

The Influence of Political Pressure Groups on the Stability of Climate Agreements

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This paper examines the effects of political pressure groups (lobbies) on the size and stability of international climate agreements. We consider two types of lobbies, industry and environmentalist. We show the potential effects of lobbying using the STAbility of COalitions (STACO) model. In a base case, without transfers, we find that lobby contributions help to stabilise international climate agreements but do little to increase global abatement and global payoff. Once we introduce an optimal transfer scheme, environmental contributions may give enough incentives to have an effective climate policy, by increasing global abatement, global payoff and the size of stable coalitions.

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1. Introduction

With few exceptions, studies on the size and stability of international environmental agreements (IEAs) tend to treat the participants in international negotiations as monolithic and benevolent governments that truly represent the common interests of their region (e.g. Hoel 1992, Carraro and Siniscalco 1993, Barrett 1997). Whereas this approach has yielded many important insights, it ignores the fact that governments often have interests not aligned with those of their domestic constituents. Moreover, it does not consider that the incentives embodied in elections and other political control systems may ultimately determine what these governments can and will do at the international negotiation tables. These ideas have long been recognized by political scientists and public choice scholars.¹

In a representative democracy, national political actors influence the policy decisions – including positions in international negotiations – of their representatives in many ways. First, the citizens may influence the international bargaining through the electoral process. Government's proposals at international negotiations should be acceptable to its domestic constituents because this, at the end, will help to win elections (Morrow 1991). Second, political pressure groups (or lobbies), such as business associations and environmental NGOs, are able to affect the behavior of politicians by providing information, by financing election campaigns, or by bringing environmental concerns to the forefront of the minds of the voter (Olson 1995, Grossman and Helpman 2001). All these political factors are taken into account when the national executives meet at the international level to decide, for instance, whether or not they will participate in an IEA.

Game theoretical analysis – from a non-cooperative perspective – has pointed out that strong free rider incentives exist in IEAs. This prevents them to be effective (e.g. Hoel 1992, Carraro and Siniscalco 1993, Barrett 1994 and 1997, and Jeppesen and Andersen 1998). Furthermore, it has been shown that whenever regions reach stable agreements, this involves a small number of participants (Finus 2001 and 2003). All of these studies assume that governments maximize only a welfare function. However, recent events in the international policy arena have illustrated the fact that lobby groups try to affect environmental policy, both at national and international level.² Industry and environmentalist lobbies have been very active in this

¹ See Persson and Tabellini (2000), for an extensive review of this literature.

² In 2002, the Competitive Enterprise Institute (CEI), a conservative lobby group in the USA, intended to discredit the USA's Environmental Protection Agency report on global warming. Moreover, in 2003, the CEI was suing other government climate research bodies that produced evidence for global warming (The

respect, and often their interests are in conflict. The aim of this paper is to develop a model in which a government's decision about IEA participation and policies are influenced by lobby groups. In our model, lobby groups organize a collective action to influence government decisions. We model this by means of contributions that reflect the willingness to pay of the lobby to change government's policies in their favor. In this respect, our paper is in the tradition of the literature that studies the influence of interest groups on policy-making (see Person and Tabellini 2000 for an overview). Most of these studies focus on the role of producer groups in the determination of trade policy. In this area, the political contributions approach of Grossman and Helpman (1994, 1995 and 1996) is a standard model. Grossman and Helpman study the effect of lobby contributions on trade policies. They consider that policymakers are self-interested and seek to maximize the overall lobby contributions and the welfare of the median voter in order to increase their chances to be reelected.

The political contributions approach has been further applied to study environmental policymaking (e.g. Fredriksson 1997, Aidt 1998, Conconi 2003, Fredriksson *et al.* 2005). Fredriksson (1997) studies the influence of lobby groups on environmental tax policy and shows that there is a relation between the strength of lobby activities and the deviation from an optimal pollution tax. Aidt (1998) analyzes the effect of environmentalist and industry lobbies on environmental policy in the presence of production externalities. Aidt shows that lobby groups, through the competitive political process, are important to internalize production externalities. Conconi (2003) analyzes the effect of environmentalist lobbies on the determination of trade and environmental policies for large countries linked by trade and transboundary pollution problems. Conconi's results show that the impact of lobby groups on environmental policy depends on the trade policy regime, the type of decision-making process for policies (if it is unilateral or cooperative) and the size of the transboundary environmental spillovers. Fredriksson *et al.* (2005) analyze and empirically test the effect of environmentalist lobby groups and degree of democracy on environmental policymaking. Their empirical analysis shows, for OECD countries, that there is an effect of lobby actions on policymaking but this effect is likely to occur in countries with sufficiently high levels of political competition.

Observer, 2003). In 2005, Scientific Alliance, a British lobby group linked to ExxonMobil, published a report challenging current views about potential effects from climate change (The Guardian, 2005).

