Working Paper WP97-1 July 1997

Trade-Environment Linkages in the

Resolution of Transboundary Externalities

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Introduction

After Saddam Hussein forcibly occupied Kuwait in late 1990, President George Bush feverishly sought to build a coalition of nations prepared to support U.S. intervention in the Gulf. It has been suggested that in the course of his discussions with the Canadian Prime Minister, another issue of longstanding importance to Canada -- acid rain -- was raised. The United States would agree to a framework for reducing transboundary SO_2 emissions, linked to Canada's commitment to support a policy of collective security in the Persian Gulf (see Cataldo, 1992). An environmental agreement was thus linked to a strategic military agreement, to the mutual benefit of both nations.

In 1992, then candidate Bill Clinton agreed to support NAFTA on the condition that an environmental side-agreement would be attached to the trade accord. Environmental groups argued that without such a side-agreement they would oppose NAFTA, increasing the likelihood, if not assuring, its defeat in Congress (see Runge, et. al., 1994). Once again, an environmental measure, focusing in large part on transboundary issues along the U.S.-Mexico border, was linked to another (in this case trade) agreement. Other examples of this kind of linkage are so-called "debt for nature swaps," in which relief of a financial obligation is exchanged for preservation of environmental resources that provide global public goods such as rainforests (see Pearce, et. al., 1995).

Each case involves an environmental dilemma which is linked to a solution to another problem, allowing the environmental dilemma to be overcome.[1] The purpose of this paper is to analyze the strategic structure of such linkages from a simple game-theoretic perspective, offering insights into incentives, rewards and policy. We shall argue that many environmental dilemmas such as transboundary pollution problems can be described as Prisoners' Dilemmas (PDs). Taken on their own, these environmental PDs lead to inferior outcomes, and offer no internal incentives for successful resolution. However, when linked to trade (or collective security) agreements, described as Assurance Problems (APs), the gains from successful resolution of the trade or collective security game can be utilized as a side-payment to transform and resolve the environmental PD game. We proceed by first describing the basic incentives of the environmental and trade games, then show how linkage can be used to move nations into preferable situations. An important conclusion is that while linkage is nearly always preferable for those playing an environmental PD, it leads to added risks for players of the trade game, explaining the reluctance of the trade community to engage in such linkage for fear of a "slippery slope" toward greater protectionism (see Jackson, 1992).

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[1]We may distinguish between four types of environmental dilemmas: (1) problems that are localized within nations; (2) transboundary pollution problems where pollution affects people in nations other than where the pollution originates (e.g., acid rain, greenhouse gases); (3) problems of common resources such as oceans or fish stocks; (4) problems where preferences for the state of environmental resources reaches across borders, such as in the tuna-dolphin case between Mexico and the United States. Linkage of type (1) problems to trade has been roundly criticized in debates over harmonization of standards (see Bhagwati and Srinivasan, 1996). However, linkage of trade to problems of types (2) and (3) have been generally acknowledged as legitimate, although possible ineffective (see Bhagwati and Srinivasan, 1996; Baumol and Oates, 1988). Linkages of type (4) problems to trade have been controversial because of sovereignty issues (see Johnson and Beaulieu, 1996; Runge, et. al., 1994). Our analysis applies to problem types (2), (3) and possibly (4).

The Structure of Incentives

Environmental dilemmas are often collective action problems described as classic Prisoner's Dilemmas (PDs). The Tragedy of the Commons takes this form, as do many other environmental dilemmas (Runge, 1981; Sandler and Sargent, 1995). However, under certain plausible conditions these dilemmas may be transformed into assurance problems (APs) in which dominant strategies to free ride are replaced by the possibility of cooperation rather than defection (Runge, 1984). In the literature on collective action considerable attention has been given to the role of iterated or repeated plays in creating incentives for cooperation (Axelrod, 1984, Axelrod and Dion, 1988). Experimental evidence also supports the possibility of cooperation when agents are assured that such behavior will be responded to in kind (Guttman, 1978; Isaac, et. al., 1989). However, especially in the case of transboundary environmental problems, the number of agents and their differences create the strong possibility of a failure to resolve these dilemmas, as evidenced by recent discussions of global climate (see *The Economist*, 1997).

