutually Advantageous Issue Linkages in International Negotiations. *International Organization* 33 (4): 425–449.
- Wendt, Alexander. 1992. Anarchy is What States Make of it: The Social Construction of Power Politics. *International Organization* 46 (2): 391–425.
- . 1994. Collective Identity Formation and the International State. *American Political Science Review* 88 (2): 384–396.

- Wirl, Franz, Claus Huber, and I.O. Walker. 1998. Joint Implementation: Strategic Reactions and Possible Remedies. *Environmental and Resource Economics* 12 (2): 203–224.
- Young, Oran R. 1989. The Politics of International Regime Formation: Managing Natural Resources and the Environment. *International Organization* 43 (3): 349–375.
- _____. 1994. *International Governance: Protecting the Environment in a Stateless Society*. Ithaca and London: Cornell University Press.
- _____. 1998. The Effectiveness of International Environmental Regimes—A Mid-Term Report. *International Environmental Affairs* 10 (4): 267–289.
- Young, Oran R., and Konrad von Moltke. 1994. The Consequences of International Environmental Regimes: Report from the Barcelona Workshop. *International Environmental Affairs* 6 (4): 348–370.
- Young, Oran R., and Gail Osherenko 1995. Testing Theories of Regime Formation: Findings from a Large Collaborative Research Project. In *Regime Theory and International Relations*, edited by Volker Rittberger and Peter Mayer, 223–251. Oxford: Clarendon Press.
- Young, Oran R., and George J. Demko. 1996. Improving the Effectiveness of International Environmental Governance Systems. In *Global Environmental Change and International Governance*, edited by Oran R. Young, George J. Demko and Kilaparti Ramakrishna, 229–246. Hanover and London: University Press of New England.