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Environmental Tax Competition and Welfare: The Good News about Lobbies*

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Abstract

This paper focuses on the welfare effects of domestic and international lobbying in the context of two countries linked by both trade and pollution. We consider a reciprocal-markets model where, in each country, a domestic firm produces a polluting good, that can result in a cross-national environmental externality, and competes in quantities in each market with a foreign firm. Each government independently sets a pollution tax under political pressure from green and industrial lobbies *à la* Grossman and Helpman (1994). Our results mainly show that political pressure from domestic and/or international lobbies can help mitigate tax competition between the two countries, resulting in an improvement in social welfare. In fact, lobbying acts much like a strategic delegation device by changing the social welfare weights in the objective function of each government. The (potential) welfare-improving effect of political pressure depends on the relative strengths of the lobbies and on the nature of the strategic interactions in taxes.

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Key-words: Lobbying, transboundary pollution, international trade, international politics, environmental tax.

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1 Introduction

Globalization is often criticized for the (harmful) consequences it can have on the environment. Copeland and Taylor (1994, 1995) addressed this issue by using the perfectly competitive models of classical trade theory. They show that trade liberalization can increase or decrease world pollution depending on a number of factors and, above all, on income heterogeneity between countries and differences in factors endowments. Since a large part of international trade is intra-industry trade, most studies in the last two decades have addressed the issue of the impact of trade on the environment by using models where trade is explained by non-competitive market structures. Imperfect competition in international markets creates strategic interactions between governments that can result in the use of inefficient environmental policies. In particular, trade liberalization can lead to lower environmental standards since governments may be tempted to relax their standards to increase the competitiveness of their firms vis-à-vis their partners. However, as Kennedy (1994) pointed out, some countries may also use environmental standards as protectionist tools or reinforce them to ban polluting production, since the consumer goods from this production can be imported. Nevertheless, this incentive is only effective if the environmental damage is purely local. In the case of global pollution, common sense dictates that trade liberalization will lead governments to engage in environmental dumping.

Another commonly held belief is that green lobbies can help to reduce the inefficiency of uncoordinated environmental regulations by exerting political pressure for the implementation of stricter environmental policies. In the study by Conconi (2003), the effect of green lobbying on pollution taxes was examined using a perfectly competitive model of trade between two large economies. Lobbying was modeled as a common agency relationship. The author demonstrates that the impact of green lobbying on pollution taxes is dependent on the trade policy regime, the terms-of-trade effect of a domestic pollution tax, and the spillover effects. The literature on the influence of green lobbying on strategic environmental policy-making also highlights that an increase in the influence of green lobbies may not be sufficient to enhance environmental protection (see, e.g., Aidt, 2005).

While the literature is systematically and exclusively interested in the question of the impact of lobbying on the stringency of environmental policies, we analyze the welfare impact of the political game in the context of two countries linked by imperfect world markets. Specifically, we consider a reciprocal-markets model with two countries (see, e.g., Brander, 1995). In each country, there is a domestic firm producing a polluting good and both the domestic and the foreign firms compete in quantities in each market. The production of the polluting good can result (or not) in a cross-national environmental externality, so that the two countries are linked by both trade and pollution. The two governments choose their environmental policies – that is

a tax on polluting production – independently of each other, and are subject to political pressure from lobby groups *à la* Grossman and Helpman (1994). More precisely, in each country, a green lobby and producer lobby oppose each other on the stringency of domestic environmental policy and offer the government some political contributions contingent on the chosen environmental policy. In this paper, we will focus on two polar cases: local pollution and global pollution.

For local pollution, agricultural products traded globally exemplify the environmental challenges our model addresses. Globally traded agricultural products cause local pollution through deforestation, biodiversity loss, land use, freshwater depletion, soil and water contamination, and air quality degradation from fertilizers and pesticides. In the EU, the European farmers' lobby in Brussels holds about 300 meetings a year and spends around 1.5 million euros on lobbying according to *www.lobbyfacts.eu*. This lobby, representing EU farmers, often clashes with green NGOs advocating for both European and global environmental issues. The National Strategy to Combat Imported Deforestation (SNDJ), adopted by France in 2018, illustrates the influence of international green lobbying on national policy. It aims to reduce the environmental impact of imported products such as soy, palm oil and beef, which are linked to deforestation in countries such as Brazil, Indonesia and Malaysia. NGOs such as Greenpeace, WWF and Rainforest Foundation France have played a key role in defending the SNDJ.

The energy production market, especially from fossil fuels, exemplifies global pollution. This market characterized by imperfect competition leads to significant environmental harm, with coal, oil, and natural gas combustion releasing sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon dioxide (CO_2), causing acid rain and climate change. The extensive international trade in energy products underscores the global nature of pollution. In the EU, the regulatory landscape for the energy market involves balancing environmental protection with energy security, economic competitiveness, and social welfare, reflecting the complex interplay of stakeholders and policy instruments central to our analysis.

Assuming that pollution is perfectly transboundary, we show that lobbying can increase domestic welfare in both countries if the influence of green lobbies is sufficiently strong relative to that of producer lobbies. This is because political competition mitigates the race to the bottom in environmental taxes. If the externality is only local, competition for political influence can increase welfare in both countries if the green and producer lobby in each country have comparable strength. However, if the influence of one interest group differs significantly from the other, the political influence game has negative welfare consequences. This is due to a pollution tax that is either too low or too high relative to the pollution tax that would maximize the joint welfare of both countries. Thus, if green lobbies have significant influence, this leads to stricter environmental policies than the two governments would have chosen cooperatively (and without lobbying). Reducing environmental damage is beneficial, but it may exacerbate

the market failure of underproduction due to imperfect competition. In this case, the welfare gain from reduced environmental damage is more than offset by the welfare loss from reduced consumer surplus.

Finally, this analysis considers the scenario in which two domestic green lobbies unite to form an international lobby that exerts political pressure on both governments. The common agency relationship then becomes a multiple principal-multiple agent relationship, as described in Prat and Rustichini (1999, 2003). When pollution is perfectly transboundary, we show that lobbying with an international green lobby is always beneficial to welfare in both countries, compared to the non-cooperative benchmark without lobbying. When pollution is local, an international green lobby can increase welfare in both countries, provided that the political influence of the international green lobby, on the one hand, and that of the producer lobbies, on the other, are not too asymmetrical. However, compared to the situation where green lobbies do not cooperate, the political strength of the international green lobby must be greater to improve welfare in both countries. This is because it advocates less stringent environmental policies than domestic green lobbies, as it internalizes the effect of its influence on environmental damage in both countries. Finally, cooperation between green lobbies can have a positive impact on social welfare in both countries, compared to the equilibrium with national green lobbies, in two ways. In one scenario, it strengthens environmental regulations when they fail to fully internalize the transnational externality. In another scenario, it facilitates the relaxation of excessively high and inefficient environmental regulations.

The main message of this analysis is that lobbying creates a policy distortion by over-representing the preferences of interest groups in the objective function of governments. Inefficiencies can interact with uncoordinated environmental policies to produce a policy outcome close to an international environmental agreement that maximizes the welfare of both countries. This is particularly true for transboundary/global pollution when green lobbies are sufficiently strong. The same is true for purely local pollution, as long as the producer and green lobbies in both countries have similar influence. In other words, *lobbying acts as a strategic delegation device* by altering the social welfare weights in each government's objective function. The welfare implications of this mechanism depend on the relative strength of the two lobbies and the nature of the strategic interactions between governments, which in turn depend on the nature of the pollution externality and the strategic interactions between firms.

The rest of the paper is organized as follows. Section 2 surveys the related literature. Section 3 presents the model. In Section 4, we examine the impact of the influence of domestic producer and green lobbies on social welfare. In Section 5, we analyze the case of international green lobbying and finally, Section 6 concludes the paper.

2 Literature review

This paper is related to the (now relatively old) literature on strategic environmental policy with early contributions by Conrad (1993), Barrett (1994), Kennedy (1994), Rauscher (1994) and Ulph (1996). The main argument of these analyses is that, under a free trade agreement, governments have incentives to relax environmental regulation to increase the competitiveness of theirs firms on international markets. Duval and Hamilton (2002) extend these analyses by considering different forms of international asymmetries, in terms of market size, production technologies, and environmental damage flows. Other studies consider that governments can use both trade and environmental policy instruments with imperfect competition between firms. Walz and Wellisch (1997) shows that banning export subsidies increases the welfare of the exporting countries when firms compete in a third country and when pollution is perfectly local. Tanguay (2001) obtains an opposite result by considering that firms compete in an integrated market between countries and that pollution is transboundary. Relatively more recent works with product differentiation have been conducted by Straume (2006) and Lai and Hu (2008). They show that increased market integration improves the global environment.

This paper is also related to the literature on the political economy of environmental policy in a small open economy. Most analyses uses the common agency model as developed by Grossman and Helpman (1994) for studying the impact of lobbying by various interest groups on environmental regulation. This literature typically considers industry and environmental lobby groups with conflicting interests in small open economies. Early studies by Fredriksson (1997, 1999) and Aidt (1998) show that more powerful green lobbies induce stricter environmental policies in (small open) competitive economy. Damania et al. (2004) obtain the same result in an imperfect market setting.

Considering small open economies eliminates strategic interactions between governments at the policy level. Thus, other studies have analyzed the role of domestic politics when governments have strategic interactions regarding environmental policy, modelled as an international public good provision game. Siqueira (2003) and Buchholz et al. (2005) consider a representative democracy framework in a two-country model, and where citizens, in each country, elect their policymaker in charge of environmental policy. They show that the median voter, in each country, strategically elects a policymaker who is less eco-friendly than herself, which in turn aggravates the environmental damage.[1]

Conconi (2003) analyzes how producer and green lobbies affect trade and environmental

[1]This outcome is explained by the nature of strategic interactions between governments. In a general framework, Cheikbossian (2016) shows that strategic voting increases the free-rider problem in public good provision when policy variables are strategic substitutes (as in Siqueira, 2003, and Buchholz et al., 2005), while it mitigates it and makes the equilibrium closer to the world optimum when policy variables are strategic complements.

policies in two large countries that can cooperate or not in both trade and environmental policies, and with perfect competition in all markets. She emphasizes that green lobbies do not necessarily advocate for more stringent environmental domestic policy due to the problem of 'emission leakage'. Indeed, a stricter environmental policy by a large country increases the terms of trade of its partners and thus their emissions that can aggravates the environment damage if emissions are (sufficiently) transboundary. Persson (2012) considers two countries negotiating pollution taxes with competitive markets. He finds that green lobbying in one country can decrease the pollution tax in the other country as a consequence of the bargaining process. Aidt (2005) assumes imperfectly competitive markets and finds that environmental lobby groups can lead to a lower domestic pollution tax. His analysis depends critically on the assumption that the pollution tax in the foreign country is exogenous and on environmentalists being concerned by pollution abroad.

Aidt and Hwang (2014) consider a general model with cross-national externalities and investigate the benefits and costs of banning or not foreign lobbying on the welfare of the target country. They show that the welfare effects of foreign lobbying depend crucially on the degree of preference alignment between unorganized groups at home and foreign lobbies. When these preferences coincide, allowing foreign lobbying improves welfare, as it allows unorganized citizens to be represented against organized groups. The result is the opposite when foreign lobbies have the same preferences as domestic lobbies, which is the case, according to Aidt and Hwang (2014), of green lobbies attentive to environmental policies. In the same spirit, Aidt et al. (2021) develop a general framework to study the reasons why foreign actors - states and lobbies - may decide to intervene in a country's domestic politics, and how. In the present analysis, we investigate the situation where the two domestic lobbies form an international lobby exerting political pressure on the two governments. We therefore also analyze the impact of foreign influence, but this is bilateral and targets the governments of both countries indifferently. We then show that this bilateral foreign influence from environmentalists can increase the welfare of both countries relative to the case where governments are subject to domestic influence only.

To summarize, part of the literature analyze environmental policies with strategic interactions at the policy level between government and at the firm level between firms, but without integrating domestic political processes. Another part of the literature investigate the effect of domestic politics on environmental policy with strategic interactions either at the policy or at the firm level. There are few papers where environmental policy is determined by a political economy process with strategic interactions both between governments and firms. In particular, Roelfsema (2007) and Hattori (2010) investigate people's incentives for strategic voting in the presence of strategic interactions among both governments and firms. They show that strategic voting can also be welfare improving by electing eco-friendly policymakers depending on the

nature of strategic interaction between firms and governments. However, to our knowledge, there does not exist analyses on the role of domestic and international lobbying on strategic environmental policies and with imperfect world markets.

3 The economic model

3.1 Assumptions and notations

We consider a reciprocal-markets model with two countries, Home and Foreign, and two firm $i = 1, 2$. Firm 1 is located in the Home country and firm 2 is located in the Foreign country. Let q_i and q_i^* be the production of firm i, for $i = 1, 2$, for respectively the Home market and the Foreign market. Thus, q_1^* represents the exports from the Home country to the Foreign country, and q_2 the imports of the Home country from the Foreign country. We abstract from any transportation cost between the two regions.

The two countries are identical in all respects, with foreign variables denoted by an asterisk ($*$). Thus, to avoid repetitions, we focus on the Home country. Yet, we need to distinguish production decisions by the two firms for the Home market and the Foreign market.

Demand originates from a quadratic and quasi-linear utility function for a representative consumer in each region (Medrano and Vives, 2001), i.e., for the Home country,

$$U(\mathbf{q}) = q_1 + q_2 - \frac{1}{2}(q_1^2 + q_2^2 + 2q_1q_2) + m$$

where m is the consumption of the numeraire good and $\mathbf{q} \equiv (q_1, q_2)$. Note that it is assumed homogeneity of the goods produced. The utility of the representative consumer in the Foreign country is similar with q_i being replaced by q_i^* for $i = 1, 2$ and $\mathbf{q}^* \equiv (q_1^*, q_2^*)$

Solving the optimization problem of the representative consumer in the two countries, homogeneity of the good gives rise to the following market demand functions:

$$p(\mathbf{q}) = 1 - q_1 - q_2 \text{ and } p^*(\mathbf{q}^*) = 1 - q_1^* - q_2^*$$

and substituting into $U(q) - p(q_1 + q_2)$, we obtain the consumer surplus in the Home country, denoted $CS(q)$,

$$CS(\mathbf{q}) = \frac{1}{2}(q_1^2 + q_2^2) + q_1q_2. \tag{1}$$

Consumer surplus in the Foreign country is defined similarly is similar with q_i being replaced by q_i^* for $i = 1, 2$.

On the production side, it is assumed that the two firms share the same technology and that there are no fixed costs of production. Total production by firm i for $i = 1, 2$ is polluting and generates emissions denoted by e_i, which can be reduced through some abatement technology.