One of the possible solutions to environmental PDs is for an outside agent to enforce or bind agents to cooperative strategies. With regard to environmental problems, this option is clearly feasible at the municipal, provincial and national levels of jurisdiction. At the international level, however, transboundary environmental dilemmas are difficult to resolve from the "top down." While international environmental rules have expanded exponentially in the last five years, national sovereignty remains far stronger than multilateral rulemaking. Indeed, international cooperation has largely been built around mutual recognition of norms of non-intervention or the rights of states to independence, and not around principles designed to recognize global common interests (Hurrell and Kingsbury, 1992).

International environmental agreements thus tend to relinquish a minimum of national sovereignty, resulting in relatively weak enforcement regimes. Usually significant cooperation emerges first only in the area of environmental monitoring (Sandler, 1997). The NAFTA, for example, has been criticized on these grounds (see Szekely, 1994). Even the Montreal Protocol, widely seen as a very successful international treaty to control ozone-depleting chemicals, faces enforcement challenges: the illegal trade in substances banned by the treaty is growing rapidly (Kennedy, 1995; Sandler, 1997). In short, international environment rules enforced from the "top down" appear problematical (Birnie, 1992; Hurrell and Kingsbury, 1992; Baumol and Oates, 1988; Sandler, 1997; Farber 1997).

Absent a global leviathan, what are the alternatives? One is to find ways of changing the incentives of environmental games so that they are no longer Prisoners' Dilemmas. Sandler (1997) notes that the type of game depends on the particular technology of pollution dispersion. We shall argue that even where the dispersion technology is not conducive to resolution of an environmental problem (that is, the technology generates a PD), a solution may be found by linking the environmental game to other games more favorable to cooperation -- notably trade. Such linkage echoes Mancur Olson's (1965) argument that collective action problems often require "selective incentives" to be resolved. However, it most closely resembles models of legislative logrolling or vote trading, in which coalitions are formed by expanding the domain of issues over which deals are made (Brams, 1990; Riker, 1980). The gains from trade, a result of longstanding in economic theory, thus forms the foundation of a selective incentive capable of transforming and resolving environmental dilemmas.

A Game Theoretic Analysis

If many international environmental dilemmas, taken on their own terms, are PDs, then what are trade negotiating games? Trade negotiations involve reciprocal concessions to expand areas of non-discrimination. In the Uruguay Round and NAFTA, for example, commitments to reduce protection in agriculture were featured prominently. If nations were assured that their trading partners would commit to these concessions, then they were more likely to commit to them too. If they were not assured of reciprocal concessions, then they were unlikely to grant them in turn (see Runge, 1993). This is an assurance problem (AP), in which the equilibrium outcome may be either a successful agreement to match concessions, or an unsuccessful one, in which nations fail to expand the domain of non-discrimination. While the outcome of trade liberalization is not always achieved, it is achievable in principle, and is Pareto-superior, offering net gains to both players (see Sugden, 1984).

In Figure 1, payoffs for each outcome of the game are represented, with the subscript representing the payoff to the player i = 1,2. The first letter in the subscript identifies the strategy played by player 1 (c = cooperate, d = defect) while the second letter in the subscript identifies the strategy play by player 2. The payoff structure of this Assurance Problem is of the form $U^1_{cc} > U^1_{dc} = 0 = U^1_{dd} > U^1_{cd}$ and $U^2_{cc} > U^2_{cd} = 0 = U^2_{dd} > U^2_{dc}$. Note that standard trade theory tends to model a cooperative trading game as of the form $U^1_{cc} > U^1_{cd} \geq U^1_{dc} \geq U^1_{dd} = 0$ and $U^2_{cc} > U^2_{dc} \geq U^2_{cd} \geq U^1_{dd} = 0$, in which there is one dominant strategy, which is to lower trade barriers. This leads Krugman (1997) to argue that there should be no need for negotiations -- that nations should liberalize unilaterally. However, we submit that the AP more closely resembles actual behavior.[2] In the AP, there are two Nash equilibria -- one corresponding to mutual protectionism and the other to mutual liberalization. Although mutual liberalization is Pareto-superior, nations will liberalize only if they can be assured that other nations will do likewise; open trade is only beneficial if reciprocated. This reality may reflect the political difficulties of persuading the public (especially politicians) that unilateral trade liberalization is not tantamount to unilateral disarmament.

