

Chapter 9: International Externalities, Treaties, and Institutions¹

I. Introduction

This chapter analyzes political aspects of negotiating and implementing treaties. Treaties are a peculiar type of agreement worked out between governments. To bind, they need to be “self-enforcing,” which is to say, abiding by the agreements has to be in the interest of each signatory to the treaty of interest. Some treaties may be regarded as cartel agreements to reduce competition for residents and capital that takes place among nations, just as they do between local governments within federal systems. Others address international externality problems in the manner of a Coasian contract. This chapter focuses for the most part on the latter. It uses environmental treaties to illustrate how such externalities might be dealt with (or might not). It also provides a bit of empirical evidence on the kinds of treaties most likely to be signed, the types of countries that are most likely to sign them, and the extent to which environmental treaties tend to affect environmental quality.

Although the literature that simultaneously addresses political and economic aspects of international environmental agreements is not very large, the problems addressed are very important, complex and multifaceted. The aim of the present chapter is to provide the reader with a sense of the main issues addressed, the strengths and weaknesses of the analyses, and the problems that remain.

A good deal of the economic work on international environmental problems assumes that the central problem is specifying policy instruments to address well understood environmental externality problems. Because of this, international environmental policy is generally approached as a fairly direct extension of work done on domestic policy. Many useful analytical points have been developed from such assumptions as evidenced in the present volume, especially by Schmidt in chapter 10. And, perhaps surprisingly, there is a sense in

¹ This chapter is based on the author’s previously published work: Congleton, R. D. (2001). Governing the global environmental commons: The political economy of international environmental treaties and institutions. In G. G. Schulze & H. W. Ursprung (Eds.), *International environmental economics: A survey of the issues* (pp. 241–263). Oxford University Press.

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which international environmental solutions will necessarily resemble domestic policies.

National sovereignty implies that any pattern of environmental policies agreed to in treaty documents have to be implemented via domestic legislation because no international body can impose laws on a sovereign government.

However, besides restricting the range of policy options, national sovereignty also implies that international environmental policy makers address political and institutional problems that can be ignored in ordinary domestic environmental legislation or regulation.

The literature reviewed in this chapter suggests that these problems largely determine the content and character of environmental treaties.

The point of departure for the literature reviewed in this chapter is that international environmental problems differ from domestic environmental problems because the *nature of the externality problem* confronted differs. Most domestic environmental legislation addresses problems that arise because self-interested firms and consumers have little reason to fully account for the broad environmental consequences of their production and consumption decisions. Most international environmental problems arise because *governments* have little reason to fully account for the broad international consequences of their domestic environmental regulations. International environmental treaties, thus, attempt to correct instances of *government failure* rather than market failure.

Remedies for international environmental problems attempt to coordinate the regulatory policies of independent governments, rather than to coordinate the economic behavior of private decision makers within a particular polity. The independence, or sovereignty, of the parties involved in international environmental problems implies that any policies adopted must be in the interest of each party involved.² It is for this reason that international

² See Black (1958, p.152) for an early public choice perspective on international treaties. Tollison and Willett (1979) model international agreements as a method of realizing mutual gains from exchange (or treaty terms) in a setting where national governments act as perfect agents for their respective citizenry. It would be more accurate to say that decisive members of national governments necessarily *expect to gain* from any treaties consummated. Baldwin (1989) discusses the GATT treaty as a device for internalizing externalities. Sykes (1991) provides a public choice based contractual explanation of the article xix of GATT, the so called escape clause. Buchanan and Tullock (1975),

environmental solutions necessarily resemble long term contracts--Coasian contracts between governments. This contrasts with domestic environmental policies where only agreement by pivotal members of a ruling coalition is required.

However, if solutions to international environmental problems are necessarily voluntary contracts, they are contracts that are very difficult to negotiate and implement. The same public goods aspects of domestic regulations that give rise to international externality problems in the first place largely remain after the agreements are negotiated insofar as no independent authority is available to assure that signatories own up to their contractual duties, Hoel (1991), Sandler (1996). Moreover, accommodating the domestic political interests of a multitude of national governments clearly has a large effect on the feasible content of the environmental treaties.

The literature reviewed in this chapter attempts to explain the observed pattern of environmental treaties. The chapter is organized as follows. Section II provides a brief history of environmental treaties signed during the last half of the twentieth century. Section III analyzes the political and economic content of the treaties that we should expect to see negotiated. It focuses on institutional and temporal aspects of negotiation which suggests that the content of treaties will be more institutionally oriented than economic analysis alone would imply. Section IV analyzes the pattern of signatories that we should expect to observe on those treaties negotiated, and reviews empirical evidence on the pattern of treaty signatures and emissions reductions to date. Section V summarizes the chapter and suggests extensions for future work.

II. Some Background Facts: A Digression on the Recent History of Environmental Treaties

The historical record of environmental regulation is very rich and extends well into antiquity. No society can long prosper if it ignores the importance of clean water and fresh air to public health. Rules to control access to common property resources, to regulate waste disposal and

and Maloney and McCormick (1982) develop the first rational choice based analyses of the politics of environmental regulation. Congleton (1996) includes a nice cross section of empirical and theoretical papers that analyze both international and domestic political aspects of environmental regulation.

assure potable supplies of water have been adopted by all enduring societies. Indeed, appreciation of the environment's role in health and aesthetics evidently coincides with the dawn of recorded history.³ A relatively modern example, written well after sunrise, is Aristotle's (330 B. C. / 1969 p. 278) description, in passing, of optimal policies concerning water and air quality in his characterization of the ideal community.

"I mention situation and water supply in particular because air and water, being just those things that we make most frequent and constant use of, have the greatest effect on our bodily condition. Hence in a state which has [the] welfare [of its citizens] at heart, water for human consumption should be separated from water for all other purposes."

Evidence of the environmental regulations adopted by the great and not so great civilizations of antiquity include, for example, aqueducts, centralized waste disposal sites and burial grounds. (It is perhaps striking that these ancient environmental policies provide one of the most important windows through which modern archeologists attempt to induce the greater sweep of long forgotten civilizations.)