Although there is a large literature on lobby groups and policy process, the analysis of the potential effects of lobbying on the formation and stability of IEAs has not been examined in detail – with exception of Haffoudhi 2005. Haffoudhi (2005) studies the impact of lobby groups on the size and stability of IEAs. She finds that, for homogeneous countries, a global agreement would be sustained by means of industry lobby contributions. Our paper takes a similar approach. First, as in Grossman and Helpman (1994) and Haffoudhi (2005), we consider that lobbies try to influence government's policy decisions and we abstract from the election process. We assume that lobbies' influence is represented by prospective contributions that enter into the government's payoff (or political revenue function) and are made conditional on a change of government's policy decisions in their favour. Second, different from Grossman and Helpman (1994), we do not model lobbying as a menu auction, where exogenously given lobby groups offer to policy-makers contribution schedules. We assume, instead, following Felli and Merlo (2005) and Haffoudhi (2005), that given the set of existing lobbies, the government chooses the lobby from which it will receive contributions. Finally, different from Haffoudhi (2005), we consider an empirical model with heterogeneous world regions and allow for transfers among coalition members. Furthermore, following Hillman and Ursprung (1992, 1994), we consider two model variants where governments consider the contributions from supergreens and greens environmentalist lobby groups. Supergreens are concerned about global environmental damages, whereas greens are concerned only about the environmental impacts that affect exclusively their fellow citizens.

Our paper extends previous work in several directions. First, we analyze coalition formation in IEAs from a public choice perspective. We extend the literature on IEAs to include political pressure (modeled by means of prospective lobby contributions) into governments' decisions when signing an agreement. Second, we extend the literature on lobbying activities and environmental policy by applying it to stability of coalitions in IEAs. Finally, we demonstrate the potential impacts of our framework using the STABILITY of COalitions (STACO) model introduced by Dellink *et al.* (2005). STACO combines an empirical-climate change module with a game theoretical module on coalition formation. This model allows us to study the environmental and economic effects of stable climate coalitions considering the pressure from lobby groups. We test for stability using the concept of internal and external stability (d'Aspremont *et al.* 1983). A coalition is said to be stable if no region wants to accede to the coalition (external stability) and no region wants to leave the coalition (internal stability).

The results from our analysis show that in the case with lobby contributions, but no transfers, lobby contributions help to stabilise international climate agreements but do little to increase global abatement and global payoff. Once we introduce an optimal transfer scheme, environmental contributions may give enough incentives to have an effective climate policy, by increasing global abatement, global payoff and the size of stable coalitions.

The next Section presents our analytical framework. Section 3 describes the empirical calibration of the payoff function including the lobby contributions schemes. Section 4 presents and analyzes the main results of our analysis. Finally, Section 5 summarizes and concludes.

2. Analytical framework

We setup a model of coalition formation with lobby contributions. In the model, governments in each region $i \in N$ seek to maximize their own payoffs (or political revenue) considering the pressure from lobby groups.³ We model lobby pressure as prospective contributions that reflect the willingness to pay of a lobby to influence government's policy decisions in their favor. The political revenue function has two components. First, it is a function of the aggregated regional net benefits of participating in an IEA to tackle climate change. Second, it is a function of the contributions from lobby groups. In each region, environmental policy is the outcome of a political process that involves governments and lobby groups. We assume that two lobby groups, environmentalist (E_i) and industry (I_i), are active in region i . Lobby groups are indexed by $h_i \in \{E_i, I_i\}$. Furthermore, we consider two types of environmentalist, supergreens (S) and greens (G), thus $E_i \in \{S_i, G_i\}$. The political revenue function of government i , π_i , reflects the net benefits of climate policy and the prospective contributions from lobby groups L_{h_i} :

$$[1] \quad \pi_i(q_i) = B_i(q) - C_i(q_i) + \rho_i \cdot L_{h_i}(q_i),$$

where B_i are the total discounted benefits from global abatement $q = \sum_{i \in N} q_i$, and C_i are the total discounted abatement costs from regional abatement q_i . We assume that B_i is concave, C_i is convex and that $q_i \in [0, e_i^{\text{BAU}}]$ where e_i^{BAU} is the emission level in the Business-as-

³ In the following we use the terms of payoff and political revenue indistinctively.

usual scenario with no abatement. The parameter $\rho_i \geq 0$ captures the relative weight of contributions compared to social welfare. In the following, for simplicity, we assume that $\rho_i = \rho_j = \rho$ for all $i, j \in N$. Finally, $L_{h_i} \geq 0$, represents the total discounted contributions from a national lobby.

We model IEAs' formation as a two-stage game of cartel formation. At the first stage, regions decide on their membership in a coalition; at the second stage, regions choose their abatement strategies. At the first stage, we assume that regions can choose between two membership strategies: to sign an IEA or not. Those who sign the IEA become signatories, *i.e.* members, of a coalition K . If no region or only a single region signs the IEA, then K is not effective and the singleton coalition structure emerges. If $K = N$ the grand coalition emerges. In our framework, considering a cartel setting with 12 heterogeneous players (regions), the game renders $2^{12} - 12 = 4084$ different coalition structures.