The AP also has mixed strategy equilibria where the players assign probabilities to playing the two

[2] **While we speak of trade as an AP here, our forthcoming analysis includes the case of trade games with a dominant open trade equilibrium.**

strategies.[3] Here, we will simply discuss how one can compute a probability p of cooperation by country 1, required for country 2 to cooperate, and a probability q of cooperation by country 2, required for country 1 to play the cooperative strategy (see Sandler and Sargent, 1995). The term 1 – p represents the probability of countries 1 and 2 defecting respectively. The probabilities are computed by finding p such that the expected payoff of cooperation is equal to the expected payoff of defection. For example, for country 2 this is calculated from

$$E(\pi_c) = p^{\rho}B_{cc}^{2} + (1 - p^{\rho})B_{dc}^{2} = p^{\rho}B_{cd}^{2} + (1 - p^{\rho})B_{dd}^{2} = E(\pi_d) \quad \textbf{(1)}$$

where π_c is the payoff from cooperation, π_d is the payoff from defection, and p^{ρ} is the probability that country 1 will cooperate in the pollution game. If the actual probability of cooperation by country 1 is greater than p^{ρ}, then country 2 will play the cooperative strategy. Similarly, the required probability q^{ρ} required for country 1 to play the cooperative strategy can be computed from an expression analogous to (1). The probability of p^{ρ} points out the role of institutions in transmitting information about the behavior of opposing players in coordination games. For example, if country 1 obtains information that country 2 will lower trade barriers with a probability greater than p^{ρ} (Assurance) then they will lower their own trade barriers.

The essence of transboundary environmental problems can also be represented as a simple two player games (Figure 1). But in contrast to the trade game, the payoff structure is a PD. The PD payoff structure ($B_{dc}^{1} > B_{cc}^{1} > B_{dd}^{1} = 0 > B_{cd}^{1}$ and $B_{cd}^{2} > B_{cc}^{2} > B_{dd}^{2} = 0 > B_{dc}^{2}$) corresponds to a transboundary pollution dilemma in which countries abate pollution within their own jurisdiction, with benefits gained at the cost of abatement. Because pollution travels across jurisdictional boundaries, benefits also accrue to other jurisdictions at no cost. Nations with significant pollution spillovers will thus be better off letting other countries bear the costs of abatement, as when the U.S. allowed SO_2 to migrate North to Canada.

Linkage

If the pollution game is a Prisoner's Dilemma and no binding commitments can be made, then the two countries are locked by dominant strategy mechanisms in the mutually disadvantageous defect-defect equilibrium.

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[3] **On mixed strategy equilibria see Kreps (1988) and Binmore (1992).**

Now consider the advantage of taking some of the gains from a successfully executed trade game and using them to transform the environmental PD. In effect, the two games are merged to become a higher order or "meta-game" (Howard, 1966).

The two countries decide that the cooperative decision in the trade game will be played only if the cooperative decision in the environment game is played, and that the gains from a cooperative trade game equilibrium will be used to transform the environmental PD so that cooperation is a Pareto-superior strategy there as well. Equivalently, the players decide that the defect decision in the environment game will be used to increase the likelihood of a defect decision in the trade game. The linked trade-environment game cooperative strategy equilibrium is "Open Trade-Increase Abatement" and the defect strategy is described by "Restrict Trade-Minimal Abatement." The mixed strategies (Open Trade-Minimal Abatement) and (Restrict Trade-Increased Abatement) are thus eliminated from consideration. Linkage is thus a commitment (or threat) by one or both nations to say that they will not play these mixed strategies. The result is the game in Figure 2, in which the payoffs of the two games are additive.[4]

Alternative Specifications

We now expand the possibilities, demonstrating the flexibility of this approach and some of its empirical implications. We consider four separate specifications in which the trade and environment games are linked: (1) the trade game is an Assurance Problem (AP) and the environment game is a Prisoner's Dilemma (PD); (2) the trade game is an AP and the environment game is also an AP; (3) the trade game has a dominant strategy open-trade equilibrium and the environment game is a PD; and (4) the trade game has a dominant strategy open-trade equilibrium and the environment game is an AP.

(1) Trade AP; Environment PD

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[4]It is quite possible and even probable that the trade regime will affect the payoffs in the environment game and vice-versa. However, this will not necessarily change the payoff structure of each game -- that is whether the games are best described as Prisoner's Dilemmas or Assurance Problems. We have chosen the separable case for simplicity.