The history of environmental treaties appears to be much shorter. I have not been able to find many instances that predate the twentieth century--although one imagines that there must have been formal and informal agreements about water rights along waterways shared by ancient cities.⁴ The lack of a clear record of international agreements predating modern times may reflect the subtlety of many international environmental problems, the difficulty of

³ Natural phenomena are of course central to the high cultures of both hunting and agricultural based societies. Such societies very often rely upon nature-based metaphors to make sense of the world at large, to address both practical and metaphysical questions. Even today, various forms of nature worship or pantheism are among the most common world religions, and increasingly central to western ideas about intergenerational duties and responsibilities. Environmental prerequisites to a comfortable and healthy life have long been practical matters at the core of personal health and economic prosperity.

⁴ Within polities, formal water rationing schemes and rules regarding effluents were evidently common in areas where irrigation was important for agriculture. Insofar as irrigation networks extended across the domains of independent sovereignties, or were fully within the autonomous powers of local governments, agreements similar to early international agreements presumably were worked out between the relevant decision making units.

negotiating and implementing agreements with neighboring empires, nations, or tribes--which are often engaged in various territorial disputes--or simply insufficient research on my part.

The modern record of environmental treaties begins late in the 19th century. The *United Nations Treaty Series* and the *U. S. Treaties and Other International Agreements* series catalogue international agreements on a variety of topics. International environmental and pollution treaties are separately indexed and document the evolution of treaty arrangements. According to these reference treaty series, most of the environmental treaties in force have been signed in the second half of the twentieth century.⁵ Table 1 lists all of the treaties on environmental matters ratified between 1969 and 1985 that are presently included in these two treaty series. Table 2 lists more recent multilateral environmental treaties. Table 2 does not attempt to include every treaty modification or minor extensions negotiated, but rather lists major treaties and protocols. The two tables report signatories, the date at which the treaties were completed (opened for signing), their focus, and the principal institutional and substantive action taken. "The pace of international environmental negotiations has greatly accelerated in the past thirty years.

All of the treaties prominently mention the anticipated mutuality of treaty benefits. However, most of the treaties devote relatively little space to articulating the terms of regulatory

⁵ For example, the 1909 Boundary Waters treaty between Great Britain (Canada) and the United States establishes an International Joint Commission of the United States and Canada which "shall have jurisdiction over and shall pass upon all cases involving the use or obstruction or diversion of the waters" within the described in the treaty. "No use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it." Water for domestic and sanitary purposes is given the highest precedence followed by uses for navigation, power and irrigation.

⁶ The data for the multilateral treaties are from treaty documents, *World Resources 1994-95* and the United Nation's web site: <http://www.unfccc.de/>. The modern historical record is consistent with the discussion of "treaties as contracts" perspective developed in the introduction. There have also been several multilateral agreements negotiated over this time period, not included in the treaty volumes available at this time. For example, the European Economic Community also promulgates environmental directives from time to time. For a discussion of the coordinating efforts of the EEC, see Smith and Kromarek (1989) or Ashworth and Papps (1991). Generally, the policies require member nations to "set up programs for handling, storing and eliminating waste in all forms (Smith and Kromarek, p.113)." S&K also note that these directives "are differently implemented by member countries (p. 113)."

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exchange or to specifying specific targets or regulations for addressing environmental hazards. It would doubtless surprise environmental economists to observe how few of the treaties mention effluent targets or specify time tables for addressing environmental concerns. Even those treaties that do directly address such issues devote relatively little of their text to characterizing policy solutions. (It certainly surprised me when I first began reading environmental treaties many years ago.)

The literature surveyed in this chapter attempts to explain why many of these features of international environmental treaties, contrary to the expectations engendered by much of the purely economic literature, should have been anticipated.

III. What Kinds of Treaties Do Nations Negotiate?

Four Phases of International Environmental Agreements

The process of addressing an international environmental problem begins with finding common interests in new environmental policies. It ends with the joint implementation of those policies agreed to. This often lengthy process normally passes through four stages of development. (i) The first stage entails the recognition of the possibility of mutual advantage. Without agreement that mutual gains can be realized there is no point to further negotiation. (ii) The second stage attempts to establish procedures by which alternative policy targets may be evaluated and chosen from. Without some process of collective decision making--especially in multilateral treaties--it will be difficult if not impossible to proceed to the third stage. (iii) In the third stage, negotiators attempt to agree on specific environmental targets that can solve or at least ameliorate the environmental problem of interest. (iv) Finally, after negotiators have agreed to effluent targets or specific regulations, each country must pass and enforce new domestic environmental legislation to meet its treaty obligations. It is only after this last entirely *domestic* stage that environmental improvements may be actually realized.

Congleton (1995) notes that after each of the first three stages of negotiation there is an environmental treaty that can be signed. Treaties negotiated during the first stage may be categorized as symbolic treaties. *Symbolic* treaties do not characterize environmental

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regulations nor targets, nor even procedures by which such substantive matters might be explored. They simply express sentiments about the prospects for better environmental policy. Agreements negotiated in the second stage may be categorized as procedural treaties. *Procedural* treaties develop institutions, often fairly rudimentary institutions, by which substantive matters regarding environmental targets or regulations may eventually be explored or developed. Such treaties build international institutions for collective decision making on specific environmental matters but do not explicitly proscribe environmental targets or regulations. (The actual text of procedural treaties often deals fairly extensively with institutional development, and nearly always includes text on matters very similar to those of symbolic treaties.)

Agreements negotiated in the third stage allow what might be called substantive treaties to be signed. *Substantive* environmental treaties specify environmental targets or regulations to be implemented via new domestic legislation by all signatory nations. (Substantive treaties normally reflect their history, and contain lengthy symbolic and procedural sections as well.)

In order for environmental treaty negotiation to be initiated, the policy makers of at least two countries must believe that participation in the negotiation process yields net political advantages *for themselves*. It does not necessarily imply that implementation of a properly drafted and coordinated set of environmental regulations will be beneficial for all of the governments participating, although in many cases it may. Participation, itself, often generates domestic and international political advantage.