In a given coalition structure, each government decides on its abatement level considering expression [1]. For our base case without lobby contributions, *i.e.* with $L_{h_i} = 0$, each government makes its abatement decisions considering only the net benefits from abatement. Thus, when governments receive contributions, abatement is influenced both by the net benefits from abatement (the first two terms on the right-hand side of [1]) and the possibility of receiving, domestically, a lobby contribution (the last term on the right-hand side of [1]). We assume that lobbies pay contributions for any abatement policy q_i that the government may choose to implement instead of the government's equilibrium abatement in the base case. In particular, we assume that the environmentalist lobby pays a contribution when government's abatement is strictly higher than the equilibrium level of abatement in the base case. In contrast, the industry lobby pays a contribution when government's abatement is strictly lower than the equilibrium level of abatement in the base case. Governments maximize their political revenue considering which of the two lobbies is making a contribution. Then, they choose the abatement level that renders the biggest payoff and consequently which lobby would pay them a contribution. In our specification, we rule out the possibility that lobbies can make simultaneous contributions.

We assume that the coalition of signatories plays non-cooperatively, behaving like a single player, against non-signatories. A stable coalition, then, represents a Nash equilibrium of the game. Non-signatories choose the efficient abatement level such that their own political

revenue (net benefits from abatement plus lobby contributions) is maximized; whereas signatories choose their abatement levels taking into account the net benefits of fellow coalition members, additionally each government also includes the lobby contributions it can collect. In contrast to the net benefits from abatement, members consider lobby contributions only regionally.

Thus, non-signatories maximize [1], whereas signatories maximize

$$[2] \quad \sum_{i \in K} [B_i(q) - C_i(q_i)] + \rho \cdot L_{h_i}(q_i).$$

3. Calibration of the model

In this section, we describe the main features of the calibration of the empirical module of the STABILITY of COalitions (STACO) model. This model focuses on abatement of CO₂ emissions – see Dellink *et al.* (2005) and Finus *et al.* (2006) for a detailed description of the calibration. STACO has been applied to several topics, including restricted membership (Finus *et al.* 2005), permit trading (Altamirano-Cabrera and Finus 2006) and surplus sharing problems (Weikard *et al.* 2006). STACO calculates payoffs (in terms of net benefits) for each region. We use these payoffs to check for stability. The regions considered are USA, Japan, European Union (EU-15), other OECD countries (O-OECD), Eastern European countries (EE), former Soviet Union (FSU), energy exporting countries (EEX), China, India, dynamic Asian economies (DAE), Brazil and "rest of the world" (ROW).⁴ STACO considers a time horizon of 100 years starting in 2010 and uses a uniform 2% discount rate for the calculation of the net present value of the payoffs.

3.1. Benefit function

In STACO, the calibration of the benefit function is based on a linear approximation of the damage cost function of the DICE model (Nordhaus 1994). We consider that benefits from global abatement are derived from reduced environmental damages caused by CO₂ emissions. Furthermore, we consider stationary abatement strategies (*i.e.* a constant abatement level) and that each region receives a share of the global benefits. The resulting (discounted) regional benefit function, $B_i(q)$, is expressed as

⁴ EU-15 comprises the 15 countries of the European Union as of 1995. O-OECD includes among other countries Canada, Australia and New Zealand. EE includes, among others, Hungary, Poland, and Czech Republic. EEX includes, among others, the Middle East Countries, Mexico, Venezuela and Indonesia. DAE comprises South

$$[3] \quad B_i(q) = \mu_i \cdot \delta_B \cdot q$$

where μ_i is the share of the benefits, $\sum_{i \in N} \mu_i = 1$, that a region gets from global abatement $q = \sum_{i \in N} q_i$, and δ_B is a parameter that captures the discounting of benefits from abatement and the stock effects of greenhouse gases. We use the calibration suggested by Dellink *et al.* (2005) and Finus *et al.* (2006) where $\delta_B = 37.4$ \$/ton. This figure represents the global marginal benefits in STACO. According to our specification, marginal benefits are constant, and marginal regional benefits are $\mu_i \cdot \delta_B = \mu_i \cdot 37.4$. With constant marginal benefits, signatories and non-signatories have dominant abatement strategies (Folmer and van Mouche 2000). That is, the abatement strategies of a region or a coalition are independent of other regions. In other words, there are no leakage effects in our model.

3.2. Abatement costs function

We rely on estimates from the EPPA model (Ellerman and Decaux 1998) for the specification of the abatement cost function. The regional (discounted) abatement costs are given by

$$[4] \quad C_i(q_i) = \delta_c \left[\frac{1}{3} \xi_i q_i^3 + \frac{1}{2} \zeta_i q_i^2 \right]$$

where ξ_i and ζ_i are regional parameters and δ_c captures discounting of abatement costs. As in Finus *et al.* (2006), we use $\delta_c = 43.1$.

The regional parameters for the benefit and abatement cost functions are listed in Appendix A, Table A.1. In our setting, the large industrialized regions are the main beneficiaries of global abatement whereas Energy exporting countries, the Dynamic Asian economies and Brazil receive the smallest share of global benefits. The marginal abatement costs vary widely: China and USA have relatively flat curves whereas Brazil as well as Japan have relatively steep curves.

