

# Environmental Protection: A Theory of Direct and Indirect Competition for Political Influence

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How is it that environmental groups can have a strong impact on environmental policy but without much lobbying? This paper develops a model of “direct” (lobbying the government) and “indirect” (persuading the public) competition for political influence and finds that they are complementary. However, an increase in the effectiveness of public persuasion, or a rise of public environmental awareness, induces substitution between the two. The findings establish that the empirical phenomenon of lack of political contribution from environmental groups may not be related to financial constraints, but to their greater effectiveness in public persuasion and growing public environmental awareness.

## 1. INTRODUCTION

How is it that some special interest groups can have a strong impact on government policy but without much lobbying (or political contribution)? The essence of political economy approaches to the determination of government policy with opposing special interests is that they engage in a kind of “direct” competition for sharing social welfare and that opposing political pressures offset each other.<sup>1</sup> According to these theories, the political strength of a group is often explained by the size of its economic stake (and hence the associated lobbying effort), and the efficiency of its organization in exerting political influence. How then can we explain why some environmental groups have been very successful against polluting industries, when the latter’s economic stakes seem very high (and they lobby more) and their interests are more efficiently organized? Some might suggest that the reason for the success of the environmental movement is that environmental groups have large memberships and can provide block votes.<sup>2</sup> However, according to Olson (1965), a large membership of an interest group is not necessarily an advantage, and it is still uncertain whether environmental groups are able to mobilize their members to cast votes based on such affiliations. This paper suggests an alternative explanation by developing a theory of “direct” and “indirect” competition between special interests for political influence rather than marshalling block votes.

A primary feature of our framework is that two opposing interest groups—an environmentalist group and an industrialist group—compete directly and indirectly for political influence in a three-stage game. The “indirect” competition takes place in the first stage, in which interest groups exert effort in persuading the public to indirectly influence government policy. The “direct” competition takes place in the second stage, in which interest groups exert effort in

1. See Hillman (1989) and Rodrik (1995) for surveys in political economy models, and Persson and Tabellini (2000) for an excellent textbook in political economy.

2. Normative economics might also point to the income effect on the public demand for better environmental quality (e.g. Pethig, 1976). We will discuss this issue in Section 5.2.

lobbying the government to directly influence government policy. An incumbent government, which cares about political contributions and public support for its policy, then chooses a politically optimal environmental policy in the third stage. As a result, both direct and indirect efforts have an impact on government policy.

By introducing public persuasion in the model, this paper provides three main results that yield new insights on the competition between special interests for political influence. First, there is complementarity between the direct and indirect competition in that the group that has relatively more political influence in direct competition also exerts relatively more effort in indirect competition. The reason for this result is that the marginal benefit of indirect effort is higher for the group with more direct political influence. Furthermore, since direct political influence mainly comes from political contribution (*i.e.* direct effort), there is also complementarity between direct and indirect effort.

Second, an increase in the effectiveness of public persuasion, however, will induce substitution between direct and indirect competition. For instance, when an interest group, *e.g.* the environmentalist group, is relatively more effective in public persuasion, it becomes more aggressive and increases its effort in the indirect competition. The converse holds for its opponent since their direct efforts are strategic substitutes. As a result, this raises the public's demand for a more stringent environmental policy, which strengthens the environmentalist group's bargaining position with the government but weakens the bargaining position of its opponent. Therefore, the environmentalist group could afford to be less aggressive but its opponent would have to be more aggressive in direct competition for political influence.

Third, the degree of public environmental awareness itself will affect not only the stringency of environmental policy but also the pattern of direct and indirect effort by both interest groups. It is shown, for instance, an increase in public environmental awareness will also induce substitution between direct and indirect competition in that the environmentalist group would become more aggressive in the indirect competition but less aggressive in the direct competition (and the converse holds for the industrialist group). These findings establish that the empirical phenomenon of lack of direct lobbying (or political donations) from environmental groups may not be related to financial constraints, but to their greater effectiveness in public persuasion and the growing public environmental awareness.

There is considerable evidence that many special interest groups engage in both the direct and indirect political competition (even polluting industries heavily engage in public persuasion—see more discussion in Section 4). Most environmental groups, however, do not make political contributions. Although some make political contributions, the amount is very small relative to their budget. For instance, in the election cycle of 1990 (a 2-year period) the Sierra Club, the biggest environmentalist donor that regularly makes political donations, donated U.S.\$410,651, which is less than 6% of its budget for that period. Furthermore, Table 1 compares the long-term trend of total political contributions from the category of “ideology/single-issue” special interest groups to that from the Sierra Club. Interestingly, between 1990 and 2000 the amount of political contributions from the Sierra Club fluctuates but declines on average, which is in a sharp contrast to the increasing trend for that category (as well as the general trend for all categories).<sup>3</sup> The traditional activity of environmental groups, however, is to “educate the public” and there is evidence of increasing of such effort (Mitchell, Mertig and Dunlap, 1992). These groups orient their appeals more to the public than to governments and their activities have greatly increased public demand for environmental protection. As a result, polluting industries

3. A reason for this could be that according to the Center for the Responsive Politics, in recent years the Sierra Club has elected to spend money on direct “issue ads” rather than giving it to candidates or political parties (homepage: [www.opensecrets.org](http://www.opensecrets.org), visited in November 2001).

TABLE 1  
*Ideology/single-issue: long-term contribution trends\**

Election cycle	Total contributions	Contributions from Sierra Club
1990	\$20,303,290	\$410,651
1992	\$33,572,707	\$613,680
1994	\$34,937,681	\$411,981
1996	\$38,987,759	\$375,860
1998	\$46,907,944	\$247,208
2000	\$82,079,379	\$382,314

\*Source: The Center for Responsive Politics (homepage: [www.opensecrets.org](http://www.opensecrets.org), visited in November 2001).

have been under pressure to spend billions of dollars each year on pollution control and abatement, despite their significant lobbying efforts. As many studies conclude, environmental movements have proven to be exceptionally successful in the U.S. and many other developed countries (*e.g.* Dunlap and Mertig, 1992).

There are surprisingly few studies on the theory of indirect competition for political influences. Although lobbying is also seen as a way of transmitting information to governments or legislatures (*e.g.* Austen-Smith, 1997), the issue that how interest groups influence government policy through persuading the general public has been neglected in the literature. The importance of public communication and persuasion in a democratic society, however, was recognized by Tullock (1967); Berry (1989). Congleton (1986, 1991, 1966) introduced this idea into the election models through political advertising.<sup>4</sup> Yokoyama (1991) also analyses persuasion in a model with three agents, but unlike Congleton, he assumes that the persuasion of the two opponents changes the preferences of the “third party”. Similar to Congleton, our view is that interest groups do not have to change the preference of the public. It is sufficient that their persuasion can influence public perception about the consequence of a particular government policy.