Incentives for governments to sign the three kinds of treaties can be more readily discussed if a bit of notation is introduced at this point. Let $p(\text{Proc} | \text{Symb})$ denote the subjective probability of consummating a procedural treaty given that a symbolic treaty is signed, and $p(\text{Subst} | \text{Proc})$ denote the subjective probability of consummating a substantive treaty given a procedural one has been signed. Let $B(\text{Symb})$ and $C(\text{Symb})$ denote the direct cost and benefit realized by signing a symbolic treaty, and so forth. In this case, the expected net environmental benefits of *signing and implementing* each of the three kinds of treaties can be written as:

$$Net(Symb) = B(Symb) - C(Symb) + P(Proc|Symb)[B(Proc) - C(Proc)] + P(Proc|Symb)P(Subst|Proc)[B(Subst) - C(Subst)] \quad (9.1a)$$

$$Net(Proc) = B(Proc) - C(Proc) + P(Subst|Proc)[B(Subst) - C(Subst)] \quad (9.1b)$$

$$Net(Subst) = B(Subst) - C(Subst) \quad (9.1c)$$

Symbolic treaties are signed because of direct net benefits associated with them and/or because they are believed to increase the likelihood that procedural and substantive treaties will be negotiated in the near future. Procedural treaties are signed because of direct net benefits associated with signing them and/or because they are believed to increase prospects that a substantive treaty will be signed. Substantive treaties are signed because of direct benefits from participation and/or anticipated environmental (net) benefits from mutual implementation.

This highly simplified, but quite general, characterization of the negotiation process has several implications for the kinds of environmental treaties that we should observe.⁷ First, it is clear that the greater is the expected flow of environmental improvements, the more likely such negotiations will be undertaken and yield substantive treaties. $B(Subst) - C(Subst)$ is an argument in the sufficient conditions for signing each kind of treaty. In the case most analyzed by economists, where the principal benefit of participating in the negotiation processes arises from *environmental* benefits, $B(Symb) = 0$ and $B(Proc) = 0$, and *every* negotiation process that begins will eventually arrive at a substantive treaty. Such an environmental treaty game can be said to be subgame perfect at the level of negotiations. On the other hand, not every potentially beneficial treaty will be negotiated because anticipated negotiation costs may exceed anticipated environmental benefits.

A somewhat weaker conclusion follows in cases where political or other benefits are realized by governments that merely participate in negotiations, e. g. when $B(Symb) > 0$ and $B(Proc) >$

⁷ See Congleton (1995) or Hoel (1991) elsewhere in this volume for more detailed analyses of the negotiation process.

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0. In this case, at least some countries may sign symbolic and procedural treaties even if their anticipated net environmental benefits from future implementation are negative. All that is required in this case is that the policy maker's *direct* domestic and international political benefits from participating in symbolic and procedural treaties be larger than the direct cost of participation. (They can avoid most of the costs of substantive treaties by not signing or implementing them.) Such countries would never implement the final substantive treaties in the absence of side payments or other non-environmental benefits.

Implementation is not sub-game perfect in this negotiation process.

A third implication, and the most relevant for the present discussion, is that symbolic and procedural treaties will be more commonplace than substantive treaties. This follows because sufficient conditions for symbolic and procedural treaties *are always reached en route* to a substantive agreement. At any moment in time, many environmental negotiations are underway, and are likely to be at different phases of negotiation. Both existing substantive agreements and those not yet consummated can be preceded by symbolic and procedural treaties. Consequently, there necessarily will have been more opportunities to have signed symbolic and procedural treaties than substantive treaties.

The relative frequency of symbolic and procedural treaties is likely to be greater than implied by the natural order of negotiation if the number of agreements being negotiated is increasing through time, or if there are significant *direct political benefits from participating* in the negotiations and signing procedural and symbolic treaties. In the latter circumstances, some governments will begin negotiations for substantive environmental treaties that they have no intention of signing or implementing. (That is to say, some environmental treaties may be signed as a form of environmental cheap talk.) It is also possible that later treaties may fail to be adopted as the power to make environmental policies is assigned to different persons or parties by national elections and/or intraparty politics.

Some Evidence from the Treaty Record

Evidence of the kinds of treaties negotiated to this point may be taken from Tables 1 and 2 above. Only two of the bilateral treaties listed in Table 1 are substantive treaties insofar as

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they explicitly list effluents, targets or establish an independent regulatory commission empowered to implement such regulations. The two substantive treaties are the *Oresund Sound Treaty* and the *1978 Great Lakes Water Quality Treaty* which clearly specify which effluents are to be controlled. However, only the Great Lakes Treaty mentions specific target levels for effluents and hazardous materials (from Acetaldehyde to Zirconium Tetrachloride), although even it does not include specific time tables for meeting the targets.

Consistent with the above analysis, these two substantive agreements are the result of negotiation efforts begun many years earlier which have generated a series of increasingly substantive treaties. The 1974 Oresund Sound Treaty between Denmark and Sweden replaced non-binding protocols signed in 1960 (*United Nations Treaties Series*, 1975, 13823). The 1978 Great Lakes Water Quality Treaty superseded and expanded a similar treaty negotiated in 1972 with distant roots in the Boundary Waters Treaty of 1909. In both of these cases, successive treaties led to more rigorous monitoring of the common pool resource of interest and to more extensive environmental obligations.

The history and substance of multilateral treaties parallels that of bilateral treaties. Multilateral substantive environmental treaties are generally preceded by a series of symbolic and procedural treaties. For example, a series of successively more stringent treaties have been negotiated concerning maritime pollution over the last seventy years. The treaty series began in 1926 when an international conference of major oceanic nations was held in Washington D. C. Seven maritime nations accepted a fifty mile discharge prohibition zone for nontankers in coastal waters near major sea ports. (See M'Gonigle and Zacher, 1978:81-83.) In 1948, the Convention on the Intergovernmental Marine Consultative Organization was negotiated, and ratified in 1958 by 21 states, by which time it had been delegated "bureau powers" by the 1954 Oil Pollution Conference. In 1983, a more stringent treaty took effect, the Convention on the Prevention of Pollution from Ships (MARPOL). (See Caldwell (1990):84.) By 1994, 63 countries had ratified the convention (*World Resources 1994-95*: Table 24.1).⁸

⁸ The evolution of environmental treaty obligations is often fairly complex. The roots of MARPOL may be traced back to an unsuccessful conference sponsored by the U. S. in 1926 dealing