3.3. Lobby payoffs and contributions

In this subsection, we specify the lobby contribution functions. The environmentalist lobby contributes if the government decides to increase abatement above the benchmark level, q_i^g ,

Korea, Philippines, Thailand and Singapore. ROW includes South Africa, Morocco and many countries in Latin America and Asia. For details, see Babiker *et al.* (2001).

that would be chosen by the government in the absence of lobby contributions. Following Hillman and Ursprung (1992, 1994), we consider environmentalist lobbies of two types: supergreen or green. A supergreen lobby is concerned about global environmental damages. They are concerned (by self-interest, aesthetic or altruistic motives) about environmental impacts that affect people worldwide. A green lobby is concerned only about the environmental impacts that affect exclusively their fellow citizens.

The contribution function for a *supergreen* lobby S_i is

$$[5] \quad L_{S_i} = \varepsilon \cdot \delta_B (q_i - q_i^g) \quad \text{for } q_i \geq q_i^g.$$

The contribution function for a *green* lobby G_i is

$$[6] \quad L_{G_i} = \varepsilon \cdot \mu_i \cdot \delta_B (q_i - q_i^g) \quad \text{for } q_i \geq q_i^g.$$

In [5] and [6], ε is a parameter $0 < \varepsilon < 1$ that reflects the strength of the willingness to pay of environmentalist lobbies for increased abatement. For our calculations and analysis, we assume that q_i^g corresponds to the abatement level of the only stable coalition from our base case (*i.e.* without contributions) which in the absence of transfers corresponds to the abatement level of the singleton coalition structure.

Note that from [5] and [6] it is clear that both types of environmentalist lobbies will pay higher contributions the more that the actual abatement exceeds q_i^g . We assume that the environmentalist lobby only pays a contribution if $q_i \geq q_i^g$; negative contributions are ruled out. The difference between expressions [5] and [6] is that the contributions of a supergreen lobby depend on the global effect (*i.e.* global benefits) of regional abatement, whereas the green lobby is only interested in the regional effect of their government's policy decisions. Therefore, expression [6] includes the regional share from global benefits μ_i .

Next, we assume that the industry is always harmed by any abatement decision of the government, given that the abatement costs are usually carried by the industry. Industry contributions are linked to the costs saved by having lower abatement levels. Thus, considering expression [4] we get:

$$[7] \quad L_i = \frac{\xi_i}{3} \left[(q_i^g)^3 - q_i^3 \right] + \frac{\zeta_i}{2} \left[(q_i^g)^2 - q_i^2 \right] \quad \text{for } q_i \leq q_i^g.$$

From expression [7] it is clear that an industry lobby pays higher contributions the more that the actual abatement level is below the government's benchmark decision without lobby contributions. Again, we rule out the possibility of negative contributions.

3.4. Scenarios for the singleton coalition structure

Following the empirical calibration of section 3, and expressions [1], [5], [6] and [7] we can derive the first order conditions for the singleton coalition structure under different lobby cases. For the case without lobby contributions (*i.e.* our base case)⁵

$$[8a] \quad \delta_B \mu_i = \delta_C [\xi_i q_i^2 + \zeta_i q_i].$$

For a singleton receiving only contributions from the supergreen lobby

$$[8b] \quad \delta_B (\mu_i + \varepsilon) = \delta_C [\xi_i q_i^2 + \zeta_i q_i].$$

For a singleton receiving only contributions from the green lobby

$$[8c] \quad \delta_B \mu_i (1 + \varepsilon) = \delta_C [\xi_i q_i^2 + \zeta_i q_i].$$

For a singleton receiving only contributions from the industry lobby

$$[8d] \quad (\delta_B \mu_i)/2 = \delta_C [\xi_i q_i^2 + \zeta_i q_i].$$

From [8a-d] we would like to highlight three features. First, lobby contributions enter into the first order conditions as an additional term on the marginal political revenue (MPR) side - *i.e.* the left hand side of these expressions. The MPR represents what a government obtains from a marginal change in its abatement decisions. Second, a region, acting as a singleton, has a higher abatement level than in the base case if it receives contributions from the environmentalist lobby and has a lower abatement level than in the base case if it receives contributions from the industry lobby. Third, the decision of whether or not to take lobby contributions is independent of the decisions of the remaining regions concerning lobby contributions and coalition membership. This is a result of the presence of constant marginal benefits (*i.e.* dominant strategies) in our model. Because of dominant strategies, any region can calculate its decision about abatement, and corresponding lobby contributions, without considering the decisions of others.

⁵ We assume that $\rho = 1$ for all our calculations.