More precisely, the production cost for firm i is:

$$c(q_i + q_i^*, e_i) \equiv c(q_i + q_i^* - e_i)$$

where $q_i + q_i^* - e_i = a_i$ denotes the level of abatement effort for firm i. Furthermore, assume that the cost of abatement is quadratic: $c(a_i) = a_i^2/2$. Apart from the abatement cost, firms bear the tax burden on emissions. Let t and t^* be the tax on emissions, respectively in the Home country and in the Foreign country. The Home firm profit thus writes:

$$\pi(\mathbf{q}, \mathbf{q}^*) = p(\mathbf{q})q_1 + p^*(\mathbf{q}^*)q_1^* - te_1 - c(a_1) \tag{2}$$

and the foreign firm profit writes:

$$\pi^*(\mathbf{q}, \mathbf{q}^*) = p^*(\mathbf{q}^*)q_2^* + p(\mathbf{q})q_2 - t^*e_2 - c(a_2). \tag{3}$$

We consider that firms compete *à la* Cournot in the two countries and hence each firm chooses q_i and q_i^* in order to maximize its profit, given the tax rates t and t^* that are in place. Considering the Cournot game between firms for given tax policies, we obtain the following (unique) equilibrium quantities and abatement efforts:

$$\hat{q}_1 = \hat{q}_1^* = \frac{1}{3}(1 - 2t + t^*); \quad \hat{a}_1 = t \tag{4}$$

$$\hat{q}_2 = \hat{q}_2^* = \frac{1}{3}(1 - 2t^* + t); \quad \hat{a}_2 = t^* \tag{5}$$

Substituting these expressions into profit functions (2) and (3), we denote the equilibrium profit of firm 1 located in the Home country as $\pi(t, t^*)$ or

$$\pi(t, t^*) = \frac{1}{18}(25t^2 - 16t(1 + t^*) + 4(1 + t^*)^2) \tag{6}$$

The equilibrium profit of firm 2 located in the Foreign country is denoted as $\pi^*(t, t^*)$, and is given by (6) by swapping t and t^*.

Similarly, the equilibrium *tax revenue/burden* in the Home country is $T(t, t^*) \equiv t\hat{e}_1(t, t^*)$, with $\hat{e}_1(t, t^*) = \hat{q}_1 + \hat{q}_1^* - \hat{a}_1$, or

$$T(t, t^*) = \frac{1}{3}t(2 - 7t + 2t^*) \tag{7}$$

The equilibrium *tax revenue/burden* in the Foreign country is obtained by swapping t and t^*.

We proceed similarly for the equilibrium consumer surplus in the Home and Foreign countries, $CS(t, t^*)$ and $CS^*(t, t^*)$, obtained by replacing quantities by their equilibrium values in (1). We have

$$CS(t, t^*) = CS^*(t, t^*) = \frac{1}{18}(2 - t - t^*)^2. \tag{8}$$

Last, emissions create an environmental damage in the Home country that is valued through the quadratic damage function $D(E) = E^2/2$ where $E = e_1 + de_2$ is the pollution level in the

Home country and d a parameter that belongs to $\{0, 1\}$. When $d = 1$, emissions are perfectly transboundary causing global pollution, and when $d = 0$, emissions are purely local causing local environmental damage only. Similarly, in the Foreign country, $E^* = e_2 + de_1$ is the pollution level with the same transboundary pollution parameter d.[2] At the Cournot equilibrium, we denote $E(t, t^*) \equiv \hat{e}_1(t, t^*) + d\hat{e}_2(t, t^*)$ and $E^*(t, t^*) \equiv \hat{e}_2(t, t^*) + d\hat{e}_1(t, t^*)$ as the equilibrium pollution levels as function of tax rates. We have

$$E(t, t^*) = \frac{1}{3}(2 - 7t + 2t^* + d(2 + 2t - 7t^*)), \tag{9}$$

while $E^*(t, t^*)$ is obtained by swapping t and t^*.

3.2 Normative benchmarks

It will be useful to compare the outcome in tax policies subject to lobbying with two benchmark frameworks where lobbies are not involved in the setting of environmental policies. In the first benchmark, we consider that the domestic and foreign governments fully cooperate in setting their environmental policies, while they do not cooperate at all in the second benchmark.

Define each country's welfare as the sum of consumer surplus, profit of the domestic firm , tax revenues on emission levels minus environmental damage. Thus, the Home country's welfare is:

$$W(t, t^*) = CS(t, t^*) + \pi(t, t^*) + te_1(t, t^*) - D(E(t, t^*)). \tag{10}$$

The Foreign country's welfare is similarly defined.

Cooperative equilibrium. Full cooperation between the two governments requires that the governments maximize the joint welfare of the home and foreign countries $W(t, t^*) + W^*(t, t^*)$. The common tax rate that maximizes the sum of welfare is such that $t = t^*$. Calculating the derivative of $W(t, t)$ (since $t = t^*$) with respect to t, setting it to 0, and using (6), (7), (8), and (9), we have

$$W_t(t, t) = \frac{1}{9}(16 + 10d(d + 2)(2 - 5t) - 76t) = 0.$$

Observing that the second-order condition is satisfied[3], the above first-order condition is sufficient for obtaining the following cooperative environmental tax:

$$\hat{t}^C = \hat{t}^{*C} = \frac{2(5d^2 + 10d + 4)}{25d^2 + 50d + 38}. \tag{11}$$

[2] As one reviewer pointed out, with this specification, an increase in d causes both an increase in pollution spillovers and an increase in total emissions, which can complicate the comparative study of local and global pollution. In the present study, however, we do not compare emissions by type of pollution. Instead, we focus on the differences in welfare in the presence and absence of lobbies when pollution is global on the one hand and local on the other, without making comparisons between the two types of pollution externality.

[3] The second derivative of $W(t, t)$ with respect to t is given by $-\frac{2}{9}(38 + 50d + 25d^2) < 0$

This common pollution tax rate is set to correct for two distortions as the market is characterized by both over-production due to the negative externality and under-production due to oligopoly pricing.

Non cooperative equilibrium. Next, we characterize the non cooperative tax equilibrium. The home and the foreign country maximize $W(t, t^*)$ and $W^*(t, t^*)$ independently of each other. Taking the derivative of $W(t, t^*)$ with respect to t, setting it to 0 and using (7), (8), and (9), we have

$$W_t(\hat{t}, \hat{t}^*) = 2(-2t + 7t^* - 2)d^2 + (28t - 53t^* + 10)d - 65t + 13t^* + 10 = 0.$$

Observing that the second-order condition is satisfied, the above first-order condition is sufficient for characterizing the optimal best reply of the home country.[4] The optimal best reply of the Foreign country is symmetric and is obtained by swapping t and t^*. Solving the system of first-order conditions, we obtain the following Nash equilibrium in tax rates:

$$\hat{t}^{NC} = \hat{t}^{*NC} = \frac{2(2d^2 - 5d - 5)}{10d^2 - 25d - 52}. \tag{12}$$

One can also observe that the cross derivatives of the welfare functions are given by $W_{tt^*} = W^*_{t^*t} = -[1 + (2 - 7d)(2d - 7)]/9$. It follows that the tax policies are strategic substitutes under global pollution ($d = 1$) while they are strategic complements under local pollution ($d = 0$).

From (11) and (12), we can state the following result.

Proposition 1. *(i) In the Nash equilibrium, environmental tax rates are lower than when the two governments fully cooperate with each other for any given value of* $d \in [0, 1]$;[5] *(ii) Tax rates are strategic complements for* $d \in [0, 0.26)$ *and strategic substitutes for* $d \in (0.26, 1]$.[6]

Full internalization of the cross-national externality requires cooperation between the two governments regarding their environmental policies. The cooperative equilibrium tax is higher than the non cooperative equilibrium tax in absence of lobbies. This result holds regardless of the nature of pollution, i.e., whether pollution is global or local, as stated in point (i) of Proposition 1. When pollution is global ($d = 1$), the cooperative equilibrium taxes are equal to $\hat{t}^C = 38/113$ and are higher than the non cooperative taxes, that are equal to $\hat{t}^{NC} = 16/67$. The same holds when pollution is local ($d = 0$). The cooperative taxes are equal to $\hat{t}^C = 4/19$, which are higher than the non cooperative equilibrium taxes that are equal to $\hat{t}^{NC} = 5/26$. The reason is that when firms compete in quantities in each market, governments have an incentive to strategically use environmental policy to increase the competitiveness of their firms (Barrett,

[4] The second derivative of $W(t, t^*)$ with respect to t is given by $\frac{1}{9}(65 - 4d(7 - d)) < 0$.

[5] Indeed, $\hat{t}^C - \hat{t}^{NC} = [18(2 + 20d + 19d^2)] / [(38 + 50d + 25d^2)(52 + 25d - 10d^2)] > 0$ for any given value of $d \in [0, 1]$.

[6] The cross derivative $W_{tt^*} = W^*_{t^*t}$ is convex in d. It is positive for $d < \frac{53}{28} - \frac{\sqrt{2081}}{28} \approx 0.26$ and $d > \frac{53}{28} + \frac{\sqrt{2081}}{28} \approx 3.5$, and thus negative for $d \in (0.26, 1]$.

1994). By cooperating, governments internalize policy effects on *both* firms' profits and, thereby, they set larger taxes than in the non cooperative case.

Point (ii) Proposition states that the nature of the strategic interactions between the environmental policies of the Home and Foreign country depends on the nature of pollution. The environmental taxes are strategic complements for local pollution or relatively low transboundary pollution and strategic substitutes otherwise.

The results of Proposition 1 make one wonder whether the introduction of lobbies could help fully or partially internalize the cross-national externality. It could indeed be the case if the competition between the green and the producer lobby in each country over the environmental policy manages to bring the non cooperative tax towards the cooperative tax.

The following Section thus explores the conditions under which lobbying can mitigate the tax competition between the Home and Foreign countries, exhibiting a welfare-improving effect. Since the nature of the strategic interactions between the governments in taxes is an important element to our analysis, we study both cases: (*i*) local pollution ($d = 0$) implying that *taxes are strategic complements* and (*ii*) global pollution ($d = 1$) implying that *taxes are strategic substitutes*.

4 The political model

4.1 Preliminaries

In each country, the government decides on its own emissions tax rate (t and t^* for respectively the Home and Foreign country) but it is also subject to the influence of producer and green lobbies. Since the two firms compete in both countries, the contributions of the lobbies in each country depend on the two pollution taxes. More precisely, some of the owners of each firm in each country are assumed to organize into a lobby making a contribution to its government, denoted $C^P(t)$ and $C^{P^*}(t^*)$ for the firms located in the Home country and Foreign country respectively, contingent on the environmental tax set by the government of its country, taking the tax rate set by the other country as fixed.[7] Similarly, some of the individuals affected by the environmental damage, organize into a green lobby making contributions as a function of environmental taxes. The contribution function of the green lobbies in the Home and Foreign countries are denoted $C^G(t)$ and $C^{G^*}(t^*)$, respectively. Consumers in the two countries are assumed not to organize into lobbies because of their large numbers and their limited stakes per capita in the political process.[8]

[7] More precisely, we assume that lobbies can only condition their contribution on the tax set by their respective government and cannot condition it explicitly on the tax set by the other government. In other words, contributions are not allowed to be outcome-contingent in the language of Prat and Rustichini (2003). A similar assumption is made in Section 5 when dealing with the international green lobby case.

[8] For a general discussion about group size and the collective action problem, see Olson (1965).

The two lobbies in each country are *functionally specialized* (Aidt, 1998, 2005). Hence, the producer lobbies are only interested in the firms' profits and the green lobbies care only about the environmental damage. The payoffs of the producer lobbies in the home and the foreign country are:

$$W^P(t,t^*) = \mu\pi(t,t^*) \text{ and } W^{P^*}(t,t^*) = \mu^*\pi^*(t,t^*),$$

where μ and μ^* both belong to $[0,1]$ and reflect the producer lobbies' effective degrees of pressure exerted on policy setting. Similarly, the payoffs of the green lobbies in the two countries are

$$W^G(t,t^*) = -\lambda D(E(t,t^*)) \text{ and } W^{G^*}(t,t^*) = -\lambda^* D(E^*(t,t^*)),$$

where λ and λ^* both belong to $[0,1]$ with a similar interpretation in terms of the influence of green lobbies on policy setting.

Following Grossman and Helpman (1994), the two governments choose their tax rates simultaneously so as to maximize a weighted sum of political contributions and social welfare given by respectively (10) for the home country and its foreign counterpart. Therefore, the government in the Home country chooses the tax rate t on emissions to maximize the following objective function:

$$V(t,t^*) = \theta W(t,t^*) + (1-\theta)[C^P(t) + C^G(t)] \tag{13}$$

where $\theta \in (0,1)$ is the weight put on welfare and $1-\theta$ is the weight put on contributions. Similarly, the government in the Foreign country chooses the tax rate t^* on emissions to maximize:

$$V^*(t,t^*) = \theta^* W^*(t,t^*) + (1-\theta^*)[C^{P^*}(t^*) + C^{G^*}(t^*)] \tag{14}$$

where $\theta^* \in (0,1)$.

As usual in the common agency literature (Grossman and Helpman, 1994), we focus on "truthful" equilibria such that the equilibrium contributions reflect the gross payoffs of lobbies up to a constant $\underline{U}^i$, which designates the gain that lobby i, for any $i \in \{G, P, G^*, P^*\}$, can secure whatever the tax decision:

$$C^i = \max\left\{W^i - \underline{U}^i; 0\right\}.$$

The political equilibrium we seek to characterize is obtained by searching for a (subgame perfect) Nash equilibrium where each government maximizes the objective function introduced in respectively (13) for Home and (14) for Foreign, assuming that equilibrium political contributions are "truthful".[9] This gives rise to the following result.

Proposition 2. *All truthful equilibria ($\hat{t}, \hat{t}^*, \left\{\hat{C}^i\right\}$ for $i \in \{G, P, G^*, P^*\}$) are such that the equilibrium taxes $\hat{t}, \hat{t}^*$ are given by*

$$\hat{t} \in \arg\max_t \mathcal{V}(t,\hat{t}^*) = \theta W(t,\hat{t}^*) + (1-\theta)\sum_{i=P,G} W^i(t,\hat{t}^*)$$

[9] We describe the lobbying equilibrium in details in Appendix A.

and

$$\hat{t}^* \in \arg\max_{t^*} \mathcal{V}^*(\hat{t}, t^*) = \theta^* W^*(\hat{t}, t^*) + (1 - \theta^*) \sum_{i=P^*,G^*} W^i(\hat{t}, t^*)$$

where $\mathcal{V}$ and $\mathcal{V}^*$ are the weighted sum of welfare and gross payoffs of lobbies for the Home and Foreign governments respectively.