The current model is based on the common-agency framework developed by Bernheim and Whinston (1986) and Grossman and Helpman (1994), which has been adopted to study different kinds of government policies, including environmental policy.<sup>5</sup> Although the literature that followed these seminal papers has addressed many important issues in different contexts, it has not yet moved significantly beyond the original framework. A notable exception is Besley and Coate (2001). They integrate the “citizen-candidate” model of representative democracy with the menu-auction model of lobbying, yielding a number of novel insights about how lobbying affects policy outcomes. Unlike this paper, however, they do not analyse the issue of public persuasion by special interest groups.<sup>6</sup>

In a recent monograph on special interest politics, Grossman and Helpman (2001) also investigate the issue of “educating voters” in an electoral-competition model with active special interest groups. Their focus is on the timing of communication of interest groups with voters, namely, “early communication” will allow the parties to react to any changes in the political climate that result from the group’s communication with the voters, which otherwise would

4. Also see the subsequent work by Ursprung (1994) and Schultz (1995).

5. *E.g.* Fredriksson (1997), Aidt (1998) and Schleich (1999).

6. It is worth noting that recently there is growing research interest in the effects of mass media on public policies (*e.g.* Besley and Burgess (2001, 2002), Strömberg (2001, 2004)). However, the focus of that literature is different from this paper. For example, Besley and Burgess examine the effects of mass media on the government responsiveness to the public needs in India. Strömberg investigates the role of mass media on public policy with the media being a profit-maximizing agent in providing information to the public.

not be possible with “late communication”.<sup>7</sup> Although they have also analysed both lobbying and educating the public, these two issues are discussed separately. The current paper is a development of the work in Yu (1999a,b) and focuses on the interaction between lobbying and public persuasion.

The rest of this paper is organized as follows. Section 2 sets out the preliminaries and the structure of the game in the formation of government environmental policy. Section 3 discusses the implication from direct competition for political influence. Section 4 characterizes the equilibrium with both direct and indirect competition. Section 5 analyses the substitution between direct and indirect competition. Section 6 concludes.

## 2. PRELIMINARIES AND STRUCTURE OF THE GAME

Suppose there are two perfectly competitive industries in an economy: one produces a numeraire good using labour only and the other produces good  $x$  using labour and an industry-specific factor. Production technology exhibits constant-returns-to-scale (CRS) in both industries. The production of good  $x$  pollutes the environment and pollution abatement requires both labour and the specific factor. To capture the abatement activity in a very simple way, suppose it uses the same factor intensities as production of good  $x$ . Then, effectively the cost of abatement is to reduce the output of good  $x$ :<sup>8</sup>

$$X = [1 - A(e)]F(L, K), \quad 0 \leq A(\cdot) \leq 1, \quad A(\cdot)' < 0, \quad A(\cdot)'' > 0 \quad (1)$$

where  $F(L, K)$  is a standard CRS production function and is the potential output of good  $x$  (without pollution abatement).  $X$  is actual (or net) output with pollution abatement and  $A(e)$  is the cost of pollution abatement in units of good  $x$ . Variable  $e$  is emissions per unit of (actual) output, an emission standard set by a government, and hence the amount of total emissions is  $eX$ .

The return to the specific factor, denoted by  $\pi(p, e)$ , is increasing in both arguments. The supply of the good is  $X = \partial\pi(p, e)/\partial p$  and is increasing in  $e$  by Hotelling's lemma.<sup>9</sup>

Tastes over private goods are assumed to be quasi-linear and separable from the public good/bad (pollution). Specifically, we assume that individuals have the following utility function:<sup>10</sup>

$$U_i(x_o, x, Xe) = u(x) + x_o - D_i(eX) \quad (2)$$

where  $x_o$  is the consumption of the numeraire good and  $u(x)$  [ $u'(\cdot) > 0$ ,  $u''(\cdot) < 0$ ] is the utility of consuming good  $x$ .  $D_i(eX)$  is individual  $i$ 's disutility of pollution, which is its perceived environmental consequence of the total emissions,  $eX$ . As Shogren (1999) points out, the costs of environmental consequences might all depend on *what you choose to believe*. Indeed, even when the amount of total emissions is known, the potential environmental damage is very likely to be uncertain due to many other factors. Such kinds of uncertainties can be reduced to one dimension in our analysis. We thus assume that  $D_i(eX) = \mu_i d(eX)$  [ $d'(\cdot) > 0$ ,  $d''(\cdot) > 0$ ], where  $\mu_i$  is individual  $i$ 's perception (or subjective belief) of the *scale* of environmental consequences of

7. “Early communication” (resp. “late communication”) means releasing information to voters before (resp. after) political parties have committed to their positions on pliable policy issues.

8. This kind of pollution abatement cost, similar to that in Antweiler, Copeland and Taylor (2001), resembles the iceberg transport cost in the international trade literature.

9. There is also a “second-order” effect that reduces output through a reduction of  $F(L, K)$ . Namely, a reduction in profit (*i.e.* rent to the specific factor), as a result of a smaller  $e$ , raises the relative factor price (wage over rent), and hence reduces the labour employment and the output.

10. Separability is a common assumption in the public economics literature and the quasi-linear assumption implies that the good  $x$  industry is small relative to the rest of the economy (*i.e.* ignoring the income effect).

pollution. Since the amount of total emissions ( $eX$ ) is increasing in  $e$ , for the rest of this paper we simply write disutility of pollution as  $\mu_i d(e)$  to avoid more notation such as  $\tilde{d}(e)$ .<sup>11</sup>

The (inverse) individual demand function for good  $x$  is  $p = u'(x)$ . Hence, the aggregate demand is  $p = u'(X^d/N)$ , where  $X^d$  is the aggregate consumption and  $N$  is the total population. Since consumption is equal to output in a closed economy, the price of the good will depend on government environmental policy and  $dp/de < 0$ .

The indirect utility function corresponding to (2) can be obtained as follows:

$$V_i(Y_i, e) = s(e) + Y_i - \mu_i d(e) \quad (3)$$

where  $Y_i$  is income and  $s(e)$ ,  $s(e) = u(x(p(e))) - p(e)x(p(e))$  is the consumer surplus of consuming good  $x$  and is increasing in  $e$ . From (3) notice that  $\mu_i$  may also be interpreted as the marginal willingness-to-pay for pollution reduction. For instance, a decrease of the parameter could indicate a reduction of the willingness-to-pay for a stricter environmental standard (because of other concerns, such as wage/job losses associated with a stricter environmental regulation).

Each individual supplies one unit of labour and there are three groups in the society: the general public, environmentalists and industrialists. For simplicity, we assume that all the public has the same subjective belief,  $\mu_p$ .<sup>12</sup> Therefore, the optimal emission standard for the public is

$$e_p = \arg \max_e \{V_p = s(e) + 1 - \mu_p d(e)\} \quad (4)$$

where 1 is the wage rate by choice of units in the numeraire sector. It is straightforward to show that  $e_p$  is decreasing in  $\mu_p$ . We assume that  $\mu_p$  is relatively small so that the general public is not organized because of the free-riding problem.

A small fraction of the population,  $N_E$  (environmentalists), has a very high subjective belief,  $\mu_E$  ( $\mu_E > \mu_p$ ). The optimal emission standard for them is

$$e_E = \arg \max_e \{V_E = s(e) + 1 - \mu_E d(e)\}. \quad (5)$$

Since  $\mu_E$  is large, they are organized as a special interest group, called the environmentalist group (or group  $E$ ), to lobby the government. The total (gross) welfare of group  $E$  is  $W_E = N_E V_E$ .

