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## Raising rivals' costs with environmental regulation: An intertemporal lobbying approach

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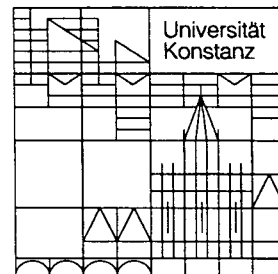
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Achim Körber

**Raising Rivals' Costs**  
**with Environmental Regulation**  
An Intertemporal Lobbying Approach

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# **Raising Rivals' Costs with Environmental Regulation**

- An Intertemporal Lobbying Approach -

**Achim Körber**

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# **Raising Rivals' Costs with Environmental Regulation**

## **- An Intertemporal Lobbying Approach - \***

by

**Achim Körber**

### **Abstract:**

This paper addresses the question why a lot of firms demand stricter environmental regulation. With non-identical producers within the same industry, lobbying for tighter environmental rules turns out to be an important strategy of raising rivals' costs. Furthermore, the paper explains when the potential target firms of stricter regulation in such an intra-industrial competition engage in counter-lobbying and when they remain silent.

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## 1. Introduction

During the last decades problems of protecting the environment advanced upon the scales of the political agenda of most western countries. Environmental damages, like the dying of forest caused by acid rain, have become very visible, and an increasing number of people agree that the protection of our natural resources is necessary.

Thus, when asked for policy advice in this field, economists were in a good position because "(w)hen the 'environmental revolution' arrived in the 1960's, economists were ready and waiting. The economic literature contained an apparently coherent view of the nature of the pollution problem together with a compelling set of implications for public policy."<sup>1</sup>

Although a broad literature, starting with Pigou (1929) and Coase (1960), on first- and second-best environmental regulation exists, inefficient and partly counterproductive laws are not the exception but the rule. Furthermore, the process of environmental decision-making is accompanied by massive, potentially socially wasteful lobbying activities. Before and during the Conference on Climate Change in Berlin at the beginning of this year different interest groups invested massively in lobbying in favour of or against stricter laws. In other cases only those groups in favour of tighter standards tried to influence the policy-maker, while the potential target of such rules remained silent.

All this seems to contradict the picture of a political process with benevolent politicians maximising society's welfare. Hence, the question arises, apart from the protection of the environment, what are the reasons for environmental regulation? The Public Choice view draws the attention to distributional effects of regulation. Maloney and McCormick (1982), for example, point out that certain quality standards restrict the firms' output and, hence, allow for cartel profits. Apart from environmentalists, there may be profit-maximising firms aiming at tighter environmental regulation. They behave "like bootleggers and baptists seeking for closing corner liquor shops on Sundays", as Yandle (1988) describes. Furthermore, stricter environmental laws are demanded by domestic producers seeking new ways of protecting their markets since GATT- or WTO-rules have made conventional protectionism more difficult.

This paper addresses another important reason for firms to demand stricter environmental regulation. Relaxing the severe assumption of identical firms leads to the conclusion that strategies of raising rivals' costs can serve as a major device of intra-industrial competition. Salop and Scheffman (1983) stressed the superiority of such firm conduct compared to predatory pricing because it does not require a deep pocket. Oster (1982) emphasises the merits of inspiring regulation to weaken competitors. This analysis aims at explaining under

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<sup>1</sup> Baumol and Oates (1980, S. 1).

which conditions firms will start to lobby for stricter environmental regulation in intra-industrial competition. Furthermore, the paper gives explanations for different lobbying behaviour of firms promoting stricter or unchanged environmental regulation. It will be shown that different types of lobbying contests are consistent with the model. On the one hand situations are explained, where all relevant groups engage in favour of or against tighter laws, like during the recent Conference on Climate Change in Berlin. On the other hand a setting is within the framework of the analysis, where the potential target group of such regulation remains silent.

In section 2 the idea of "Raising Rivals' Costs" and different categories of lobbying are discussed. In section 3 a static lobbying model with two firms deciding simultaneously on their lobbying contributions is developed. Section 3.1 interprets the different lobbying equilibria. In the fourth part the model is extended by a second period to analyse whether firms have different equilibrium strategies in both periods. Section 5 concludes.

## **2. Intra-Industrial Competition and Environmental Regulation**

Although much of the Public Choice literature treats interest groups as homogenous entities, "(f)irms competing in the same market need not choose identical corporate strategies..." (Newman, 1978). Firms belonging to the same interest group can be different in size, technology, level of integration, etc. Caves and Porter (1977) and Porter (1979) recognise sub-groups within an industry and define them in terms of different strategies. Given actual or potential barriers to entry, competition will increase if these groups are fairly independent.

Thus, given such intra-industrial competition, strategies of raising rivals' costs to weaken competitors become important. A promising instrument to achieve this goal is lobbying for stricter environmental regulation<sup>2</sup> because these laws frequently classify production processes as being either environmentally sound or not environmentally friendly<sup>3</sup>. Those considered to be "dirty" are regularly subject to potential environmental regulation. Hence, for those sub-groups that can meet certain standards more easily than their competitors, it is reasonable to influence the political process in favour of stricter regulation. The behaviour of those firms which are subject to potential environmental regulation crucially depends on their access to the new and "clean" technology. If they cannot buy new production lines, even in the long-run, "counter" lobbying in order to decrease the probability of implementing the "offending" regulation will be

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<sup>2</sup> Oster (1982) stresses the importance of inducing discriminative regulation to weaken competitors in the market place.

<sup>3</sup> See e.g. the German Bundesimmissionsschutzgesetz which aims at controlling emissions. Firms with old and new technologies are treated differently.

the only way to defend their position in the market. If there is access to the new technology in the short run, the value of the old machines will be likely to dominate the firms' decisions and they will shift to lobbying efforts, while in the long run substitution of the "dirty" technology will tend to be the favourable strategy.

At some airports, for example, competing airlines use different kinds of planes. Some firms own relatively silent planes while others stick to older and louder ones. It can be profitable for the firms with the modern and more silent planes to engage in lobbying for stricter noise-reduction standards at the airports<sup>4</sup>. These stricter noise reduction standards can result in higher fees for their competitors or withdrawal of the permission to use the airport. In the short run the "offended" firms are not able to substitute their old planes for more silent aircraft. Hence, such attempts to exclude a competitor from the market or at least increase its costs might of course encourage the firm which is subject to potential regulation to engage in a kind of counter lobbying.

It is standard to define lobbying as a mapping from lobbying contributions into political outcomes. Lobbying outlays usually influence the probability of winning a contest. Tullock (1980) and Hirshleifer (1989), for example, developed their well-known contest-success functions this way. But the definition of lobbying contributions itself is very broad. It consists of money invested in influencing the media, campaign contributions, donations to political parties, as well as perquisites and presents for bureaucrats. Broadly one can divide up these lobbying efforts into two categories:

- public lobbying and
- hidden lobbying.