Ultimately, the tax equilibrium depends on a set of political parameters which includes θ, λ, μ and their counterparts for the foreign country. To reduce the dimensionality of the sets of parameters, it is convenient to redefine them as follows: let $\tilde{\lambda} = \frac{\theta+(1-\theta)\lambda}{\theta}$ and $\tilde{\mu} = \frac{\theta+(1-\theta)\mu}{\theta}$. Thus, $\tilde{\lambda} \geq 1$ represents the relative weight of the environmental damage to the sum of consumers' and taxpayers' surplus. Similarly, parameter $\tilde{\mu} \geq 1$ represent the relative weight of firm's surplus to the sum of consumers' and taxpayers' surplus. An increase in $\tilde{\lambda}$ (or in $\tilde{\mu}$) can be due to either a higher ability of environmentalists (or producers) to organize into a lobby or to a decrease in the weight attached to social welfare in the government's objective function. This allows us to simplify the presentation of the model and therefore to derive clearer results. With these new notations and using the welfare expression in (10) and its foreign counterpart in respectively (13) and (14), the system of maximization problems leading to the tax equilibrium in Proposition 2 can be equivalently reformulated as follows:

$$\hat{t} \in \arg\max_{t} \mathcal{V}(t, \hat{t}^*) = \theta \left[CS(t, t^*) + T(t, t^*) + \tilde{\mu}\pi(t, t^*) - \tilde{\lambda} D(E(t, t^*)) \right] \tag{15}$$

and

$$\hat{t}^* \in \arg\max_{t^*} \mathcal{V}^*(\hat{t}, t^*) = \theta^* \left[CS^*(t, t^*) + T^*(t, t^*) + \tilde{\mu}^*\pi^*(t, t^*) - \tilde{\lambda}^* D(E^*(t, t^*)) \right] \tag{16}$$

The following Section explores the conditions under which lobbying can mitigate the tax competition between *symmetric* home and foreign countries, exhibiting a welfare-improving effect. By symmetry, we mean that the political weights of lobbies are symmetric across countries, i.e $\tilde{\mu} = \tilde{\mu}^*$ and $\tilde{\lambda} = \tilde{\lambda}^*$. Since the nature of the strategic interactions between the governments in taxes is an important element to our analysis, we study separately two cases: (*i*) local pollution ($d = 0$) and (*ii*) global pollution ($d = 1$). From Proposition 1, we know that, *in the absence of lobbying*, environmental taxes are *strategic substitutes* in the case of a local externality and *strategic complements* in the case of a global externality. We will see in the next section whether or not these properties hold when the tax competition game is subject to lobbying.

4.2 Lobbying and global pollution

Let first consider the case of global pollution with $d = 1$. From now on and the rest of the analysis, we assume that both θ and θ^* are larger than 1/2, which implies that $\tilde{\mu} = \tilde{\mu}^*$ and $\tilde{\lambda} = \tilde{\lambda}^*$ are bounded above by 2. This assumption is reasonable insofar as it implies that governments value

aggregate welfare at least as much as political contributions. It is also necessary for technical reasons since when the relative political weights of lobbies are not bounded above, governments' objective functions are not always concave in the policy instrument which may pose a problem for the existence of equilibrium.[10]

Because of symmetry, from (15) and (16) and using (7), (8), and (9), the symmetric equilibrium environmental tax rate $\hat{t} = \hat{t}^*$ must satisfy the following first-order condition:

$$2(4 - 34\hat{t}) + 10(4 - 10\hat{t})\tilde{\lambda} + 2(17\hat{t} - 8)\tilde{\mu} = 0$$

Solving the above equation yields the following symmetric equilibrium in taxes:

$$\hat{t} = \hat{t}^* = \frac{4(2\tilde{\mu} - 5\tilde{\lambda} - 1)}{17\tilde{\mu} - 50\tilde{\lambda} - 34}. \tag{17}$$

Since $V_{tt^*} = V^*_{tt^*} \leq 0$, the equilibrium taxes are strategic substitutes.[11] Therefore, in regards of Proposition 1, the introduction of lobbies which alters the nature of each government's objective function does not change the nature of the strategic interactions between them regarding the pollution tax rates. Since the political pressure stage occurs before the tax competition game, we can expect lobbies to anticipate the nature of the strategic interactions and shape their lobbying strategies accordingly. We check that the equilibrium contributions of each lobby are feasible in Appendix B.

To study the effect of lobbies on each country welfare, we will now calculate the difference between the equilibrium welfare in the presence of lobbies and that in the absence of lobbies (and non-cooperation between governments). We have:

$$W(\hat{t}, \hat{t}^*) - W(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{8(395\tilde{\mu} + 1065\tilde{\lambda} + 6781)(45\tilde{\lambda} - 22\tilde{\mu} - 23)}{4489(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2}. \tag{18}$$

As the sign of the difference is that of the RHS of the numerator of (18), we thus have the following Proposition.

Proposition 3. *When the pollution is global:*

- *The environmental taxes are strategic substitutes in the presence of domestic lobbies;*
- *The introduction of lobbies improves welfare if and only if* $\tilde{\lambda} \geq \hat{\lambda}_1 = (23+22\tilde{\mu})/45 \Leftrightarrow \lambda/\mu \geq 22/45$.

[10] In the case of global pollution, the second derivatives of the objective functions of the governments with respect to their policy instruments are $V_{tt} = V_{t^*t^*} = \frac{1}{9}(-41 + 25(\tilde{\mu} - \tilde{\lambda})$. With θ or θ^* belonging to $[1/2, 1]$, they are strictly negative because $\tilde{\lambda}$ and $\tilde{\mu}$ are lower than 2, which would not be the case if θ or θ^* were lower than 1/2. Under our assumption, the second-order conditions being verified, the first-order conditions are necessary and sufficient for characterizing the equilibrium tax rates. One can easily verified that is also the case when pollution is local and when there is an international green lobby whether pollution is global or local.

[11] The cross derivative of each government's objective function is given by: $V_{tt^*} = V^*_{tt^*} = \frac{7-8\tilde{\mu}-25\tilde{\lambda}}{9} \leq 0$ for all $\tilde{\mu}$ and $\tilde{\lambda}$ larger than 1.

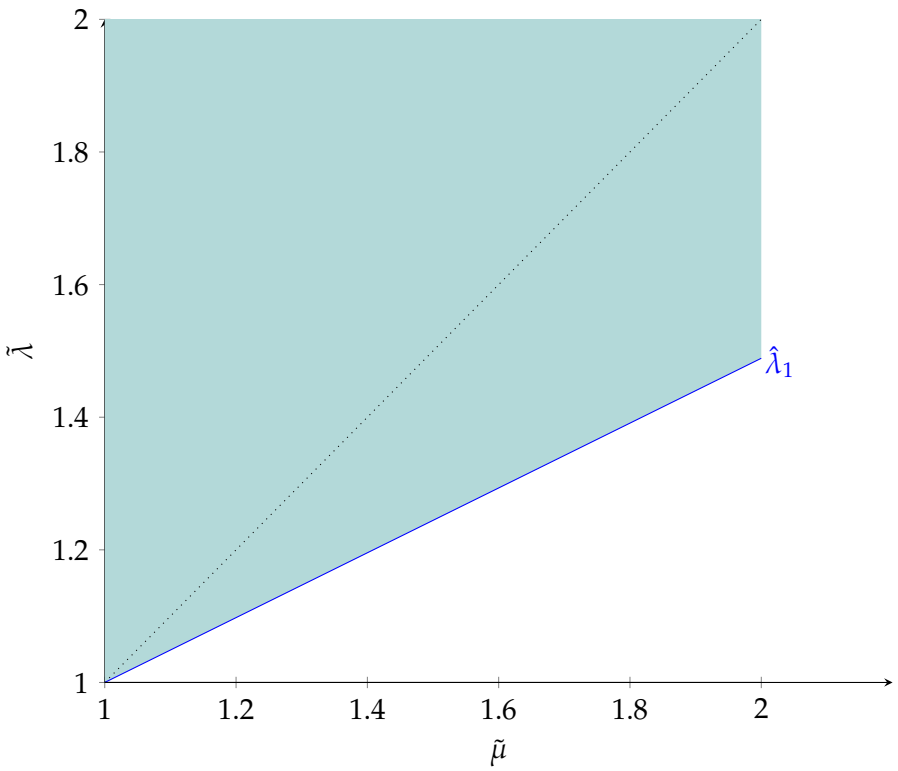

Figure 1: Comparison of welfare with and without lobbies ($d = 1$).

This result states that the introduction of lobbies could be welfare enhancing under a certain condition regarding the power of the lobbies λ and μ, and independently of the degree of benevolence of governments (i.e. independently of θ). As mentioned in the previous section, full internalization of the cross-national externality requires cooperation between the two governments regarding their environmental policies. Therefore, if the introduction of lobbies can bring the non cooperative equilibrium taxes towards $\hat{t}^C$, then it raises social welfare in both countries. By contrast, any movement of the tax rates in the opposite direction will lead to a deterioration in social welfare.[12] According to the second part of Proposition 3, if the green lobby is sufficiently more powerful than the industrial lobby, which is captured by the condition $\lambda/\mu \geq 22/45$, the influence of lobbying pushes environmental taxes in the desired direction (towards the cooperative taxes). As a result, overall pollution is reduced and social welfare is enhanced (colored area in Figure 1).

By contrast, when $\lambda/\mu \leq 22/45$, the opposite result holds. Specifically, this condition states that if the producer lobby is sufficiently more powerful than the green lobby, the environmental tax could fall below the non cooperative tax rate $\hat{t}^{NC}$, leading to more pollution in both countries and, consequently, to a deterioration in social welfare.

[12]The non cooperative tax $\hat{t}^{NC}$ without lobbies is greater than the tax with lobbies $\hat{t}$ when the difference (18) is negative. The opposite holds when the difference is positive.

Note that the tax in the presence of lobbies never increases enough to exceed the cooperative tax. Indeed, setting a very stringent environmental policy is not beneficial strategy when the pollution is transboundary, because the emissions from foreign country will still cause damage in home country and vice versa. Therefore, even if the green lobby is very powerful compared to the producer lobby, the environmental tax will not exceed the cooperative tax $\hat{t}^C$.

Finally, let us figure out what happens when, for given values of λ and μ, the degree of benevolence θ of the government increases. This can be appreciated from the Figure 1 by taking any given point and drawing a line from it to the origin, i.e. the point (1,1).[13] The starting point can be interpreted as being associated with a situation where $\theta = 1/2$ and where the values set for λ and μ depend on the point considered. It can be seen that if the starting point is in the colored area of the Figure, then an increase in θ leaves the welfare superiority result unchanged in the presence of lobbies. In other words, *having a more benevolent government and therefore less sensitive to lobbies' contributions does not mean that lobbies lose their positive role*. Conversely, if the starting point is in the uncolored zone, then having a more benevolent government leaves the inferiority result for welfare in the presence of lobbies unchanged.

4.3 Lobbying and local pollution

Let us now investigate the case of local pollution with $d = 0$. Again, because of symmetry, from (15) and (16) and using (7), (8), and (9), the symmetric equilibrium environmental tax rates $\hat{t} = \hat{t}^*$ must satisfy the following first-order condition:

$$2(4 - 34\hat{t}) + 14(2 - 5\hat{t})\tilde{\lambda} + 2(17\hat{t} - 8)\tilde{\mu} = 0.$$

Solving the above equation yields the following (symmetric) equilibrium tax rates:[14]

$$\hat{t} = \hat{t}^* = \frac{2(4\tilde{\mu} - 7\tilde{\lambda} - 2)}{17\tilde{\mu} - 35\tilde{\lambda} - 34}. \tag{19}$$

The environmental taxes are strategic complements as it was the case without lobbies.[15] Since, again, the political pressure stage occurs before the policy games between governments, lobbies should take advantage of the nature of the strategic interactions in shaping their lobbying strategies. We check that the equilibrium contributions of each lobby are feasible in Appendix B.

To study the effect of lobbies on each country welfare, we calculate the difference between the equilibrium welfare in the presence of lobbies and that in the absence of lobbies (and non-cooperation between governments). We have:

$$W(\hat{t}, \hat{t}^*) - W(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{(63\tilde{\lambda} - 41\tilde{\mu} - 22)(677\tilde{\mu} - 987\tilde{\lambda} + 622)}{676(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2}. \tag{20}$$

[13] Taking the definitions of $\tilde{\lambda}$ and $\tilde{\mu}$, we see that when θ converges to 1 then both $\tilde{\lambda}$ and $\tilde{\mu}$ converges to 1 as well. Moreover, eliminating θ yields that $\tilde{\lambda} = 1 + (\tilde{\mu} - 1)\lambda/\mu$ which is a straight line in space $(\tilde{\mu}, \tilde{\lambda})$.

[14] The concavity of (15) and (16) for $d = 0$ are always verified.

[15] The cross derivative is given by: $V_{t t^*} = (7 - 8\tilde{\mu} + 14\tilde{\lambda})/9 \geq 0$.

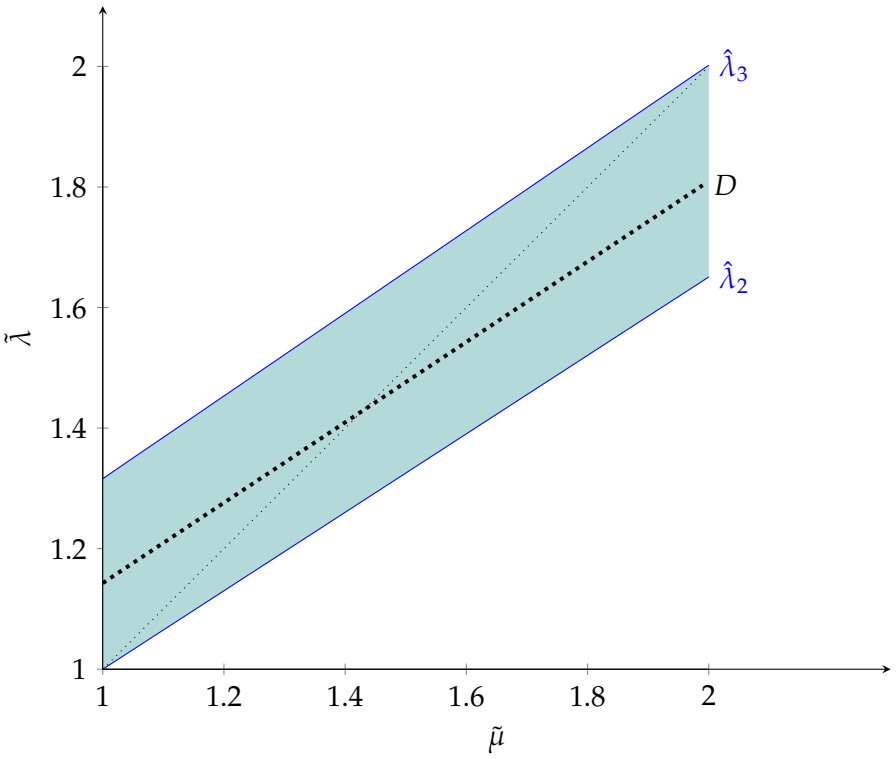

Figure 2: Comparison of welfare with and without lobbies ($d = 0$). The dashed line D indicates the locus of $\tilde{\mu}$ and $\tilde{\lambda}$ such that the equilibrium tax under lobbying coincides with the optimal cooperative tax, i.e. $\hat{t} = \hat{t}^C$.

The sign of the welfare difference depends on the sign of the numerator of the LHS of (20). We obtain the following result.

Proposition 4. *When the pollution is local:*

- *The environmental taxes are strategic complements in the presence of domestic lobbies;*
- *The introduction of lobbies improves welfare if and only if* $\tilde{\lambda} \in [\hat{\lambda}_2, \hat{\lambda}_3]$, *where* $\hat{\lambda}_2 = (41+22\tilde{\mu})/63 \Leftrightarrow \lambda/\mu \geq 22/63$, *and* $\hat{\lambda}_3 = (622 + 677\tilde{\mu})/987$.