In case (1) the resulting linked or merged game can result in either a PD or an AP. If the benefits of trade are sufficiently large to offset the benefits of the "minimal abatement" strategy in the environment game ($U^1_{cc} + B^1_{cc} > B^1_{dc}$ and $U^2_{cc} + B^2_{cc} > B^2_{cd}$) then the linked environment-trade game is an AP. If the benefits are not sufficiently large then the linked game is a PD, in which case there is no benefit to either country in linking trade to environmental protection, since the potential benefits of trade would be lost by linking it to the PD environment game. The implication is clear: gains from mutual trade liberalization must be sufficiently large to pay for abatement, or linkage threatens trade liberalization and does nothing to transform the environmental dilemma.

Even where the gains from trade liberalization are large, linking trade to the environment game may lessen the chances of achieving the cooperative outcome in the trade area. Specifically: with linkage, the probability of country 1's cooperation, required for country 2 to play the linked cooperation strategy (or vice versa), is greater than the probability of cooperation required when the trade game is played separately. To compute the probability p^τ required for play of a cooperative trade strategy for player 2 we set:

$$E(\pi^\tau_c) = p^\tau U^2_{cc} + (1 - p^\tau) U^2_{dc} = 0 = E(\pi^\tau_d) \quad (2)$$

and solve for p^τ which yields:

$$p^\tau = \frac{-U^2_{dc}}{U^2_{cc} - U^2_{dc}} \quad (3)$$

since $-U^2_{dc} > 0$ and $U^2_d > 0$. To compute the probability p^ℓ required for a cooperative linked "open trade-increased abatement" strategy we set:

$$E(\pi^\ell_c) = p^\ell (U^2_{cc} + B^2_{cc}) + (1 - p^\ell)(U^2_{dc} + B^2_{dc}) = p^\ell B^2_{cd} = E(\pi^\ell_d) \quad (4)$$

and solve for p^ℓ which yields

$$p^\ell = \frac{-U^2_{dc} - B^2_{dc}}{U^2_{cc} - U^2_{dc} + B^2_{cc} - B^2_{cd} - B^2_{dc}} \quad (5)$$

Since $B^2_{cc} - B^2_{cd} < 0$ by the assumption of prisoner's dilemma payoffs then:

$$\frac{-B_{dc}^{2}}{B_{cc}^{2} - B_{cd}^{2} - B_{dc}^{2}} > 1,$$

$$\frac{-B_{dc}^{2}}{B_{cc}^{2} - B_{cd}^{2} - B_{dc}^{2}} < 0, \qquad (6)$$

or

$$B_{cc}^{2} - B_{cd}^{2} - B_{dc}^{2} = 0$$

which implies that $p^{\ell} > p^{\tau}$. Hence the probability of cooperation required of country *i* for country *j* to cooperate is higher in the linked game than in the trade game. The result agrees with the observation that when trade negotiations are linked or combined with environmental considerations the negotiations become more complex, decreasing the changes of coming to an agreement relative to the single issue case. However, the tradeoff is that the linkage of trade to environment has made the resolution of the dilemma in the environment game more probable.

(2) Trade AP; Environment AP

In case (2) the resulting linked trade-environment game is clearly an AP.[5] In this case, the probabilities are such that $p^{\tau} \leq p^{\ell} \leq p^{\rho}$ or $p^{\tau} \geq p^{\ell} \geq p_{\rho}$, with the direction of the inequality depending on whether the

[5] See Sandler (1997) for a discussion of pollution dispersion technologies that result in coordination problems such as the Assurance Problem.

probability requirements for playing cooperative strategies are greater in the trade game or the environment game. It is interesting that when both games are APs, the case for linkage is more difficult, suggesting that it is the ***difference*** in game structures that supports the logic of importing the gains from trade into the resolution of environmental PDs.

(3) Trade Liberalization Dominant; Environment PD

In case (3) the resulting linked pollution-trade game is a PD, an AP or a game with dominant cooperate-cooperate strategies. It is an AP if $U^2_{dc} + B^2_{dc} < 0$, $U^1_{cd} + B^1_{cd} < 0$, $B^1_{dc} < U^1_{cc} + B^1_{cc}$ and $B^2_{cd} < U^2_{cc} + B^2_{cc}$. If, however, the benefits of defecting in the environment game while the other country cooperates are greater than the combined benefits of cooperating on both trade and environment ($B^1_{dc} > U^1_{cc} + B^1_{cc}$ and $B^2_{cd} > U^2_{cc} + B^2_{cc}$) then the game is a PD.[6] Finally if $U^2_{dc} + B^2_{dc} > 0$, $U^1_{cd} + B^1_{cd} > 0$, $B^1_{dc} < U^1_{cc} + B^1_{cc}$ and $B^2_{cd} < U^2_{cc} + B^2_{cc}$ then the linked mutually cooperative outcome is dominant.