A small fraction of the population,  $N_I$ , owns the specific factor of the polluting industry and therefore they earn profits in addition to wages. Their subjective belief is  $\mu_I$ , which could be either higher or lower than (but not very different from)  $\mu_p$ . Therefore, the optimal emission standard for them is

$$e_I = \arg \max_e \left\{ V_I = s(e) + 1 + \frac{\pi(p(e), e)}{N_I} - \mu_I d(e) \right\}. \quad (6)$$

Assume that  $\pi/N_I$  is large relative to wages so that  $e_I > e_p$ .<sup>13</sup> They are also organized as a special interest group, called the industrialist group (or group  $I$ ), to lobby the government. The total welfare of group  $I$  is  $W_I = N_I V_I$ .

An incumbent government cares about the “political cost” of a policy that deviates from the median-voter’s preference, which is  $e_p$  in our model, provided that the population of the general public is large relative to the two special interest groups. The objective function (or “political

11. If we assume that  $e$  is the emissions per unit of the potential output, then the amount of total emissions becomes  $eF(L, K)$ , which is also increasing in  $e$  since, as discussed earlier,  $F(L, K)$  is also increasing in  $e$  due to a second-order effect. Thus, in that case we can also write  $D_i = \mu_i d(e)$  and our analysis will not be affected.

12. In an earlier version I assume heterogeneous beliefs, which adds little extra insight except complicating the analysis. I thank the referees for suggesting the current version, and the above alternative interpretation for  $\mu_i$ .

13. As long as the return from the specific factor is significant compared to wages, and  $\mu_I$  is not very different from  $\mu_p$ , we would have  $e_I > e_p$ .

support") of the incumbent government takes the following form:<sup>14</sup>

$$G = C_E + C_I - aM(e - e_p), \quad a > 0 \quad (7)$$

where  $C_E$  (resp.  $C_I$ ) is the political contribution from group  $E$  (resp. group  $I$ ) and parameter  $a$  is the relative weight attached to the political cost,  $M(\cdot)$ , which is defined as a symmetric U-shaped function with  $M(0) = M'(0) = 0$  and  $M''(\cdot) > 0$ .

The formation of government environmental policy is a non-cooperative three-stage game. The indirect competition takes place in the first stage, in which each group exerts its effort to persuade the general public. The direct competition takes place in the second stage, in which each group offers the government a political-contribution *schedule* that is contingent on the level of the environmental policy. Then, the government sets a policy to maximize its objective function in the third stage. The subgame-perfect equilibrium is solved by backward induction.

### 3. DIRECT COMPETITION FOR POLITICAL INFLUENCE

In this section we first examine the last two (the second and the third) stages of the game. This two-stage game is then similar to those in public choice and political economy literature that focus only on the direct competition for political influence. We model this two-stage game as a common-agency problem following Bernheim and Whinston (1986) and Grossman and Helpman (1994). Specifically, taking the other group's strategy as given, in the second stage each interest group simultaneously offers the incumbent government a policy-contingent political contribution *schedule* [ $C_j(e)$ ,  $j = E, I$ ] to maximize its own (net) welfare,

$$W_j(e) - C_j(e), \quad j = E, I. \quad (8)$$

In the third stage the government, which cares about the amount of total political contributions and the political cost of its policy, chooses an environmental policy to maximize the following objective function:

$$G = C_E(e) + C_I(e) - aM(e - e_p). \quad (9)$$

Following these authors, we focus on the "truthful contribution schedule", which pays the excess of an interest group's gross welfare relative to some base level. Specifically, a truthful political contribution schedule from group  $j$  is defined as  $C_j^T(e, b_j) = \max[0, W_j(e) - b_j]$ , where  $b_j$  is a constant and is some base level of its welfare chosen by  $j$ .<sup>15</sup>

The subgame-perfect Nash equilibrium can be characterized by the following lemma.

**Lemma 1.** (i) *The equilibrium level of environmental standard/policy satisfies*

$$e^o = \arg \max_e W_E(e) + W_I(e) - aM(e - e_p); \quad (10)$$

(ii) *the equilibrium levels of political contribution are (for  $i, j = E, I$ )*

$$C_i^o(e^o, b_i^o) = [W_j(e^j) - aM(e^j - e_p)] - [W_j(e^o) - aM(e^o - e_p)], \quad (11)$$

where  $e^j$  is the "jointly optimal" environmental standard/policy for group  $j$  and the government, and it satisfies

$$e^j = \arg \max_e f_j(e) \equiv W_j(e) - aM(e - e_p). \quad (12)$$

14. Notice that in addition to political contributions, the government cares about the political cost of its policy that deviates from the median-voter's preferences, instead of social welfare. Therefore, even in the absence of political contributions, unlike that in Grossman and Helpman (1994) the government in this current model is self-interested since it chooses a policy according to the median-voter's preference rather than social welfare.

15. These authors show that the equilibrium supported by the truthful contribution functions are coalition proof and therefore could become focal among the set of Nash equilibria.

*Proof.* See the Appendix.

From Lemma 1, the equilibrium value of  $e^o$  is determined by the following first-order condition

$$W'_E(e^o) + W'_I(e^o) - aM'(e^o - e_p) = 0. \quad (13)$$

Notice that  $W'_E(e^o)$  and  $W'_I(e^o)$  describe the welfare impact of government policy on the two groups at the margin. We thus define  $|W'_E(e^o)|$  and  $|W'_I(e^o)|$  as their economic “stake” in the government policy, respectively. From the first-order condition in (13), we have the following result.

**Proposition 1.** *If group I has a larger stake in the environmental policy than group E (i.e.  $|W'_I(e^o)| \geq |W'_E(e^o)|$ ), it will lobby more at the margin (i.e.  $|C'_I(e^o)| > |C'_E(e^o)|$ ) and, as a result, we have  $e^o \geq e_p$ ; otherwise,  $e^o < e_p$ .*

The reason for the result is that the truthful political-contribution schedule has the following property:  $C'_i(e) = W'_i(e)$ ,  $i = E, I$ . Therefore, if the industrialist group has a larger stake than the environmentalist group, it will lobby more at the margin and, as a result, have a stronger impact on government environmental policy than the environmentalist group. This is the prediction from the direct competition for political influence.

Having solved the last two stages of this three-stage game, in the next section we will focus on the first stage of the game.

#### 4. INDIRECT COMPETITION FOR POLITICAL INFLUENCE

Public persuasion is a common real-life phenomenon. Interest groups and political parties often disseminate information to voters in order to shift their opinions.<sup>16</sup> While there are many methods in political advertising, releasing information and advertising through mass media are used by almost all interest groups. For instance, among the 175 lobbying organizations interviewed by Schlozman and Tierney (1986; quoted by Grossman and Helpman (2001)), 86% of them provided information to the mass media. Environmental groups, however, particularly rely on direct mailing, organizing political protests and educating the public. The National Audubon Society, for example, sends millions of letters each year through direct mailing (Mitchell *et al.*, 1992). The recent revolution in communication technology also has a huge impact on the way that interest groups communicate with the public. The New Cyber Centre of Greenpeace World Wide, for example, is an initiative to eliminate geographical boundaries and to mobilize cyber-activists. The purpose of all these activities is to get their political “messages” out to the public, and to change public perception about the environment and the environmental consequences of government policy.