Efforts to influence the public opinion by, for example, supplying information through own research institutes and hearings, or campaigns in favour of or against certain policy measures belong mainly to the first category. Such lobbying efforts can easily be observed by the public. On the other hand donations to parties or campaign contributions for individual candidates are usually hidden from the public<sup>5</sup>. These hidden contributions or presents can include perquisites for bureaucrats and politicians. Whether the borderline between legal ways of supporting a certain policy and corruption is crossed, crucially depends on the legal order of the country. Thus, it is not claimed that politicians or bureaucrats who are involved in such lobbying processes are corrupt. Nevertheless, it should be stressed that the distinction between

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<sup>4</sup> Gialloretto (1989) describes such lobbying activities at the Frankfurt/Main airport.

<sup>5</sup> Nevertheless, the borderline between both categories of lobbying might be unclear. In some countries parties or single candidates to an election have to publish at least a part of the contributions they get.

supporting parties or candidates to election and corruption is drawn by the law and not by a significantly different economic behaviour of the single actors.

The process of environmental decision-making reflects both forms of lobbying contests. The UN-Conference on Climate Change in Berlin at the beginning of 1995 can serve as an example that some problems of protecting the global commons are discussed in public. Hence, many of the efforts of certain interest groups to influence the discussion were very visible. On the other hand regulating local environmental problems, for example, either on the national or local level, like noise reduction standards or emission permissions for factories, seems more likely to fall into the category of hidden lobbying. These local environmental regulations discriminating among firms and sometimes among regions are one promising candidate for firms to use as a strategy of "Raising Rivals' Costs".

Compared to other strategies of intra-industrial competition, lobbying for stricter environmental laws contains an element of irreversibility or in other words a kind of ratchet effect. Thus, once implemented we hardly observe that environmental regulation is lowered again in the next period.

### 3. The One-Period Model

Consider a two-firm contest where both firms ( $U_1, U_2$ ) are assumed to be identical except for their technology.  $U_2$  uses a dirtier technology than  $U_1$  and is subject to potential governmental regulation. For simplicity it is assumed that once regulatory measures are taken, firm 2 has to drop out of the market because its profits are reduced to zero. On the other hand  $U_1$  will earn the monopoly profit  $[\pi^M]^6$ . If no regulation is taken at all, both firms will earn normal duopoly profits  $[\pi^D]$ .

The firms are assumed to be risk-neutral and to maximise their expected profits. They can influence the regulatory process by making lobbying contributions. If both firms engage in lobbying and spend outlays ( $L_i, i = 1, 2$ ), the regulation will be implemented with the probability  $p_1$ . If only  $U_1$  enters the lobbying process, the implementation probability is  $p_2$  which is higher than  $p_1$ . In both cases the probabilities that the regulation is not implemented are  $1-p_1$  and  $1-p_2$  respectively. Thus, for  $U_2$  it can pay to enter the lobbying process in order to decrease the probability of being forced to leave the market from  $p_2$  to  $p_1$ . If there is no lobbying at all, no regulation will be passed for sure.

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<sup>6</sup> It should be noted that  $\pi^M > 2 \pi^D$ .



Both firms' lobbying activities are restricted to either not spending lobbying outlays or investing the maximum possible amount. Thus, normalising, the strategies in each period are  $L_i = 0$  and  $L_i = 1$  with  $i = 1, 2$ <sup>7</sup>.

To capture the main idea of hidden lobbying it is necessary that both firms decide on their lobbying contributions without knowing each other's decision. If otherwise the focus is on public lobbying, three scenarios can be considered. On the one hand it is possible that both firms have to decide in a certain order. Either firm 1 or firm 2, therefore, takes the position of the Stackelberg leader. In a hearing or a court trial, for example, the order of the moves is determined in advance and a Stackelberg game would be the appropriate framework. On the other hand public lobbying in the sense of influencing the people by campaigns, advertisements, etc. means that there is a certain period of time where both competitors have the chance to engage in the lobbying process. This seems to be very likely in regulatory processes. Firms can take part in hearings held by the government or the parliament, contributions can be spent on measures to use the media for influencing the regulator before its decision. Until the policy-maker makes a decision, both firms can only have beliefs about each other's behaviour because it is always possible that one of them will again spend lobbying outlays. The later ideas, like those of hidden lobbying, can be caught in a game of imperfect information.

The game can be described by the following game tree:

Insert Figure 1

$U_1$  decides on engaging in lobbying or not and sets  $L_1 = 1$  or  $L_1 = 0$ . Now firm 2 has to make up its mind concerning on its lobbying activities without knowing whether it is on the right or the left branch of the game tree. After the second firm's decision stricter environmental regulation will be implemented with the probability  $p_1$  if both firms spend lobbying outlays and with the probability  $p_2$  if only firm 1 invests resources to influence the regulator. The probability  $p_2$  is assumed to be larger than  $p_1$  because if there is no kind of "counter-lobbying" by the offended firm, the regulator will be more likely to implement stricter environmental standards. If the regulation is passed, firm 2's profit will be reduced to zero while firm 1 will earn a monopoly rent. The regulator or policy-maker is just the broker of the different interests, and, therefore, plays no active role.

Each firm will engage in lobbying if its expected profit with lobbying is higher than with refraining from such activity. Using the pay-offs depicted in figure 1 we obtain the firms' reaction equations depicted in Appendix 1.

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<sup>7</sup> It should be noted, therefore, that  $\pi^M$  and  $\pi^D$  reflect the monopoly or duopoly profit divided by the fixed maximum amount of lobbying outlays.

### 3.1 Results of the One-Period Model

Knowing the firms' reaction equations the parameter values of the different equilibria are derived. Setting  $L_1$  and  $L_2$  equal to 1, for example, leads us to the following conditions:

$$L_1 = 1 \Leftrightarrow (\pi^M - \pi^D) p_1 > 1 \quad (1')$$

$$L_2 = 1 \Leftrightarrow \pi^D (p_2 - p_1) > 1 \quad (3')$$

With  $p_2 > p_1$  and  $\pi^M > \pi^D$  which follow from the structure of the model both conditions can be fulfilled simultaneously. According to (1')  $U_1$  will engage in lobbying if its expected profit exceeds its expected cost from lobbying. The expected profit is equal to the difference of the monopoly and duopoly profit weighted with  $p_1$ , the probability of winning a two-sided lobbying contest, while the normalised cost of lobbying equal 1. Firm 2's decision, respectively, is driven by its expected cost which are equal to 1 and its expected profit which is the duopoly profit weighted with firm 1's probability of success in a one-sided lobbying contest minus  $U_1$ 's probability of success in a one-sided contest

By the same procedure three equilibria in pure strategies can be derived where the first column describes  $U_1$ 's equilibrium strategy while column 2 denotes  $U_2$ 's optimal behaviour<sup>8</sup>:

$$(1, 1), \quad (1, 0), \quad (0, 0).$$

Figure 2 depicts all equilibria in the  $p_2$ - $p_1$ -space:

Insert Figure 2

The above equilibria depend on four exogenous variables. The monopoly and the duopoly profit are determined by the characteristics of the market. Thus, the absolute and relative size of the profits differ from industry to industry.