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Several major multilateral agreements on CFC emissions and green house gases have been recently negotiated under United Nations auspices. The Vienna Convention (1985) was a largely procedural agreement that established a process by which future substantive agreements could be achieved. The Vienna Convention did not call for specific targets for CFC emissions. Rather, article 6 of the Vienna Convention established a "Conference of the Parties" which "shall keep under continuous review the implementation of this convention, and, in addition, shall ... consider and undertake any additional action that may be required for the achievement of the purposes of this convention." The substantive Montreal Protocol (1987) was an outcome of the process established.⁹

Similarly, the 1992 Climate Control Convention negotiated in New York and Rio de Janeiro established a process by which future more substantive regulatory targets might be negotiated with the aim of reducing anticipated increases in global temperatures. The procedural framework institutionalized the "Conference of the Parties" and the use of the UN Secretariat which reduced the institutional requirements of subsequent negotiations. A series of meetings in New York, Berlin, Geneva and elsewhere eventually yielded a substantive treaty, the Kyoto Protocol of 1998, which specifies targets for reductions in greenhouse gas emissions by nation

with dumping waste oil in the ocean by ships. See M'Gonigle and Zacher (1979, Ch. 4). Shortly after the conference, the British government appealed to the International Shipping Conference to adopt a 50 mile discharge prohibition zone. The ship owners of seven countries agreed to implement this prohibition. During the 1930's the League of Nations promoted an accord on oil pollution control. After the second World War, the 1948 Convention of the Intergovernmental Maritime Consultative Organization was negotiated under United Nations auspices in 1948. This convention did not itself mention pollution or environmental matters but the organization founded by it was assigned bureau powers for the conventions negotiated at the 1954 Oil Pollution Conference. These conventions gave it the responsibility to monitor international agreements regarding intentional oil spills (previously a normal part of the process of ship maintenance). This authority was extended to unintentional spills after the Torrey Canyon spill in 1967. In 1973 a separate "Convention on the Prevention of Pollution from Ships" (MARPOL) was negotiated under United Nations auspices which was subsequently revised in 1978. As of 1994, the 63 contracting parties to MARPOL, as negotiated in 1978, include all major maritime countries: the major Western industrialized nations, Korea, China and the U. S. S. R.

⁹ Murdoch and Sandler (1997) argue that although the Montreal Protocol is a substantive treaty, it has had minimal impact on signatory trajectories of CFC emissions. They argue that the observed pattern of curtailed emissions is consistent with a Nash model of pollution abatement.

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to be implemented by the year 2012. (As of January 1999, 71 countries have signed the Kyoto protocol, although only two have ratified it.)

It bears noting that the analysis above allows the possibility that all three kinds of treaties may be forms of what game theorists call cheap talk, here "*environmental cheap talk*." Symbolic and procedural treaties can be signed and implemented at minor cost by any interested party but do not, themselves, affect national or international environmental quality. Substantive treaties can also be signed at low cost insofar as the principal economic cost of substantive treaties arises only after they are implemented by adopting new domestic legislation. Indeed, substantive treaties may be signed by nations with no intention (or political feasibility) of implementing the policies agreed to.

However, although the content of many of the above treaties seems consistent with a cheap talk interpretation, game theorists would be surprised at how few nations sign treaty documents. No environmental treaty has yet achieved the "unanimous support" that a cheap talk interpretation seems to imply. If signing is free, and "backing a good cause" is politically useful to policy makers, all nations should be expected to sign environmental treaties. This fact remains something of a puzzle. Evidently, indirect reputational effects discourage such insincere signing from taking place, at least to some extent. A government's reputation as a reliable agent or negotiation partner evidently has value in other policy areas in which international negotiations take place. For example, a politician or party's reputation for faithfully delivering on its promises may help assure its success in future elections. Similarly, a negotiator's reputation in environmental and other policy forums-- as a political agent, as a trading partner, as a facilitator of a military alliance, or as a potential member of other international treaty organizations -- may have value in that it reduces transactions costs.

Such reputational effects may partly account for the reluctance of pivotal policy makers to sign treaties that *have no provisions to punish* signatory nations that fail to comply with treaty mandates. Just as the main private benefits that policy makers realize by implementing environmental treaties tend to be reputational rather than environmental, so apparently are the main costs of not implementing such treaties. In other cases, as within the European Union,

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modifying domestic environmental policies may be seen as a necessary step for advancing other policy interests in related multilateral forums.

On the other hand, if the predictions of a cheap talk equilibrium do not seem to hold, neither does the other extreme of perfect implementation. As noted above, the substantive part of those treaties that actually specify targets or regulations is generally a relatively small part of the total text of environmental treaties--which is largely focused on assuring mutual advantage and specifying procedural arrangements. Moreover, the fully implemented environmental treaties that attract so much attention in theoretical analyses of environmental treaties are rare. For example, very few signatory nations have taken any steps to implement the recent series of treaties concerned with global warming.

IV. Who Signs Environmental Treaties?

At every stage of negotiation, participants are forward looking. Taken at face value, symbolic treaties increase the prospects for procedural and substantive treaties. Procedural treaties affect expectations by increasing the likelihood that a substantive treaty will be signed.

Substantive environmental treaties affect expectations by committing signatory governments to enacting and enforcing more stringent domestic environmental regulations. In every case, the interests of policy makers must be advanced if treaties are to be signed, and must advance those of a majority of the national legislature or ruling junta if they are to be implemented.

¹⁰The question arises as to whether there are any systematic economic or institutional factors that affect the net benefits that national policy makers realize from environmental treaties, and thereby whether there is a systematic component to the pattern of signatures observed on the treaties negotiated.

Utility Maximizing Pollution Standards for Democracies and Dictatorships

Congleton (1992) first modeled and estimated the propensities of nations to adopt domestic environmental legislation and to sign international environmental treaties. The model

¹⁰ See Mueller (1989) for an extensive overview of rational choice based models of government decision making.

examined how differences in political institutions can affect national propensities to enact domestic environmental regulation and sign international environmental treaties. More recently, Murdoch and Sandler (1997) have demonstrated how public goods aspects of adopting domestic environmental regulation may affect propensities to sign and implement environmental treaties.

