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Trois Essais sur la Compétition entre Lobbies et Politique Environnementale

Houda Hafidi

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THÈSE POUR OBTENIR LE GRADE DE DOCTEUR DE L'UNIVERSITÉ DE MONTPELLIER

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École Doctorale d'Économie et de Gestion (EDEG)

Center for Environmental Economics-Montpellier (CEE-M)

Competition between Lobbies and Environmental Regulation: Three Essays

Présentée par Houda HAFIDI

Le 5 décembre 2022

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UNIVERSITÉ
DE MONTPELLIER

« L'Université n'entend donner aucune approbation ni improbation aux opinions émises dans cette thèse : ces opinions doivent être considérées comme propres à leur auteur. »

*To my grand parents, El-batoul and Abdelkader HAFIDI, Habiba and
Abdelrahman MESTARI*

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Preface

This dissertation focuses on the competition between environmental lobbies (green NGOs) and industrial lobby groups around environmental regulation. It contains three theoretical articles, each approaching the competition between these lobby groups from a different perspective, organized into three chapters.

The first chapter, Lobbying, Public Persuasion, and Environmental Policy under Imperfect Competition, is a paper coauthored with Pr. Guillaume Cheikbossian and it is published in *Annals of Economics and Statistics* No. 145, March 2022 (published version available on the link: <https://doi.org/10.2307/48655903>).

The Third chapter, Trade and Strategic Environmental Policy: Can Allowing Lobbying be Welfare-Enhancing?, is the extended version of a paper co-written with Pr. Guillaume Cheikbossian and Philippe Bontems (INRAE, TSE-P). The extension to the article version starts from section 3.5.

General summary

With climate change and environmental problems becoming arguably the biggest threat facing humanity, a compelling need has emerged for both public and private environmental regulation. Groups directly affected by these regulations are heavily involved in the policy making, turning the environmental policy into a fertile ground for special interests politics or simply lobbying. This thesis aims at studying the competition between lobbies around environmental policy and its impacts on social welfare. We therefore provide three theoretical chapters, each adopting a quite different approach to model the interactions between green and industrial lobbies. The first chapter is motivated by the growing evidence that lobbies, and in particular environmental groups, are investing in public persuasion (i.e., indirect lobbying), to influence the environmental awareness of the general public, which is considered very important in the environmental policy making in democracies. We therefore develop a micro-founded model to study the impact of direct (i.e., providing political contributions to policy-makers) and indirect lobbying on the stringency of the environmental policy. Our results show a more aggressive behavior in the public persuasion competition for the green lobby. Moreover, an increase in the power of the green lobby always results in a more stringent environmental policy while the opposite does not always hold for the industrial lobby. The second chapter attempts to link both realms of environmental regulation: private and public politics, considering a green NGO and a polluting firm competing on these two levels. We particularly analyse the fundraising strategies of the green NGO, modeled as a private politics competition between the firm and the NGO, in order to finance its public politics/lobbying expenditures. Our results show that the intensity of competition in the public politics between the two lobbies depend on the relationship between the curvatures of the damage and the benefit functions from polluting emissions. However, in the private politics competition, the NGO always shows a more aggressive behavior. Moreover, the environmental policy becomes always more stringent as the NGO becomes more efficient in collecting funds. Finally, the third chapter investigates whether the competition between green and industrial lobbies is profitable from a social welfare perspective. To do so, we

develop a reciprocal-market model with two countries, linked by trade and transboundary pollution. Green and industrial lobbies compete over the stringency of the environmental policy by directly lobbying the policy maker in each country. Our results show that allowing national and/or international lobbying could be Pareto-improving, under certain conditions on the strengths of the lobbies. This result is of particular interest since it shows that competition between lobbies can mimic the effect of International or Regional Environmental Agreements (IEA and REA), especially in a context where environmental policy coordination among sovereign countries is becoming increasingly difficult.