4. Results and stability analysis

In this section, we present the results from our analysis for the following cases: i) the base case, ii) lobby contributions and no transfers, iii) lobby contributions and transfers, and iv) a sensitivity analysis. For the base case, without lobby contributions, we find that regions undertake some abatement effort even in the absence of an agreement – *i.e.* in the singleton coalition structure. The heterogeneity of our regions, in terms of cost-benefit structure (see Appendix A, Table A.1) results in different level of abatements. For instance, the USA undertake the largest abatement effort in the singleton coalition structure given its low marginal abatement costs and high marginal benefits. Also China, which has relatively low marginal benefits but the lowest marginal costs, undertakes an important abatement effort. In contrast, regions like Brazil or the Energy exporting countries (EEX), with high marginal cost and low marginal benefits, have a small incentive to abate.

4.1. Lobby contributions without transfers

In Table 1, we show the results for the singleton coalition structure once we include lobby contributions. As expected, the influence of lobbies on abatement levels and payoffs depends mainly on the type of the environmentalist lobby. When we consider a supergreen lobby, contributions have a positive effect on global abatement and consequently on global payoff. For the singleton coalition structure, we find an increase in abatement of about 40 % compared to the base case. Global abatement increases even though there are three regions (USA, Japan and EU-15) that receive industry contributions and hence reduce their abatement below the base case levels. However, when we consider a green lobby, contributions have a negative effect on global abatement. There is a decrease of 40 % compared with the base case, because all regions take contributions from the industry lobby and consequently reduce their abatement levels below the base case.

Table 1: Results for singleton coalition structure with lobby contributions (supergreen and green lobbies)

Region	Industry or supergreen lobby contributions			Industry or green lobby contributions		
	Abatement over century	Payoff over century	Contributions over century ^{a)}	Abatement over century	Payoff over century	Contributions over century ^{a)}
	(gton)	(bln \$)	(bln \$)	(gton)	(bln \$)	(bln \$)
USA	11	692	35*	11	308	35*
Japan	0	515	2*	0	223	2*
EU-15	4	712	16*	4	312	16*
O-OECD	4	103	7	1	45	1*
EE	3	42	9	1	17	0*
FSU	8	195	11	3	88	3*
EEX	3	91	8	0	39	0*
China	31	164	58	9	86	11*
India	7	147	14	2	65	2*
DAE	2	76	6	0	32	0*
Brazil	0	46	0	0	20	0*
ROW	7	197	11	2	89	3*
World	80	2,981	176	34	1,325	73

Note: a) regions indicated with an * are receiving industry contributions, otherwise they receive environmentalist contributions.

In order to explain which lobby is successful in influencing government's abatement decisions, Figure 1 presents the general shape of the political revenue function for a singleton (the solid lines) with industry lobby contributions π_i^I , with environmentalist lobby contributions π_i^E and without contributions π_i . From the figure, it can be seen that it is always better to take lobby contributions. The local optima for the payoff with lobby contributions (points A and C) represent a higher payoff than the base case optimum (point B). This pattern applies to all regions. For instance, the region represented in Figure 1 takes industry contributions – the highest local optimum is point A.

The situation is different for coalition members. As a coalition member, region i maximizes [2]. This causes an upward shift of the political revenue curves (the curves with broken lines in Figure 1). The solution is represented by points D and E for the cases with industry and environmental contributions. As we assume that each coalition member considers the externality imposed on other members, its abatement decisions correspond to points that are always to the right of the local optima. Thus, when joining a coalition, the region depicted in Figure 1 decides to switch and take contributions from the environmentalist lobby given that point E (abatement considering environmentalist lobby contributions) represents a higher payoff than point D (abatement considering industry lobby contributions). However, the exact position of points D and E depends on the specific characteristics of the other coalition members, in particular on their marginal benefits.

Insert Figure 1 here

We test for stability using the concept of internal and external stability. Internal stability means that none of the coalition members has an incentive to leave the coalition. External stability means that none of the non-coalition members has incentives to join the coalition. We found that none of the resulting 4084 coalition structures are stable in the base case. In fact, out of these only 14 coalition structures are internally stable. This shows that there are strong free-rider incentives. The situation changes once we consider lobby contributions. First, we notice that lobby contributions help in reaching a stable agreement. We find one stable coalition comprising EU-15 and Japan. This coalition is stable considering industry and supergreen lobby contributions and with industry and green lobby contributions – see Table 2.

Table 2: Reference and stable coalitions with lobby contributions (no transfers)

Case	Coalition	Abatement over century	Payoff over century
		(gton)	(bln \$)
Base case	singleton coalition*	55	1,960
	grand coalition	256	6,031
With industry and supergreen contributions	singleton coalition	80	2,981
	{Japan, EU-15}*	83	3,076
	grand coalition	270	6,809
With industry and green contributions	singleton coalition	34	1,325
	{Japan, EU-15}*	38	1,410
	grand coalition	258	6,093

*Note: * means that this is a stable coalition.*

Second, we find that, depending on its coalition partner, a region may change its decision from which lobby to collect a contribution. In the stable coalition, EU-15 takes contributions from the industry but, upon joining the coalition, Japan changes its decision as a singleton (taking industry contributions, see Table 1) and takes contributions either from the supergreen or the green lobby. As shown in Figure 1, Japan’s political revenue function shift upwards once a coalition with EU-15 is formed. The upward shift of this function is due to an increase in benefits from global abatement, given that EU-15’s abatements increase when joining the coalition. The increase in global benefits is sufficient to make Japan change its decision and switch to take contributions from the environmentalist – see Figure 1, there the region moves from point C to point E. Nevertheless, the increase in benefits from global abatement is not large enough to make EU-15 change its decision about contributions. A coalition partner with higher marginal benefits (such as USA) or a larger coalition would be needed to make EU-15 change its decision on contributions.

