The Political Economy of an International Environmental Agreement

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Abstract

This paper analyzes two small open countries that share a natural environment and consider an environmental agreement. The government representative in each country does not just maximize the general welfare, but picks a policy partially in response to 'functionally specialized' industrial and environmental lobbies. It is shown that an IEA (International Environmental Agreement) will be made as a subgame-perfect equilibrium if in both countries under the IEA industrial lobby's profit reduction fall short of the sum of general welfare gain and environmental lobby's extra benefit.

Key Words: Political Economy, IEA, Lobby, Subgame-Perfect Equilibrium.

1. Introduction

Environmental improvement in an internationally common environment is a prisoners' dilemma problem. The dominant strategy for each one of the relevant countries is to emit too much from a global point of view. Non-cooperation is the natural outcome in this game. Then, why do we observe cooperation like Montreal Protocols, Kyoto Protocols, etc? Many authors have explained or proposed alternative solutions for cooperation in the internationally common environment. Repetition of the prisoners' dilemma game (Barrett, 1994 and Kim, 1999), Matching (Guttman, 1978), Leadership (Hoel, 1991) and Side Payments (Carraro and Siniscalco, 1993) are examples. The government representative in these models has been implicitly assumed to be politically neutral. They are just like a machine that maximizes the general welfare. Siqueira (2003) is an exception. He analyzes two countries with reciprocal externalities in a median voters' model. Putnam (1988) also has analyzed diplomats facing both domestic politics and international negotiation.

In the same spirit this paper analyzes two small open countries sharing a natural environment and considering an agreement on improving the common environment. For this a simple model is presented where the government representative picks a policy in favor of its own interests. He (or she) is an elected official and wants to be reelected. So he (or she) cares about lobbies' contributions for election campaign money as well as general voters' welfare. Lobbies are assumed to arise easily overcoming a free-rider's problem. It is assumed that there are only two lobbies: industrial and environmental lobby. Lobbies are all 'functionally specialized' (Aidt, 1998). That is, industrial lobby cares only about member industries' profits and environmental lobby cares only about environmental damages to member consumers. Lobby formation and election process are left out of analysis just for simplicity. In each country lobbies offer contribution schedules non-cooperatively first and then politicians pick a policy each in an international negotiation.

This paper has followed Aidt (1998)'s lobby-politician framework and has applied Grossman and Helpman (1995)'s international agreement model to an international environmental problem. Grossman and Helpman (1995) has applied Bernheim and Whinston (1986)'s menu auction theory to FTAs (Free Trade Agreements). The purpose of this paper is to identify the condition under which a politically viable IEA evolves. It is shown that an IEA (International Environmental Agreement) will be made as a subgame-perfect equilibrium if the relevant countries' fundamental parameters like production technology, damage function, lobby organization

parameter and politicians' sensitivity to average voters' welfare are such that in both countries under the IEA industrial lobby's profit reduction fall short of the sum of general welfare gain and environmental lobby's extra benefit. Section 2 presents a basic framework. Section 3 analyzes the condition under which an IEA appears as an equilibrium. Lastly section 4 makes concluding remarks.

2. A Model

We consider two sovereign countries, $i = 1,2$ sharing a natural environment. Each country has $(n+1)$ competitive industries, $k = 0,1,...,n,$ and Good 0 is numeraire. The countries are small open economies. p_k^* is the world price for the kth goods. Country specific superscripts are to be omitted temporarily. Labor is the only input for producing the numeraire goods with CRS technology. Labor market is assumed to be competitive and thus the equilibrium wage rate is 1. The remaining n industries emit a pollutant, polluting the international common environment during the production processes. These polluting industries use three production inputs: labor l_k, industry specific capital goods K_k and raw material r_k. The use of raw material is the only source of pollution and the emission follows $e_k = h_k(r_k)$. Profit maximization leads to the following restricted profit function $\pi_k(p_k, w, z_k)$ where p_k and z_k are the domestic prices for the kth goods and raw material in the industry respectively. The profit function is strictly convex. By Hotelling's lemma, $\partial\pi_k / \partial p_k = x_k$ and $\partial\pi_k / \partial z_k = -r_k$.