Résumé général

Le changement climatique et les problèmes environnementaux devenant sans doute la plus grande menace à laquelle l'humanité est confrontée, un besoin impérieux de réglementation environnementale publique et privée s'est imposé. Les groupes directement affectés par ces réglementations sont fortement impliqués dans l'élaboration des politiques, faisant de la politique environnementale un terrain fertile pour les politiques d'intérêts spéciaux ou simplement le lobbying. Cette thèse vise à étudier la compétition entre les lobbies autour des politiques environnementales et ses impacts sur le bien-être social. Nous proposons donc trois chapitres théoriques, chacun adoptant une approche assez différente pour modéliser les interactions entre les lobbies verts et industriels. Le premier chapitre est motivé par le constat de plus en plus évident que les lobbies, et en particulier les groupes environnementaux, investissent dans la persuasion publique (le lobbying indirect), afin d'influencer la conscience environnementale du grand public, qui est très importante dans l'élaboration des politiques environnementales au sein des démocraties. Nous développons donc un modèle microfondé pour étudier l'impact du lobbying direct (fournir des contributions politiques aux décideurs publics) et indirect sur la rigueur de la politique environnementale. Nos résultats montrent un comportement plus agressif dans la compétition de persuasion publique pour le lobby vert. En outre, une augmentation du pouvoir du lobby vert entraîne toujours une politique environnementale plus stricte, alors que l'inverse n'est pas toujours vrai pour le lobby

industriel. Le deuxième chapitre tente de relier les deux domaines de la réglementation environnementale : la politique privée et la politique publique, en considérant une ONG verte et une entreprise polluante en concurrence sur ces deux niveaux. Nous analysons en particulier les stratégies de collecte de fonds de l'ONG verte, modélisées comme une compétition de politique privée entre l'entreprise et l'ONG, afin de financer ses dépenses de politique publique/lobbying. Nos résultats montrent que l'intensité de la concurrence dans la politique publique entre les deux lobbies dépend de la relation entre les courbures des fonctions de dommage et de bénéfice des émissions polluantes. Cependant, dans la compétition politique privée, l'ONG montre toujours un comportement plus agressif. En outre, la politique environnementale devient toujours plus stricte à mesure que l'ONG devient plus efficace dans la collecte de fonds. Enfin, le troisième chapitre cherche à savoir si la concurrence entre les lobbies verts et industriels est profitable du point de vue du bien-être social. Pour ce faire, nous développons un modèle de marché réciproque avec deux pays, liés par le commerce et la pollution transfrontalière. Les lobbies verts et industriels se font concurrence sur la rigueur de la politique environnementale en faisant directement pression sur le décideur public de chaque pays. Nos résultats montrent que l'autorisation du lobbying national et/ou international peut entraîner une amélioration du bien-être social, sous certaines conditions relatives à la force des lobbies. Ce résultat est particulièrement intéressant car il montre que la concurrence entre les lobbies peut imiter l'effet des accords environnementaux internationaux ou régionaux, surtout dans un contexte où la coordination des politiques environnementales entre pays souverains devient de plus en plus difficile.

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General introduction

Background and context

Environmental problems and climate issues have always been closely linked to human and economic activities. Therefore, practices and actions aimed at protecting the environment date back to ancient civilizations. In fact, the earliest documented environmental practice took place 5000 years ago in the Indus civilization of Mohenjo Daro (modern day Pakistan), and it consisted of practicing waste management and sanitation. In ancient Greece, 2500 years ago, an environmental law was implemented in order to govern forest harvesting. Fast forward to the late 19th and early 20th centuries where the negative effects of industrialization in Europe and the United States of America began to threaten human health, the role of the state in the protection of the environment was broadly legitimized as more serious environmental regulation was needed. This era was particularly known for the protection of wildlife and natural landscapes, in the name of their national and aesthetic value, through the creation of natural parks. In France, for example, in 1861, 1097 hectares of Forest of Fontainebleau were spared from forestry exploitation because of their aesthetic quality (Selmi, 2009). The recognition of the role of the public authorities in the protection of the environment was more obvious in the USA where two national parks were created: the Yosemite National Park in 1864 and the Yellowstone National Park in 1872 (Mathis, 2012). In fact, during this period of time, we started to perceive the environment's components (ecosystems, water, air...) as geographical units that needed to be subject to legal protection (Tarlock, 2009). Put differently, the motivation behind pro-environmental practices