(4) Trade Liberalization Dominant; Environment AP

In case (4) the resulting linked pollution-trade game is an AP or a game with dominant cooperation strategies. Clearly, in the case where the ***linked*** game has dominant cooperation strategies (i.e., Open Trade-Increased Abatement is a dominant strategy) there is an advantage to linking the two games and in this case there is no ambiguity: a mutually cooperative solution has a probability of one, provided that the linkage of trade and environment is certain.

This analysis has shown that it can be an advantage for countries to link trade and environment negotiations, but that such linkage is not without risks. One way of thinking of linkage is as a two stage negotiation process. In stage one countries decide whether they will play the linked game or whether they will play the trade and environment games separately. In stage two, the games are then played out either separately or in merged form.

Further Permutations

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[6] **Alternatively, the costs of environmental cooperation cannot be too large.**

In addition to the four specifications considered above, it will also be important how the benefits of environmental abatement and/or liberalization are distributed across countries. We consider two cases: (1) where the benefits of trade liberalization fall more or less evenly to each country but the benefits of environmental abatement fall almost wholly with one country; and (2) where the benefits of trade liberalization accrue largely to one country and the benefits of environmental abatement accrue largely to the other. An example of the first case is acid rain between the U.S. and Canada. Let $0 \geq B^1_{cc} \geq B^1_{cd}$ and $B^1_{dc} = 0$. In this case, the linked game may be a PD, an AP if the trade game itself is an AP, or a game with a dominant mutually cooperative equilibrium if the trade game itself has a dominant mutually cooperative equilibrium. Hence, the country which stands to gain from environmental cooperation (e.g., Canada) may be able to induce the country which stands to gain only on the trade front (e.g., the U.S.) to cooperate on the transboundary pollution issue if the costs of cooperation are not too high (i.e., if $B^1_{cc} + U^1_{cc} > 0$). One possible outcome of the negotiation process in this case is that the country that gains nothing on the pollution issue refuses to link it to trade. For example, if pollution control is more beneficial to country 2 than to country 1 then country 1 might prefer the outcome: Country 1 plays Open Trade-Minimal Abatement and country 2 plays Open Trade-Increase Abatement. If country 1 attempts to play this strategy does country 2 have any recourse? Country 2 does if they refuse to play the trade and pollution games separately and they can anticipate country 1's strategy of open trade with minimal abatement.[7]

In case (2) recall that the benefits from each issue domain fall mostly on one country. The payoffs in this case would satisfy, $0 \geq B^1_{cc} \geq B^1_{cd}$, $B^1_{dc} = 0$, $0 \geq U^2_{cc} \geq U^2_{dc}$ and $U^2_{cd} = 0$, and the two games yield dominant strategies for one player. In the environment game, the dominant strategy is for the first player is to defect. Similarly, defection is the dominant strategy for the second player in the trade game. However, if the two games are linked,

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[7]The assumption is similar to Hirshleifer and Coll's (1988) modeling of single period "Tit for Tat" strategies in their evolutionary model of collective action. The larger the difference $U^1_{cc} + B^1_{cc} - U^1_{cd}$ the more likely country 1's strategy will work. From an economic point of view this strategy may be quite weak if the open trade strategy is dominant in the trade game, the standard new if neoclassical trade theory (e.g., Bhagwati and Srinivasan, 1996). However, if the political costs of unilateral reduction of trade barriers ($-U^1_{cd}$) is high or the benefits of trade from country 1's point of view stem mainly from country 2 reciprocal lowering of its trade barriers, country 2's strategy of linkage may be quite effective.

then the linked game is a PD or an AP depending on the magnitude of the payoffs. If $B^{2}_{cc} > B^{2}_{dc}$ and $U^{1}_{cc} > U^{2}_{cc}$ then the linked game is an AP and if $B^{2}_{cc} < B^{2}_{dc}$ and $B^{2}_{cc} > B^{2}_{dc}$ then the linked game is a PD. Of course if the linked game is a PD the countries will have made little progress towards resolving the two issues. However, if the linked game is an AP then a coordinated solution becomes more likely. Examples of this type of situation are trade-environment linkages between the United States and Mexico, debt for nature swaps between wealthy countries and developing countries, and the acid rain-Gulf War linkage mentioned earlier.