While the profits reflect features of the relevant markets, both probabilities,  $p_1$  and  $p_2$ , describe the regulator's responsiveness to lobbying for stricter environmental regulation. In a setting where both probabilities are low the policy-maker will hardly implement stricter environmental laws, regardless whether one or both firms engage in lobbying. That might result from institutional constraints on the politicians' and bureaucrats' ability to appropriate lobbying contributions or a general unwillingness of the policy-maker to use environmental regulation.

If both probabilities are high, the government will be very willing to use environmental regulation if firm 1 engages in lobbying while the counter lobbying of firm 2 cannot

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<sup>8</sup> See Appendix 1.

significantly decrease the probability. One might speak of a "Green Government" where the regulator will generally like to use environmental regulation if it obtains lobbying contributions<sup>9</sup>.

The case where  $p_2$  is very high compared to  $p_1$  describes a situation where the government is very willing to implement stricter environmental regulation as long only one firm engages in lobbying. As soon as the second firm enters the lobbying contest the probability of implementation decreases to a low  $p_1$ . Perhaps, the second firm has better access to politicians and bureaucrats and as soon as it starts lobbying firm 1's influence is significantly diminished. Hence, the government switches to a policy where it is more unlikely to pass stricter regulation.

### Two-Sided Lobbying Contest (1, 1)

In such a setting firm 1 enters the contest, because  $p_2$  and  $p_1$  are beyond threshold values which are determined by its stake, the difference between the monopoly and the duopoly profit ( $E4$  and  $E3$ )<sup>10</sup>. The higher the stakes, the lower will be the minimum probabilities for  $U_1$  to enter the contest.

The "dirty" firm can change the probability of implementation from  $p_2$  to  $p_1$  by entering the lobbying process. In this equilibrium the difference is high enough to make it profitable for firm 2 to invest in lobbying ( $E1$ ).

A two-sided lobbying contest with both firms engaging in lobbying occurs in a setting where  $p_2$  is high and  $p_1$  exceeds a certain threshold value ( $E3$ ). The policy-maker will generally be fond of using environmental regulation if he receives lobbying contributions. Thus, it is likely for firm 1 to increase its profits from  $\pi^D$  to  $\pi^M$  by lobbying for political measures. For  $U_2$  it is profitable to spend resources on influencing the regulator because the difference  $p_2 - p_1$  is large. Hence, it pays for  $U_2$  to engage in lobbying in order to significantly decrease the probability of losing the duopoly profit from  $p_2$  to  $p_1$ . The area of this equilibrium within the  $p_2$ - $p_1$ -space will increase if  $U_1$ 's stake, the difference between  $\pi^M$  and  $\pi^D$ , increases ( $E3$ ). Likewise, the higher  $U_2$ 's duopoly profit the more firm 2 is willing to spend lobbying outlays, even if the difference of the probabilities becomes smaller ( $E1$ ).

Such an equilibrium belongs to an institutional framework where the government generally has no objections using environmental regulation. Protection of natural resources might be a very

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<sup>9</sup> However, apart from this general willingness to use environmental regulation, the high probabilities might depend on firm 1's superior access to politicians as well.

<sup>10</sup> The constraints  $E1$  to  $E11$  refer to the Figure 2 and Figure 4 and are derived in Appendix 1 and Appendix 2.

sensible topic and measures undertaken to decrease e.g. pollution will be widely appreciated, even if one interest group is disadvantaged. Nevertheless, the potential "target firms" of the new laws have access to the policy-maker because they are able to decrease the probability of implementing the "offending" regulation by setting  $L_2 = 1$ .

#### One-Sided Contest (1, 0)

Firm 1 enters the contest, because  $p_2$  exceeds a minimum requirement given by  $p_2 > 1/(\pi^M - \pi^D)$  (E4) which is determined by  $U_1$ 's stake. Thus, the larger firm 1's stake, the smaller the threshold value of  $p_2$  for it to enter the contest.

Only firm 2 does not spend any resources on lobbying because the difference between the probability of implementing the new regulation with only firm 1 in the contest ( $p_1$ ) and the one with both firms trying to influence the regulator ( $p_2$ ) is too small. Thus, switching from  $p_1$  to  $p_2$  does not pay for  $U_2$ .

Nevertheless, by Constraint (E1) we know that the smaller  $U_2$ 's stake,  $\pi^D$ , the larger must be  $p_2 - p_1$  in order to make it advantageous for firm 2 to set  $L_2 = 1$ . With an increasing stake for firm 2 the area of one-sided lobbying decreases because the restriction comes closer to the 45°-degree-line. Firm 1, on the other hand, will always enter the lobbying contest as long as  $p_2$  is larger than a threshold which is given by (E4). As firm 1's stake, which is identical to  $\pi^M - \pi^D$ , increases, the threshold value of  $p_2$  will decrease and the region of (1, 0) will grow at the expense of the "No-Lobbying Area".

This outcome suggests that firm 2's influence on the policy-maker is very limited because its lobbying outlays can only minimally reduce the probability of implementation.

#### No-Lobbying Contest (0, 0)

As already mentioned firm 2 will not play  $L_2 = 1$  if  $p_2$  and  $p_1$  are too similar, and thus it will not pay to invest resources in lobbying. Hence, the situation for  $U_2$  is structurally the same as in the "One-sided Lobbying Contest".

For  $U_1$  the conditions are different. Both,  $p_2$  and  $p_1$ , are too small to make it profitable for the "clean" firm to engage in lobbying. Both probabilities are below a certain threshold which is directly determined by firm 1's stake. Hence, if the stake decreases, minimum probabilities increase. Thus, given a decreasing stake of  $U_1$ , the size of this area increases according to the constraints (E3) and (E4).

The equilibrium (0, 0) is likely when the regulator prefers not to use environmental regulation and, therefore, the probabilities of implementation are very low. This might apply to an

institutional frame where the state generally objects to interventions, or protection of the environment is not regarded as a pressing problem.

#### 4. Extension: The Intertemporal Model

By neglecting the time-dimension, the model developed so far cannot address the question whether there might exist an incentive for the firms to use different strategies over time. Will there, thus, be more parameter constellations where one or both firms engage in lobbying?

To answer this question the model is extended by a second period. Hence, firm 1 has the chance to influence the regulator in a second period, and the "dirty" firm has to decide twice whether to respond to possible lobbying activities by entering the contest itself.

Compared to other strategies of intra-industrial competition, lobbying for stricter environmental laws contains an element of irreversibility or in other words a kind of ratchet effect. Thus, once implemented, it is hardly observed that environmental standards are lowered again very soon. Hence, the decision is irreversible<sup>11</sup>.

The game, therefore, can be summarised in Figure 3.

Insert Figure 3

In the first period  $U_1$  decides whether it should engage in lobbying or not. Again, firm 2 does not know whether it is in the left or the right branch of the game tree and decides under this informational constraints whether to lobby or not. Normalising, the lobbying outlays  $L_i$  can equal zero or one.

If both firms decide to lobby the first time, stricter environmental regulation will be implemented with the probability  $p_1$ , and with the bigger probability  $p_2$  if only  $U_1$  was in the contest. Given stricter regulation in the first period firm 1 earns a monopoly profit in both periods while firm 2's profits are reduced to zero. The policy-maker's decision, therefore, cannot be contested again in the second period. If firm 1 did not spend any lobbying outlays in the first period, no regulation will be implemented for sure in this period.