These two approaches complement each other and may be combined to form the basis of an analysis that captures both public goods and institutional aspects of propensities to engage in domestic and international environmental regulation. Again, a few equations may clarify the discussion. Suppose that all individuals, whether dictators or ordinary citizens, maximize a two-dimensional utility function defined over measured real income, C (consumption), as per GNP accounting practices and environmental quality, E , that is: $U_i = u(C_i, E)$. These two areas of choice, while technologically linked, are disjoint since environmental quality is not included in the most widely used measures of national output. Environmental quality may be thought of as an index of the concentrations of undesired effluents in the untreated air and water supply. Real national income or gross domestic product can be considered to be a pure private good, an index of manufactured private goods and services purchased in markets. *Personal* incomes can be approximated as a monotone increasing function of national income.

Assume that every individual, i , receives a constant fraction, α_i , of national product, Y , as personal income. This fraction, α_i , clearly varies among individuals. For example, a dictator receives a much higher fraction of national income than a typical citizen or the median voter. Given national income and individual i 's income share, his personal income or non-environmental consumption is $C_i = \alpha_i Y$. Environmental regulations affect personal income through effects on national output. The discussion above suggests that national income is affected by its resource base, N , and domestic environmental regulations, $Y = y(R, N)$. The relationship between environmental regulations and national income is non-monotonic. Over an initial range, more stringent domestic environmental standards increase national output by improving the health and productivity of labor, and/or by freeing resources that would otherwise have been used by individuals to reduce exposure to the local environment--air

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filters, water purifiers, and the like--for more valuable uses. Beyond this initial range, more stringent environmental standards reduce nonenvironmental output as less productive technologies are mandated and inputs are diverted from ordinary economic production to environmental improvement without offsetting productivity gains.

In this last economically relevant range, a trade off between personal income and environmental quality exists. More stringent regulations improve average environmental quality but increase the cost of consumer goods relative to income, reducing measured national income and thereby the non-environmental consumption of a typical individual. This tradeoff is the private marginal cost of environmental regulation. In other words, the private marginal cost of environmental quality generated by more stringent regulation is not reflected by changes in ordinary tax burden, but rather by indirect effects that more stringent environmental standards have on personal income. In this respect, environmental standards (and many other regulations) are unlike ordinary government expenditure programs where tax revenues are used to finance the provision of a public service.

Not only does environmental quality affect national and personal income, but national income affects environmental quality. The link between environmental quality, environmental standards and national income perceived by policy makers is stochastic. This reflects random elements of the underlying natural processes involved and the unpredictable nature of scientific progress in understanding the physical and social mechanisms involved. In the case of interest here, the probability of high domestic environmental quality levels increases as domestic and world environmental standards, R and R^w , become more stringent and falls as national and world output, Y and Y^w , increase, $F = e(E | R, Y, R^w, Y^w)$. Standards adopted by other nations affect the base quality confronted and the extent to which domestic regulations may improve local environmental quality.

Domestic environmental regulations serve as a form of social insurance which reduces downside environmental risk. Each individual prefers the environmental standard that maximizes life-time expected utility given various personal constraints. This characterization of the environmental regulation at issue together with a finite time horizon, T , implies that an

individual's preferred regulation or environmental standard can be characterized as that which maximizes:

$$U^e = \int_0^T \int_{-\infty}^{\infty} u(E, \alpha_i y(R)) e(E|R, y(R), R_w, Y_w) \delta E \delta t \quad (9.2)$$

Assuming that the expected utility function is strictly concave, we can characterize the individual's ideal environmental policy with the first order condition:

$$U_R^e = \int_0^T \int_{-\infty}^{\infty} [U_C \alpha Y_R e(E|R, y(R), R_w, Y_w) + u(E, \alpha_i y(R))(e_R + e_Y Y_R)] \delta E \delta t \quad (9.3)$$

(Subscripted variables represent partial derivatives with respect to the variable subscripted.)

Equation 3 demonstrates that the effect of environmental regulation on personal welfare occurs through its effects on personal income and on the probability distribution of environmental quality. Each individual prefers the environmental standard that sets the expected present value of his subjective marginal cost for more stringent environmental regulation (in terms of reduced measured income or consumption) equal to the present discounted value of the time stream of marginal utility from greater environmental quality.

The geometry of a typical person's preferred environmental standard is illustrated in figure 1. The relationship between economic output and environmental quality determines the shape of the regulatory opportunity set faced. It represents the steady-state relationship between non-environmental (or pecuniary) income and environmental quality. The indifference curves represent constant levels of expected lifetime utility over the time horizon of interest. The relevant part of the constraint for policy makers is from R_y to $R^{\max}$. A policy maker who values income but cares nothing for the environment would prefer the standard which maximizes national output, R_y . A policy maker that values both manufactured consumption goods and environmental goods tends to prefer an intermediate level of regulation such as R^* between R_y and $R^{\max}$.

The implicit function theorem applied to equation 3 implies that each person's ideal level of environmental quality can be written as a function of their individual time horizons, domestic

national income share, the national resource base, and the regulatory regimes and output of the rest of the world, e. g.

$$R_i^* = r_i(\alpha_i, T_i, N_i, R_w, Y_w) \quad (9.4)$$

These five parameters of the individual's optimization problem all affect the pivotal policy maker's preferred domestic environmental regulation. The qualitative effects of changes in these parameters on preferred policies can be characterized by differentiating equation 4 with respect to each of the parameters of the individual's choice problem.

For example, an increase in the share of national income received by an individual has two effects.¹⁰ First, there is an income effect which tends to increase consumption of all goods, including environmental quality. Such effects may include reductions in personal

¹⁰ For example, differentiating with respect to α_i allows the effect of income share on a person's preferred environmental policy to be characterized as:

$$R_{i\alpha}^* = \frac{U_{R\alpha}^e}{-U_{RR}^e} \quad (9.5)$$

The denominator is less than zero since this is simply the second order condition of the original optimization problem, $U_{RR}^e < 0$. Consequently the numerator determines the sign of $R_{i\alpha}^*$. The numerator is:

$$U_{R\alpha}^e = \int_0^T \int_{-\infty}^{\infty} \{ [U_{C_i C_i} Y \alpha + U_{C_i}] Y_R e(E|R, y(R)) + U_{C_i} Y (e_R + e_Y Y_R) \} \delta E \delta t$$

or

$$U_{R\alpha}^e = \int_0^T \int_{-\infty}^{\infty} \{ \alpha U_{C_i C_i} Y_R Y e + U_{C_i} [Y_R e + Y (e_R + e_Y Y_R)] \} \delta E \delta t \quad (9.6)$$

income based on changes in the costs of consumer goods or reductions in national income generated by reduced exports, Leidy and Hoekman (1996). Second, there is a relative price effect which increases the marginal cost of environmental quality, and reduces the preferred degree of environmental protection. In the case where the relative price effect dominates the income effect, a policy maker that receives a higher share of national income will prefer less restrictive environmental standards than one that receives a smaller portion of national

income as personal income. (Increases in national resource base, on the other hand, have an income effect but no relative price effect and would increase the demand for both ordinary consumption and environmental protection.)¹¹