Finally, we find that with a supergreen lobby, stable coalitions would not do much to tackle climate change. This finding is in line with other studies about coalition formation (see, for instance, Hoel 1992; Barrett 1994) that show that only small coalitions are stable and that these are not successful in tackling the environmental problem. Note from Table 2 that the increase in abatement for the stable coalition represents a small improvement with respect to the singleton coalition structure. Likewise, the stable coalition of Japan and EU-15 helps little to reap the gains from cooperation, *i.e.* to close the gap between the situation without cooperation (singleton coalition structure) and full cooperation (grand coalition structure). The coalition only closes this gap by 1.5%, either with supergreen and industry contributions or with green and industry contributions. Furthermore, when there are green and industry contributions, the stable coalition falls short of achieving the abatement level of the singleton coalition structure in the base case – it achieves 30% less. Nevertheless, as we will describe in the next section, welfare gains and stability increase substantially once we consider transfers between coalition members.

4.2. Lobby contributions with optimal transfers

The coalition formation literature has shown that the gloomy results about the size of stable coalitions can be improved if transfers are included in the analysis – see, for instance, Botteon and Carraro (1997). For our analysis, we only consider transfers among coalition members as a result of a redistribution of the coalitional payoff – *i.e.* the sum of the individual payoffs under a specific coalition. We analyze a transfer scheme such that the coalitional payoff is distributed proportional to the outside option for each coalition member. The outside option payoff is the one that would be obtained if a coalition member becomes a singleton but the remaining regions stay in the coalition. Thus, it represents the incentive of a region to free-ride. Weikard (2005) has shown that this “optimal sharing rule” guarantees internal stability whenever it is feasible. Hence, following this rule, it is possible to determine the largest possible stable coalition.⁶

Define $\pi(K)$ as the coalitional payoff and $\pi_i(K_{-i})$ as the outside option payoff for region i , then, the optimal sharing rule assigns to each coalition member a payoff

$$[9] \quad \pi_i(K) = \frac{\pi_i(K_{-i})}{\sum_{i \in K} \pi_i(K_{-i})} \pi(K).$$

⁶ For complete details about the properties and general results for the optimal sharing rule see Weikard (2005).

We find that, with an optimal transfer scheme, there is a considerable improvement in terms of the number and size of stable coalitions. In our base case, with an optimal transfer scheme and no contributions, we find 181 stable coalitions and from these the largest coalition comprises six members. However, the best stable coalition in terms of global abatement and payoff is a five-member coalition comprising USA, EE, China, India and DAE.⁷ Hence, membership matters and the success of an IEA does not depend on the number of members. We present the global results for the reference coalitions (singleton coalition and grand coalition) and for the largest and best stable coalition (with and without contributions) in table 3. We find that the best stable coalition achieves an important improvement in terms of gains from cooperation. It helps to close the gap between the payoffs in the singleton and the grand coalition structure by 45 %.

Table 3: Reference and stable coalitions with optimal transfers for the base case and with lobby contributions

Case	Coalition	Abatement over century (gton)	Payoff over century (bln \$)
Base case	singleton coalition	55	1,960
	{USA, EE, EEX, China, DAE, Brazil}*	114	3,713
	{USA, EE, China, India, DAE}*	118	3,822
	grand coalition	256	6,031
With industry and supergreen contributions	singleton coalition	80	2,981
	{USA, Japan, EU-15, O-OOE, EE, EEX, DAE, Brazil, ROW}*	121	3,862
	{USA, Japan, EU-15, EE, China, India, ROW}*	188	5,328
	grand coalition	270	6,809

*Note: * means that this is a stable coalition.*

In order to include lobby contributions in our model with an optimal transfer scheme, we assume that the government's reference level of abatement, q_i^g , is the abatement level that gives each region the highest payoff as a member in a stable coalition without contributions. This level of abatement is always larger than the abatement in the singleton coalition structure. We find that, first, when transfers are available, lobby contributions help to increase stability with respect to the case with transfers and no contributions. The improvement is both in the number and size of stable coalitions.⁸ In our base with optimal transfers we find 181

⁷ See also the detailed results for this coalition in Appendix B, table B.1

⁸ We focus here only in the case of supergreen lobby contributions.

stable coalitions with the largest comprising six members. With lobby contributions, we find 237 stable coalitions with the largest comprising nine members (see table 3).