Polluting industries are also heavily engaged in public persuasion. They often try to highlight the potential high costs that a stricter environmental regulation might add to their products (or even the potential job losses, etc.). In addition, they often try to show that they are also environmentally responsible. For instance, Chevron Nigeria Limited, one of the four principal joint venture partners with the Federal Government in the U.S. crude oil and gas

16. We do not focus on how interest groups recruit more members and increase their size, the effect of which can be examined in the model by changes in  $N_E$  or  $N_I$ . An increase in  $N_E$  will strengthen the power of group  $E$  and tighten the environmental regulation, but the effect of an increase in  $N_I$  is not obvious. An increase in  $N_I$  tends to increase  $W_I$  but the optimal environmental standard for industrialists,  $e_I$ , will be lower since each individual share of profits,  $\pi(e)/N_I$ , decreases (because industrial profits do not change with  $N_I$ ).

production, recently announced a proposal of an amount of U.S.\$18 million for the environmental campaign in an effort to improve the nation's fast-depreciating environment as well as to raise visibility with its host communities (*Africa News Service*, 17 July 2000).<sup>17</sup>

As discussed earlier, interest groups do not have to change the preference of the public. It is sufficient that their persuasion can influence public perception about the scale of environmental consequences of a particular government policy. We assume that the general public do not have perfect knowledge and rationality about environmental issues although they do when it comes to the consumption of private goods. Specifically, the public in this model are like those *uninformed* voters in Baron (1994) that could be influenced by the messages received in election campaigns.<sup>18</sup>

There are several ways of capturing how political advertising could influence voters' perception in the literature on elections.<sup>19</sup> Following Congleton (1986), we use a mechanism analogous to Bayes' law. A Bayesian mechanism is desirable because it captures the issue that persuasion has an effect on the public's perception through affecting their posterior beliefs. This approach is common in the political science literature and can also be found elsewhere in the political economy literature (*e.g.* Grossman and Helpman, 2001).

Suppose the public has a prior,  $\mu_o$ , for the scale of environmental consequences of pollution and they will update their belief upon the messages received from interest groups. Group  $E$  sends messages to increase  $\mu_p$  but group  $I$  does the opposite. Unlike the signalling games in which informed agents try to reveal to the public the signals they receive, the role of the two interest groups in this model is simply to either raise or lower the public's belief, respectively. Therefore, the posterior belief is a function of  $\mu_o$ ,  $m_E$  and  $m_I$ . Specifically, we assume that

$$\mu_p = \mu(m_E, m_I, \mu_o), \quad \mu_1 > 0, \quad \mu_2 < 0, \quad \mu_3 > 0; \quad \mu_{12} = 0, \quad \mu_{13} > 0, \quad \mu_{23} > 0 \quad (14)$$

where  $m_E$  and  $m_I$  are respectively the number of messages from groups  $E$  and  $I$ , or namely, each group's *effort in indirect competition* (or "indirect effort"). Without loss of generality, we assume  $\mu_o = 1$  except in Section 5.2. We also assume that  $m_E$  and  $-m_I$  enter into function (14) symmetrically and in particular,  $\mu_1 = -\mu_2$  and  $\mu(m_E, m_I, \mu_o) = \mu_o$  when  $m_E = m_I$ .<sup>20</sup> To focus on changes around the equilibrium, we are interested in the range for the values of  $\mu_E$  and  $\mu_I$  (or  $N_I$ ) that ensure  $e_E < e_p < e_I$ .

From (7) the political cost of a particular government policy also depends on the optimal emission standard for the public,  $e_p$ . Hence, any change in the public's belief about the scale of environmental consequences of pollution would have an impact on the equilibrium level of environmental policy. Therefore, prior to the direct competition, interest groups will compete to influence the general public.

Suppose the cost of effort in sending messages is  $c(m_j)$  [ $c'(\cdot) > 0$  and  $c''(\cdot) > 0$ ]. Therefore, in the first stage group  $I$  and group  $E$  face the following optimization problems:

$$\max_{m_I} F^I(m_I, m_E) \equiv W_I(e^o) - C_I^o - c(m_I) \quad (15)$$

$$\max_{m_E} F^E(m_E, m_I) \equiv W_E(e^o) - C_E^o - c(m_E). \quad (16)$$

17. This amount is almost the same as the entire campaign spending by Greenpeace International (based in Amsterdam) in 1999, which is 18.455 million euros according to the *Greenpeace Annual Report 2001*.

18. In the signalling games on advertising, however, consumers are assumed to be fully rational (*e.g.* Nelson (1974), Milgrom and Roberts (1986)).

19. *E.g.* see Crain and Tollison (1976) and Kau, Keenan and Rubin (1982).

20. The specification of (14) implies that the number of messages sent by interest groups is equal to that received by the public (the next section will discuss the implication when they are not the same). Also, we assume  $\mu_{12} = 0$  to eliminate any other strategic interaction that is not the interest of this paper.

Using Lemma 1 (replacing  $C_I^o$  and  $C_E^o$ ), we obtain

$$\begin{aligned} \max_{m_I} F^I &= \{[W_E(e^o) + W_I(e^o) - aM(e^o - e_p)] \\ &\quad - [W_E(e^E) - aM(e^E - e_p)]\} - c(m_I) \end{aligned} \tag{17}$$

$$\begin{aligned} \max_{m_E} F^E &= \{[W_E(e^o) + W_I(e^o) - aM(e^o - e_p)] \\ &\quad - [W_I(e^I) - aM(e^I - e_p)]\} - c(m_E). \end{aligned} \tag{18}$$

From (17) and Lemma 1, notice that  $e^o$  maximizes the terms in the first square bracket and  $e^E$  maximizes those in the second. Therefore, by the envelope theorem we obtain the following first-order condition:

$$\begin{aligned} F_1^I &= ae'_p(\mu_p) \frac{d\mu_p}{dm_I} [M'(e^o - e_p) - M'(e^E - e_p)] - c'(m_I) \\ &= ae'_p(\mu_p) \mu_2 M''(0)(e^o - e^E) - c'(m_I) = 0 \end{aligned} \tag{19}$$

where the second equation follows from Taylor's expansion (neglecting the second and high order effects) that  $M'(e^o - e_p) = M''(0)(e^o - e_p)$  and  $M'(e^E - e_p) = M''(0)(e^E - e_p)$ .<sup>21</sup> The first term in (19) is the marginal benefit and the second is the marginal cost of persuading the public. Intuitively, the marginal benefit is increasing in the effectiveness of changing the public's belief and the relative weight attached to the political cost. It also depends on  $e^o - e^E$ , which is, to be discussed shortly, group  $I$ 's "direct political influence" (or political influence in the direct competition).

Similarly, from (18) we obtain

$$\begin{aligned} F_1^E &= ae'_p(\mu_p) \frac{d\mu_p}{dm_E} [M'(e^o - e_p) - M'(e^I - e_p)] - c'(m_E) \\ &= ae'_p(\mu_p) \mu_1 M''(0)(e^o - e^I) - c'(m_E) = 0 \end{aligned} \tag{20}$$

where  $|e^o - e^I|$ , or  $e^I - e^o$ , is group  $E$ 's direct political influence.