In the second period the game will be played again, if either firm 1 engages in lobbying before, but the implementation of the stricter rules failed with the probabilities  $1 - p_1$  or  $1 - p_2$ , or if  $U_1$  does nothing the first time.

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<sup>11</sup> For a discussion of "final decisions" see Stephan/Ursprung (1995).

The game is solved by backward-induction. Using Table 1 the firms' reaction equations for period 2 are calculated.

Insert Table 1

The resulting subgame equilibria for the second period are the same as in the static model. For each possible subgame equilibrium of this stage the pay-offs of the first period are calculated.

Providing an example, Table 2<sup>12</sup> gives the pay-offs of the first period subject to a second-period subgame equilibrium of (0, 0).

Insert Table 2

Again the firms' reaction equations are calculated subject to each pair of optimal second-period strategies<sup>13</sup>. This leads us to the following equilibria, where the columns depict the firms, and the rows the periods.

$$\begin{pmatrix} 0, & 0 \\ 0, & 0 \end{pmatrix}, \quad \begin{pmatrix} 1, & 0 \\ 0, & 0 \end{pmatrix}, \quad \begin{pmatrix} 1, & 0 \\ 1, & 0 \end{pmatrix}, \quad \begin{pmatrix} 1, & 1 \\ 1, & 0 \end{pmatrix}, \quad \begin{pmatrix} 1, & 1 \\ 1, & 1 \end{pmatrix}.$$

Thus, in two out of five pure-strategy equilibria both firms will change their optimal behaviour from period to period, which are explained in more detail. For the other equilibria the explanations given for the static model can be applied again.

Insert Figure 4

#### One-Sided Lobbying Contest in Period 1 and No Lobbying in Period 2

Firm 1 will always engage in lobbying as long as the probability of implementation with only one firm in the contest exceeds a certain threshold value. This minimum  $p_2$ , which is determined by firm 1's stake, is different in both periods. With a lower value in the first period the "clean" firm is willing to engage in lobbying at a lower stake than in the second period. This is due to the fact that  $U_1$ 's expected gains from lobbying are decreasing over time.

Firm 2 is still not in the contest because it cannot benefit enough to "switch" from  $p_1$  to  $p_2$  by entering the contest. This equilibrium area in the  $p_2$ - $p_1$ -space will shrink if firm 1's stake (E3 and (E4) or firm 2's stake (E1) rises.

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<sup>12</sup> The structure of the first-period game tree is the same as in the static case. Hence, the pay-offs (a) - (f) of Table 3 can be combined with Figure 1.

<sup>13</sup> See Appendix 2.

## Two-Sided Lobbying Contest in Period 1 and One-Sided Lobbying Contest in Period 2

In this equilibrium firm 2 changes its strategy from period 1 to period 2. While at first it will spend lobbying outlays if the difference between the probabilities  $p_2$  and  $p_1$  is large enough (E9) it will not invest any resources in the second period. Compared to the two-sided lobbying contest in both periods where  $U_2$  will invest contributions if the difference between both probabilities exceeds the value given by constraint E1, the threshold for entering the contest is smaller here. This is due to the fact that  $U_2$ 's expected loss from potential environmental regulation is decreasing over time. Thus, in the second period the decrease in the probability of losing the profit (E1) has to be larger than in the first period (E9) because firm 2's expected losses are smaller and it has less to lose.

For firm 1 not too much changes compared to the static model. As soon as  $p_2$  is beyond a certain threshold  $U_1$  starts to invest in lobbying. Nevertheless, the area of no equilibrium in the  $p_2$ - $p_1$ -space increases in the first period.

Hence, including the time-dimension in the model generates more parameter constellations under which one or both firms invest resources in lobbying.

## **5. Conclusions**

This paper analysed a new rationale for environmental decision-making from a Public Choice perspective. Strategies of "Raising Rivals' Costs" in an intra-industrial competition give an additional reason why even domestic firms engage in lobbying for stricter environmental regulation. Two firms, one using a "clean", and the other employing a "dirty" production technology, tried to influence the policy-maker in favour of or against tighter environmental standards. The "clean" firm aimed at excluding the "dirty" firm from the market by raising these standards, while its competitor tried to defend its profits by "counter" lobbying.

The paper explained different kinds of lobbying contests known from actual environmental decision-making. Conditions for two-sided, one-sided and no lobbying contests were worked out where the decisive determinants were the firms' stakes and the institutional setting represented by the regulator's willingness to implement tighter environmental standards. Furthermore, trying to explain the empirical fact that some firms change their lobbying strategy over time we could show in an intertemporal model that there exist situations in which firms change their equilibrium strategy over time. This is due to the fact that  $U_1$ 's expected gains from lobbying decrease over time while firm 2's expected loss from potential environmental regulation decreases over time.

This paper was a first step to analyse intra-industrial competition by lobbying for stricter environmental regulation. However, as mentioned before, the analysis so far was restricted to hidden lobbying and some aspects of public lobbying. It is subject to further research to capture further features of lobbying contests. Furthermore, as an extension one could think of a framework where the regulator strategically chooses the institutional framework in order to maximise its lobbying contributions<sup>14</sup>.

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<sup>14</sup> see, for example, Körber/Kolmar (1995).



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## 7. Appendix 1: Subgame Equilibria in Period 2

### 1. The Firms' Reaction Equations

Firm 2:

- Assume  $L_1 = 1$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow (p_2 - p_1) \pi^D \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (1') \\ (1'') \end{matrix}$$

- Assume  $L_1 = 0$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow \pi^D - 1 \begin{Bmatrix} \geq \\ < \end{Bmatrix} \pi^D \quad \begin{matrix} (2') \\ (2'') \end{matrix}$$

Firm 1:

- Assume  $L_2 = 1$

$$L_1 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow p_1 (\pi^M - \pi^D) \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (3') \\ (3'') \end{matrix}$$

- Assume  $L_2 = 0$

$$L_1 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow p_2 (\pi^M - \pi^D) \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (4') \\ (4'') \end{matrix}$$

### 2. Parameter values of the Subgame Equilibria in Period 2

a) (0, 0)

$$\pi^D - 1 < \pi^D \quad (2'')$$

$$\wedge p_2 (\pi^M - \pi^D) < 1 \quad (4'')$$

b) (0, 1)

$$\pi^D - 1 \geq \pi^D \quad (2')$$

$$\wedge p_1 (\pi^M - \pi^D) < 1 \quad (3'')$$

This is not a possible outcome because (2') cannot be fulfilled.

c) (1, 0)

$$(p_2 - p_1) \pi^D < 1 \quad (1'')$$

$$\wedge p_2 (\pi^M - \pi^D) \geq 1 \quad (4')$$

Both conditions can be fulfilled simultaneously. Substituting (1'') in (4') leads to

$$\pi^D \left(2 - \frac{p_1}{p_2}\right) < \pi^M \text{ which always valid because } \pi^M > 2 \pi^D.$$

d) (1, 1)

$$(p_2 - p_1) \pi^D \geq 1 \quad (1')$$

$$\wedge p_1 (\pi^M - \pi^D) \geq 1 \quad (3')$$

Solving (1') and (3') for  $p_1$  leads to

$$p_2 \geq \frac{\pi^M}{(\pi^M - \pi^D) \pi^D}.$$

Because  $p_1$  and  $p_2$  are probabilities and hence  $p_1 < 1 \wedge p_2 \leq 1$ , existence requires

$$\frac{\pi^M}{\pi^D} \leq \pi^M - \pi^D.$$

## 8. Appendix 2: Subgame Equilibria in Period 1

This appendix is divided up into three subsections dealing with the three pure strategy subgame equilibria of period 2. Within these sections the firms' reaction equations are calculated and the Parameter values for the subgame equilibria of period 1 are derived.