and concern for natural resources has shifted from a primarily anthropocentric to a more biocentric approach. This marked the beginning of modern environmental regulation.

Simultaneously, this era witnessed the beginnings of the environmental movement, especially in the USA, through the creation of the first non-governmental organization (NGO) the *Sierra Club* by the activist John Muir in 1892. The environmental movement carried by the NGOs in the late 19th and early 20th centuries aimed at nature conservation, wildlife protection, and reducing the pollution from industrialisation and urbanization. The movement, at this time, arose from two distinct concerns: a protectionist concern for managing resources for future use and enjoyment, and a more biocentric concern first promoted by John Muir and the naturalist and forester Aldo Leopold. The idea, long been advanced and defended by environmental NGOs, that the environment components are a fragile system vulnerable to damage caused by human activities started to gain more acceptance only in the late 1960s, as the environmental costs of economic progress became more appealing.¹ From there, the environmental movement gained in power as more environmental NGOs have been created during this period. Some of these powerful NGOs that still operate today are the World Wildlife Fund (WWF) founded in 1961, Friends of the Earth in 1969 and Greenpeace in 1971. The mid and late 60s marked the beginning of the modern environmentalism, which is considered as the most important social movement of all time. In fact, during this period of time, the environmental movement started to adopt a political dimension. This political expression took two major forms, engaging in mainstream politics through the establishment of green political parties and influencing the policy making through the exertion of pressure on legislators.² By the late 1980s, the political involvement of environmental groups took off in force at both the national and international levels as the global climate change issue became more salient.

¹In the USA, a series of environmental disasters took place in the 1960: the smog in Los Angeles and New York City, the Santa Barbara disaster and the Cuyahoga fire... These unfortunate series of events were referred to by the "environmental crisis" and they played a huge role in the raise of environmental awareness.

²The entry of the environmental movement into electoral politics was in the early 1970s, in order to make the environment a central concern of public policy. The world's first green political party is the Values Party, it was established in 1972 in New Zealand, and the most successful environmental party has been the German Green Party founded in 1980. In fact, since 2021 the German Greens is the fourth largest party in Germany and it won 14.88% of votes in the same year's federal elections.

The environmental movement mobilizes a multitude of actors ranging from the more institutionalized, such as green parties and environmental NGOs, to the less institutionalized, such as radical activists. Consequently, the actions and strategies adopted by these different actors cover a wide range of activities, from the organization of radical manifestations and boycotts to direct and indirect organized participation in the environmental regulation process. Regardless of the strategy adopted by the environmentalists, the demands of the environmental movement put the special interests of the largest industries and corporations at stake, a danger, that these stakeholders were not ready to accept. As a result, the environmentalists found themselves facing very powerful opponents, who were well established in political scene long before the green movement. The environmentalists and their antagonists present stakes in divergent or even opposing special interests. These special interests are directly and heavily affected by environmental regulations, hence the incentive to exert pressure on legislators in order to influence the decision-making. In other words, both stakeholders engage in *Special Interests Politics* (Grossman and Helpman, 2001), commonly known as *lobbying*, and the green NGOs and the polluting industries are *special interests groups* (SIGs) or simply *lobbies*.