To interpret Proposition 4, let us first recall what happens in the absence of lobbies, with and without cooperation. If the home country and the foreign country do not cooperate in setting their environmental policies, each government only considers the pollution caused by local firms. It does not have to worry about the impact of its decision on pollution in the other country because it does not suffer from it. Their reasoning is mainly focused on increasing the competitiveness of the domestic firm while minimising the environmental damage caused by local pollution. The introduction of lobbies will thus steer environmental policy in the direction preferred by the most powerful lobby, depending on the degree of benevolence of the policy maker.

The condition in the second part of Proposition 4 states that the introduction of lobbies can be welfare enhancing only if the weight attached to the firm's profit $\tilde{\mu}$ and the weight attached to the damage $\tilde{\lambda}$ are comparable. Specifically, for a given level of benevolence of governments (i.e., a given value of θ), if the producer lobby has an influence similar to that of the green lobby, social welfare may increase in both countries. It is certain that the two lobbies are trying to push the environmental policies toward opposite directions. The green lobby prefers a more stringent environmental policy, whilst the industrial lobby prefers a less strict environmental policy. However, under our specification, the effect of a stronger green lobby on the environmental tax is greater than the effect of a more powerful industrial lobby (i.e., $\partial\hat{t}/\partial\tilde{\lambda} \geq |\partial\hat{t}/\partial\tilde{\mu}|$). Therefore, even if the environmental lobby is slightly less powerful than the industrial lobby, we can still observe a welfare-improving effect of lobbying.

Similarly to the case of global pollution, the social welfare in both countries is enhanced if the lobbies can push the non cooperative taxes toward the cooperative equilibrium environmental policies $\hat{t}^C$. In the limit, on the D line, the two taxes are the same. In the bottom uncolored part of Figure 2, the producer lobby is significantly more powerful than the green lobby, and thus the equilibrium welfare levels in both countries decline. The underlying explanation is that a more powerful industrial lobby relative to the green lobby, will induce a decrease in the environmental taxes below the non cooperative equilibrium taxes resulting in a deterioration of welfare.[16]

We can also see from the top uncolored part of Figure 2 that a similar outcome in terms of welfare appears if the green lobby is significantly more influential than the producer lobby. A more powerful green lobby relative to the producer lobby, will push the environmental taxes well above the cooperative equilibrium taxes, again leading to a decrease in social welfare. The intuition goes like this. Recall that governments are not concerned by foreign pollution. If the domestic green lobby is relatively very powerful, this may induce the adoption of a very protectionist environmental strategy, i.e., the implementation of a very strict environmental policy which, certainly limits the domestic pollution but also reduces the consumer surplus and the firm's profit, resulting in a deterioration of social welfare. More precisely, an increase in the environmental tax beyond the cooperative tax ($\hat{t} > \hat{t}^C$) is still opening possibilities for welfare enhancement, as the decrease in damage can still counteract the loss of consumer surplus and the firm profit.[17] However, if the tax increases well beyond $\hat{t}^C$, the loss in the consumer surplus and the firm's profit can no longer be counteracted by the decrease in the environmental damage.

As in the previous case of global pollution, it is interesting to ask what happens if governments become more and more benevolent for fixed μ and λ. Again, it is sufficient to draw a line from

[16]The environmental tax $\hat{t}$ is lower than the non cooperative tax $\hat{t}^{NC}$ for $\tilde{\lambda} \leq (41\tilde{\mu} + 22)/63$, which is represented by the bottom uncolored part in Figure 2.

[17]The equilibrium environmental tax $\hat{t}$ is greater than the cooperative tax $\hat{t}^C$ for $\tilde{\lambda} \geq (14\tilde{\mu} + 10)/21$, which is represented by the upper part of the colored area and the top uncolored area in Figure 2.

any point to the origin (1,1) to see the consequences of increasing θ from 1/2 to 1. Starting from a point in the upper uncolored part of Figure 2, we go from a situation where lobbies are harmful to a situation where lobbies are beneficial in terms of welfare as governments become more and more benevolent. This seems counterintuitive at first sight, but it is so because, as governments become more benevolent, the values of $\tilde{\mu}$ and $\tilde{\lambda}$ mechanically converge toward each other and thus toward the intermediate zone where the presence of lobbies is welcome. It is as if, by being more benevolent, each government perceives the weights attached to each of the lobbies as closer to each other. On the contrary, in the colored zone or in the lower uncolored zone, increasing the degree of benevolence does not change the outcome of the welfare comparison.

4.4 Discussion of results

Comparing the welfare analysis for both types of pollution, we see that when pollution is transboundary and the green lobby is more powerful than the producer lobby, we do not see a welfare loss, in contrast to the case of local pollution. To understand this, let us first recall that each government faces two market failures that pull in opposite directions: underproduction due to duopoly pricing and overproduction due to pollution, which is exacerbated when $d = 1$. In fact, for both types of pollution, a slightly stricter tax than the one that would maximize the joint welfare of both governments and fully internalize the cross-country pollution externality might still be better than the non-cooperative tax, since it generates more welfare than the non-cooperative benchmark. Up to a certain level of the tax, the loss of consumer surplus and the firm's profit can be offset by the reduction in environmental damage. However, when the tax rises significantly above the cooperative tax, the reduction in pollution damage can no longer offset the losses in other welfare components because it exacerbates the underproduction due to duopoly pricing.

When pollution is global, we have shown in Proposition 3 that environmental taxes are strategic substitutes. An increase in the domestic environmental tax causes a decrease in the foreign environmental tax, resulting in more damage from foreign pollution. Since the lobbying game takes place before the environmental policy setting by governments and the market game between firms, lobbies decide on their lobbying strategies by anticipating the nature of the strategic interactions in taxes between governments and in quantities between firms. Specifically, the domestic green lobby does not lobby for significantly strict environmental policies when it anticipates that taxes are strategic substitutes. The underlying explanation is that by doing so, it can experience more damage from foreign pollution (Conconi, 2003). Conversely, when pollution is local, green lobbies are more aggressive in their lobbying strategies because, on the one hand, they do not suffer from foreign pollution and, on the other hand, taxes are strategic complements.

5 International green lobbying

In this section, we take our analysis a step further by assuming that domestic green lobbies can cooperate and form an international lobby to pressure both governments on environmental policy. The rationale behind this assumption is that domestic lobbies are affected not only by their national government, but also by the decision of the other country. Therefore, they have an incentive to cooperate in the form of an international pressure group in order to influence the other government to adopt the desired environmental policy. Similar to the previous section, governments set their taxes unilaterally.

5.1 Preliminaries

The international green lobby with superscript IG is the result of the coordination between the two domestic lobbies G and G^*. Compared to our previous setting of pure *competing* common agencies, the influence game now also involves a lobby that offers contributions to two governments that compete in taxes, which is an instance of a principal multiagent game with externalities between agents as in Segal (1999). We will therefore analyze the game using the multiprincipal multiagent theory under complete information developed in particular by Prat and Rustichini (2003). More precisely, we rely on their extension to games played through agents with externalities, contained in the working paper version of their article (Prat and Rustichini (1999)). In our context, governments face a coordination problem due to tax competition. If only the international green lobby offered contributions to governments, we could assume public contributions, and if there was a coordination problem, governments would choose what is preferred by the international green lobby. Since we also have producer lobbies, this modeling strategy cannot be used and, according to Segal (1999), another strategy for characterizing an equilibrium is to assume secret contributions and passive beliefs instead. Passive beliefs result from the simplifying assumption that the beliefs each government has about the (secret) contributions received by the other government do not depend on the contributions it has received. Consequently, when a government observes a deviation from the equilibrium, it assumes that the deviating lobby is still offering the equilibrium contributions to the other government.

As already emphasized in Section 4, another important feature of the equilibrium characterization in Prat and Rustichini (2003) is that contributions are not allowed to be outcome-contingent, i.e. the contribution of a lobby to a government cannot depend on the tax choice of the other government in our context. As there is no general characterization of equilibria in games played through agents with outcome-contingent contracts, we adopt this assumption here. [18]

[18]This is in stark contrast to Aidt and Hwang (2008) and Aidt and Hwang (2014), who implicitly assume that

We proceed in a rather similar way as for the exposition of the competing common agencies equilibrium in Appendix A. Let us denote the net payoff of lobby $i \in \{P, P^*, IG\}$ as follows:

$$U^i = W^i - C^i$$

where W^i is the gross payoff and C^i the total contribution paid. In the case of the home producer lobby, the gross payoff is as before $W^P = \mu\pi$ and its contribution $C^P = C^P(t)$ is a function of the domestic tax rate only. Similarly, for the foreign producer lobby, the gross payoff is $W^{P^*} = \mu\pi^*$ and its contribution to the foreign government $C^{P^*} = C^{P^*}(t^*)$ is a function of the foreign tax rate only. The international green lobby has a gross payoff given by

$$W^{IG} = -\lambda[D(E) + D(E^*)]$$

and its total contribution to the two governments can be decomposed as

$$C^{IG} = C^G + C^{G^*}$$

where the contribution to the home (resp. foreign) government is a function of the home (foreign) tax rate only, i.e. $C^G = C^G(t)$ and $C^{G^*} = C^{G^*}(t^*)$.

Each government has no bargaining power but it is free to reject any of these offers if it wishes. This hypothesis therefore implies that there is no loss of generality in considering positive contributions, i.e. $C^i \geq 0$ for $i \in \{P, P^*, G, G^*\}$. Indeed, a government would never choose to accept an offer that requires him to pay the lobbies for the decision it would choose. Under this condition, it is always (weakly) optimal to accept all offers made by the lobbies. Each government then chooses the optimal policy to maximize his payoff. Hence, given the equilibrium contributions $\hat{C}^i$ for $i \in \{P, P^*, G, G^*\}$, the equilibrium taxes are such that

$$\hat{t} \in \arg\max_t V(t, \hat{t}^*) \equiv \theta W(t, \hat{t}^*) + (1-\theta) \sum_{i=P,G} \hat{C}^i(t) \qquad (AM)$$

$$\hat{t}^* \in \arg\max_{t^*} V^*(\hat{t}, t^*) \equiv \theta W^*(\hat{t}, t^*) + (1-\theta) \sum_{i=P^*,G^*} \hat{C}^i(t^*) \qquad (AM^*)$$

These conditions simply state that for each government its tax choice is a best response to the lobbies contributions and to the other government's choice.[19]

Each lobby $i \in \{P, P^*, IG\}$ seeks to maximize the gain of the coalition it forms with the government(s) it subsidizes and tries at the same time to reduce the share of surplus left to the latter(s). This gives rise to two conditions, one restricting the tax choice(s) and the other

contributions are outcome-contingent. This assumption is crucial for the type of outcomes that can be achieved by the lobbying game, but unfortunately the characterization of equilibria cannot then rely on the theorems of Prat and Rustichini (2003), which explicitly exclude the case of outcome-contingent contributions.

[19] Prat and Rustichini (1999) refer to these conditions as the agent maximization conditions (AM) in their theorem 8. In standard contract theory, this would correspond to agent's incentive compatibility constraints.

one restricting the equilibrium contribution(s). More precisely, let us take the case of the home producer lobby. First, the equilibrium home tax should maximize the joint payoff of lobby P and of the home government:

$$\hat{t} \in \arg\max_{t} W^{P}(t, \hat{t}^*) + \theta W(t, \hat{t}^*) + (1-\theta)\hat{C}^{G}(t) - \theta \hat{C}^{P}(t), \qquad (IC_P)$$

given the equilibrium foreign tax and the contribution of the international green lobby.[20] Second, the contribution should make the home government indifferent between accepting or not the offer of lobby P:

$$\theta W(\hat{t}, \hat{t}^*) + (1-\theta)\hat{C}^{P}(\hat{t}) + (1-\theta)\hat{C}^{G}(\hat{t}) = V_{-P} \qquad (CM_P)$$

where

$$V_{-P} = \max_{t} \left[\theta W(t, \hat{t}^*) + (1-\theta)\hat{C}^{G}(t)\right]$$

is the government's gain in case of refusal.[21] These two conditions characterize the set of best responses $\hat{C}^P$ of lobby P. By symmetry, we can deduce the two conditions that characterize the set of best responses of lobby P^* :

$$\hat{t}^* \in \arg\max_{t^*} W^{P^*}(\hat{t}, t^*) + \theta W^*(\hat{t}, t^*) + (1-\theta)\hat{C}^{G^*}(t^*) - \theta \hat{C}^{P^*}(t^*) \qquad (IC_{P^*})$$

and

$$\theta W^*(\hat{t}, \hat{t}^*) + (1-\theta)\hat{C}^{P^*}(\hat{t}^*) + (1-\theta)\hat{C}^{G^*}(\hat{t}^*) = V^*_{-P^*} \qquad (CM_{P^*})$$

where

$$V^*_{-P^*} = \max_{t^*} \left[\theta W^*(\hat{t}, t^*) + (1-\theta)\hat{C}^{G^*}(t^*)\right].$$

It remains to write the conditions that characterize the set of best responses for the international green lobby IG. First, we have that

$$(\hat{t}, \hat{t}^*) \in \arg\max_{t, t^*} \left[W^{IG}(t, t^*) + \theta W(t, t^*) + (1-\theta)\hat{C}^{P}(t) + \theta W^*(t, t^*) + (1-\theta)\hat{C}^{P^*}(t^*) - \theta \hat{C}^{IG}(t, t^*)\right] \qquad (IC_{IG})$$

We also have the cost minimization conditions, which are respectively:

$$\theta W(\hat{t}, \hat{t}^*) + (1-\theta)\hat{C}^{P}(\hat{t}) + (1-\theta)\hat{C}^{G}(\hat{t}) = V_{-IG}(\hat{t}^*) \qquad (CM_G)$$

and

$$\theta W^*(\hat{t}, \hat{t}^*) + (1-\theta)\hat{C}^{P^*}(\hat{t}^*) + (1-\theta)\hat{C}^{G^*}(\hat{t}^*) = V^*_{-IG}(\hat{t}) \qquad (CM_{G^*})$$

where

$$\begin{aligned} V_{-IG}(\hat{t}^*) &= \max_{t} \left[\theta W(t, \hat{t}^*) + (1-\theta)\hat{C}^{P}(t)\right] \\ V^*_{-IG}(\hat{t}) &= \max_{t^*} \left[\theta W^*(\hat{t}, t^*) + (1-\theta)\hat{C}^{P^*}(t^*)\right]. \end{aligned}$$

[20] Prat and Rustichini (1999) refer to this condition as the Incentive Compatibility condition (IC) in their theorem 8.
[21] Prat and Rustichini (1999) refer to this condition as Cost Minimization (CM) in their theorem 8.