### I. Subgame Equilibrium in Period 2: (0, 0)

#### 1. The Firms' Reaction Equations

##### Firm 2:

- Assume  $L_1 = 1$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow 2 (p_2 - p_1) \pi^D \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (5') \\ (5'') \end{matrix}$$

- Assume  $L_1 = 0$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow 2 \pi^D - 1 \begin{Bmatrix} \geq \\ < \end{Bmatrix} 2 \pi^D \quad \begin{matrix} (6') \\ (6'') \end{matrix}$$

##### Firm 1:

- Assume  $L_2 = 1$

$$L_1 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow 2 p_1 (\pi^M - \pi^D) \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (7') \\ (7'') \end{matrix}$$

- Assume  $L_2 = 0$

$$L_1 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow 2 p_2 (\pi^M - \pi^D) \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (8') \\ (8'') \end{matrix}$$

#### 2. Parameter values of the Subgame Equilibria in Period 1

##### a) (0,0)

$$2 \pi^D - 1 < 2 \pi^D \quad (6'')$$

$$\wedge 2 p_2 (\pi^M - \pi^D) < 1 \quad (8'')$$

Both conditions can be fulfilled simultaneously.

b) (0,1)

$$2 \pi^D - 1 \geq 2 \pi^D \quad (6')$$

$$\wedge 2 p_1 (\pi^M - \pi^D) < 1 \quad (7'')$$

This is not an possible outcome because equation (5') cannot be fulfilled.

c) (1, 0)

$$2 (p_2 - p_1) \pi^D < 1 \quad (5'')$$

$$\wedge 2 p_2 (\pi^M - \pi^D) \geq 1 \quad (8')$$

Both conditions can be fulfilled simultaneously.

d) (1, 1)

$$2 (p_2 - p_1) \pi^D \geq 1 \quad (5')$$

$$\wedge 2 p_1 (\pi^M - \pi^D) \geq 1 \quad (7')$$

Taking into account equation (4') from period 2 all three equations cannot be fulfilled simultaneously.

If  $2 \pi^D < \pi^M \leq 3 \pi^D$  (see equations (1'') and (4'')) there will exist parameter constellation with no equilibrium in period 1.

II. Subgame Equilibrium in Period 2: (1, 0)

**1. The Firms' Reaction Functions**

Firm 2:

- Assume  $L_1 = 1$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow (2 - p_2) (p_2 - p_1) \pi^D \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad \begin{matrix} (9') \\ (9'') \end{matrix}$$

- Assume  $L_1 = 0$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow \pi^D (2 - p_2) - 1 \begin{Bmatrix} \geq \\ < \end{Bmatrix} \pi^D (2 - p_2) \quad \begin{matrix} (10') \\ (10'') \end{matrix}$$

Firm 1:

- Assume  $L_2 = 1$

$$L_1 = \begin{cases} 1 \\ 0 \end{cases} \Leftrightarrow (\pi^M - \pi^D) p_1 (2 - p_2) + p_2 \begin{cases} \geq \\ < \end{cases} 1 \quad (11')$$

$$(11'')$$

- Assume  $L_2 = 0$

$$L_1 = \begin{cases} 1 \\ 0 \end{cases} \Leftrightarrow (\pi^M - \pi^D) p_2 (2 - p_2) + p_2 \begin{cases} \geq \\ < \end{cases} 1 \quad (12')$$

$$(12'')$$

**2. Parameter Values of the Subgame Equilibria in Period 1**

a) (0, 0)

$$\pi^D (2 - p_2) - 1 < \pi^D (2 - p_2) \quad (10'')$$

$$\wedge (\pi^M - \pi^D) p_2 (2 - p_2) + p_2 < 1 \quad (12'')$$

Taking into account equation (4') from period 2 this condition cannot be met.

b) (0, 1)

$$\pi^D (2 - p_2) - 1 \geq \pi^D (2 - p_2) \quad (10')$$

$$\wedge (\pi^M - \pi^D) p_1 (2 - p_2) + p_2 < 1 \quad (11'')$$

This is not a possible outcome because (10') can never be fulfilled.

c) (1, 0)

$$(2 - p_2) (p_2 - p_1) \pi^D < 1 \quad (9'')$$

$$\wedge (\pi^M - \pi^D) p_2 (2 - p_2) + p_2 \geq 1 \quad (12')$$

Both equations can be fulfilled simultaneously.

d) (1, 1)

$$(2 - p_2) (p_2 - p_1) \pi^D \geq 1 \quad (9')$$

$$\wedge (\pi^M - \pi^D) p_1 (2 - p_2) + p_2 \geq 1 \quad (11')$$

Both equations can be fulfilled simultaneously.

There is also the possibility of no subgame equilibrium in period 1 subject to the subgame equilibrium (1, 0) in period 2.

### III. Subgame Equilibrium in Period 2: (1, 1)

#### **1. The Firms' Reaction Equations**

Firm 2:

- Assume  $L_1 = 1$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow \pi^D (p_2 - p_1) (2 - p_1) - p_2 + p_1 \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad (13')$$

$$(13'')$$

- Assume  $L_1 = 0$

$$L_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow \pi^D (2 - p_1) - 2 \begin{Bmatrix} \geq \\ < \end{Bmatrix} \pi^D (2 - p_1) - 1 \quad (14')$$

$$(14'')$$

Firm 1:

- Assume  $L_2 = 1$

$$L_1 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow (\pi^M - \pi^D) p_1 (2 - p_1) + p_1 \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad (15')$$

$$(15'')$$

- Assume  $L_2 = 0$

$$L_1 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix} \Leftrightarrow (\pi^M - \pi^D) p_2 (2 - p_1) + p_2 \begin{Bmatrix} \geq \\ < \end{Bmatrix} 1 \quad (16')$$

$$(16'')$$

#### **2. Parameter Values of the Subgame Equilibria in Period 1**

a) (0, 0)

$$\pi^D (2 - p_1) - 2 < \pi^D (2 - p_1) - 1 \quad (14'')$$

$$\wedge (\pi^M - \pi^D) p_2 (2 - p_1) + p_2 < 1 \quad (16'')$$

These conditions, together with (3') from period 2 cannot be fulfilled simultaneously.

b) (0, 1)

$$\pi^D (2 - p_1) - 2 \geq \pi^D (2 - p_1) - 1 \quad (14')$$



$$\wedge (\pi^M - \pi^D) p_1 (2 - p_1) + p_1 < 1 \quad (15'')$$

These is not a possible outcome because condition (14'') can never be met.

c) (1, 0)

$$\pi^D (p_2 - p_1) (2 - p_1) - p_2 + p_1 < 1 \quad (13'')$$

$$\wedge (\pi^M - \pi^D) p_2 (2 - p_1) + p_2 \geq 1 \quad (16')$$

These conditions, together with (1') and (3') from period 2, cannot be met for  $p_1 < 1$ .

d) (1, 1)

$$\pi^D (p_2 - p_1) (2 - p_1) - p_2 + p_1 \geq 1 \quad (13')$$

$$\wedge (\pi^M - \pi^D) p_1 (2 - p_1) + p_1 \geq 1 \quad (15')$$

The conditions can be met simultaneously.