The model implies that utility maximizing policy makers within and among nations will disagree about the optimal environmental standard, even if they agree about the "proper" tradeoff between environmental quality and material consumption, and also agree about the underlying environmental science.¹² For example, national policy makers with similar incomes and time horizons would tend to disagree about ideal environmental regulations if domestic environmental policies have different effects on expected national environmental quality. As emphasized by Murdoch et. al. (1997) and implied by Boadway and Hayashi (1999), this would be the case if domestic emissions fell mainly on neighbors or fell mainly within their own national boundaries. Similarly, policy preferences would vary if nations face different environmental spillovers from their neighbors.¹³

¹¹ Note that the model sketched out above may be extended to characterize the overall pattern of world regulation and income as a Nash Equilibrium. At the Nash equilibrium to the domestic regulation game, the world pattern of regulation, R^w and the world income, Y^w , would reflect equilibrium decisions by policy makers in every country in the world. Because the Nash equilibrium is unlikely to be Pareto optimal, potential gains to trade in environmental regulations exist. Negotiating substantive international environmental treaties is, of course, one method by which those potential gains to trade may be realized.

¹² Current scientific disagreements and the evolving state of scientific knowledge clearly make the political and economic benefits and tradeoffs of environmental policy more difficult to calculate. The economic costs and benefits of long term environmental policies also tend to change through time as innovation and business cycles take place. Such problems are often greater for international environmental problems than domestic ones. The long-term nature of regional and global environmental problems and the cumulative nature of the processes involved often allow wider scope for reasonable scientists and policy makers to disagree about the consequences of alternative environmental policies. Because of all these political, scientific, and valuation problems, the net benefits that a particular government may secure by signing a particular treaty often remain highly uncertain.

¹³ National interests in domestic and international environmental regulation differ for many reasons even for polities with similar forms of governance. Patterns of wind or water often generate quite different environmental consequences for upstream and downstream nations. The thinning of the Ozone layer is uneven, and has larger effects on countries near the polar regions than near the equator. Global warming is likely to improve the economies of countries near the polar regions while those near to the equator will be economically disadvantaged. Even if similar losses from environmental hazards are expected, national demands for environmental regulations may differ

Political institutions also affect the environmental policies that will be adopted by a given country insofar as different regimes imply different pivotal policy makers with systematically different incomes, interests, and time horizons as noted by Congleton (1992). This effect is clearest for the extremes of political organization: democracies and dictatorships. Recall that the pivotal decision maker within a democratic country can be approximated as its *median voter*. The median voter is approximately the voter with the median income share and time horizon. The median voter, as such, can not be an "outlier." On the other hand, the pivotal decision maker within an authoritarian regime is the ruler (or ruling council) who tends to be an outlier in many dimensions. Authoritarians have far greater than a median share of national income, and tend to have a shorter than average time horizon and greater risk tolerance than the median voter given the high turnover of authoritarian regimes, Bienen and van de Walle (1989). Under the restricted circumstances previously discussed, a larger national income share and shorter time horizon tends to reduce the stringency of the pivotal policy maker's desired environmental standard. Consequently, authoritarians tend to prefer lower environmental standards than the median voter of an otherwise similar democracy.

Democracies will be more inclined to sign and implement environmental treaties than dictatorships, other things being equal. In such cases, authoritarian regimes will require additional inducements--direct cash or in kind transfers--to persuade them to sign an environmental treaty and adopt its more restrictive domestic environmental regulations. Empirical evidence is largely in accord with these conclusions.

Evidence on the Pattern of Treaty Signatures

Several papers have used statistical methods to determine whether the pattern of signatures on various multinational international environmental treaties can be explained as functions of such variables as national resource endowments, income, market structure, and political institutions as indicated above.

because incomes, tastes, lifestyles, political institutions, or time horizon differ among nations. Even similar national governments facing similar environmental losses imposed on economically and culturally similar citizenries may disagree about ideal environmental policies if they face different costs for implementing environmental regulations.

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Murdoch and Sandler (1997) estimate reductions in CFC using 1989 data. The data set, thus, is after the conclusion of the Montreal protocol (1986), but before the date at which signatories were obligated to reduce emissions (1993). They found that national reductions in CFC emissions are larger in high income states than in low income states, and that reductions in CFC emissions are greater in free countries (democracies) than in nonfree (dictatorships). The latter results are consistent with the Congleton (1992) estimates of propensities of dictatorships and democracies to engage in domestic regulation as proxied by their ratification of the international treaties regarding the control of CFC emissions.

However, Murdoch and Sandler note that the CFC treaties, themselves, appear to have done little to reduce CFC emissions. Only 38 of the 61 countries that reduced CFC emissions between 1986 and 1989 had ratified the Montreal Protocol. Nonratifiers were essentially as likely to have reduced emissions as ratifiers. Rather, they argue that observed reductions in CFC emissions were simply the voluntary provision of a public good rather than evidence of cooperative behavior. The CFC treaties appear to have ratified reductions that national policy makers were already prepared to make on the basis of their own independent self-interest.

Fredriksson and Gaston (1999) analyze the time that it takes nations to sign and ratify environmental treaties. They focus on the United Nations Framework Convention on Climate Change (FCCC) negotiated in New York and Rio De Janeiro in 1992. The average time from signing the convention to ratifying it was 810 days. Fredriksson and Gaston find that the time a particular nation takes to ratify the treaty (once signed) can be explained with many of the same political and economic variables used in the Congleton and Murdoch and Sandler studies. They found that nations with greater civil liberties and smaller CO₂ emissions had a more rapid ratification of the FCCC than those with low civil liberties and high CO₂ emissions in all their model specifications. The estimated effects of other variables used to characterize national preferences for environmental policies were less robust. National area and population, interpreted as proxies for national resource endowments, were found to be significant in several of their estimates.