There are N consumers and the typical consumer derives utility from consuming $(n+1)$ goods and disutility from the total amount of pollutants $\sum_i \sum_k e_k^i$. Notice that the disutility comes from the other country's emission as well as its own. These are summarized by the following quasi-linear utility function: $U = c_0 + \sum_{k=1}^{n} u_k(c_k) - D(\sum_i \sum_k e_k^i)$. Utility maximization leads to the demand functions for n polluting goods $d_k(q_k)$ and the demand for the numeraire goods $d_0(q_1,...,q_n) = I - \sum_k q_k d_k$ where q_k is the consumer price for kth goods.

The social welfare function W is consisted of three parts: consumers' indirect utilities, producers' profits and government revenue. The government revenue is just

the tax revenue minus subsidy expenditure and so it is a function of p,q and z: $R(p,q,z)$. Following Aidt (1998) the government revenue function is defined as follows: $R(p,z)=\sum_{k=1}^{n}(p_k^*-p_k)x_k+\sum_{k=1}^{n}(z_k-z_k^*)r_k$. Thus the social welfare function can be expressed as follows.

$$W=l+\sum_k \pi_k+R+N[\sum_{k=1}^{n}u_k(d_k)-\sum_{k=1}^{n}q_k d_k]-ND(\sum_i\sum_k e_k^i)$$

Notice that the environmental quality one country enjoys is influenced by the other country's pollution as well as its own. So, without cooperation, each country emits ignoring the effect of its emission on the other country's welfare through degrading the common environment and the resulting pollution level is too much from world optimum. Suppose the two countries consider an environmental agreement.

We assume that the incumbent government has been elected and is concerned with reelection or continuation of its office. So the government counts lobbies' giving campaign money for various interests. It is assumed that there are only two 'functionally specialized' lobbies: industrialists' lobby and environmentalists' lobby. A subset of n polluting industries, $j=1,...,m$, organize a producer lobby I that is only concerned with members' profits $\sum_j \pi_j$. Also environmentalists organize a lobby E to advocate environmental protection. The environmental lobby is only concerned with members' environmental benefits $K-s_E D$ where K is a constant and s_E is the proportion of environmentalists in the population. Lobbies compete each other in non-cooperative fashion by offering a money contribution schedule $\{C_{IR}\}$ and $\{C_{ER}\}$ to influence the government's choice where R represents a regime the incumbent government picks in an international negotiation.

Since the incumbent government cares about both campaign gifts and general voters' welfare, W, we assume that the government tries to maximize a weighted sum of campaign gifts and social welfare: $\sum_L C_L+aW$ for $L\in\{I,E\}$. Given the lobbies' gifts the politician picks a position A or N to maximize its objective, where A,N stands for signing on the agreement and not, respectively. Domestically in each country each lobby sets a contribution schedule non-cooperatively given the other lobby's offer. Then the politician, given the lobbies' offers, takes a position in the international

negotiation. The politician signs on the agreement if $\sum_L C_{LA} + aW_A \geq \sum_L C_{LN} + aW_N$.

Each country is assumed to manage the environment by imposing a pollution tax and subsidy. So the countries discuss on the globally optimal tax profile. Since we have assumed that the government representatives are sensitive to lobbies. it could be odd to assume that they negotiate just on the globally optimal tax rates. For whatever reason we just assume that they consider an agreement on the tax profile that maximizes $\sum_i W^i$, the true world optimum. To get the globally optimal tax rates the government representatives solve the following problem:

$$\underset{\{p_k^i, z_k^i\}}{Max}\ W^1 + W^2$$

The first order conditions are:

$$\frac{\partial \pi_k^i}{\partial p_k^i} + \frac{\partial R^i}{\partial p_k^i} - N^i \frac{\partial D^i}{\partial p_k^i} - N^j \frac{\partial D^j}{\partial p_k^i} = 0$$
$$\frac{\partial \pi_k^i}{\partial z_k^i} + \frac{\partial R^i}{\partial z_k^i} - N^i \frac{\partial D^i}{\partial z_k^i} - N^j \frac{\partial D^j}{\partial z_k^i} = 0 \quad \text{for all } i = 1,2,\ j = 1,2,\ i \neq j,\ k = 1,...,n.$$

These give us the globally optimal producer prices, $\{p_k^{i^*}\}, \{z_k^{i^*}\}$. We want to compare these to the ones under non-cooperative behavior. Without cooperation each country i solves the following problem, given the emission level of country $j \neq i$.