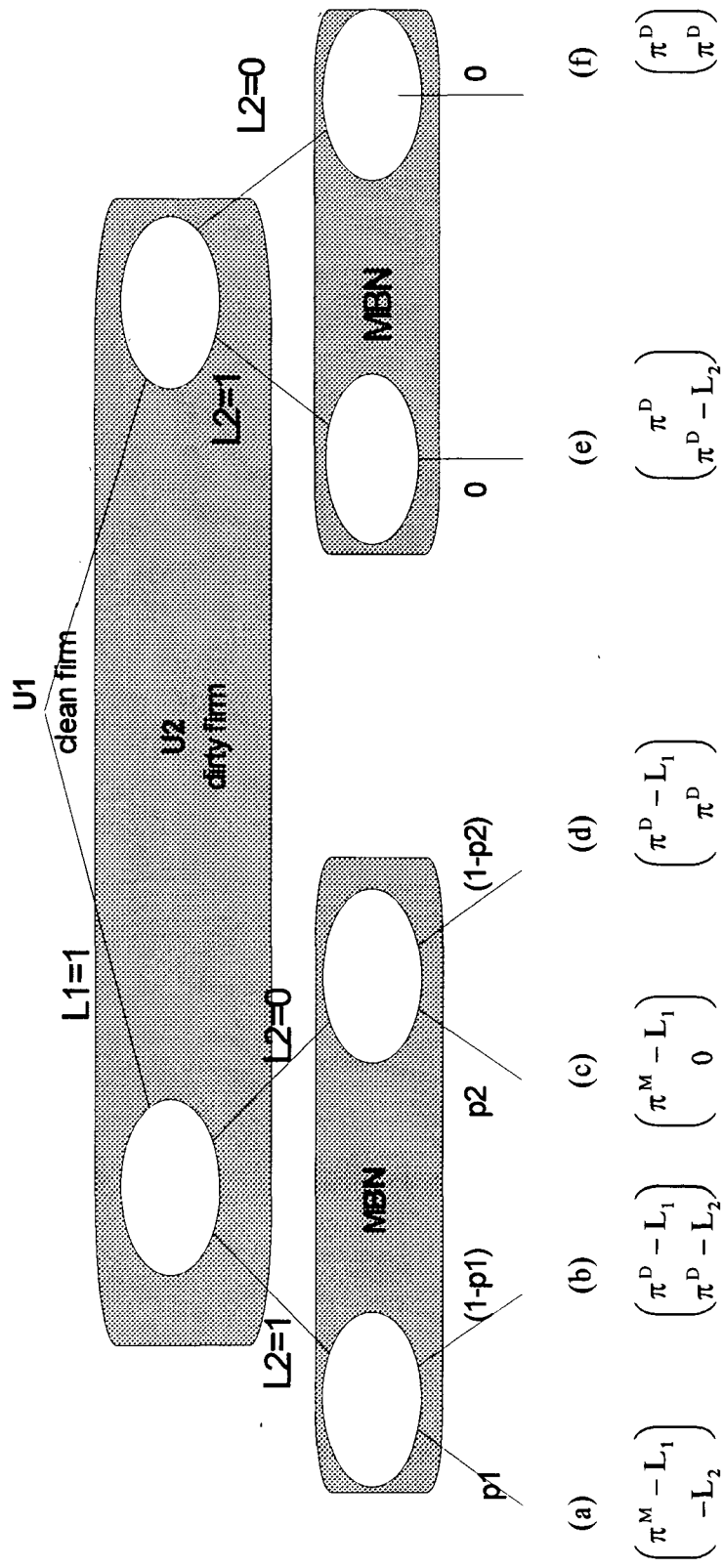


Figure 1

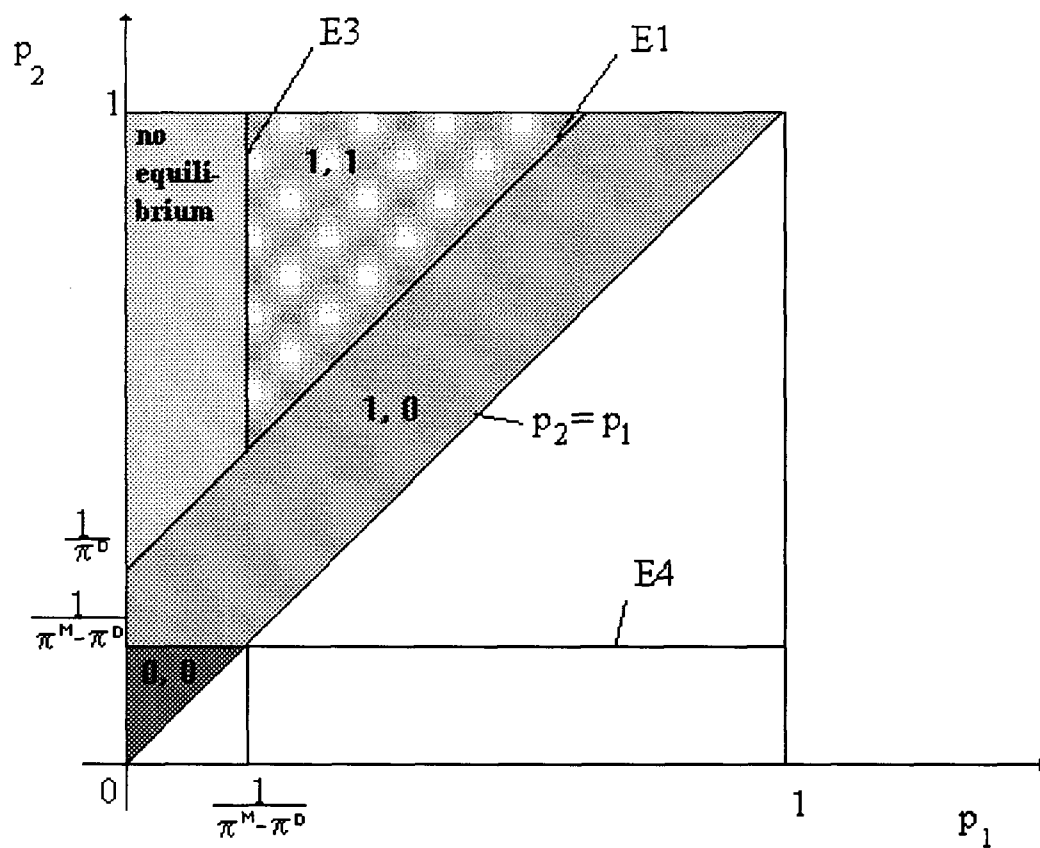


Figure 2

Constraints:

$$E1: \quad p_2 - p_1 - \frac{1}{\pi^D} = 0$$

$$E3: \quad p_1 - \frac{1}{\pi^M - \pi^D} = 0$$

$$E4: \quad p_2 - \frac{1}{\pi^M - \pi^D} = 0$$

$$p_2 - p_1 = 0$$

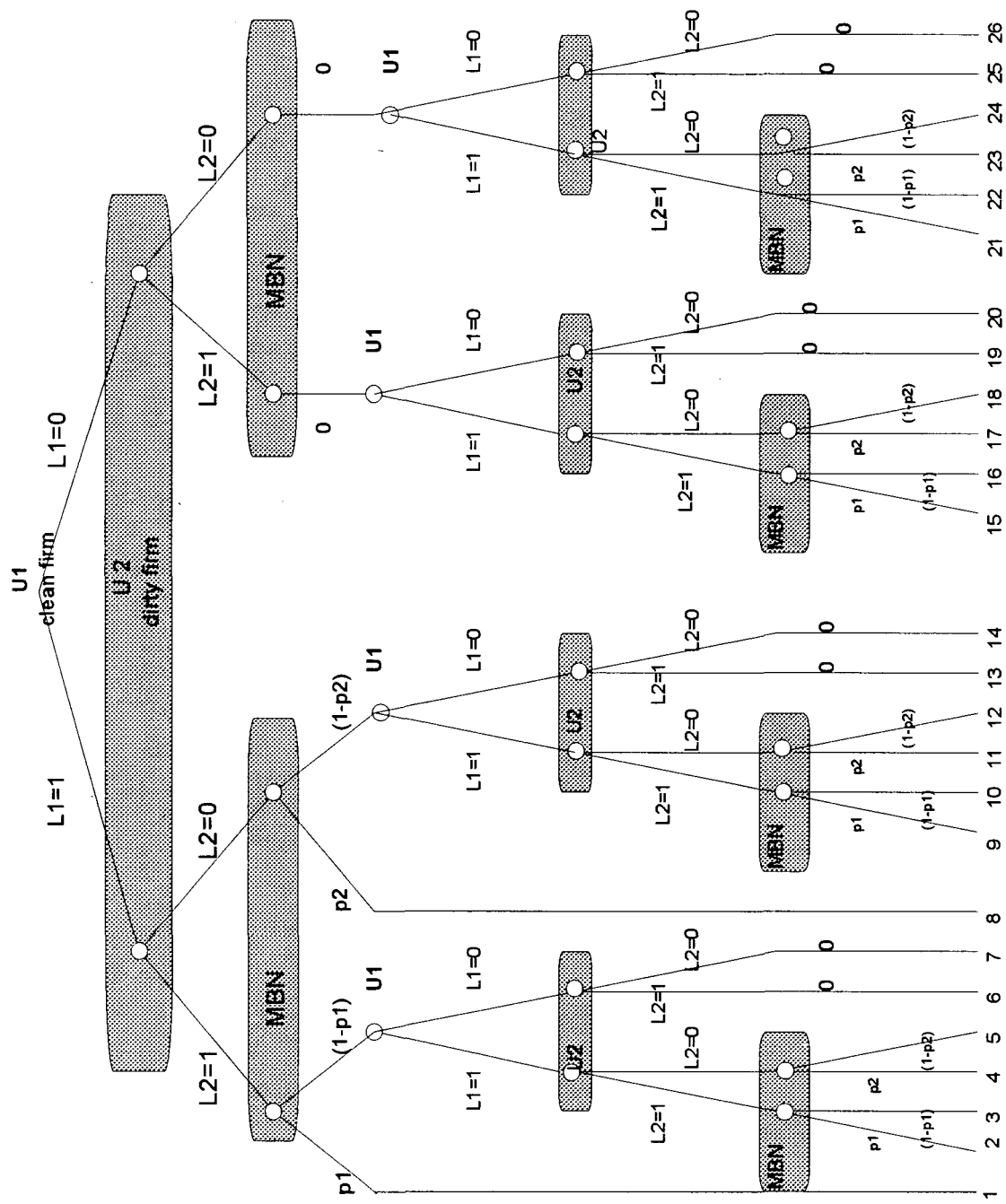


Figure 3

### Payoffs in Period 2

	Firm 1 ( $U_1$ )	Firm 2 ( $U_2$ )
1	$\pi^M$	0
2	$\pi^M - L_1$	$-L_2$
3	$\pi^D - L_1$	$\pi^D - L_2$
4	$\pi^M - L_1$	0
5	$\pi^D - L_1$	$\pi^D$
6	$\pi^D$	$\pi^D - L_2$
7	$\pi^D$	$\pi^D$
8	$\pi^M$	0
9	$\pi^M - L_1$	$-L_2$
10	$\pi^D - L_1$	$\pi^D - L_2$
11	$\pi^M - L_1$	0
12	$\pi^D - L_1$	$\pi^D$
13	$\pi^D$	$\pi^D - L_2$
14	$\pi^D$	$\pi^D$
15	$\pi^M - L_1$	$-L_2$
16	$\pi^D - L_1$	$\pi^D - L_2$
17	$\pi^M - L_1$	0
18	$\pi^D - L_1$	$\pi^D$
19	$\pi^D$	$\pi^D - L_2$
20	$\pi^D$	$\pi^D$
21	$\pi^M - L_1$	$-L_2$
22	$\pi^D - L_1$	$\pi^D - L_2$
23	$\pi^M - L_1$	0
24	$\pi^D - L_1$	$\pi^D$
25	$\pi^D$	$\pi^D - L_2$
26	$\pi^D$	$\pi^D$

Table 1

**Payoffs in Period 1**  
**given Subgame Equilibrium (0, 0) in Period 2**

See Figure 1	Firm 1 ( $U_1$ )	Firm 2 ( $U_2$ )
a	$2 \pi^M - L_1$	$- L_2$
b	$2 \pi^D - L_1$	$2 \pi^D - L_2$
c	$2 \pi^M - L_1$	0
d	$2 \pi^D - L_1$	$2 \pi^D$
e	$2 \pi^D$	$2 \pi^D - L_2$
f	$2 \pi^D$	$2 \pi^D$