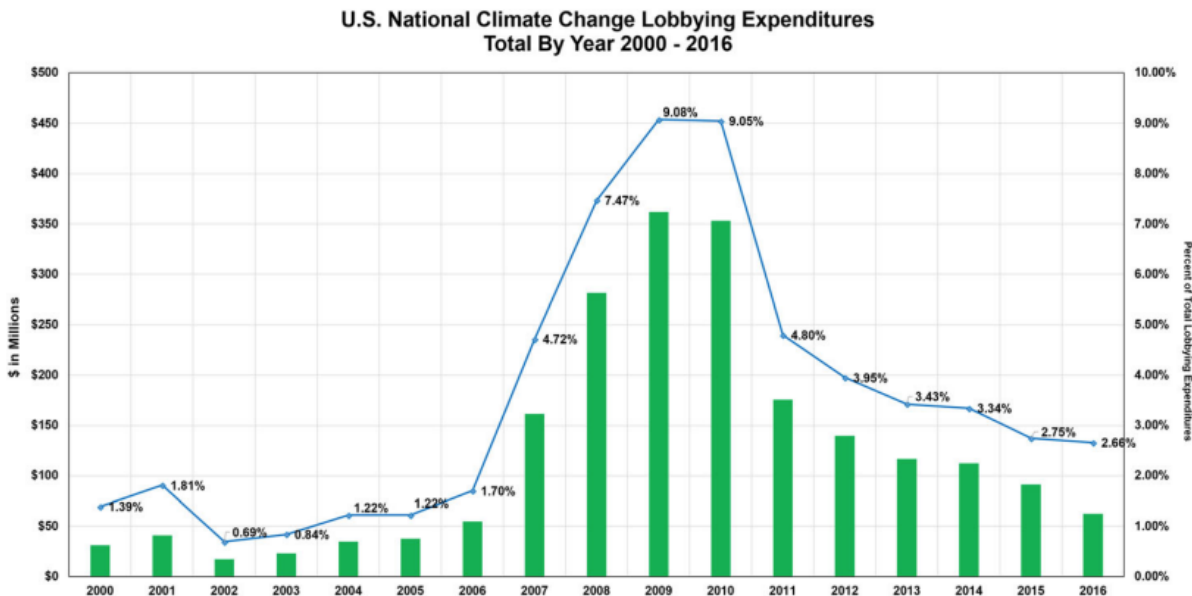
Lobbying is defined as any attempt by individuals or private interest groups to influence the decisions of legislators. An act that is as old as government itself (Norris, 1958). Lobbying, as a way to inform and influence governments, has been part of democracy for at least the last two centuries. According to Norris (1958), industrial lobbying finds its roots in the 18th centuries in England. Similarly in the USA, lobbying the congress in return for policy favors dates back to the mid and late 19th century (Brulle, 2018).³ Since the interests of environmentalists and industries are affected by the environmental regulation, it only seemed natural that environmental lobbying see the day light. Environmental and climate lobbying flourished in the 1970s and 1980s and has reached its peak in the last two decades. Figure 1 shows that in the USA only more than \$2 billion were spent by both environmental groups and polluting industries on climate change lobbying between 2000 and 2016, which

³Industrial lobbying is not exclusively dedicated to environmental regulation, it cover multiple aspects of the public policy (trade, competitiveness...).

counts for 3.98% of total lobbying expenditures. The evolution of environmental lobbying spending differs significantly during this period of time, peaking in 2009 by reaching 9% of total lobbying expenditures. However, climate lobbying expenditures by environmental groups constitute only 3% of total climate lobbying spending.

In the EU, there are an estimated 25,000 lobbyists working in the heart of European democracy Brussels, representing the interests of corporations and their lobby groups. Moreover, nearly all the biggest international environmental NGOs are permanently based in Brussels. They are heavily engaged in influencing the environmental and climate related regulation. According to The European Union Transparency Register, 382 meetings were held between the EU commissioners and environmental NGOs’ representatives in 2014 only.⁴

Figure 1: US national climate change lobbying expenditures total by year 2000-2016
(Brulle, 2018)



More recently, environmental activism resulted in an complementary and alternative to traditional public environmental regulation, that is private environmental governance (PEG).