From (19) and (20) we can solve for the equilibrium level of effort in the indirect competition (or "indirect effort"),  $m_E^*$  and  $m_I^*$ . Since only the interior equilibrium is of interest, the second-order and regularity conditions require  $F_{11}^I, F_{12}^I, F_{11}^E, F_{12}^E < 0$ ,<sup>22</sup> and  $F_{11}^E F_{11}^I - F_{12}^E F_{12}^I > 0$ . Figure 1 illustrates the equilibrium using the two reaction functions,  $F_1^I$ -curve and  $F_1^E$ -curve, associated with the two first-order conditions (19)–(20). The slopes of the reaction function curves are  $\partial m_I / \partial m_E = -F_{12}^I / F_{11}^I$  and  $\partial m_I / \partial m_E = -F_{11}^E / F_{12}^E$ , and are negative from the second-order condition. Therefore, the indirect efforts of the two interest groups are strategic substitutes. Since the first stage of the game affects the equilibrium outcomes of the last two stages only through  $\mu_p$ ,<sup>23</sup> for convenience we continue using superscript "o" to denote other equilibrium variables. Therefore, the equilibrium outcomes are  $\{m_E^*, m_I^*, C_E^o(e; m_E^*, m_I^*), C_I^o(e; m_E^*, m_I^*); e = e^o(m_E^*, m_I^*)\}$ . That is, in the first-stage each interest group simultaneously chooses an equilibrium level of direct effort; in the second-stage each group then chooses an equilibrium political-contribution *schedule*; in the third stage the government chooses an equilibrium level of environmental policy.

The reason to call  $e^o - e^E$  (resp.  $e^I - e^o$ ) group  $I$ 's (resp. group  $E$ 's) "direct political influence" is as follows. From (10) and (12) in Lemma 1, notice that the equilibrium

21. Expanding  $M'(e^o - e_p)$  around  $e^o = e_p$  gives us  $M'(0) + M''(0)(e^o - e_p) \dots$  but  $M'(0) = 0$ .

22. Since the model is very general, some structural restrictions/assumptions for the functional forms are needed for the second-order conditions to hold. See further discussion in the Appendix.

23. That is, the political influence of indirect competition on government policy is channelled through changes in  $\mu_p$  by two groups' indirect effort.

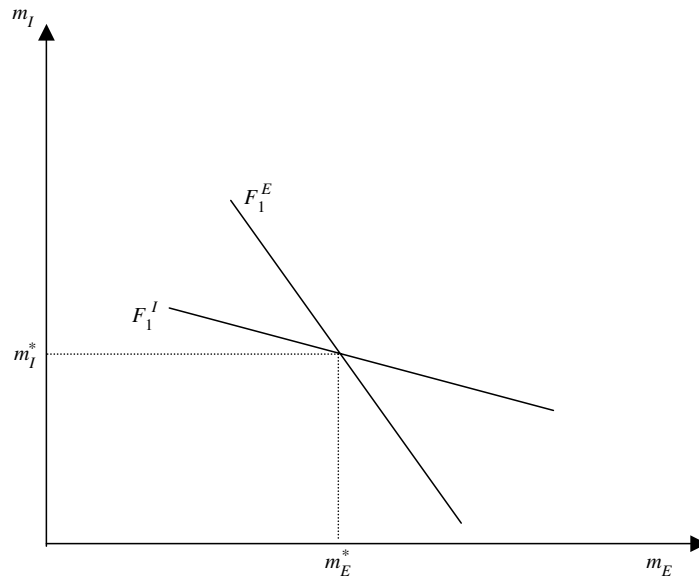


FIGURE 1

Reaction functions of the indirect effort

environmental standard,  $e^o$ , is determined when both groups' interests are taken into account by the government but the jointly optimal environmental standard for group  $j$  and the government,  $e^j$ , is determined when only group  $j$ 's interests ( $j = E, I$ ) are taken into account. For example, if group  $I$  does not provide political contributions,  $e^E$  will be the level of the environmental policy. When it does,  $e^o$  is the level of environmental policy. Therefore, we obtain the following results that characterize the equilibrium relationship between direct and indirect competition for political influence.

**Proposition 2.** *There is complementarity between the direct and indirect competition. Specifically,*

- (i)  $\text{sign}[m_I^* - m_E^*] = \text{sign}[(e^o - e^E) - (e^I - e^o)]$ ;
- (ii) *When  $-f'_E(\frac{e^E+e^o}{2}) \geq f'_I(\frac{e^I+e^o}{2})$ ,  $C_I^o(e^o) > C_E^o(e^o)$  if  $m_I^* > m_E^*$ , and  $m_I^* < m_E^*$  if  $C_I^o(e^o) < C_E^o(e^o)$ ; when  $-f'_E(\frac{e^E+e^o}{2}) < f'_I(\frac{e^I+e^o}{2})$ ,  $C_I^o(e^o) < C_E^o(e^o)$  if  $m_I^* < m_E^*$ , and  $m_I^* > m_E^*$  if  $C_I^o(e^o) > C_E^o(e^o)$ , where  $f_j(\cdot)$ ,  $j = I, E$ , is the joint welfare between group  $j$  and the government from Lemma 1.*

*Proof.* See the Appendix.

Part (i) of Proposition 2 states that the group that has relatively more direct political influence also exerts relatively more indirect effort. The reason for the result is that, as explained earlier in (19), the marginal benefit of indirect effort is higher for the group with more direct political influence. Now from (A.11) in the Appendix notice that  $e^o - e^E = -[1/f'_E(\frac{e^E+e^o}{2})]C_I^o(e^o)$ , where  $-[1/f'_E(\frac{e^E+e^o}{2})]$  is the "elasticity" of the direct political influence (since  $C_I^o(e^E) = 0$ ). That is, the direct political influence of an interest group is mainly supported

by its political contribution (*i.e.* direct effort). Thus, there is also complementarity between the direct and indirect effort as revealed by part (ii) of this proposition.

As mentioned earlier, however, environmental groups allocate much more effort towards indirect competition (such as educating the public, direct mailing, organizing political protests, etc.) than direct competition for political influence, and the converse holds for polluting industries. This begs for an explanation, which is the focus of the next section.

## 5. SUBSTITUTION BETWEEN DIRECT AND INDIRECT EFFORT

### 5.1. Relative effectiveness in persuading the public

So far we have assumed that the public have no doubt about the credibility of the messages from interest groups, and public persuasion by both groups are equally effective. In the real world, however, the credibility of the messages from interest groups is a very important issue. There is lots of evidence suggesting that the effectiveness of public persuasion is quite different among different interest groups.<sup>24</sup> In the case of environmental issues, for example, empirical evidence suggests that environmental groups were most likely to consider themselves successful in informing the general public as compared to business industry (Steel, Pierce and Lovrich, 1996). This is probably because the general public may view persuasion from business industry as mainly financially motivated but environmental groups as representing public interests. According to Pierce, Steger, Steel and Lovrich (1992, reported in Table 3.1) the level of public trust on information from environmental groups on acid rain and the environment is much higher than that from the business industry.