The effect of international spillovers ("spill ins" and "spill outs") on propensities to sign international treaties and to adopt domestic legislation is examined in Murdoch, Sandler, and

Sargent (1997). They analyze the impact of two substantive protocols to the Long Range Transboundary Air Pollution convention negotiated in 1979. The Helsinki protocol was negotiated in 1985 and required sulfur emissions to be reduced to 70% of 1987 emission rates by 1993. The Sofia protocol was negotiated in 1988 and required reduction in nitrogen oxide emissions to 1987 rates by 1994. Murdoch, Sandler, and Sargent estimate the effects that various national parameters have on emissions rates for the relevant effluents before and after the treaties were in effect. Generally, they find greater reductions in national effluent emissions in countries where relatively more of domestic emissions fall within a nation's boundaries. Reductions are smaller if national air quality is caused by the emissions of upwind countries. They interpret these empirical results as evidence of strategic (Nash-like) behavior on the part of domestic policy makers.¹⁴ Civil liberties again appear to affect the stringency of the regulations adopted.

Perhaps the most interesting of their many empirical results is that the countries that signed the Helsinki and Sofia protocols are inclined to make larger reductions in domestic emissions than those that do not. They interpret this pattern as evidence of a *screening effect* rather than of a treaty effect because the Sofia protocol *had not yet entered into force* at the time of their study. That is to say, nations with smaller emissions are more inclined to sign international environmental treaties than those with larger emissions.

In general, the results to date have affirmed the conclusion that political institutions, national income, and public goods aspects of environmental regulation affect the propensities of countries to adopt domestic environmental regulations, and to sign international environmental treaties. The degree to which the treaties have been implemented has not been extensively studied although the Murdoch et. al. papers suggest that treaties have had only a modest effect on the level of national emissions of targeted effluents.

¹⁴ The effect of wind direction on the propensities of nations to negotiate international agreements is also well illustrated by a case along the German-French border analyzed by Feld, Pommerehne, and Hart (1996). In that case, money was raised in Kleinblittersdorf, the downwind city, to upgrade a new incinerator in Grosbliederstroff, the upwind French town. Here wind direction not only determined the incentives for international negotiation but also the direction of monetary flows in the Coasian contract negotiated.

V. Overview and Conclusion

In principle, environmental treaties attempt to coordinate domestic and international environmental regulations in order to secure long term mutual advantage for the signatories. The regulatory aim of environmental treaties suggests that environmental treaties will resemble domestic environmental regulations that deal specifically with emissions targets and policy instruments. The voluntary nature of environmental treaties suggests that environmental treaties will resemble ordinary long term contracts in as much as they are based upon the mutual agreement of all participating parties, and are only partly motivated by immediately observable benefits for the parties involved.

However, the treaties that we observe differ substantially from ordinary contracts and from ordinary domestic environmental regulations. The specification of regulatory terms of trade takes up surprisingly little of the text of most environmental treaties. Much more space is devoted to listing potential gains to trade and to establishing institutions and procedures by which further negotiations may take place. Unlike ordinary contracts, the actual parties to international environmental agreements are often not fully known for many years after a treaty is negotiated and opened for signing. The delay between opening negotiations, signing, ratifying and implementing is often substantial. Nor do all signatories of treaties implement the regulatory changes negotiated. Evidently, environmental "contracts" between sovereign nations are not ordinary contracts, nor domestic environmental regulations writ large.

This chapter has summarized efforts to understand the nature of the international treaties negotiated and the pattern of signatures observed. The literature reviewed argues that treaty content can not be accounted for by economic factors alone, nor can agreements be taken as necessarily indicating policy coordination. From a political vantage point, the treaties negotiated are signals about the direction that domestic environmental policies in signatory nations may take rather than environmental policies, per se. Consequently, the political advantage from signing symbolic, procedural, and substantive treaties are very similar in the short term, and all may be expected to attract the signatures of governments with environmental constituencies. Each form of treaty signals future environmental benefits

without imposing immediate costs on signatory nations.¹⁵ Sovereignty implies that any new environmental policies agreed to will be implemented via domestic legislation. Thus international environmental agreements must yield wide spread political advantage within all signatory governments if they are to be fully implemented.

The pattern of signatures that we observe suggests that political institutions and public goods aspects of the environmental regulations at issue play a large role in determining whether or not environmental treaties are signed. Democracies are more likely to sign than dictatorships. Countries that experience large spillovers from other countries are more likely to sign than others. The latter suggests that environmental treaties address genuine environmental problems, and are not entirely politically expedient cheap talk. Moreover, efforts to address institutional and political concerns that make substantive treaties feasible are very much in evidence in treaty documents.

All but the most symbolic treaties establish or augment standing international institutional arrangements. For example, international environmental treaties generally establish specialized commissions with representation from all signatory countries. The environmental commissions established generally use unanimous agreement as their decision rule, which assures mutual gains from treaty terms. However, relatively little explicit authority is delegated to the commissions created. Final approval and implementation of environmental policies resides with the ruling legislatures and councils of signatory countries. The commissions established are generally delegated the power to make proposals to signatory nations and to file periodic reports. In substantive treaties the commissions are explicitly given responsibility for monitoring, implementing treaty obligations, and coordinating information flows.¹⁶

decisions are cast in terms of the interests of pivotal government decision makers. These may not assure domestic Pareto optimality.

¹⁵ Relative price effects generated by environmental regulations may be politically as important as the regulations themselves. I focus on environmental quality throughout this chapter largely to simplify the analysis. Political agency issues are only indirectly analyzed in this chapter.

¹⁶ Environmental treaties also depart from the Coasian perspective in that the contracting parties are governments, rather than individuals, who may or may not promote the interests of their citizenry by aiming for Pareto optimal domestic and international policies. See Bhagwati (1988), McGee (1989) or Vaubel and Willett (1991) for examinations of government incentives in the negotiation of international trade arrangements.

Environmental treaties have not been subject to similar scrutiny. A preliminary look at The institutions established have not to this point fully addressed the final implementation problems analyzed in chapter 10. Rather substantive treaties have implicitly relied upon the good faith of signatories or implicit incentives for compliance. The absence of explicit treaty provisions for penalizing noncompliance together with the absence of credible international enforcement agencies empowered to impose costs on nonperforming countries implies that incentives to implement treaty obligations are results of reputational effects or various international forms of *continuous dealings*.