⁴It is worth pointing out that even though lobbying activities fundamentally serve the same purpose both in USA and EU, there are several important differences between the American approach and the European approach to lobby. We refer the interested reader to consult the work of Vymetal (2015) and the discussion provided in the introduction of chapter 1 of this document.

PEG or private regulation essentially refers to the voluntary adoption of pro-environmental rules by companies without the intervention of public agents and is the direct outcome of "private politics". According to Vandenberg (2013) "*PEG occurs when non-governmental entities, such as corporations, non-profit organizations, private universities, and religious organizations, perform the traditionally governmental functions of reducing negative externalities, providing public goods, managing common pool resources, or providing a more equitable distribution of goods and services*". Basically, activists strategies can induce firms to reshape their policies by voluntarily adopting pro-environment strategies, without the need for a public institution, if they are harmful to the firms' reputation (Baron, 2001). When a firm is a target of activists' boycotts or protests, it suffer damage to its image that may result in financial losses. Therefore, to avoid such a situation, the firm voluntary self-regulates. For instance, 7% of all fish caught for human consumption and 14% of the temperate forests in the world are subject to private certification system (Vandenberg, 2013).

From the discussion provided above, we can firmly state that a proper understanding of modern environmental politics is nearly impossible without examining SIGs politics. Environmental politics is generally described as a competition between a non-governmental pro-environment lobby against an anti-climate industry lobby. The following questions naturally arise at this level: *What form this competition could take? How do SIGs/lobbies influence the environmental policy in their favor? and Could the competition between these SIGs be profitable from a social welfare perspective?*

Moreover and in a context where environmental policy coordination among sovereign countries is becoming increasingly difficult, especially in a global trend of international trade liberalization. Governments are reluctant to give up sovereignty over environmental policy and join international and/or regional environmental agreements (IEA and REA), because they may use such policy for international trade-related purposes. An other question arises at this level about the potential role of lobbies: *Could competition between national and international lobbies around environmental policy help to mimic a similar effect to IAE and REA?*

This doctoral dissertation contributes to the theoretical literature aimed at finding an-

swers to these questions.

Point of departure

The literature on SIGs competition falls under two main streams: *Public Politics* and *Private Politics* (Baron, 2003). Every strategy aiming at influencing policymakers into setting regulations that serve the lobbies special interests falls under the public politics literature (i.e., lobbying). By contrast, private politics refer to the direct confrontation between the SIGs, without the intervention of legislators.

Public Politics: lobbying

It might be difficult to track the beginnings of the interest given by economists and political scientists to the study of the SIGs behaviour. One can nevertheless refer to the work of Bently (1908) as one of the pioneering studies that state the involvement of pressure groups in the process of decision making. According to this work, societies have been formed by groups that share a common attitude or interest and therefore existing societies are the balance of pressure from these different groups.

Inspired by this vision about the society organization, scholars have developed more framed approaches to study the political competition among pressure groups for political influence. We refer mainly to the work of Stigler (1971), Peltzman (1976) and Becker (1983) about the process of decision making adopted by governments given the influence of interests groups. The work of Becker (1983) in particular shows that the government does not only seek the correction of market failures but also tends to favor the politically powerful groups through the policies implemented.