There are two ways of introducing asymmetry of the effectiveness in public persuasion into our model. First, we can use a discount factor for  $m_j$  ( $j = E, I$ ) in (14), namely, that the amount of messages received by the public (or having a real effect on  $\mu_p$ ) is different from that sent by interest groups. Alternatively, we could still keep (14) and consider  $m_j$  as the amount of “effective” messages received by the public but instead, assume that the cost of producing messages is different among interest groups. Since these two approaches are analytically equivalent, we adopt the second one for our analysis. Furthermore, since there are only two groups in the model, we only introduce one parameter to capture the relative effectiveness in public persuasion.

Suppose group  $I$ 's cost function of producing messages is still the same,  $c(\cdot)$ . But for group  $E$ , it becomes  $c(\cdot)/\gamma$ , where  $\gamma \geq 1$ . When  $\gamma$  is equal to one, two groups are equally effective in public persuasion; an increase in  $\gamma$  means an increase in the effectiveness of group  $E$  in public persuasion relative to group  $I$ . Therefore, (15)–(16) now become

$$\max_{m_I} W_I(e^o) - C_I^o - c(m_I) \quad (21)$$

$$\max_{m_E} W_E(e^o) - C_E^o - c(m_E)/\gamma, \quad \gamma \geq 1. \quad (22)$$

Similar to (19)–(20), we obtain the following first-order conditions:

$$F_1^I = ae'_p(\mu_p)\mu_2 M''(0)(e^o - e^E) - c'(m_I) = 0 \quad (23)$$

$$F_1^E = ae'_p(\mu_p)\mu_1 M''(0)(e^o - e^I) - c'(m_E)/\gamma = 0. \quad (24)$$

Therefore, we obtain

24. For a recent survey of NGO's ability to influence the public, see the Press Release (08/11/2002) by the *World Economic Forum*, Geneva.

**Proposition 3.**

$$\frac{dm_E^*}{d\gamma} > 0; \quad \frac{dm_I^*}{d\gamma} < 0. \quad (25)$$

*Proof.* Totally differentiating (23) and (24), we have

$$F_{11}^I dm_I^* + F_{12}^I dm_E^* = 0 \quad (26)$$

$$F_{12}^E dm_I^* + F_{11}^E dm_E^* + \frac{c'(m_E^*)}{\gamma^2} d\gamma = 0. \quad (27)$$

Given the second-order and regularity conditions discussed above, we obtain that

$$\frac{dm_E^*}{d\gamma} = \frac{-F_{11}^I c'(m_E^*)}{D \gamma^2} > 0; \quad \frac{dm_I^*}{d\gamma} = \frac{F_{12}^I c'(m_E^*)}{D \gamma^2} < 0 \quad (28)$$

where  $D = F_{11}^I F_{11}^E - F_{12}^I F_{12}^E > 0$ .  $\parallel$

When group  $E$  is more effective in public persuasion, it becomes more aggressive and increases its effort in the indirect competition. The converse holds for group  $I$  since their direct efforts are strategic substitutes. Proposition 3 can also be illustrated by using the reaction functions in Figure 1. Since an increase in  $\gamma$  reduces group  $E$ 's marginal cost of public persuasion, the  $F_I^E$ -curve would shift to the right, resulting in a higher level of  $m_E^*$  and a lower level of  $m_I^*$ .

How does an increase in  $\gamma$  affect two groups' equilibrium *strategies* in the direct competition? To answer this question, we must examine their equilibrium political-contribution *schedules* in the second stage of the game. This is characterized by the next proposition.

**Proposition 4.**

$$\frac{dC_E^o(e; m_E^*, m_I^*)}{d\gamma} < 0; \quad \frac{dC_I^o(e; m_E^*, m_I^*)}{d\gamma} > 0. \quad (29)$$

*Proof.* See the Appendix.

The details of the proof are given in the Appendix but the intuitions for the result are as follows. When group  $E$  becomes relatively more effective in public persuasion, the equilibrium level of  $m_E^*$  increases and that of  $m_I^*$  decreases (from Proposition 3). As a result,  $\mu_p$  rises and hence  $e_p$  becomes lower, which strengthens (resp. weakens) group  $E$ 's (resp. group  $I$ 's) bargaining position with the government. Consequently, group  $E$  could afford to reduce its equilibrium political-contribution *schedule* in the second stage (direct competition) and hence increases the base level of its welfare. On the other hand, group  $I$  would have to increase its equilibrium political-contribution *schedule* and reduce the base level of its welfare.

Propositions 3 and 4 together have revealed an interesting substitution of interest groups' equilibrium *strategies* in the direct and indirect competitions. Specifically, when group  $E$  becomes relatively more effective in public persuasion, it increases the level of its equilibrium effort in public persuasion but reduces the offer of its equilibrium political-contribution *schedule*. In other words, group  $E$  becomes more aggressive in the indirect competition but less aggressive in the direct competition. The converse holds for group  $I$ .

A less aggressive strategy in the second stage (*i.e.* a reduced political-contribution schedule), however, does not always imply that the actual level of political contribution necessarily decreases. It depends on how the equilibrium level of government policy changes in the

third stage. For instance, if the equilibrium level of environmental policy/standard becomes more stringent, *ceteris paribus*, this will raise (resp. lower) the level of political contribution from group *E* (resp. group *I*) since the actual level of contribution is contingent on the level of the government policy for any given contribution schedule. The next proposition shows that an increase in  $\gamma$  would indeed lower the equilibrium level of  $e^o$ .

**Proposition 5.**

$$\frac{de^o(m_E^*, m_I^*)}{d\gamma} < 0. \tag{30}$$

*Proof.* The optimal choice of  $e$  is determined by the following first-order condition (see (13)):

$$W'_E[e^o(m_E^*, m_I^*)] + W'_I[e^o(m_E^*, m_I^*)] - aM'[e^o(m_E^*, m_I^*) - e_p] = 0. \tag{31}$$

Totally differentiating (31) and using Proposition 3, we obtain

$$\frac{de^o(m_E^*, m_I^*)}{d\gamma} = \frac{-a}{\Delta} M''(\cdot) e'_p(\cdot) \left( \mu_1 \frac{dm_E^*}{d\gamma} + \mu_2 \frac{dm_I^*}{d\gamma} \right) < 0 \tag{32}$$

where  $\Delta$  is the second-order condition and is negative.  $\parallel$

The intuitions for the result are as follows. Since any truthful political contribution has the following property:  $C'_i(e) = W'_i(e)$ ,  $i = E, I$  (as discussed in Section 3), the change in the equilibrium political-contribution schedule, as a result of an increase in  $\gamma$ , should not affect the level of  $e^o$  (see (13)). Therefore, the equilibrium level of  $e^o$  is only affected by  $\gamma$  through changes in  $\mu_p$ . From Proposition 3, an increase in  $\gamma$  raises  $m_E^*$  but lowers  $m_I^*$ , which leads to a higher level of  $\mu_p$  (or a lower level of  $e_p$ ). This increases the (marginal) political cost of its policy at the margin, resulting in a lower level of  $e^o$ .