Table 2

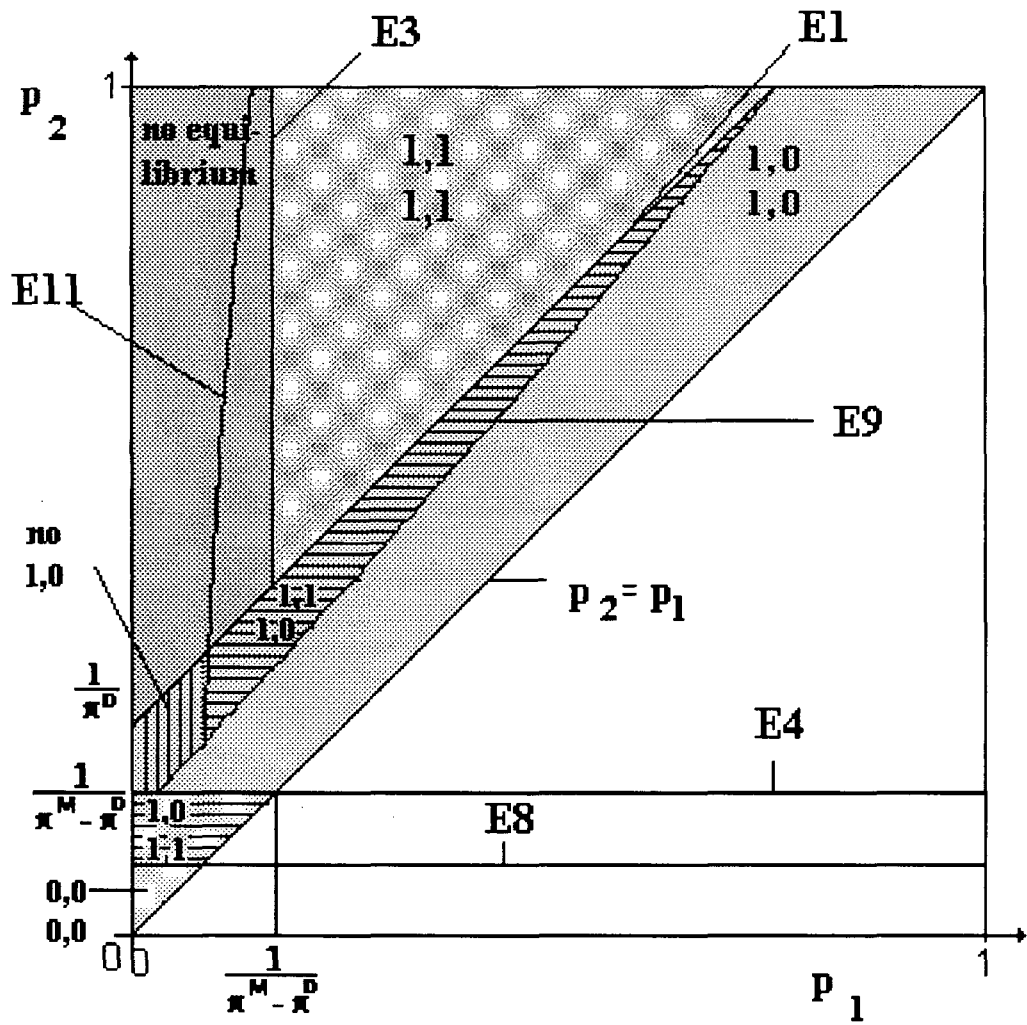


Figure 4

Constraints:

$$E1: \quad p_2 - p_1 - \frac{1}{\pi^D} = 0$$

$$E3: \quad p_1 - \frac{1}{\pi^M - \pi^D} = 0$$

$$E7: \quad p_2 - \frac{1}{2(\pi^M - \pi^D)} = 0$$

$$E4: \quad p_2 - \frac{1}{\pi^M - \pi^D} = 0$$

$$E9: \quad (p_2 - p_1) \pi^D (2 - p_2) - 1 = 0$$

$$E11: \quad (\pi^M - \pi^D) p_1 (2 - p_2) - 1 + p_2 = 0$$

## Workshop 1995

### Environmental Policy in Open Economies

June 5-7, 1995  
Waldhaus Jakob, Eichhornstrasse 84, D-78464 Konstanz

#### Monday, June 5, 1995

19.00 - 21.00     Welcome Reception.

#### Tuesday, June 6, 1995

*Chairman:* Heinrich Ursprung.

9.00 - 9.45     *Opening Address:* Hans-Jürgen Vosgerau (Speaker of the SFB 178, Konstanz).

*Introduction:*     Bernd Genser (SFB 178, Konstanz).

9.45 - 10.30     Coffee Break.

10.30 - 12.00     James R. Markusen (University of Colorado, Boulder):  
*Costly Pollution Abatement, Competitiveness, and Plant Location Decisions.*  
*Discussant:*     Ulrich Landwehr (University of Mannheim).

Gunter Stephan (University of Bern):  
*Laissez-Faire, International Cooperation or National Greenhouse Policy:*  
*A CGE Study.*

*Discussant:*     Andreas Haufler (University of Konstanz).

12.00 - 14.00     Lunch Break.

14.00 - 15.30     Roger D. Congleton (George Mason University):  
*Return to Rio: On the Political Economy of Environmental Treaties.*  
*Discussant:*     Hans Peter Grüner (University of Konstanz).

Rolf Bommer (SFB 178, Konstanz):  
*Endogenous Environmental Policy and Trade Liberalization - A Signaling Approach.*

*Discussant:*     Ronald Jones (University of Rochester).

15.30 - 16.00     Coffee Break.



- 16.00 - 17.30 Michael Rauscher (University of Kiel):  
*Protectionists, Environmentalists, and the Formation of Environmental Policy in an Open Economy.*  
 Discussant: John S. Chipman (University of Minnesota).  
 Achim Körber (SFB 178, Konstanz):  
*Raising Rivals' Costs with Environmental Policy - A Lobbying Approach.*  
 Discussant: Hans Gersbach (University of Basel).

### **Wednesday, June 7, 1995**

*Chairman:* Bernd Genser.

- 9.00 - 10.30 Ernst Mohr (University of Kiel, Hochschule St.Gallen):  
*Sustainable Development and International Distribution: Theory and Application to Rainforests as Carbon Sinks.*  
 Discussant: Carsten Schmidt (University of Konstanz).  
 Sebastian Killinger (SFB 178, Konstanz):  
*Decentralized Internalization of International Externalities.*  
 Discussant: Lucas Bretschger (University of Zürich).
- 10.30 - 11.00 Coffee Break.
- 11.00 - 12.30 Ronnie Schöb (University of München):  
*Choosing the Right Instrument: Environmental Policy in the Presence of a Double Dividend.*  
 Discussant: Frank Hettich (SFB 178, Konstanz).  
 Günther Schulze and Rolf Bommer (SFB 178, Konstanz):  
 Economic Integration and Economic Policy. Does NAFTA Increase Pollution?  
 Discussant: Sven Arndt (McKenna College).
- 12.30 - 14.30 Lunch Break.
- 14.30 - 16.00 Albert Schweinberger (SFB 178, Konstanz):  
*Environmental and Commercial Policies in More or Less Populous Open Economies.*  
 Discussant: James R. Markusen (University of Colorado, Boulder).  
 Ruud de Mooij (Ministry of Economic Affairs, The Hague) and  
 Lans A. Bovenberg (University of Tilburg):  
*Environmental Taxation and the Double Dividend: The Role of Factor Substitution and Capital Mobility.*  
 Discussant: Gebhard Kirchgässner (University of St. Gallen).
- 16.00 Closing Address: Heinrich Ursprung (SFB 178, Konstanz).