$$\underset{\{p_k^i, z_k^i\}}{Max}\ W^i$$

The first order conditions are:

$$\frac{\partial \pi_k^i}{\partial p_k^i} + \frac{\partial R^i}{\partial p_k^i} - N^i \frac{\partial D^i}{\partial p_k^i} = 0$$
$$\frac{\partial \pi_k^i}{\partial z_k^i} + \frac{\partial R^i}{\partial z_k^i} - N^i \frac{\partial D^i}{\partial z_k^i} = 0 \quad \text{for all } i = 1,2,\ k = 1,...,n.$$

Again we can solve these equations to get $\{p_k^{i^N}\},\{z_k^{i^N}\}$. Now for comparison, convert the first order condition for world optimum for country i and industry k as follows:

$$(p_k^* - p_k)\cdot\frac{\partial x_k}{\partial p_k} = (\sum_i N^i D^{i'})\cdot\frac{\partial h_k}{\partial r_k}\cdot\frac{\partial r_k}{\partial p_k}$$

The condition requires that the tax rate should be set according to an equi-marginal principle: to balance a marginal cost (reduction of tax revenue) and a marginal benefit (reduction of environmental damages). Notice that $p_k^* > p_k$ because all the other terms in the equation are strictly positive. Likewise, convert the first order condition for non-cooperative equilibrium:

$$(p_k^* - p_k)\cdot\frac{\partial x_k}{\partial p_k} = N^i D^{i'}\cdot\frac{\partial h_k}{\partial r_k}\cdot\frac{\partial r_k}{\partial p_k}$$

From these two we get $(p_k^* - p_k^A)\cdot\frac{\partial x_k}{\partial p_k}(p_k^A) > (p_k^* - p_k^N)\cdot\frac{\partial x_k}{\partial p_k}(p_k^N)$. Since the profit function is strictly convex, $\pi_{pp} > 0$. However we assume that π_p increases at a decreasing rate. This guarantees that $p_k^A < p_k^N$. In other words, the globally optimal tax rates are higher than the ones under non-cooperative equilibrium.

Assuming an agreement has been made and implemented, the welfare of the industrial lobby (or the environmental lobby) will be decreased (or increased) respectively: $\pi_j(p_j^A, z_j^A) < \pi_j(p_j^N, z_j^N)$ for all $j = 1,...,m$ and $D(\sum_i\sum_k e_k^i(r_k^i(p_k^{i^A}, z_k^{i^A}))) < D(\sum_i\sum_k e_k^i(r_k^i(p_k^{i^N}, z_k^{i^N})))$. Surely the total welfare under a global optimum will be increased from the stand-point of non-cooperative actions. However, a global optimum does not assign each country a higher national welfare. We just assume that the welfare of each country under the global optimum will be increased: $W_A^i > W_N^i$ for all $i = 1,2.$ so that the negotiation under consideration makes a sense to all countries.

3. Equilibrium Agreement

For an agreement to be made countries' voluntary participation is needed. Any country cannot be forced to sign on a document without its consent. Every country is sovereign entity. For dealing with this we just follow Grossman and Helpman (1995)'s notion of a unilateral stance. It represents the policy position that a country would pick if it believes its choice will determine the fate of an agreement. So for an agreement to be made it should be supported as a unilateral stance of each country.

Definition 1: A choice of regime $R \in \{A, N\}$ is a unilateral stance if there exits a set of political contributions $\{C_{LR}\}_{L\in\{I,E\}}$ such that (a) all contributions are non-negative; (b) for industrialists $C_{IK} \le \max\{0, \sum_{j=1}^{m} \pi_j(p_j^K) - \sum_{j=1}^{m} \pi_j(p_j^J)\}$ for $J = A, N; K = A, N; J \neq K$ and for environmentalists $C_{EK} \le \max\{0, s_E(D(\sum_i \sum_k e_k^J) - D(\sum_i \sum_k e_k^K))\}$ for $J = A, N; K = A, N; J \neq K$; (c) $\sum_L C_{LR} + aW_R > \sum_L C_{LK} + aW_K$ for $L = I, E$ and $K = A, N$; (d) for every lobby $L \in \{I, E\}$ there exist no non-negative contributions $(\hat{C}_{LA}\, \hat{C}_{LN})$ and no regime $\hat{R}_L \in \{A, N\}$ such that (i) $\hat{C}_{L\hat{R}_L} + C_{O\hat{R}_L} + aW_{\hat{R}_L} \ge \hat{C}_{LK} + C_{OK} + aW_K$ for $O \in \{I, E\}$, $L \neq O$ and for $K \in \{A, N\}$ and (ii) for the industrial lobby $\sum_j \pi_j(p_j^{\hat{R}_I}) - \hat{C}_{I\hat{R}_I} > \sum_j \pi_j(p_j^R) - C_{IR}$ and for the environmental lobby $s_E D(\sum_i \sum_k e_k^{\hat{R}_E}) + \hat{C}_{E\hat{R}_E} < s_E D(\sum_i \sum_k e_k^R) + C_{ER}$.