Now suppose the environmentalist group is more effective in public persuasion than the industrialist group. Will the presence of this political channel of indirect competition result in a more stringent environmental policy? Specifically, let  $e^o(m_E^*, m_I^*)$  and  $e^o(0, 0)$  denote the equilibrium environmental policy with and without indirect competition, respectively. Will it be enough that  $\gamma > 1$  to ensure that  $e^o(m_E^*, m_I^*) < e^o(0, 0)$ ?

The answer to this question is actually negative because of the result of complementarity in Proposition 2. It may not be enough if  $\gamma$  is simply greater than one. Using (23), (24), (31) and following the procedure of proving Propositions 2 and 5, however, the next proposition provides a sufficient condition for  $e^o(m_E^*, m_I^*) < e^o(0, 0)$  to be true.

**Proposition 6.** *When  $\gamma > \tilde{\gamma}$ , we have  $e^o(m_E^*, m_I^*) < e^o(0, 0)$ , where  $\tilde{\gamma} = \{[e^o(m_E^*, m_I^*) - e^E]/[e^I - e^o(m_E^*, m_I^*)]\}^{1/2}$ .*

Notice that when  $e^o(m_E^*, m_I^*) - e^E \leq e^I - e^o(m_E^*, m_I^*)$ ,  $\tilde{\gamma} \leq 1$ . The condition holds by definition. That is, since from Proposition 2 we have  $m_E^* \geq m_I^*$  when  $e^o(m_E^*, m_I^*) - e^E \leq e^I - e^o(m_E^*, m_I^*)$ ,  $\mu_p$  rises. Then,  $e^o(m_E^*, m_I^*)$  would be lower than  $e^o(0, 0)$  even when  $\gamma = 1$ .

When  $e^o(m_E^*, m_I^*) - e^E > e^I - e^o(m_E^*, m_I^*)$ , (and therefore  $\tilde{\gamma} > 1$ ), however, we have  $m_E^* < m_I^*$  when  $\gamma = 1$  (from Proposition 2). Then, given that  $dm_E^*/d\gamma > 0$  and  $dm_I^*/d\gamma < 0$  from Proposition 3,  $\gamma$  has to be sufficiently greater than one so that  $m_E^*$  would become greater than  $m_I^*$  in the equilibrium. This will then raise  $\mu_p$  and ensure that  $e^o(m_E^*, m_I^*) < e^o(0, 0)$ . Therefore, for indirect competition to benefit the environmentalist group in the formation of government environmental policy, it may not be enough that the environmentalist group is simply

being relatively more effective in public persuasion. The effectiveness of the environmentalist group in public persuasion may have to be sufficiently greater than that of the industrialist group.

### 5.2. Public environmental awareness

The purpose of most campaigns by environmental groups is to increase public awareness of the fast-depreciating environment. Public environmental awareness, however, could also increase due to other factors. For example, if Olson's "rational ignorance" exists because there are costs of acquiring information, the rising of living standard and the increase of income in most industrialized countries will raise the demand for environmental quality and public environmental awareness. Moreover, citizens in most developed countries have a high level of literacy and better communication channels (e.g. radios, TVs). A better access to the mass media makes it easier for the general public to be aware of the fast-depreciating environment around the world and hence for keeping up environmental awareness.<sup>25</sup>

The effect of a higher public environmental awareness on the stringency of government environmental policy is fairly intuitive. Suppose that in (14)  $\mu_o$  represents the degree of (intrinsic) public environmental awareness. It is straightforward to show that  $de^o/d\mu_o < 0$ , that is, a higher  $\mu_o$  would increase the stringency of equilibrium environmental policy. As shown in the next proposition, however, the degree of public environmental awareness could also affect the pattern of direct and indirect effort by both interest groups.

**Proposition 7.** (i)

$$\frac{dm_E^*}{d\mu_o} > 0; \quad \frac{dm_I^*}{d\mu_o} < 0. \quad (33)$$

(ii)

$$\frac{dC_E^o(e; m_E^*, m_I^*)}{d\mu_o} < 0; \quad \frac{dC_I^o(e; m_E^*, m_I^*)}{d\mu_o} > 0. \quad (34)$$

*Proof.* See the Appendix.

Intuitively, an increase in public environmental awareness helps the environmentalist group in public persuasion and hence makes the environmentalist group (resp. industrialist group) more (resp. less) aggressive in the indirect competition. For the reaction functions in Figure 1, this will be reflected by an outward-shift of the  $F_1^E$ -curve and an inward-shift of the  $F_1^I$ -curve. Therefore,  $m_E^*$  increases but  $m_I^*$  decreases. Together with the initial increase in  $\mu_o$ , it implies that  $\mu_p$  must be higher. This improves the environmentalist group's bargaining position with the government and therefore it can afford to be less aggressive in the direct competition. The converse holds for the industrialist group. Thus, an increase in public environmental awareness also induces substitution of direct and indirect competition from both interest groups.

## 6. CONCLUDING REMARKS

This paper develops a model of direct and indirect competition for political influence and finds that they are complementary. It is also found, however, an increase in the effectiveness of public persuasion, or a rise of public environmental awareness, will induce substitution between

25. Better communication technology may also benefit environmental groups in persuading the public. For example, the growing availability of personal computers greatly facilitated the use of direct mailing. However, in this paper we do not focus on such an asymmetry between the two groups.

the two. The results are interesting and have a much broader implication. It has been observed that the amount of political contributions from public interest groups is relatively small. For instance, according to a report from the centre for responsive politics in the U.S., “politicians received nearly \$50 from energy, agricultural and natural resources interests for every \$1 from environmentalists in 1996” (*In Business*, 1998). A reason for this could be that some public interest groups are financially constrained. The results of this paper, however, suggest a new explanation. They establish that the empirical phenomenon of lack of political contributions from environmental groups may not be related to financial constraints, but to their greater effectiveness in public persuasion and the growing public environmental awareness.

Studies on direct competition for political influence focus on how interest groups lobby governments. The analysis of indirect competition for political influence, however, focuses on how interest groups win over the general public. As long as public preferences are to some extent taken into account by the government, public persuasion can indirectly influence government policy. Thus, the idea of indirect competition for political influence makes a complement to that of direct competition for political influence. A combination of these two could become a very useful framework in analysing the formation of public policy. Although we use environmental policy for an application of the model, the theory developed in this paper is general. In the model,  $e$  could represent the level of a public good, or any public policy, to be chosen by a government. Therefore, the results obtained in this paper have a much broader implication for research in political economy and political science.