Conclusions and Further Elaborations

Although we have presented linkage in terms of a one period game, the theory of repeated games (evolutionary or as in the Folk theorem) is also relevant. The Folk theorem says that many cooperative equilibria are possible in repeated PD games (suggesting that they resemble APs), while the evolutionary models of Hirshleifer and Coll (1988) and Sethin and Somanathan (1986) show that cooperative strategies may evolve as equilibrium strategies when agents can learn and adjust their expectations about how the other players behave in a PD. Hence, even in the asymmetrical case where the linked game is a PD situation, the fact that nations repeatedly interact yields the possibility of cooperation evolving over time. In repeated games, cooperation is supported by the ability of the players to sanction other players for noncooperative behavior. In the world of international relations sanctioning devices for non-cooperative behavior are limited. Since trade provisions are one of the few sanctioning devices available, it is perhaps inevitable that proposals to include trade measures in transboundary environmental agreements will continue. There are already a number of environmental agreements that include some trade measures. For example, the Montreal Protocol includes measures that restrict trade in substances that the treaty bans, with non-party countries (see Esty, 1994; Benedict, 1991; Sandler, 1997). The Montreal Protocol is also an interesting case because it provides selective incentives in the form of a $240 million fund to assist developing countries in phasing out CFCs, and a delayed phase-in period for CFC substitutes (Esty, 1994; Sandler, 1997).

Linkage of trade to the environment is not without controversy, especially if environmental problems are not transboundary in nature. Bhagwati and Srinivasan (1996) describe in some detail the arguments against this type of linkage, predominantly of the "slippery slope" variety. We have shown some of the specific considerations that define the risks of linkage even where transboundary externalities are present. The role of economists in these issues will be to frame the debate so that trade instruments are available for legitimate reasons -- such as the case when environmental issues are transboundary-- and are curtailed when they appear to be susceptible to hijacking for protectionist purposes.

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Figure 1. Trade and Environment Games

The Trade Game

		Country 2: Restricted Trade	Country 2: Open Trade	
Country 1	Restricted Trade	0, 0	0, U^2_{dc}	$1 - p^\tau$
	Open Trade	U^1_{cd} , 0	U^1_{cc} , U^2_{cc}	p^τ
		$1 - q^\tau$	q^τ	

The Environment Game

		Country 2: Don't Abate	Country 2: Abate	
Country 1	Don't Abate	0, 0	B^1_{dc} , B^2_{dc}	$1 - p^\rho$
	Abate	B^1_{cd} , B^2_{cd}	B^1_{cc} , B^2_{cc}	p^ρ
		$1 - q^\rho$	q^ρ	

Figure 2. The Linked Pollution-Trade Game

		Country 2		
		Restricted Trade-Moderate Abatement	Open Trade-Increased Abatement	
Country 1	Restricted Trade-Moderate Abatement	0, 0	B^{1}_{dc} , $U^{2}_{dc} + B^{2}_{dc}$	$1 - p^{\ell}$
	Open Trade-Increased Abatement	$U^{1}_{cd} + B^{1}_{cd}$, B^{2}_{cd}	$U^{1}_{cc} + B^{1}_{cc}$, $U^{2}_{cc} + B^{2}_{cc}$	p^{ℓ}
		$1 - q^{\ell}$	q^{ℓ}	

Figure 3.

Here it is assumed that pollution abatement is more beneficial to country 2 than to country 1. Another assumption is that country 2 can anticipate country 1's strategy of Open Trade with Minimal Abatement. Country 2 informs country 1 that if country 1 plays Open Trade-Minimal Abatement country 2 will respond with Restricted Trade-Minimal Abatement. If country 2 commits to this strategy, country 1's best strategy is Open Trade-Increased Abatement.

		Country 2: Restricted Trade-Minimal Abatement
Country 1	Restricted Trade-Minimal Abatement	0, 0
	Restricted Trade-Increased Abatement	B^1_{cd} , B^2_{cd}
	Open Trade-Minimal Abatement	U^1_{cd} , 0
	Open Trade-Increased Abatement	$U^1_{cd} + B^1_{cd}$, B^2_{cd}