The reputational "performance bond" can be significant for nations that continually deal with each other in a variety of economic and political policy areas, as among members of the European Union. Renegade signatory countries lose their reputations as reliable trading partners which places at risk benefits from future dealings with the other signatory nations. Such implicit performance bonds require no external agency to enforce them, and can be effective if reduced future transactions pose a credible threat to potential violators.¹⁷

Although treaties are a more cumbersome method of solving externality problems than other supranational regulatory solutions that might be imagined, environmental treaties are likely to remain the principal vehicle by which international environmental problems are addressed. Even if greater policy making authority were delegated to international commissions, or incentive compatible treaty language were agreed to, sovereignty implies that

incentives faced by dictatorships and well-functioning democracies in signing environmental treaties is developed in Congleton (1992).

¹⁷ For such a threat to be credible, the parties must believe that non-violators are better off ending a treaty and/or other future relationship with a non-performing "partner" than continuing them. This is often the case in treaties where only two parties are involved and environmental concerns are transparent, simultaneous, and reciprocal. It can also be the case in multilateral treaties where the parties deal with each other on a wide range of policy areas. In such cases, implementing environmental treaties can be sub-game perfect in cooperation.

The logic for bilateral environmental treaties is straightforward. Since each party in a bilateral

treaty only has an interest in observing the treaty if the other party adheres to treaty terms, return to the pre-treaty state is a credible threat. Thus, expected net gains from breach are negative for each party at every instant. See Telser (1980) or Schmidt (1999) for an overview of the theory of incentive compatible contracts.

domestic legislation would remain the method by which such international environmental policies are implemented. The contractual nature of treaties reduces domestic political risks by guaranteeing that *all* participating governments benefit from the regulations finally adopted.¹⁶

The literature reviewed in this chapter indicates that international contractual solutions to environmental problems are clearly more challenging to achieve than solutions to domestic environmental problems because the political and institutional problems that have to be overcome are more complex. Those challenges seem likely to remain as long as nations remain sovereign. Consequently, analysis of the complex interplay between the political and economic determinants of international agreements is likely to remain a fruitful area of research for the foreseeable future.

¹⁶ Analysis of the internal operation of the various international organizations established by both procedural and substantive environmental treaties is left for future analysis. Analysis of other international organizations (see Vaubel and Willett (1991)) suggests that principal-agent problems at the government commission level of analysis are likely to occur. Even without policy making powers, environmental commissions may have a substantial impact on the agendas of domestic governments through their ability to make policy recommendations and by their superior knowledge of environmental detail in their area of responsibility. The delegation of relatively little authority to the institutions established implies that governments are well aware of political agency problems. Such policies reduce the likelihood of "capture" whereby interest groups unduly influence regulatory agencies to promote their own narrow ends. Legislative oversight of treaty implementation does not rule out such influence, but does make extreme outcomes less likely inasmuch as legislatures can not freely ignore the electorate's welfare.

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Table 1: International Environmental Treaties

Signatory Signatory	Year	Focus	Action	Responsibility
UK W. Germany	1969	Oil slicks	Coordination	Inform each other of existing or potential oil spills
France Switzerland	1971	Lake Geneva	Commission formed	Recommend policies and monitor water pollution
USA USSR	1972	General	Commission formed	Exchange of scientific information , joint conferences
Italy Switzerland	1972	Border Lakes	Commission formed	Recommend policies and investigate pollution sources
USA Canada	1972	St. Johns River	Commission	Monitor water quality and coordinate policies
USA Canada	1974	Oil spills	Contingency planning	Development of a marine contingency plan
USA W. Germany	1974	General	Cooperation	May harmonize policies and share information
Poland Czechoslovakia	1975	Air Pollution	Commission (Plenipotentiaries)	Coordinate monitoring and exchange information
Denmark Sweden	1975	Oresund Sound	Commission	Recommend policies and coordinate research

International Externalities.

USA Canada	1978	Great Lakes	Commission	Recommend policies and report on treaty programs
USA Mexico	1980	Maritime Boundaries	Contingency plan	To coordinate a joint response to hazardous substance spills
USA Canada	1980	Air pollution	Commission	Recommend policies and coordinate and share research
USA Mexico	1983	Border area pollution	Commission (2 coordinators)	Coordinate policies and meet at least once a year
USA Canada	1984	St. Johns River	Continuation of 1972 agreement	Monitor water quality and recommend targets
USA Mexico	1985	Hazardous Substances	Contingency plan	Coordinate responses to accidents along the border

Table 2: Major International Treaties on Air and Water Pollution

Treaty Name and Focus	#CPs (1998)	Year	Institutional Action	Substantive Goal/Obligations
Stockholm Action Plan for the Human Environment	UN	1972	Recommended UNEP	109 general and nonbinding recommendations
Convention on Prevention of Marine Pollution	57	1972		
MARPOL: Ship Pollution	63	1978		
Geneva Convention on Long-Range Transboundary Air Pollution		1979	Representative Executive Body	Exchange of information, consultation, research and monitoring, develop policies
Helsinki Protocol Concerning the Reduction of Sulfur Emissions	(Europe)	1985		Agree to reduce Sulfur emissions by 30% of 1980 levels by 1993
Vienna Convention on Protection of the Ozone Layer	100	1985		Promote research and monitor the ozone layer
Montreal Protocol on Substances that Deplete the Ozone Layer	92	1987		Requires nations to cut consumption of 8 substances to 50 % of 1986 levels

International Externalities.

Sofia Protocol on the Control of Nitrogen Emissions	(Europe)	1988		Require reductions in NOx emissions to 1987 levels by 1994
Basel Convention on the Control of Movements of Hazardous Wastes	34	1989	Secretariat and Conference of the Parties	Requires notification by waste exporting countries and consent by waste importing countries
Rio: Framework Convention on Climate Change	176	1992	Secretariat and Conference of the Parties COP)	Technology and information sharing, <i>aim</i> to reduce relevant emissions levels to 1990 levels
Kyoto Protocol to the Convention on Climate Change	2	1998	Secretariat and Conference of the Parties	Reduce emissions of green House gases (Generally to about 8% below 1990 levels by 2012.)

Figure 1