APPENDIX

*Proof of Lemma 1.* Here we only provide a sketch of the argument. Readers should consult Grossman and Helpman (1994, 1995) for further details. (i) Since the benefits of all the parties are maximized, we have

$$C_E^o(e^o) + C_I^o(e^o) - aM(e^o - e_p) \geq C_E^o(e) + C_I^o(e) - aM(e - e_p) \tag{A.1}$$

for the government,

$$W_E(e^o) - C_E^o(e^o) \geq W_E(e) - C_E^o(e) \tag{A.2}$$

for the environmentalists, and

$$W_I(e^o) - C_I^o(e^o) \geq W_I(e) - C_I^o(e) \tag{A.3}$$

for the industrialists. Combining (A.1)–(A.3), we obtain

$$W_E(e^o) + W_I(e^o) - aM(e^o - e_p) \geq W_E(e) + W_I(e) - aM(e - e_p). \tag{A.4}$$

(ii) In equilibrium, we have  $C_I^o(e^o) = W_I(e^o) - b_I^o$ . As  $C_I^o(e^I)$  must also be positive (because  $C_I^o(e^I) > C_I^o(e^o)$ ), we have  $C_I^o(e^I) = W_I(e^I) - b_I^o$ . Combining these two equations, we obtain

$$C_I^o(e^I) - C_I^o(e^o) = W_I(e^I) - W_I(e^o). \tag{A.5}$$

Also, the environmentalists will raise  $b_E^o$  until the government is indifferent between choosing  $e^o$  and choosing  $e^I$  (see the discussion in Grossman and Helpman (1994, pp. 845–846)). This means

$$C_E^o(e^o, b_E^o) + C_I^o(e^o) - aM(e^o - e_p) = C_I^o(e^I) - aM(e^I - e_p). \tag{A.6}$$

Together with (A.4)–(A.5), we have

$$C_E^o(e^o, b_E^o) = [W_I(e^I) - aM(e^I - e_p)] - [W_I(e^o) - aM(e^o - e_p)]. \tag{A.7}$$

Accordingly, we can also obtain  $C_I^o$ . ||

*Proof of Proposition 2.* First, we show that for the second-order conditions of (19)–(20) to hold, it is sufficient if we have  $\mu_{11} < 0$  and  $\mu_{22} > 0$  for (14) (i.e. decreasing returns in changing the public’s belief) and that  $e_p''(\cdot)$  is not large. For example, from (19) we obtain

$$F_{11}^I \approx ae_p'(\mu_p)\mu_{22}M''(0)(e^o - e^E) + ae_p''(\mu_p)(\mu_2)^2M''(0)(e^o - e^E) - c''(m_I) < 0 \tag{A.8}$$

and (using (14))

$$F_{12}^I \approx ae_p''(\mu_p)\mu_2\mu_1M''(0)(e^o - e^E) - c''(m_I) < 0. \quad (\text{A.9})$$

Similarly, we can show  $F_{11}^E < 0$  and  $F_{12}^E < 0$ .

Now we prove Proposition 2: (i) Using (14), part (i) of the proposition immediately follows from (19) to (20) since  $M''(0) > 0$ .

(ii) Using Taylor's expansion (neglecting the second and high order effects) we can write the joint welfare of group  $E$  and the government (as in Lemma 1) as follows:

$$f_E(e^E) = f_E(e^o) + f_E' \left( \frac{e^E + e^o}{2} \right) (e^E - e^o). \quad (\text{A.10})$$

From Lemma 1, notice that  $C_I^o(e^o) = f_E(e^E) - f_E(e^o)$  and thus we obtain

$$C_I^o(e^o) = -f_E' \left( \frac{e^E + e^o}{2} \right) (e^o - e^E) \quad \text{or,} \quad e^o - e^E = - \left[ 1/f_E' \left( \frac{e^E + e^o}{2} \right) \right] C_I^o(e^o). \quad (\text{A.11})$$

Similarly,

$$e^I - e^o = \left[ 1/f_I' \left( \frac{e^I + e^o}{2} \right) \right] C_E^o(e^o). \quad (\text{A.12})$$

Therefore, when  $-f_E' \left( \frac{e^E + e^o}{2} \right) \geq f_I' \left( \frac{e^I + e^o}{2} \right)$ ,  $C_I^o(e^o) > C_E^o(e^o)$  if  $(e^o - e^E) > (e^I - e^o)$ , and  $(e^o - e^E) < (e^I - e^o)$  if  $C_I^o(e^o) < C_E^o(e^o)$ ; when  $-f_E' \left( \frac{e^E + e^o}{2} \right) < f_I' \left( \frac{e^I + e^o}{2} \right)$ ,  $C_I^o(e^o) < C_E^o(e^o)$  if  $(e^o - e^E) < (e^I - e^o)$ , and  $(e^o - e^E) > (e^I - e^o)$  if  $C_I^o(e^o) > C_E^o(e^o)$ . Then using part (i) of this proposition, we obtain the result in (ii).

*Proof of Proposition 4.* Since political contributions cannot be reduced below zero, we are only interested in the positive level of  $C_E^o(e; m_I^*, m_E^*)$ . To ease expression, we still use superscript  $o$  to denote the equilibrium variables and we also omit the arguments of  $m_I^*$  and  $m_E^*$  within other variables. Using equations similar to (11), we can derive that

$$\begin{aligned} C_E^o(e, b_E^o) &= W_E(e) - b_E^o \\ &= W_E(e) - [W_E(e^o) - C_E^o(e^o)] \\ &= W_E(e) - W_E(e^o) + [W_I(e^I) - aM(e^I - e_p)] - [W_I(e^o) - aM(e^o - e_p)] \\ &= W_E(e) + [W_I(e^I) - aM(e^I - e_p)] - [W_E(e^o) + W_I(e^o) - aM(e^o - e_p)]. \end{aligned}$$

Using the envelope theorem and Taylor expansion (neglecting the second and higher order effects) we obtain (together with Proposition 3)

$$\begin{aligned} \frac{dC_E^o(e, b_E^o)}{d\gamma} &= aM'(e^I - e_p) \frac{de_p}{d\gamma} - aM'(e^o - e_p) \frac{de_p}{d\gamma} \\ &= aM''(0)(e^I - e^o)e_p'(\cdot) \left[ \mu_1 \left( \frac{dm_E}{d\gamma} \right) + \mu_2 \left( \frac{dm_I}{d\gamma} \right) \right] < 0. \end{aligned}$$

Similarly, we can derive that

$$\frac{dC_I^o(e)}{d\gamma} > 0. \quad \parallel$$

*Proof of Proposition 7.* (i) Totally differentiating (19)–(20) and focusing only on the first-order and direct effects, we obtain (after rearranging)

$$F_{11}^I dm_I^* + F_{12}^I dm_E^* = -ae_p'(\cdot)\mu_{23}M''(0)(e^o - e^E)d\mu_o \quad (\text{A.13})$$

$$F_{12}^E dm_I^* + F_{11}^E dm_E^* = -ae_p'(\cdot)\mu_{13}M''(0)(e^o - e^I)d\mu_o. \quad (\text{A.14})$$

Therefore we have

$$\frac{dm_E^*}{d\mu_o} = \frac{F_{12}^E aM''(0)e_p'\mu_{23}(e^o - e^E) - F_{11}^I aM''(0)e_p'\mu_{13}(e^o - e^I)}{D} > 0 \quad (\text{A.15})$$

and

$$\frac{dm_I^*}{d\mu_o} = \frac{F_{12}^I aM''(0)e_p'\mu_{13}(e^o - e^I) - F_{11}^E aM''(0)e_p'\mu_{23}(e^o - e^E)}{D} < 0 \quad (\text{A.16})$$

where  $D = F_{11}^I F_{11}^E - F_{12}^I F_{12}^E > 0$  and  $F_{11}^I, F_{12}^I, F_{12}^E, F_{22}^E < 0$ . Proof of part (ii) follows that of Proposition 4 similarly.  $\parallel$

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