Condition (b) means that each lobby contributes for some regime the maximum extra benefits it can earn under that regime at most. For an example the industrial lobby sees its profits decrease under the agreement. So with condition (a) the industrial lobby contributes nothing for the agreement. Likewise the environmental lobby contributes nothing for maintaining the status quo non-cooperative actions. Condition (c) summarizes the politician's optimal response to lobbies' campaign gifts. The politician

just picks the position that maximizes its own objective. Lastly condition (d) requires that for each lobby there is no alternative contribution available leading to a higher welfare given the other lobby's contribution and the politician's optimal response.

Generically there are two kinds of a unilateral stance: an unpressured and a pressured one. An unpressured (unilateral) stance means the position the politician would pick even though all lobbies contribute nothing for that position. There always exists an unpressured stance in favor of regime $R \in \{A, N\}$. Suppose every lobby contribute nothing (i.e., $C_{IR} = C_{ER} = 0$) and does earn an extra benefits at most $a(W_R - W_{\tilde{R}})$ where $\tilde{R}$ stands for the alternative regime. Then no lobby would try to change the government decision and the government picks the position because it maximizes the general voter's welfare. However we already know that $W_A > W_N$ and thus there exist an unpressured stance only in support of the environmental agreement.

Next we would like to consider a more interesting case, a pressured stance. A pressured stance represents the position that the government would pick partly in response to the lobbies' positive contributions.

Proposition 1: (Grossman and Helpman (1995)) If there exits a pressured stance in support of regime R, then

$$(\sum_j \pi_j(p_j^R)) + K - D(\sum_i \sum_k e_k^R)) + aW_R \geq (\sum_j (\pi_j(p_j^{\tilde{R}})) + K - D(\sum_i \sum_k e_k^{\tilde{R}}) + aW_{\tilde{R}}$$

Proof: First, the government must be left indifferent between the two regimes, A, N. Otherwise, the winning side can reduce its contribution without affecting the government's choice. Suppose the regime A have been picked up. Then, $\sum_L C_{LA} + aW_A = \sum_L C_{LN} + aW_N$. Once we know the government is left indifferent, we also know that the industrial lobby (losing side under regime A) bids for the full amount of what it stands to lose under regime A. Otherwise, the industrial lobby could make a marginal increase in its contribution for regime N, causing to break the balance towards its preferred regime N. So, $C_{IN} = \sum_j (\pi_j(p_j^N) - \pi_j(p_j^A))$. Since $C_{IA} = C_{EN} = 0$ and the environmental lobby bids for A at most what it stands to get under regime A, $s_E(D(\sum_i \sum_k e_k^N) - D(\sum_i \sum_k e_k^A))$, finally we get

$s_E(D(\sum_i \sum_k e_k^N) - D(\sum_i \sum_k e_k^A)) + aW_A \geq \sum_j (\pi_j(p_j^N) - \pi_j(p_j^A)) + aW_N$. The other case of the regime N being picked up can be proved likewise. □

Proposition 1 says that the pressured stance maximizes the sum of lobbies' total benefits and a times general voters' welfare. Both non-cooperation and cooperation can be taken as a unilateral stance. Notice, however, that the government as well as environmentalists cares about the environmental quality and if non-cooperation could be sustained as a unilateral stance the profits loss of industrialists under the agreement is sufficiently large so that the industrial lobby's contribution exceed the sum of the environmental lobby's contribution and a times general welfare gain.

So far we have seen that there can exit both an unpressured and a pressured unilateral stance and an unpressured one exits only for $R = A$. What if both an unpressured and a pressured stance exit and are different from each other? In other words, if an unpressured stance exit for A and a pressured stance exit for N, what would the government pick? Following Bernheim et. al. (1987) and Grossman and Helpman (1995), we argue that the pressured stance prevail as a coalition-proof equilibrium. Under an unpressured stance A the losing side (industrialists) can form a coalition and given the zero contribution of non-members of the coalition (environmentalists) contribute a positive amount for N exceeding a times general voters' welfare loss, but less than their extra profits under N.