Second, we find that supergreen contributions, considering that transfers are available, help to reap a large part of the gains from cooperation. The best stable coalition in terms of global abatement and global payoff comprises USA, Japan, EU-15, EE, China, India and ROW as members.⁹ We find that all coalition members are taking contributions from the supergreen lobby, whereas singletons receive contributions from the industry. Even though six of the regions are taking contributions from the industry, the success of this coalition is not hampered. This coalition reaps about 75% of the gains from cooperation, compared to the 40% without lobbying. Furthermore, we find that, as in the case without contributions, membership matters. The largest stable coalition comprises nine members, however, the best results in terms of global abatement and global payoff are achieved by a coalition that has two members less.

Finally, the results with an optimal transfer scheme can provide us with a rough estimate of how much money would be needed to stabilize the grand coalition. This is measured by the aggregate incentive to change membership in the grand coalition. We find that it would be necessary to spend 1,922 billion US\$ over 100 years in order to make the grand coalition stable. This amount is equivalent to half of the gains from full cooperation. One channel to obtain these resources could be through contributions from the environmentalist lobbies. However, we find that even with a supergreen lobby there are not enough monetary resources to stabilize the grand coalition.

4.3. Sensitivity analysis

We have conducted a sensitivity analysis with respect to a selection of parameters from our model. We focus on two parameters, the strength of environmentalist lobbies' willingness to pay towards abatement policies (ε) and the relative weight of contributions compared with social welfare (ρ). Our sensitivity analysis focuses on testing the robustness of our benchmark results. Hence, the scenario that we choose for this test is the one without transfers and considering only a supergreen lobby. We analyze the effects of a lower impact of lobby contributions, *i.e.* we test for a decrease in the value of the parameters ε and ρ . First, we investigate what the effects are of having an environmentalist lobby with weaker willingness

⁹ See also the detailed results for this coalition in Appendix B, table B.2.

to pay towards abatement policies. We test this through a decrease in the value of ε from 0.1 (its original level) to 0.01. Second, we investigate the effect of having a government that is less concerned about lobby contributions. We test this by decreasing the value of ρ from 1 (its original level) to 0.5. We find that, in both cases, our results are robust to these changes. There are no changes in terms of stability and effectiveness of coalitions. The only difference that we find is in which lobby is successful in influencing government's abatement decision. We may expect that with a lower level of ε environmentalist contributions have a lower weight and hence most regions would prefer to take contributions from the industry. We find that this is true in the singleton coalition structure. For $\varepsilon = 0.01$ all regions take contributions from the industry. For a lower level of ρ , we find that there are no changes in the singleton coalition, USA, EU-15 and Japan are still taking contributions from the industry. Finally, in terms of stability, our results are robust to having lower levels of ε and ρ . In both cases the coalition between EU-15 and Japan is stable. The only change is that now EU-15 and Japan take contributions from the supergreen lobby.

5. Summary and conclusions

In this paper, we study the effect of political pressure groups (lobbies) on the size and stability of international environmental agreements (IEAs) on climate change. We study IEAs as a coalition formation process. Coalition formation is modelled as a two-stage game in which governments choose their participation in an agreement at the first stage and their abatement strategies in the second stage – considering both net benefits from abatement and lobby contributions. We assume that there are only two lobbies from which governments obtain contributions: industry and environmentalist. We consider that the level of contributions depends on each lobby's payoff function and the abatement strategy chosen by the government. The payoff of an environmentalist lobby depends on the additional abatement efforts undertaken by the government. We consider two types of environmentalist lobbies, supergreen and green. A supergreen lobby is interested in the global effects of the abatement policies. A green lobby is only interested in the regional effects of abatement policies. The payoff function of the industry lobby assumes that industries are always harmed by their government abatement decisions given the associated abatement costs.

We test stability of IEAs using the definition of internal and external stability. For this test we use the STABILITY of COalitions (STACO) model that provides us with benefit and cost estimates for twelve world regions. Moreover, STACO helps us to calculate the level of

pressure exerted by lobbies, in terms of contributions. The final payoffs depend on the abatement strategy chosen by a region and the prospective contributions received from a lobby. We perform a sensitivity analysis with respect to the parameters that reflect the strength of environmentalist willingness to pay for abatement policies and the intensity of preferences over money with respect to the environmental policy. We find that our main results and conclusions are robust to these changes.

There are four key results from our analysis. First, we find that in the *absence* of an agreement (*i.e.* the singleton coalition structure) supergreen lobby contributions may help to foster an increase in abatement efforts. When we consider supergreen and industry lobby contributions, we find that the singleton coalition structure improves upon our base case. There are only three regions that receive industry contributions but this does not offset the global increase in abatement. In contrast, when we consider industry and green lobby contributions, all regions take contributions from the industry. This has a clear detrimental effect for global abatement and global payoff.

Second, we find that even with a supergreen lobby, *stable* agreements would not do much to tackle climate change. We find that lobby contributions help to increase stability in our model (there were no stable coalition in our base case) but the success of stable coalitions depends on the type of preferences of the environmentalist lobby. There was a stable coalition between Japan and EU-15 with environmentalist (supergreen and green) and industry contributions. In both cases, this stable coalition helps little to close the gap between the situation without cooperation (singleton coalition structure) and full cooperation (grand coalition structure). Furthermore, when there are green and industry lobby contributions, the stable coalition falls short of achieving the abatement level of the singleton coalition structure in the base case.