Using Prat and Rustichini (1999) (Theorem 8), one can show that the taxes and contributions denoted $(\hat{t}, \hat{t}^*, \left\{\hat{C}^i\right\}$ for $i \in \{P, P^*, IG\})$ arise in a pure strategy passive belief equilibrium if and only if all conditions from (AM) to (CM_{G^*}) are satisfied. In general, there are multiple pure strategy equilibria and a way to reduce their number is to extend the notion of truthfulness to the case of games played through agents with externalities. For this purpose, Prat and Rustichini (1999) introduce the notion of weak truthfulness which imposes the following condition: a contribution $\hat{C}^i$ for $i \in \{P, P^*, IG\}$ is weakly truthful relative to $(\hat{t}, \hat{t}^*)$ if

$$\hat{t}, \hat{t}^* \in \arg\max_{t,t^*} W^i(t, t^*) - \hat{C}^i. \tag{WT_i}$$

They prove that the taxes and contributions denoted $(\hat{t}, \hat{t}^*, \left\{\hat{C}^i\right\}$ for $i \in \{P, P^*, IG\})$ arise in a weakly truthful passive belief equilibrium if and only if conditions (AM), (AM^*), (WT_i), (CM_P), (CM_{P^*}), (CM_G) and (CM_{G^*}) are satisfied. The necessary and sufficient conditions for a weakly truthful passive belief equilibrium are the same as those for a passive belief equilibrium except that incentive compatibility conditions (IC_i) are substituted with the stronger requirement (WT_i).

In our context, we can prove the following additional result.

Proposition 5. *All weakly truthful passive belief equilibria are such that the equilibrium taxes $\hat{t}, \hat{t}^*$ are given by*

$$\hat{t} \in \arg\max_t \mathcal{V}(t, \hat{t}^*) = \theta W(t, \hat{t}^*) + (1 - \theta) \sum_{i=P,IG} W^i(t, \hat{t}^*)$$

and

$$\hat{t}^* \in \arg\max_{t^*} \mathcal{V}^*(\hat{t}, t^*) = \theta W^*(\hat{t}, t^*) + (1 - \theta) \sum_{i=P^*,IG} W^i(\hat{t}, t^*)$$

where $\mathcal{V}$ and $\mathcal{V}^*$ are the weighted sum of welfare and gross payoffs of lobbies for the Home and Foreign governments respectively.

Proof. See Appendix C. ■

Hence, at a weakly truthful passive belief equilibrium, everything happens as if taxes were a Nash equilibrium of a non-cooperative game, with two players maximizing $\mathcal{V}$ and $\mathcal{V}^*$ respectively by choosing t and t^*. Therefore, the outcome with the international green lobby resembles to the outcome obtained with domestic green lobbies with the exception that the gross payoff of the green lobby in both $\mathcal{V}$ and $\mathcal{V}^*$ is now $W^{IG} = W^G + W^{G^*}$, instead of respectively W^G and W^{G^*}. Not surprisingly, the coordination effort of green lobbies is reflected into the rule that determines the tax equilibrium.

In the following, we identify the equilibrium taxes and show that the influence of lobbies can, under certain conditions, improve welfare. Note that the formation of the international lobby is exogenous to our framework as we do not study the incentive for each domestic lobby to join the international lobby. We focus instead on welfare effect of the presence of an international

green lobby. To proceed with the welfare analysis, we shall stress the type of pollution like we did in Section 4, i.e. by specifying the value of $d = \{0, 1\}$.

5.2 International green lobbying and global pollution

Let first consider the case of global pollution with $d = 1$. Again, because of symmetry, from Proposition 5 and using (7), (8), and (9), the symmetric equilibrium environmental tax rates $\hat{t}^{IG} = \hat{t}^{*IG}$ must satisfy the following first-order condition:

$$(4 - 34\hat{t}^{IG}) + 10(4 - 10\hat{t}^{IG})\tilde{\lambda} + (17\hat{t}^{IG} - 8)\tilde{\mu} = 0, \tag{33}$$

which leads to the following equilibrium environmental tax rates in the home and foreign country:

$$\hat{t}^{IG} = \hat{t}^{*IG} = \frac{4(2\tilde{\mu} - 10\tilde{\lambda} - 1)}{17\tilde{\mu} - 100\tilde{\lambda} - 34}. \tag{34}$$

These environmental taxes are strategic substitutes.[22]

Once again, we calculate the difference between the equilibrium welfare in the presence of lobbies and that in the absence of lobbies (and non-cooperation between countries). We have:

$$\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{8(395\tilde{\mu} + 2130\tilde{\lambda} + 6781)(90\tilde{\lambda} - 22\tilde{\mu} - 23)}{4489(17\tilde{\mu} - 100\tilde{\lambda} + 34)^2}, \tag{35}$$

which is always positive.

To compare the effect of domestic lobbying on social welfare with that of an international green lobby, we calculate the following difference $\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}(\hat{t}, \hat{t}^{*})$=

$$-\frac{40\tilde{\lambda}(\tilde{\mu} + 8)(731\tilde{\mu}^2 - 4755\tilde{\lambda}\tilde{\mu} + 6000\tilde{\lambda} + 918\tilde{\mu} - 7440\tilde{\lambda} - 4760)}{(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2(17\tilde{\mu} - 100\tilde{\lambda} - 34)^2}. \tag{36}$$

This expression is always positive. An international green lobby always improves welfare relative to the case of domestic lobbies, each operating independently in one country.

Proposition 6. *When the pollution is global and an international green lobby is formed:*

- *The environmental taxes are strategic substitutes;*
- *The social welfare is always enhanced compared to the non cooperative benchmark between governments without lobbies;*
- *The social welfare is always improved compared to the case of two domestic green lobbies.*

[22]The cross derivative is equal to $(7 - 8\tilde{\mu} - 50\tilde{\lambda})/9$ and it is always negative.

Cooperation between national green lobbies always increases social welfare compared to the non-cooperative benchmark case without lobbies. This welfare is a direct result of the increase in taxes towards the cooperative tax rates $\hat{t}^C$. The underlying explanation is that the international green lobby is concerned about environmental damage in both countries and prefers stricter environmental policies, which is reflected in their political contributions to the domestic and foreign governments. This creates an asymmetry in favor of the greens in the objective function of the two policymakers. As a result, an international green lobby can induce the improvement of social welfare for certain values of of $\tilde{\lambda}$ and $\tilde{\mu}$ that domestic green lobbies cannot. In other words, one international green lobby is more effective than two domestic green lobbies in raising the non-cooperative taxes towards the cooperative taxes $\hat{t}^C$.

From (36) we can clearly see that the cooperation between the two domestic green lobbies is always more favorable in terms of welfare than competition. As discussed earlier, since the pollution is global, each domestic green lobby wants stricter environmental policy at home and abroad. The fact that they can coordinate their lobbying efforts, through the formation of the international green lobby, makes their preferences prevailing to both governments, as this is reflected in the contributions schedules the international green lobby offers to both countries. As a result, the equilibrium tax $\hat{t}^{IG}$ more efficiently internalizes the cross-national pollution externality.

5.3 International green lobbying and local pollution

Let us now investigate the case of local pollution with $d = 0$. Again, because of symmetry, from Proposition 5 and using (7), (8), and (9), the symmetric equilibrium environmental tax rates $\hat{t}^{IG} = \hat{t}^{*IG}$ must satisfy the following first-order condition:

$$(4 - 34\hat{t}^{IG}) + 5(2 - 5\hat{t}^{IG})\tilde{\lambda} + (17\hat{t}^{IG} - 8)\tilde{\mu} = 0, \tag{37}$$

which yields the following equilibrium taxes:

$$\hat{t}^{IG} = \hat{t}^{*IG} = \frac{2(4\tilde{\mu} - 5\tilde{\lambda} - 2)}{17\tilde{\mu} - 25\tilde{\lambda} - 34}. \tag{38}$$

These taxes are strategic complements.[23] Comparing this result with the one presented in Proposition 4 shows that the cooperation between the two domestic green lobbies does not change the nature of the strategic interactions in taxes. The difference between the equilibrium welfare in the presence of lobbies and the equilibrium welfare in the absence of lobbies and no cooperation between countries is given by:

$$\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{(677\tilde{\mu} - 705\tilde{\lambda} + 622)(45\tilde{\lambda} - 41\tilde{\mu} - 22)}{676(17\tilde{\mu} - 25\tilde{\lambda} - 34)^2}. \tag{39}$$

[23]The cross-derivative is given by: $\frac{1}{9}(-8\tilde{\mu} + 28\tilde{\lambda} + 7) > 0$.

This difference is positive for $\frac{41\tilde{\mu}+22}{45} \leq \tilde{\lambda} \leq \frac{677\tilde{\mu}+622}{705}$.

In order to compare the effect of domestic lobbying only and that of an international green lobby, we calculate the following :

$$\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}(\hat{t}, \hat{t}^{*}) = \frac{16\tilde{\lambda}(\tilde{\mu}+8)(238\tilde{\mu}^2 - 726\tilde{\lambda}\tilde{\mu} + 525\tilde{\lambda}^2 - 306\tilde{\mu} + 312\tilde{\lambda} - 340)}{(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2(17\tilde{\mu} - 25\tilde{\lambda} - 34)^2}. \quad (40)$$

When the expression above is positive, the cooperation between the two domestic green lobbies is welfare enhancing. .

From (39) and (40), we obtain the following Proposition.

Proposition 7. *When the pollution is local and an international green lobby is being formed:*

- *The environmental taxes t^{IG} and t^{*IG} are strategic complements;*
- *The social welfare is enhanced compared to the non cooperative benchmark between governments without lobbies if $\tilde{\lambda} \in [\hat{\lambda}_4, \hat{\lambda}_5]$, where $\hat{\lambda}_4 = (22 + 41\tilde{\mu})/45$, and $\hat{\lambda}_5 = (622 + 677\tilde{\mu})/705$;*
- *The social welfare is improved compared to the case of two domestic lobbies if $\tilde{\lambda} \geq \hat{\lambda}_6$, where $\hat{\lambda}_6 = \left[-156 + 363\tilde{\mu} + \sqrt{6819\tilde{\mu}^2 + 47394\tilde{\mu} + 20283}\right]/525$.*

In the case of local pollution, the cooperation between the domestic green lobbies does not change the nature of the strategic interactions in taxes between governments. Moreover, the welfare effect of green lobbies whether they cooperate or not is quite similar. Indeed, as in Figure 2, Figure 3 shows an intermediate zone representing the powers of lobbies for which a welfare improvement takes place. This means that the political weights of the international green lobby on the one hand and the producer lobbies on the other must not be too asymmetrical for their activism to increase welfare in both countries. In this case, cooperation between green lobbies manages to push the non cooperative taxes towards the cooperative taxes or even a little beyond it, without reducing welfare. However, we can see that the intermediate zone moves upwards when green lobbies cooperate, compared with the non-cooperative case (since $\hat{\lambda}_4 > \hat{\lambda}_2$, and $\hat{\lambda}_5 > \hat{\lambda}_3$). In other words, the political weight of the international green lobby must be sufficiently greater (but not too great) than that of domestic producer lobbies to increase welfare in both countries.

The explanation is as follows. When pollution is local and green lobbies do not cooperate, they push for the strictest possible environmental policy in their own country, because they do not care about environmental damage in the other country. An international green lobby, however, realizes that lobbying for a very high environmental tax in one country will certainly reduce production and environmental damage in that country, but will lead to an increase in production and environmental damage in the other country. By definition, an international green

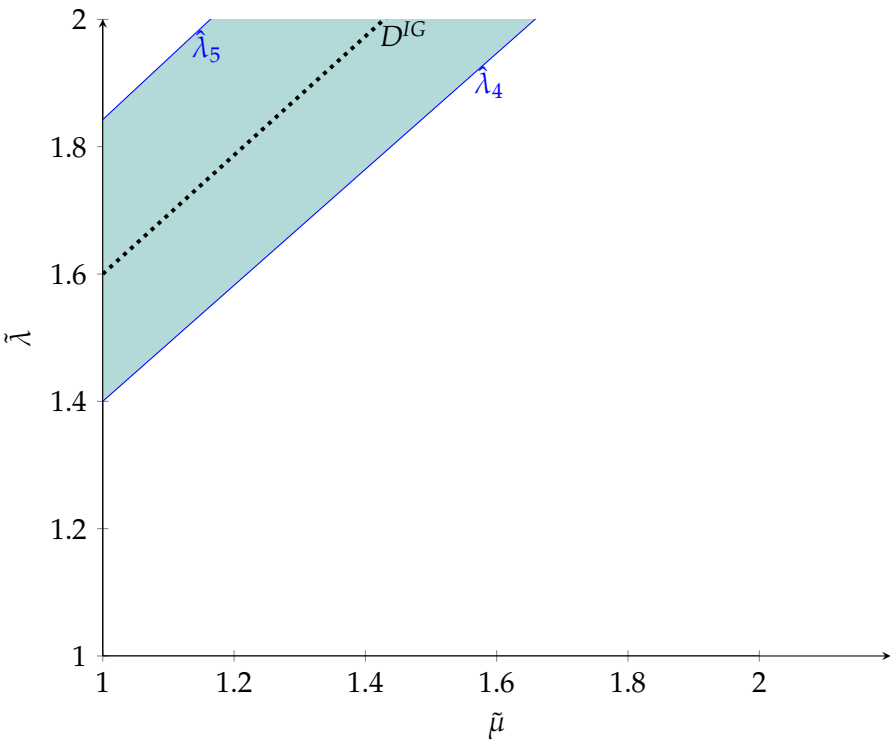

Figure 3: Comparison of welfare with and without lobbies ($d = 0$). The dashed line D^{IG} indicates the locus of $\tilde{\mu}$ and $\tilde{\lambda}$ such that the equilibrium tax under lobbying coincides with the optimal cooperative tax, i.e. $\hat{t}^{IG} = \hat{t}^{C}$.

lobby takes into account environmental damage in all countries. Consequently, an international green lobby will push for lower environmental taxes than domestic green lobbies. As a result, if the conflict of influence between the international green lobby and domestic producer lobbies is to lead to an increase in welfare in each country, the international green lobby must give environmental concerns greater weight in its objective function than domestic green lobbies (i.e. for a given $\tilde{\mu}$, $\tilde{\lambda}$ must be higher).

The fact that cooperation between green lobbies shifts upward the colored region where lobbies are beneficial from a welfare point of view has consequences for the effect of the degree of benevolence of governments for fixed weights of lobbies. Indeed, if we start from a point in the colored zone, then increasingly benevolent governments necessarily lead to situations where the presence of lobbies reduces welfare, which is in line with intuition. If we start from a point in the upper uncolored region, then increasing the degree of benevolence leads to crossing the colored region before entering the lower uncolored region and converging to the origin (1,1). Thus, lobbies are only beneficial for intermediate values of θ.

Finally, for cooperation between green lobbies to increase welfare in both countries as opposed to competition between them, $\tilde{\lambda}$ just has to be high enough relative to $\tilde{\mu}$ (that is $\tilde{\lambda} \geq \hat{\lambda}_6$).