Now it's the time to analyze the international negotiation. The game proceeds as follows: lobbies move first anticipating the other government's choice and then the politicians negotiate. The negotiation will fail if at least one of the countries takes N as its unilateral stance. The IEA can be made only when each country anticipates the other country will take A and their anticipations come true. Again we just follow Grossman and Helpman (1995)'s notion.

Definition 2: An IEA (International Environmental Agreement) is an equilibrium agreement if and only if $R = A$ is a unilateral stance in both countries.

Thus an IEA is a subgame-perfect equilibrium. In order that an agreement can be reached either the environmental lobby in each country needs to prevail politically, or no lobbies contribute anything and industrial lobby has no incentive to change the government's choice. In other words, the profits loss accruing to the industrial lobby should not be such a large one that the industrial lobby is to prevail in the political game.

So we can characterize the condition under which an IEA can be sustained as a subgame-perfect equilibrium as follows.

Proposition 2: If the production technology $\{h_k^i\}$, damage function $\{D^i\}$, lobby organization parameter $\{m^i, s_E^i\}$ and politicians' sensitivity to general voters $\{a^i\}$ in both countries are such that $\sum_j(\pi_j(p_j^N)-\pi_j(p_j^A)) \le a(W_A - W_N) + s_E(D(\sum_i\sum_k e_k^N) - D(\sum_i\sum_k e_k^A))$, an IEA (international environmental agreement) will be made as a subgame-perfect equilibrium.

The less the industrial production relies on environmental inputs, the more consumers are sensitive to the environmental degradation, the less industrialists are organized, the more environmentalists are organized and the more politicians are sensitive to general voters' welfare, the more the industrial lobby's profit reduction $\sum_j(\pi_j(p_j^N)-\pi_j(p_j^A))$ fall short of the sum of general welfare gain $a(W_A - W_N)$ and environmental lobby's benefit $s_E(D(\sum_i\sum_k e_k^N) - D(\sum_i\sum_k e_k^A))$. If the industrial lobby's profit reduction get even smaller and fall short of $a(W_A - W_N)$, lobbies contribute nothing and the government picks A nonetheless.

4. Conclusion

Countries sharing a common environment play a prisoners' dilemma game when they decide how much to emit and non-cooperation evolves certainly in one-shot game. Cooperation gives a higher global welfare to the relevant parties, however. Many authors explain cooperation as they have observed or propose alternative solutions for cooperation. Repetition of the prisoners' dilemma game, Matching, Leadership and Side Payments are examples. However, these models assume a politically neutral government representative implicitly. Different from these traditional models, this paper has the government representative as an explicit player in both domestic political game and international negotiation as we observe in reality.

It is assumed that an IEA can be reached only if all the politicians in relevant countries take 'signing on the agreement' as their unilateral stances. We have shown

the condition under which an IEA will be made as a subgame-perfect equilibrium: if the relevant countries' fundamental parameters like production technology, damage function, lobby organization parameter and politicians' sensitivity to average voters' welfare are such that in both countries under the IEA industrial lobby's profit reduction fall short of the sum of general welfare gain and environmental lobby's extra benefit. In any one of relevant countries, as long as industrial lobby's profit reduction is greater than general welfare gain, but still less than the sum of general welfare gain and environmental lobby's extra benefit, industrial lobby contributes as much as what it stands to lose, environmental lobby contributes just as much as the difference between general welfare gain and industrial lobby's contribution, and the government politician picks 'signing on the agreement' as its policy. If the profit reduction gets smaller than general welfare gain in both countries, then lobbies contribute nothing and politicians sign on the agreement nonetheless.

This paper has several limitations. Industrialists as consumers must have a concern for environmental quality and environmentalists as input owners must have a concern for profits. That is, everyone has multiple goals, but only two lobbies are assumed to exit and to be all 'functionally specialized' (Aidt, 1998). Lobby formation and election process are left out of analysis. It is just assumed that people can overcome the 'free riders problem' in forming a lobby. The condition for an IEA being able to be made needs to be more parameterized, but only a general result is presented. A Multilateral IEA like Montreal Protocols and Kyoto Protocols is more interesting and realistic, but only a bilateral agreement is analyzed. Lastly it is implicitly assumed that countries will abide by the agreement once it has been made. However, enforcement is a critical problem in reality. These are all left for future studies.

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