Recent economic literature makes the distinction between two types of lobbying: *direct* or *inside* lobbying and *indirect* or *outside* lobbying.⁵ Direct lobbying refers to any action taken by lobbies to directly exert influence on the decision of the politician. Direct lobbying could take the form of *political* and *campaign contributions* or *information provision*

⁵Indirect lobbying is also referred to by *Grassroots* lobbying by certain scholars (e.g., Bergan, 2009)

(Grossman and Helpman, 2001), defining two types of direct lobbying modeling in the economic literature. Most studies model lobbying as a common agency game (Grossman and Helpman, 1994). In their seminal work, Grossman and Helpman (1994), based on the menu auction framework developed by Bernheim and Whinston (1986), consider that lobbies buy influence using campaign contributions as an instrument.⁶ This framework assumes that policymakers in democracies are supposed to be semi-benevolent. They value both social welfare and political contributions. The reason behind is that ensuring a greater level of social welfare is supposed to increase the probability of reelection, and collecting political contributions allow policymakers to finance their political campaigns. Therefore, SIGs offer contributions schedules to a policymaker, who will set the regulation based on its preferences (and/or those of the median voter) for policy and the contributions offered by lobbies. The majority of studies investigating environmental policy under special interests are inspired by this analysis. In fact, the common agency model was initially used by Grossman and Helpman (1994) in the context of international trade to explain how lobbying actions influence trade policies. Later, it was adopted by other economists to study environmental and climate regulation (e.g., Fredriksson, 1997, Damania and Fredriksson, 2003, Aidt, 1998, Conconi, 2003, Kawahara, 2014).

Direct lobbying is also modeled as information provision, to which we refer by *Informational Lobbying*. Informational lobbying is "*the transfer of information in private meetings and venues between interest groups and politicians, their staffs, and agents*" (De Figueiredo and Richter, 2013). Lobbies might have relevant information that could be useful to legislators and help them in the making of the policy, hence the lobbies gain influence by strategically revealing these information (e.g., Potters and Van Winden, 1992, Hall and Deardorff, 2006, Schnakenberg, 2017). SIGs can use both campaign contribution and informational lobbying to buy influence (e.g., Bennedsen and Feldmann, 2006, Dahm and Porteiro, 2008, Cotton, 2012).

An other form of public lobbying is indirect lobbying. The concept of "indirect lobbying"

⁶Lobbies buy political favors in return for campaign contributions to policymakers, Fowler et al. (2020) and other scholars refer to this lobbying approach by *Quid Pro Quo lobbying*.

was first introduced by Yu (2005) and it attempts to give an alternative explanation to lobbying. It consists in launching information campaigns to the general public to change their preferences (or those of the median voter), which in turn modifies government policies. In fact, policymakers maximize social welfare, which reflects the general public's preferences over different issues. Therefore, by contrast to direct lobbying that adds a component to the objective function (social welfare) of the policymaker, indirect lobbying targets the social welfare function itself by changing the public's beliefs/perceptions or preferences over the issue in question. As argued by Yu (2005), we can expect green lobbies to rely extensively on this channel relative to their opponents because they have, presumably, less financial resources.

Influencing or changing people's beliefs or preferences is commonly called *public persuasion*. According to Congleton (1986), persuasion is usually modelled as a Bayesian mechanism allowing receivers of signals to update their prior beliefs about an issue (e.g., Kamenica and Gentzkow, 2011 and Kamenica, 2019). The use of public persuasion as a lobbying strategy was first popularized by Grossman and Helpman (2001), and since then, a growing literature has investigated in depth its mechanism and relationship with mass media (e.g., Sobbrío, 2011, Petrova, 2012 and Shapiro, 2016).

Both direct and indirect lobbying fall under the public politics literature. The actions of lobbies aims at influencing the environmental regulation, either directly by offering political contributions or relevant information to legislators, or indirectly by influencing the preferences of the public whose final belief might be significantly influential in the final policy outcome.

Private politics

The term "private politics" was first introduced by Baron in 2001 (Baron, 2001) by opposition to "public politics" to describe non market interactions between SIGs. It essentially refers to the resolution of conflicts without the need of regulation or law, but instead through self-regulation, usually between an activist NGO and a for-profit organization. Since the

corporations hold a lot of power over the political process, NGOs and green activists must seek alternatives in an attempt to turn the balance of power into their favor. Formally, the socially irresponsible firm receives "a take it or leave it" harmful proposition (threat), from the activist NGO. It will hence respond to that threat by conceding to the activists requests and self-regulating or fighting back given the assumption of being rational (e.g., Baron, 2003; Baron and Diermeier, 2007 and Baron et al., 2012).