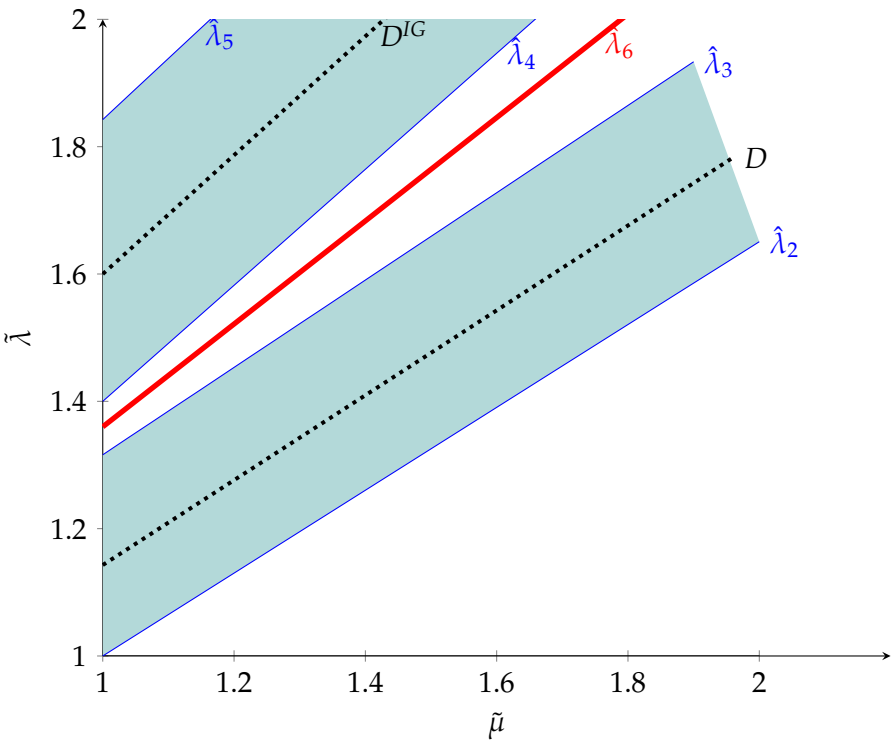

Figure 4: Comparison of welfare with domestic lobbies and with an international green lobby.

In Figure 4, we combine the results from Figures 2 and 3 and also draw the red line that figurates the threshold $\hat{\lambda}_6$.

Above $\hat{\lambda}_6$, if lobbying does not increase welfare relative to the benchmark of no lobbying, then welfare losses are lower under the cooperation of green lobbies. And below $\hat{\lambda}_6$, if lobbying does not increase welfare relative to the benchmark of no lobbying, then welfare losses are lower in the absence of cooperation between green lobbies.

To interpret Figure 4, let us compare the equilibrium taxes: $\hat{t}$ (domestic lobbying framework), $\hat{t}^{IG}$ (international green lobbying framework), and $\hat{t}^{C}$ (cooperative benchmark). In the area above D^{IG} we have that $\hat{t}^{C} < \hat{t}^{IG} < \hat{t}$ and in the area between D and D^{IG} we have that $\hat{t}^{IG} < \hat{t}^{C} < \hat{t}$. Recall that $\hat{t}^{C}$ is the tax that fully internalizes externalities, leading to maximum social welfare. Lobbying enhances welfare only if it brings taxes closer to $\hat{t}^{C}$. International green lobbying is thus more beneficial in comparison to domestic lobbying for social welfare if $\hat{t}^{IG}$ is closer to $\hat{t}^{C}$ than $\hat{t}$. This actually holds true for the area above $\hat{\lambda}_6$.

Furthermore, as $\tilde{\lambda}$ increases relative to $\tilde{\mu}$, indicating a growing relative power of the green lobby (domestic or international), then taxes $\hat{t}$ and $\hat{t}^{IG}$ are expected to increase. However, the international green lobby adopts a less aggressive strategy than the domestic lobby because it also worries about foreign pollution, and especially about pollution leakage (as explained earlier). Therefore, a more powerful international green lobby ($\tilde{\lambda} > \hat{\lambda}_6$) will advocate stricter

environmental policies, but not to the extent that it far exceeds cooperative policies and harms social welfare, unlike the strategy of the domestic green lobby.

Finally, below $\hat{\lambda}_6$, we have that $\hat{t}^{IG} < \hat{t^C} < \hat{t}$ above D and $\hat{t}^{IG} < \hat{t} < \hat{t}^C$ below D. Cooperation between green lobbies does not improve welfare relative to no lobbies, and in any case lowers welfare relative to the situation of domestic green lobbies, because the international green lobby adopts a softer strategy than any domestic green lobby. As a result, $\hat{t}^{IG}$ is lower than $\hat{t}$, which is closer to $\hat{t}^C$.

6 Conclusion

In a globalized economy, the policies implemented in one country can significantly impact the well-being of workers/consumers and firms in other countries. In this paper, we are concerned about the environment, but we believe that the model can also be used to represent other situations because various policies, including those related to trade, taxation, social security, and labor markets, can create these cross-border effects. It is often the case that there is then a "race to the bottom," where countries lower their policy standards to provide local firms with a competitive edge or to attract new businesses, resulting in policies falling below the globally optimal level. Conversely, it is also possible that there is a phenomenon whereby countries adopt overly stringent environmental policies in order to avoid the localised damage that may result from emissions. This phenomenon is usually referred to as the "Not in my backyard" phenomenon.

While it is widely accepted that such cross-border externalities can be managed through government cooperation and coordination, achieving this is challenging. Free rider issues and domestic political constraints make it difficult to ratify and enforce these agreements effectively. Our work indicates that lobbying can under some conditions make outcomes close to those obtained under cooperation or even sometimes replicate them.

However, the conditions under which lobbying is welcome for that reason are probably particular to each case. In our context, in the presence of domestic green lobbies and when pollution is global, political pressure from domestic lobbies increases social welfare in both countries if the influence of green lobbies is sufficiently strong relative to that of producer lobbies. Second, when pollution is local, domestic lobbies can also ensure an improvement in social welfare if the producer lobby and the green lobby are of comparable strength.

When an international green lobby faces two producer lobbies and pollution is global, it can be shown that an international green lobby always leads to higher welfare than in the absence of lobbies. Moreover, from a welfare perspective, cooperation is always more profitable than competition between the green lobbies. When pollution is local, the welfare effect of cooperation between green lobbies is similar to that of domestic lobbies, except the relative power of the

international green lobby must be larger than when they do not cooperate.

Overall, when the presence of lobbying increases welfare relative to the absence of influence, lobbying acts as a strategic delegation device, altering the weights of social welfare in the objective function of governments and enabling them to commit to environmental taxes that would be unattainable in the absence of influence.

In future work, it would be interesting to examine whether these results hold when firms can also relocate to their preferred country, in which case the influence of lobbies might be reduced as firms have more opportunities to escape strict environmental policies. It might also be interesting to endogenize the formation of international lobbies in the model and the way lobbies raise money, especially for the green lobbies. It could also be interesting to analyze the impact of varying the intensity of competition on each market (and other details of the market structure) on the potential welfare gains brought by the competition between lobbies. We leave all these questions for future research.

Appendix

A Characterization of the lobbying game equilibrium

In this Appendix, we first describe how to characterize the lobbying game equilibrium in the Home country while taking into account the tax t^* chosen abroad. In particular we show how to compute the equilibrium tax and contributions of each lobby as a best response to t^*. Then, using symmetry, we fully characterize the competing common agencies equilibrium.

As emphasized by Martimort (2018), the theory of common agency under complete information (Bernheim and Whinston (1986)) is taken as a *metaphore* of the influence game played by some lobbies on a policymaker by Grossman and Helpman (1994). The environment is Coasian in the sense that there are no transaction costs, information is complete and political rights are clearly defined and enforced. It follows that the issue of the lobbying game is efficient in the sense that it maximizes the gain of the coalition composed of the policymaker and the two lobbies in our context. However, we are interested here in whether the presence of lobbying can increase welfare, which is only one component of the policymaker's payoff and whose weight increases with the degree of benevolence θ.

In what follows, the exposition essentially follows the standard exposition of common agency game analysis (e.g. Martimort (2018)) while adapting to our context of a tax competition game between policymakers that we call a *competing common agencies game*. Let us introduce some additional notations. First, for each lobby $i = G, P$, we define the net payoff as U^i given by:

$$U^i = W^i - C^i \tag{A.1}$$

where W^i is the gross payoff and C^i the contribution to the government. Obviously, W^i and C^i (and thus U^i) depend on the taxes t and t^*, but for the sake of simplicity we omit this dependency for the moment. Recall that the payoff of the government under influence is given by (13):

$$V = \theta W + (1 - \theta) \sum_{i=P,G} C^i. \tag{A.2}$$

Let us denote $\mathcal{G}$ as the gain of the coalition formed by the government and the two lobbies:

$$\mathcal{G} = V + \sum_{i=P,G} U^i = \theta W + \sum_{i=P,G} W^i - \theta \sum_{i=P,G} C^i, \tag{A.3}$$

using (A.1) and (A.2). Clearly, the tax t that is preferred by the coalition and thus that maximizes $\mathcal{G}$ given t^* depends on the specification of the contributions. Let us assume that the contributions are "truthful" and thus reflect the gross payoffs of lobbies up to a constant $\underline{U^i}$ which designates the gain that lobby i can secure whatever the tax decision:

$$C^i = \max\left\{W^i - \underline{U^i}; 0\right\}. \tag{A.4}$$

With "truthful" contributions, the tax that maximizes the coalition gain $\mathcal{G}$ is clearly defined. Indeed, using (A.4) in (A.3) leads to

$$\hat{t} \in \arg\max_{t} \theta W + (1-\theta) \sum_{i=P,G} W^i \tag{A.5}$$

keeping in mind that $W = W(t, t^*)$ and $W^i = W^i(t, t^*)$. Hence, (A.5) suggests that the best-response $\hat{t} \equiv \hat{t}(t^*)$ maximizes the weighted sum of welfare and gross payoffs of lobbies.

After having defined the preferred tax this way, i.e. as a best-response to the outcome of the lobbying game in the foreign country conditionally on the assumption that contributions are "truthful", we can introduce $\mathcal{V}$ as the weighted sum of welfare and gross payoffs of lobbies:

$$\mathcal{V}(\hat{t}, t^*) = \theta W(\hat{t}, t^*) + (1-\theta) \sum_{i=P,G} W^i(\hat{t}, t^*). \tag{A.6}$$

The theory of common agency allows to *decentralize* the preferred tax given by (A.5) through a game of influence where lobbies offer contributions, C^i for $i = P, G$, that depend on the final decision (as well as on the foreign tax in our context) simultaneously and the government accept or not each contribution. The government has no bargaining power but he is free to reject any of these offers if he wishes. This hypothesis therefore implies that there is no loss of generality in considering positive contributions, i.e. $C^i \geq 0$. Indeed, the decision maker would never choose to accept an offer that requires him to pay the lobbies for the decision he would choose. Under this condition, it is always (weakly) optimal to accept all offers made by the lobbies. The government then chooses the optimal policy to maximize his payoff V given by (A.2).

For the equilibrium of such a game to lead the government to choose the efficient decision $\hat{t}$, the best way to do this is undoubtedly to offer a contribution that perfectly reflects the lobby's preferences. Moreover, as suggested above, this contribution must be acceptable to the government, which means it must be positive. Hence, we consider "truthful" contributions given by (A.4) in the influence game. To check that offers like these form an equilibrium, we have to show that the best-response of say lobby i to the lobby j that offers $C^j = \max\left\{W^j - \underline{U}^j; 0\right\}$ is itself "truthful".

The "truthful" contribution $C^j = \max\left\{W^j - \underline{U}^j; 0\right\}$ gives the government a gain equal to V_{-i} given by

$$V_{-i} = \max_{t} \left[\theta W + (1-\theta) \max\left\{W^j - \underline{U}^j; 0\right\}\right]. \tag{A.7}$$

The lobby i seeks to maximize the gain of the coalition it forms with the government, while trying to reduce the share of this surplus obtained by the latter. This implies the two following conditions:

$$\tilde{t} \in \arg\max \left[W^i + \theta W + (1-\theta) \max\left\{W^j - \underline{U}^j; 0\right\} - \theta C^i\right] \tag{A.8}$$

that is the equilibrium tax decision $\tilde{t}$ maximizes the joint payoff of the lobby i and of the government, and

$$\theta W(\tilde{t}, t^*) + (1-\theta)C^i(\tilde{t}) + (1-\theta)\max\left\{W^j(\tilde{t}, t^*) - \underline{U}^j; 0\right\} = V_{-i} \tag{A.9}$$

that is the government is indifferent between accepting or not the offer of lobby i (in which case, it gets V_{-i} given by (A.7)). These two conditions characterize the set of best-response of lobby i and clearly this set contains the "truthful" contribution $C^i = \max\left\{W^i - \underline{U}^i; 0\right\}$. Hence, there is no loss of generality to restrict the lobbies to employ "truthful" contributions. Using conditions (A.8) and (A.9) and their counterparts for lobby j, it is straightforward to see in light of (A.5) that efficiency is obtained at the equilibrium in "truthful" contributions:

$$\tilde{t} = \hat{t}.$$

Moreover, because the lobbies have conflicting preferences over the tax rate, the "truthful" contributions allow to determine a *unique* sharing of total coalition surplus $\mathcal{G}$. Indeed, from (A.9) and using (A.6) we have that

$$\mathcal{V}(\hat{t}, t^*) - (1-\theta)\sum_{i=P,G}\underline{U}^i = V_{-i}(t^*) \tag{A.10}$$

Denoting

$$\mathcal{V}_{-i}(t^*) = \max_t\left[\theta W(t, t^*) + (1-\theta)W^j(t, t^*)\right] \tag{A.11}$$

and using (A.7), (A.10) rewrites as

$$\mathcal{V}(\hat{t}, t^*) - (1-\theta)\sum_{i=P,G}\underline{U}^i = \mathcal{V}_{-i}(t^*) - (1-\theta)\underline{U}^j$$

and consequently the sure gain that lobby i can secure is

$$\underline{U}^i = \frac{1}{1-\theta}\left(\mathcal{V}(\hat{t}, t^*) - \mathcal{V}_{-i}(t^*)\right).$$

It follows that the equilibrium contribution for lobby $i = G, P$, taking as given the foreign tax t^* is

$$C^i(\hat{t}) = W^i(\hat{t}, t^*) - \frac{1}{1-\theta}\left(\mathcal{V}(\hat{t}, t^*) - \mathcal{V}_{-i}(t^*)\right). \tag{A.12}$$

Using (A.6) and (A.11) and rearranging, (A.12) rewrites finally

$$C^i(\hat{t}) = \frac{\theta}{1-\theta}\left(\max_t\left[W(t, t^*) + \frac{1-\theta}{\theta}W^j(t, t^*)\right] - W(\hat{t}, t^*) - \frac{1-\theta}{\theta}W^j(\hat{t}, t^*)\right)$$

and the contribution of lobby i is *feasible*, i.e. positive, if and only if

$$\max_t\left[W(t, t^*) + \frac{1-\theta}{\theta}W^j(t, t^*)\right] - W(\hat{t}, t^*) - \frac{1-\theta}{\theta}W^j(\hat{t}, t^*) \geq 0. \tag{A.13}$$

By symmetry, a similar reasoning leads to show that "truthful" contributions in the foreign country, taking the domestic tax t as given, are:

$$C^i(\hat{t}^*) = W^i(t, \hat{t}^*) - \frac{1}{1-\theta}\left(\mathcal{V}^*(t, \hat{t}^*) - \mathcal{V}^*_{-i}(t)\right), \tag{A.14}$$

for $i \in \{P^*, G^*\}$ and where

$$\mathcal{V}^*(t, \hat{t}^*) = \theta W^*(t, \hat{t}^*) + (1-\theta) \sum_{i=P^*, G^*} W^i(t, \hat{t}^*)$$

and

$$\mathcal{V}^*_{-i}(t) = \max_{t^*} \left[\theta W^*(t, t^*) + (1-\theta) W^j(t, t^*)\right].$$

Overall, the contributions given by (A.12) and (A.14) as well as the taxes $\hat{t}$ and $\hat{t}^*$ form the competing common agencies "truthful" equilibrium.