Third, we find that supergreen lobby contributions, in combination with transfers foster a stable agreement that reap a large part of the gains from cooperation, and hence, it gives incentives to have a more effective climate change policy. When we consider industry and supergreen lobby contributions we find an improvement in the number and size of stable coalitions with respect to the case of transfers but no contributions. The best stable coalition, in terms of global abatement and payoff, comprises six members and achieves 75 % of the gains from full cooperation, even though all non-coalition members receive contributions from the industry lobby.

Fourth, we observe that lobby contributions may not be sufficient to guarantee full participation in an international climate agreement. From our results with an optimal transfer scheme, we can produce an estimate of the side-payments needed to stabilize the grand coalition. We find that almost the double of the gains from cooperation in the base case is needed in order to compensate all regions and ensure that they will stay in the grand coalition. Lobby contributions were not enough to provide such an amount. This calls for finding alternative channels to this end, for instance, through issue linkage or joint implementation projects.

Regarding future research, we propose the following main extensions. First, we can employ a game theoretical voting model to characterize stability of IEAs, in order to study if membership is conditional upon a domestic ratification vote. Second, we could extend our model to include competition among lobbies, allowing them to play a game at the regional level.

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Appendix A –Parameters

Table A.1: Emissions, Benefit and Abatement Cost Parameters*

Regions	Emissions in 2010 (Gton)	Share of global benefits s_i	Abatement cost parameter α_i	Abatement cost parameter β_i
1 USA	2.42	0.226	0.0005	0.00398
2 Japan	0.56	0.173	0.0155	0.18160
3 European Union (EU-15)	1.4	0.236	0.0024	0.01503
4 Other OECD Countries (O-OECD)	0.62	0.035	0.0083	0
5 Eastern European Countries (EE)	0.51	0.013	0.0079	0.00486
6 Former Soviet Union (FSU)	1	0.068	0.0023	0.00042
7 Energy Exporting Countries (EEX)	1.22	0.030	0.0032	0.03029
8 China	2.36	0.062	0.00007	0.00239
9 India	0.63	0.050	0.0015	0.00787
10 Dynamic Asian Economies (DAE)	0.41	0.025	0.0047	0.03774
11 Brazil	0.13	0.015	0.5612	0.84974
12 Rest of the World (ROW)	0.7	0.068	0.0021	0.00805
World	11.96	1	-	-

Source: Finus *et al.* (2006).

Appendix B – Tables for best stable coalition with optimal transfers

Table B.1: Stable coalition {USA, EE, China, India, DAE} with optimal transfer scheme

Regions	Abatement over century	Abatement costs over century	Benefits from abatement over century	Transfers over century	Payoff over century	ICM over century
	gton	bln US\$	bln US\$ over 100 years	bln US\$ over 100 years	bln US\$ over 100 years	bln US\$ over 100 years
USA	22	116	996	-271	608	-4
Japan	1	2	759	-	757	-85
EU-15	7	24	1,039	-	1,015	-112
O-OECD	2	1	152	-	151	-8
EE	6	30	57	27	54	0
FSU	5	4	297	-	293	-24
EEX	1	0	132	-	132	-6
China	53	299	273	185	159	-1
India	12	67	220	35	188	-1
DAE	5	32	110	25	102	-1
Brazil	0	0	67	-	67	-1
ROW	4	4	299	-	295	-25
World	118	580	4,402	-	3,822	-4

Note: ICM = incentive to change membership.

Table B.2: Stable coalition {USA, Japan, EU-15, EE, China, India, ROW} with lobby contributions and optimal transfer scheme

Regions	Abatement over century	Abatement costs over century	Benefits from abatement over century	Contributions over century	Transfers over century	Payoff over century	ICM over century
	gton	bln US\$	bln US\$ over 100 years	bln US\$ over 100 years	bln US\$ over 100 years	bln US\$ over 100 years	bln US\$ over 100 years
USA	34	386	1,593	42	-327	922	-6
Japan	3	45	1,214	7	-454	722	-4
EU-15	14	172	1,661	20	-572	937	-6
O-OECD	1	0	243	31*	-	274	-10
EE	9	98	91	12	112	117	-1
FSU	3	1	475	57*	-	530	-33
EEX	0	0	211	42*	-	253	-9
China	86	1,010	436	121	932	479	-3
India	19	222	352	25	195	351	-2
DAE	0	0	175	32*	-	207	-6
Brazil	0	0	108	2*	-	110	-1
ROW	17	188	479	22	114	426	-3
World	188	2,122	7,038	411	-	5,328	-

Note * means that the region receives contributions from the industry lobby otherwise the region receives contributions from the environmentalist (supergreen) lobby. ICM = incentive to change membership.

FIGURES

Figure 1: Political revenue for a representative region as singleton and coalition member