The core idea behind this growing literature is that the NGOs use confrontational strategies to apply social pressure in order to change the behavior of their target, in the hope of creating a long-term social change. This confrontational strategies adopted by NGOs gained more popularity in the last two decades, leading to corporate environmental management being not exclusively a matter of compliance with regulations, but also as a strategic response to activists campaigns and requests. This stream of literature attempts to provide an answer to the question of why firms invest in Corporate Social Responsibility (CSR). Baron (2001) work is based on the hypothesis that the image or the reputation of a firm has a positive effect on the demand for its products, hence the necessity of investing in CSR to improve it (Egorov and Harstad, 2017). Therefore, if activists want the firms to reshape their CSR investments or increase them, they can simply engage in destructive tactics to the firms' image (Abito et al., 2016). Private politics' tactics include mass media and social media campaigns, manifestations and consumers boycotts. They all can have significant impacts of firms overall reputation and profits. An example of a successful campaign/boycott is the one conducted by the NGO People of Ethical Treatment of Animals (PETA), against the two large fast-food companies, McDonald's and Burger King in 2001 and 2002 because of their environmental unfriendly way to produce meat.

Despite the distinction made by the economic theory between Private and Public Politics, observation of the modern environmental political arena suggests that the two are intimately linked and interact in multiple ways. However, literature linking the two realms of politics remains very scarce.

Structure of the thesis

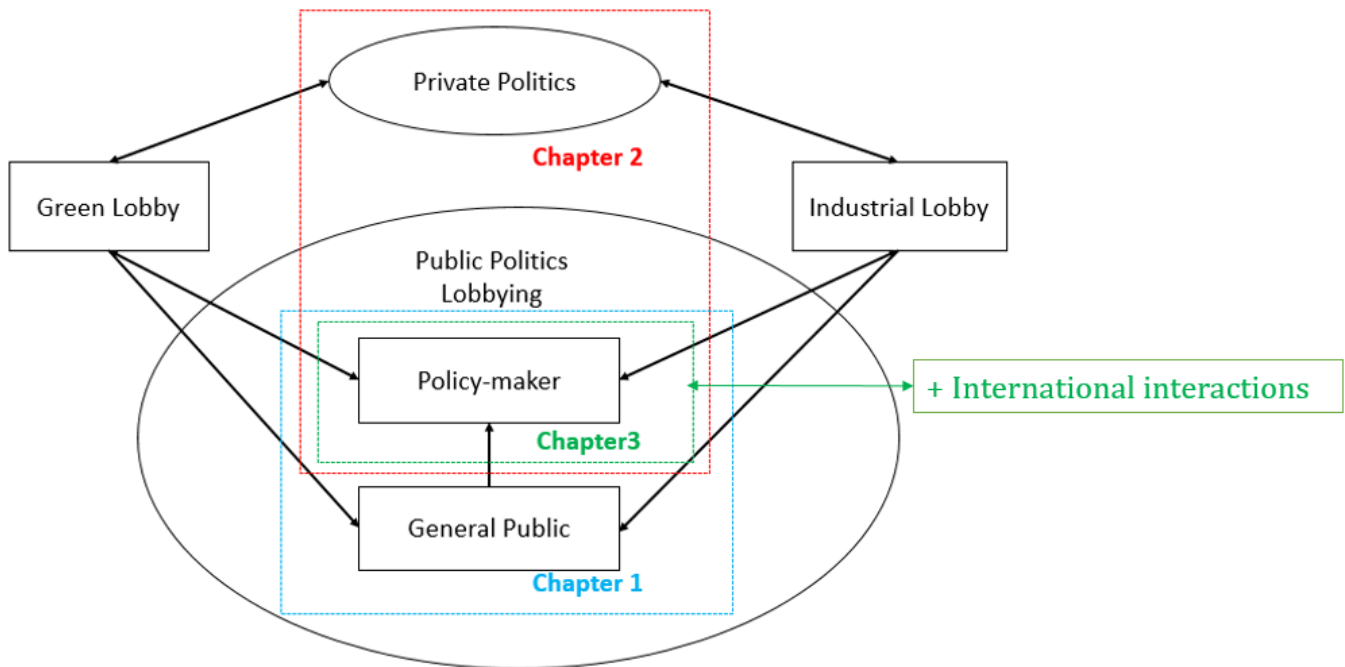
This doctoral thesis is composed of three chapters. Each chapter models the competition between green lobbies and industrial lobbies around environmental regulation. The first and the second chapters deal with domestic environmental regulation and domestic SIGs, whilst the third chapter models lobbying in an open economy with cross-national pollution externality and the possibility of international lobbying.