B Feasibility of equilibrium contributions for domestic lobbies

In this section, we will check that equilibrium contributions are feasible for both domestic lobbies. Recall from (15) that the best response to t^* satisfies

$$\hat{t} = \arg\max_t [CS(t, t^*) + T(t, t^*)] + \tilde{\mu}\pi(t, t^*) - \tilde{\lambda} D(E(t, t^*)).$$

The equilibrium level of political contributions for the green lobby in the home country has to compensate at least the government for choosing $\hat{t}$ instead of choosing the best response t_P that would maximize its payoff without the political contribution of the green lobby. As political contributions are costly, we have from (A.12):

$$\begin{aligned}\hat{C}^G &= W^G(\hat{t}, \hat{t}^*) - \frac{1}{1-\theta}\left[[\theta W(\hat{t}, \hat{t}^*) + (1-\theta) W^P(\hat{t}, \hat{t}^*) + (1-\theta) W^G(\hat{t}, \hat{t}^*)] - [\theta W(t_P, \hat{t}^*) + (1-\theta) W^G(t_P, \hat{t}^*)]\right] \\ &= \frac{1}{1-\theta}\left[[\theta W(t_P, \hat{t}^*) + (1-\theta) W^P(t_P, \hat{t}^*)] - [\theta W(\hat{t}, \hat{t}^*) + (1-\theta) W^P(\hat{t}, \hat{t}^*)]\right], \end{aligned} \tag{B.1}$$

which can be equivalently reformulated as follows :

$$\begin{aligned}\hat{C}^G = \frac{1}{1-\theta}[&[CS(t_P, \hat{t}^*) + T(t_P, \hat{t}^*) - D(E(t_P, \hat{t}^*)) + \tilde{\mu}\pi(t_P, \hat{t}^*)] \\ &- [CS(\hat{t}, \hat{t}^*) + T(\hat{t}, \hat{t}^*) - D(E(\hat{t}, \hat{t}^*)) + \tilde{\mu}\pi(\hat{t}, \hat{t}^*)]].\end{aligned} \tag{B.2}$$

In the foreign country, from (16), we similarly have that the best response to t satisfies

$$\hat{t}^* = \arg\max_{t^*} [CS^*(t, t^*) + T^*(t, t^*)] + \tilde{\mu}^*\pi^*(t, t^*) - \tilde{\lambda}^* D^*(E^*(t, t^*)).$$

And the equilibrium level of political contributions for the green lobby in the foreign country is:

$$\begin{aligned}\hat{C}^{G^*} = \frac{1}{1-\theta}[&[CS^*(t_P^*, \hat{t}) + T^*(t_P^*, \hat{t}) - D^*(E^*(t_P^*, \hat{t})) + \tilde{\mu}^*\pi^*(t_P^*, \hat{t})] \\ &- [CS^*(\hat{t}, \hat{t}^*) + T^*(\hat{t}, \hat{t}^*) - D^*(E^*(\hat{t}, \hat{t}^*)) + \tilde{\mu}^*\pi^*(\hat{t}, \hat{t}^*)]],\end{aligned} \tag{B.3}$$

A similar reasoning for the equilibrium contributions of producer lobbies in the two countries leads to the following expressions:

$$\hat{C}^P = \frac{1}{1-\theta}[[CS(t_G, \hat{t}^*) + T(t_G, \hat{t}^*) + \pi(t_G, \hat{t}^*) - \tilde{\lambda}D(E(t_G, \hat{t}^*)] - [CS(\hat{t}, \hat{t}^*) + T(\hat{t}, \hat{t^*}) + \pi(\hat{t}, \hat{t}^*) - \tilde{\lambda}D(E(\hat{t}, \hat{t}^*))]], \tag{B.4}$$

and

$$\hat{C}^{P^*} = \frac{1}{1-\theta}[[CS^*(t^*_G, \hat{t}) + T^*(t^*_G, \hat{t}) + \pi^*(t^*_G, \hat{t}) - \tilde{\lambda}^* D^*(E^*(t^*_G, \hat{t})] - [CS^*(\hat{t}, \hat{t}^*) + T^*(\hat{t}, \hat{t^*}) + \pi^*(\hat{t}, \hat{t}^*) - \tilde{\lambda}^* D^*(E^*(\hat{t}, \hat{t}^*))]]. \tag{B.5}$$

B.1 Global pollution

Green lobby. Let us calculate the tax rates (t_P, t^*_P) that maximises the joint payoff of the government and the producer lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_P = t^*_P$ must satisfy the following first-order condition:

$$-3[28t_P + 8] + \tilde{\mu}[17t_P - 8] = 0 \tag{B.6}$$

Solving the above equation yields the following symmetric solution:

$$t_P = t^*_P = \frac{8(\tilde{\mu} - 3)}{17\tilde{\mu} - 84}. \tag{B.7}$$

We can then compute the equilibrium contributions of the green lobby by substituting (E.8) and (17) into (B.2) and (B.3):

$$\hat{C}^G = \hat{C}^{G^*} = \frac{600(\tilde{\lambda} - 1)^2(34 - 3\tilde{\mu})(\tilde{\mu} + 8)^2}{(1-\theta)(17\tilde{\mu} - 84)^2(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2},$$

which are always positive when $34 - 3\tilde{\mu} \geq 0$.

Producer lobby. Let us now calculate the tax rates (t_G, t^*_G) that maximises the joint payoff of the government and the green lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_G = t^*_G$ must satisfy the following first-order condition:

$$17t_G + 4 - \tilde{\lambda}[-50t_G + 20] = 0. \tag{B.8}$$

Solving the above equation yields the following symmetric solution:

$$t_G = t^*_G = \frac{4(5\tilde{\lambda} - 1)}{50\tilde{\lambda} + 17}. \tag{B.9}$$

We can then compute the equilibrium contributions of the producer lobby by substituting (E.10) and (17) into (B.4) and (B.5):

$$\hat{C}^P = \hat{C}^{P^*} = \frac{24(25\tilde{\lambda} + 6)(17 + 5\tilde{\lambda})^2(\tilde{\mu} - 1)^2}{(1 - \theta)(50\tilde{\lambda} + 17)^2(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2},$$

which are always positive.

B.2 Local pollution

Green lobby. The tax rates (t_P, t_P^*) that maximises the joint payoff of the government and the producer lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_P = t_P^*$ must satisfy the following first-order condition:

$$3[-23t_P + 6] + \tilde{\mu}[17t_P - 8] = 0 \tag{B.10}$$

Solving the above equation yields the following symmetric solution:

$$t_P = t_P^* = \frac{2(4\tilde{\mu} - 9)}{17\tilde{\mu} - 69} \tag{B.11}$$

We can then compute the equilibrium contributions of the green lobby by substituting (E.12) and (19) into (B.2) and (B.3):

$$\hat{C}^G = \hat{C}^{G^*} = \frac{294(16 - 3\tilde{\mu})(\tilde{\lambda} - 1)^2(\tilde{\mu} + 8)^2}{(1 - \theta)(17\tilde{\mu} - 69)^2(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2},$$

which are always positive when $16 - 3\tilde{\mu} \geq 0$.

Producer lobby. The tax rates (t_G, t_G^*) that maximises the joint payoff of the government and the green lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_G = t_G^*$ must satisfy the following first-order condition:

$$-17t_G - 4 + 7\tilde{\lambda}[-5t_G + 2] = 0. \tag{B.12}$$

Solving the above equation yields the following symmetric solution:

$$t_G = t_G^* = \frac{2(7\tilde{\lambda} - 2)}{35\tilde{\lambda} + 17}. \tag{B.13}$$

We can then compute the equilibrium contributions of the producer lobby by substituting (E.14) and (19) into (B.4) and (B.5):

$$\hat{C}^P = \hat{C}^{P^*} = \frac{6(7\tilde{\lambda} + 6)(7\tilde{\lambda} + 34)^2(\tilde{\mu} - 1)^2}{(1 - \theta)(35\tilde{\lambda} + 17)^2(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2},$$

which are always positive.

C Proof of Proposition 5

At any weakly truthful passive belief equilibrium $(\hat{t}, \hat{t}^*, \left\{\hat{C}^i\right\}$ for $i \in \{P, P^*, IG\})$, the taxes are determined by the agent maximization constraints (AM) and (AM^*) as well as the weakly truthfulness constraints (WT_i) for $i \in \{P, P^*, IG\}$. Let us consider the home country first. By summing the constraints (WT_{IG}) and (WT_P) written as inequalities, we have that for any t and t^* :

$$W^{IG}(\hat{t}, \hat{t}^*) - \hat{C}^G(\hat{t}) - \hat{C}^{G^*}(\hat{t}^*) + W^P(\hat{t}, \hat{t}^*) - \hat{C}^P(\hat{t}) \geq W^{IG}(t, t^*) - \hat{C}^G(t) - \hat{C}^{G^*}(t^*) + W^P(t, t^*) - \hat{C}^P(t). \quad \text{(C.1)}$$

The agent maximization constraint (AM) for the home government writes for any t:

$$\theta W(\hat{t}, \hat{t}^*) + (1-\theta)\left[\hat{C}^G(\hat{t}) + \hat{C}^P(\hat{t})\right] \geq \theta W(t, \hat{t}^*) + (1-\theta)\left[\hat{C}^G(t) + \hat{C}^P(t)\right] \quad \text{(C.2)}$$

Taking (C.1) in $t^* = \hat{t}^*$, multiplying it by $(1-\theta)$ and summing it with (C.2) yields:

$$\begin{aligned} & (1-\theta)\left[W^{IG}(\hat{t}, \hat{t}^*) - \hat{C}^G(\hat{t}) - \hat{C}^{G^*}(\hat{t}^*) + W^P(\hat{t}, \hat{t}^*) - \hat{C}^P(\hat{t})\right] + \theta W(\hat{t}, \hat{t}^*) + (1-\theta)\left[\hat{C}^G(\hat{t}) + \hat{C}^P(\hat{t})\right] \\ \geq \; & (1-\theta)\left[W^{IG}(t, \hat{t}^*) - \hat{C}^G(t) - \hat{C}^{G^*}(\hat{t}^*) + W^P(t, \hat{t}^*) - \hat{C}^P(t)\right] + \theta W(t, \hat{t}^*) + (1-\theta)\left[\hat{C}^G(t) + \hat{C}^P(t)\right] \end{aligned}$$

which simplifies into

$$\theta W(\hat{t}, \hat{t}^*) + (1-\theta)\left[W^{IG}(\hat{t}, \hat{t}^*) + W^P(\hat{t}, \hat{t}^*)\right] \geq \theta W(t, \hat{t}^*) + (1-\theta)\left[W^{IG}(t, \hat{t}^*) + W^P(t, \hat{t}^*)\right]$$

for any t and therefore $\hat{t} \in \arg\max_t \mathcal{V}(t, \hat{t}^*)$. By symmetry, a similar result holds for the foreign country.

D A "truthful" equilibrium in the presence of an international green lobby

While Proposition 5 does not fully characterize the set of weakly truthful passive belief equilibria but only the equilibrium taxes, we now focus in the following Proposition on a particular equilibrium involving "truthful" contributions. For this, we denote $\mathcal{V}_{-i}(\hat{t}^*)$ as the maximized weighted sum of welfare and gross payoff of lobby $j \neq i$ for $i \in \{P, IG\}$:

$$\mathcal{V}_{-i}(\hat{t}^*) = \max_t \left[\theta W(t, \hat{t}^*) + (1-\theta) W^j(t, \hat{t}^*)\right],$$

and we denote $\mathcal{V}^*_{-i}(\hat{t})$ as the analog quantity for $i \in \{P^*, IG\}$.

Proposition D.1. *The following "truthful" contributions are part of a weakly truthful passive belief equilibrium:*

(i) $\hat{C}^P(t) = \max\left\{W^P(t,\hat{t}^*) - \underline{U}^P, 0\right\}$ *with* $\underline{U}^P = \frac{1}{1-\theta}\left(\mathcal{V}(\hat{t},\hat{t}^*) - \mathcal{V}_{-P}(\hat{t}^*)\right)$,

(ii) $\hat{C}^{P^*}(t^*) = \max\left\{W^{P^*}(\hat{t},t^*) - \underline{U}^{P^*}, 0\right\}$ *with* $\underline{U}^{P^*} = \frac{1}{1-\theta}\left(\mathcal{V}^*(\hat{t},\hat{t}^*) - \mathcal{V}^*_{-P^*}(\hat{t})\right)$,

(iii) $\hat{C}^G(t) = \max\left\{W^{IG}(t,\hat{t}^*) - \underline{U}^G, 0\right\}$ *and* $\hat{C}^{G^*}(t^*) = \max\left\{W^{IG}(\hat{t},t^*) - \underline{U}^{G^*}, 0\right\}$ *with*

$$\underline{U}^G = \frac{1}{1-\theta}\left(\mathcal{V}(\hat{t},\hat{t}^*) - \mathcal{V}_{-IG}(\hat{t}^*)\right) \text{ and } \underline{U}^{G^*} = \frac{1}{1-\theta}\left(\mathcal{V}^*(\hat{t},\hat{t}^*) - \mathcal{V}^*_{-IG}(\hat{t})\right).$$

Proof. To check that these "truthful" offers form an equilibrium, we have to show that the best response of lobby $i \in \{P, P^*, IG\}$ to the other lobbies offering a "truthful" contribution is itself "truthful". Let us consider first the problem of lobby P. Recall that, first, weakly truthfulness imposes that the optimal tax $\tilde{t}$ is such that

$$\tilde{t} \in \arg\max_t W^P(t,\hat{t}^*) - \hat{C}^P(t), \tag{WT_P}$$

and, second, the contribution should make the home government indifferent between accepting or not the offer of lobby P:

$$\theta W(\tilde{t},\hat{t}^*) + (1-\theta)\hat{C}^P(\tilde{t}) + (1-\theta)\max\left\{W^{IG}(\tilde{t},\hat{t}^*) - \underline{U}^G, 0\right\} = V_{-P} \tag{CM_P}$$

where

$$V_{-P} = \max_t\left[\theta W(t,\hat{t}^*) + (1-\theta)\max\left\{W^{IG}(t,\hat{t}^*) - \underline{U}^G, 0\right\}\right]$$

These two conditions characterize the set of best responses of lobby P and clearly this set contains the "truthful" contribution $\hat{C}^P(t) = \max\left\{W^P(t,\hat{t}^*) - \underline{U}^P, 0\right\}$. Indeed, in that case, the agent maximization constraint (AM) yields $\tilde{t} = \hat{t}$ and the constraint (CM_P) rewrites as

$$\theta W(\hat{t},\hat{t}^*) + (1-\theta)\left(W^P(\hat{t},\hat{t}^*) - \underline{U}^P\right) + (1-\theta)\max W^{IG}(\hat{t},\hat{t}^*) = \max_t\left[\theta W(t,\hat{t}^*) + (1-\theta)W^{IG}(t,\hat{t}^*)\right] \tag{D.1}$$

which yields

$$\underline{U}^P = \frac{1}{1-\theta}\left(\mathcal{V}(\hat{t},\hat{t}^*) - \mathcal{V}_{-P}(\hat{t}^*)\right)$$

denoting $\mathcal{V}_{-P}(\hat{t}^*) = \max_t\left[\theta W(t,\hat{t}^*) + (1-\theta)W^{IG}(t,\hat{t}^*)\right]$, which is the RHS of equality (D.1). A similar reasoning leads to $\hat{C}^{P^*}(t^*) = \max\left\{W^{P^*}(\hat{t},t^*) - \underline{U}^{P^*}, 0\right\}$ as part of the set of best reponses for lobby P^* with

$$\underline{U}^{P^*} = \frac{1}{1-\theta}\left(\mathcal{V}^*(\hat{t},\hat{t}^*) - \mathcal{V}^*_{-P^*}(\hat{t})\right).$$

Let us consider finally the case of the international green lobby. Weak truthfulness imposes that the equilibrium taxes are such that:

$$(\tilde{t},\tilde{t}^*) \in \arg\max_{t,t^*}\left[W^{IG}(t,t^*) - \hat{C}^G(t) - \hat{C}^{G^*}(t^*)\right] \tag{WT_{IG}}$$

and cost minimization conditions are respectively:

$$\theta W(\tilde{t},\tilde{t}^*) + (1-\theta)\max\left\{W^P(\tilde{t},\tilde{t}^*) - \underline{U}^P, 0\right\} + (1-\theta)\hat{C}^G(\tilde{t}) = V_{-IG}(\tilde{t}^*) \tag{CM_G}$$

and

$$\theta W^*(\tilde{t},\tilde{t}^*) + (1-\theta)\max\left\{W^{P^*}(\tilde{t},\tilde{t}^*) - \underline{U}^{P^*}, 0\right\} + (1-\theta)\hat{C}^{G^*}(\tilde{t}^*) = V^*_{-IG}(\hat{t}) \qquad (CM_{G^*})$$

where

$$\begin{aligned} V_{-IG}(\tilde{t}^*) &= \max_t \left[\theta W(t,\tilde{t}^*) + (1-\theta)\max\left\{W^P(t,\tilde{t}^*) - \underline{U}^P, 0\right\}\right] \\ V^*_{-IG}(\tilde{t}) &= \max_{t^*} \left[\theta W^*(\tilde{t},t^*) + (1-\theta)\max\left\{W^{P^*}(\tilde{t},t^*) - \underline{U}^{P^*}, 0\right\}\right]. \end{aligned}$$

These conditions characterize the set of best responses of lobby IG and clearly the latter contains the "truthful" contributions $\hat{C}^G(t) = \max\left\{W^{IG}(t,\hat{t}^*) - \underline{U}^G, 0\right\}$ and $\hat{C}^{G^*}(t^*) = \max\left\{W^{IG}(\hat{t},t^*) - \underline{U}^{G^*}, 0\right\}$. Indeed, in that case, the agent maximization constraints (AM) and (AM^*) yield $\tilde{t} = \hat{t}$ and $\tilde{t}^* = \hat{t}^*$. It follows that the constraint (CM_G) rewrites as

$$\theta W(\hat{t},\hat{t}^*) + (1-\theta)W^P(\hat{t},\hat{t}^*) + (1-\theta)\left(W^{IG}(\hat{t},\hat{t}^*) - \underline{U}^G\right) = \max_t \left[\theta W(t,\hat{t}^*) + (1-\theta)W^P(t,\hat{t}^*)\right]$$

which yields

$$\underline{U}^G = \frac{1}{1-\theta}\left(\mathcal{V}(\hat{t},\hat{t}^*) - \mathcal{V}_{-IG}(\hat{t}^*)\right)$$

denoting $\mathcal{V}_{-IG}(\hat{t}^*) = \max_t \left[\theta W(t,\hat{t}^*) + (1-\theta)W^P(t,\hat{t}^*)\right]$. Similarly, by symmetry, the constraint (CM_{G^*}) yields

$$\underline{U}^{G^*} = \frac{1}{1-\theta}\left(\mathcal{V}^*(\hat{t},\hat{t}^*) - \mathcal{V}^*_{-IG}(\hat{t})\right).$$

Overall, the sure gain that IG can secure at the equibrium is $\underline{U}^{IG}$ given by

$$\underline{U}^{IG} = W^{IG}(\hat{t},\hat{t}^*) - \hat{C}^G(\hat{t}) - \hat{C}^{G^*}(\hat{t}^*)$$

which rewrites

$$\underline{U}^{IG} = \underline{U}^G + \underline{U}^{G^*} - W^{IG}(\hat{t},\hat{t}^*).$$

■

Importantly, our context slightly differ from Prat and Rustichini (2003) because governments' action sets are not finite, since the tax decision is a continuous choice. It follows that existence of weakly truthful equilibria cannot be proved using the method of Prat and Rustichini (2003) which relies on Farkas Lemma. This is why we focus on the "truthful" equilibrium exhibited in the above Proposition and prove in the next section that these equilibrium contributions are feasible.

E Feasibility of "truthful" contributions in the presence of an international green lobby

In this section, we will check that equilibrium contributions are feasible for the domestic producer lobbies and the international green lobby. To do so, we use the expressions presented in Proposition D.1 to characterize the equilibrium contributions.

The equilibrium level of political contributions for the international green lobby in the home country has to compensate at least the government for choosing $\hat{t}^{IG}$ instead of choosing the best response t_P that would maximize its payoff without the political contribution of the international green lobby. Recall that the best response to t^{*IG} satisfies

$$\hat{t}^{IG} = \arg\max_{t}[CS(t,t^*) + T(t,t^*)] + \tilde{\mu}\pi(t,t^*) - \tilde{\lambda}[D(E(t,t^*)) + D^*(E^*(t,t^*))].$$

As political contributions are costly, we have from (iii) in Proposition D.1 the following :

$$\begin{aligned}\hat{C}^G &= W^{IG}(\hat{t}^{IG},\hat{t}^{*IG}) - \frac{1}{1-\theta}[[\theta W(\hat{t}^{IG},\hat{t}^{*IG}) + (1-\theta)W^P(\hat{t}^{IG},\hat{t}^{*IG}) + (1-\theta)W^{IG}(\hat{t}^{IG},\hat{t}^{*IG})] \qquad \text{(E.1)}\\ &- [\theta W(t_P,\hat{t}^{*IG}) + (1-\theta)W^{IG}(t_P,\hat{t}^{*IG})]]\\ &= \frac{1}{1-\theta}\Big[[\theta W(t_P,\hat{t}^{*IG}) + (1-\theta)W^P(t_P,\hat{t}^{*IG})] - [\theta W(\hat{t}^{IG},\hat{t}^{*IG}) + (1-\theta)W^P(\hat{t}^{IG},\hat{t}^{*IG})]\Big], \qquad \text{(E.2)}\end{aligned}$$

which can be equivalently reformulated as follows :

$$\begin{aligned}\hat{C}^G &= \frac{1}{1-\theta}[[CS(t_P,\hat{t}^{*IG}) + T(t_P,\hat{t}^{*IG}) - D(E(t_P,\hat{t}^{*IG})) + \tilde{\mu}\pi(t_P,\hat{t}^{*IG})] \qquad \text{(E.3)}\\ &- [CS(\hat{t}^{IG},\hat{t}^{*IG}) + T(\hat{t}^{IG},\hat{t}^{*IG}) - D(E(\hat{t}^{IG},\hat{t}^{*IG})) + \tilde{\mu}\pi(\hat{t}^{IG},\hat{t}^{*IG})]].\end{aligned}$$

In the foreign country, we similarly have that the best response to t satifies

$$\hat{t}^{*IG} = \arg\max_{t^*}[CS^*(t,t^*) + T^*(t,t^*)] + \tilde{\mu}^*\pi^*(t,t^*) - \tilde{\lambda}^*[D^*(E^*(t,t^*)) + D(E(t,t^*))].$$

And the equilibrium level of political contributions for the green lobby in the foreign country is:

$$\begin{aligned}\hat{C}^{G^*} &= \frac{1}{1-\theta}[[CS^*(t_P^*,\hat{t}^{IG}) + T^*(t_P^*,\hat{t}^{IG}) - D^*(E^*(t_P^*,\hat{t}^{IG})) + \tilde{\mu}^*\pi^*(t_P^*,\hat{t}^{IG})]\\ &- [CS^*(\hat{t}^{IG},\hat{t}^{*IG}) + T^*(\hat{t}^{IG},\hat{t}^{*IG}) - D^*(E^*(\hat{t}^{IG},\hat{t}^{*IG})) + \tilde{\mu}^*\pi^*(\hat{t}^{IG},\hat{t}^{*IG})]], \qquad \text{(E.4)}\end{aligned}$$

A similar reasoning for the equilibrium contributions of producer lobbies in the two countries leads to the following expressions:

$$\begin{aligned}\hat{C}^P &= \frac{1}{1-\theta}[[CS(t_G,\hat{t}^{*IG}) + T(t_G,\hat{t}^{*IG}) + \pi(t_G,\hat{t}^{*IG}) - \tilde{\lambda}[D(E(t_G,\hat{t}^{*IG}) + D^*(E^*(t_G,\hat{t}^{*IG})] \qquad \text{(E.5)}\\ &- [CS(\hat{t}^{IG},\hat{t}^{*IG}) + T(\hat{t}^{IG},\hat{t}^{*IG}) + \pi(\hat{t}^{IG},\hat{t}^{*IG}) - \tilde{\lambda}[D(E(\hat{t}^{IG},\hat{t}^{*IG})) + D^*(E^*(\hat{t}^{IG},\hat{t}^{*IG}))]],\end{aligned}$$

and

$$\begin{aligned}\hat{C}^{P^*} &= \frac{1}{1-\theta}[[CS^*(t_G^*,\hat{t}^{IG}) + T^*(t_G^*,\hat{t}^{IG}) + \pi^*(t_G^*,\hat{t}^{IG}) - \tilde{\lambda}^*[D^*(E^*(t_G^*,\hat{t}^{IG}) + D(E(t_G^*,\hat{t}^{IG})] \qquad \text{(E.6)}\\ &- [CS^*(\hat{t}^{IG},\hat{t}^{*IG}) + T^*(\hat{t}^{IG},\hat{t}^{*IG}) + \pi^*(\hat{t}^{IG},\hat{t}^{*IG}) - \tilde{\lambda}^*[D^*(E^*(\hat{t}^{IG},\hat{t}^{*IG})) + D(E(\hat{t}^{IG},\hat{t}^{*IG}))]].\end{aligned}$$

E.1 Global pollution

International green lobby. Let us calculate the tax rates (t_P, t_P^*) that maximises the joint payoff of the government and the producer lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_P = t_P^*$ must satisfy the following first-order condition:

$$-3[28t_P + 8] + \tilde{\mu}[17t_P - 8] = 0 \tag{E.7}$$

Solving the above equation yields the following symmetric solution:

$$t_P = t_P^* = \frac{8(\tilde{\mu} - 3)}{17\tilde{\mu} - 84}. \tag{E.8}$$

We can then compute the equilibrium contributions of the green lobby by substituting (E.8) and (34) into (E.3) and (E.4):

$$\hat{C}^G = \hat{C}^{G^*} = \frac{600(2\tilde{\lambda} - 1)^2(34 - 3\tilde{\mu})(\tilde{\mu} + 8)^2}{(1 - \theta)(17\tilde{\mu} - 84)^2(17\tilde{\mu} - 100\tilde{\lambda} - 34)^2},$$

which are always positive when $34 - 3\tilde{\mu} \geq 0$.

Producer lobby. Let us now calculate the tax rates (t_G, t_G^*) that maximises the joint payoff of the government and the international green lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_G = t_G^*$ must satisfy the following first-order condition:

$$17t_G + 4 - 10\tilde{\lambda}[-10t_G + 4] = 0. \tag{E.9}$$

Solving the above equation yields the following symmetric solution:

$$t_G = t_G^* = \frac{4(10\tilde{\lambda} - 1)}{100\tilde{\lambda} + 17}. \tag{E.10}$$

We can then compute the equilibrium contributions of the producer lobby by substituting (E.10) and (34) into (E.5) and (E.6):

$$\hat{C}^P = \hat{C}^{P^*} = \frac{48(25\tilde{\lambda} + 3)(17 + 10\tilde{\lambda})^2(\tilde{\mu} - 1)^2}{(1 - \theta)(100\tilde{\lambda} + 17)^2(17\tilde{\mu} - 100\tilde{\lambda} - 34)^2},$$

which are always positive.

E.2 Local pollution

International green lobby. The tax rates (t_P, t_P^*) that maximises the joint payoff of the government and the producer lobby in home and foreign country. Given full symmetry

between home and foreign country, the environmental tax rate $t_P = t_P^*$ must satisfy the following first-order condition:

$$3[-23t_P + 6] + \tilde{\mu}[17t_P - 8] = 0 \tag{E.11}$$

Solving the above equation yields the following symmetric solution:

$$t_P = t_P^* = \frac{2(4\tilde{\mu} - 9)}{17\tilde{\mu} - 69} \tag{E.12}$$

We can then compute the equilibrium contributions of the green lobby by substituting (E.12) and (38) into (E.3) and (E.4):

$$\hat{C}^G = \hat{C}^{G^*} = \frac{6(5\tilde{\lambda} - 7)^2(16 - 3\tilde{\mu})(\tilde{\mu} + 8)^2}{(1-\theta)(17\tilde{\mu} - 69)^2(17\tilde{\mu} - 25\tilde{\lambda} - 34)^2},$$

which are always positive when $16 - 3\tilde{\mu} \geq 0$.

Producer lobby. The tax rates (t_G, t_G^*) that maximises the joint payoff of the government and the international green lobby in home and foreign country. Given full symmetry between home and foreign country, the environmental tax rate $t_G = t_G^*$ must satisfy the following first-order condition:

$$-17t_G - 4 + 5\tilde{\lambda}[-5t_G + 2] = 0. \tag{E.13}$$

Solving the above equation yields the following symmetric solution:

$$t_G = t_G^* = \frac{2(5\tilde{\lambda} - 2)}{25\tilde{\lambda} + 17}. \tag{E.14}$$

We can then compute the equilibrium contributions of the producer lobby by substituting (E.14) and (38) into (E.5) and (E.6):

$$\hat{C}^P = \hat{C}^{P^*} = \frac{6(6 - \tilde{\lambda})(5\tilde{\lambda} + 34)^2(\tilde{\mu} - 1)^2}{(1-\theta)(25\tilde{\lambda} + 17)^2(17\tilde{\mu} - 25\tilde{\lambda} - 34)^2},$$

which are positive when $6 - \tilde{\lambda} \geq 0$.

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