The first and the third chapters fall under the "Public Politics" literature. The first chapter models the competition between an environmental lobby and an industrial lobby in the form of direct and indirect lobbying. The third chapter models an open economy with a cross-national pollution externality. In each country a green lobby and a producer lobby compete regarding the environmental policy, and the competition take the form of direct lobbying only. In both these chapters, direct lobbying is modeled *à la* Grossman and Helpman (1994). The second chapter aims at linking the two realms of literature on SIGs politics described in the previous section: "Private Politics" and "Public Politics". The latter takes the form of direct lobbying, that departs from the traditional agency model as it is modeled as a rent-seeking contest like in Cheikbossian (2008).

The first and the second chapters put the emphasis on the different "Public Politics" and "Private Politics" tactics utilized by SIGs, the way they interact and the nature of the strategic interactions linking them. In fact, we allow the lobbies to use, in addition to direct political lobbying, other types of strategies. In the first chapter, the additional strategy falls under the "Public Politics" literature: indirect lobbying commonly known by public persuasion. In the second chapter, we give the SIGs the possibility to use "Private Politics" tactics in addition to direct political lobbying. To be able to focus on the interaction between the two types of strategies in each of these two chapters, we consider domestic lobbies and domestic politics at a national level. By contrast, the third chapter models an international economy formed by two countries linked by trade and pollution, where political lobbying competition could be domestic or international. This chapter differs from the first and the second by the fact that it looks at the competition between the SIGs from a social welfare

perspective. Figure 2 shows which type of SIGs politics is modeled in each chapter.

Figure 2: Structure of the thesis "The Environmental Politics Arena"



A common assumption to the three chapters is that SIGs are considered *Functionally Specialized*. Functionally specialized lobbies are a type of SIGs that were initially introduced by Aidt (1998), based on empirical evidence given by Marshall (1999). These lobby groups care and advocate only for one aspect of their welfare, as the rest of their welfare dimensions are weighted negligibly (see also Aidt, 1998). The assumption of functionally specialized lobbies is now rather standard in the literature (see Fredriksson et al., 2005; Ovaere et al., 2013; Lefebvre and Martimort, 2020). This assumption has the advantage of, in addition to be more realistic, simplifying the theoretical analysis of the influence of interest groups.

While all three papers deal with very similar research topics, each article puts forward distinct research questions and can be read on its own.

Chapter 1: Lobbying, Public Persuasion, and Environmental Policy under Imperfect Competition

This chapter relies on the following two ideas: first, the increasing evidence that both green and polluting-industry lobbies invest in social and mass media campaigns to support their stakes/preferences in front of the general public, whose final belief might be significantly influential in the final policy outcome.⁷ Second, the recognition that powerful industrial groups make important political donations, especially in US politics during election cycles and that environmental NGOs are also increasingly active in policy-making processes by meeting with legislators and regulators. As a result, we model an industry with a monopoly position producing a polluting good. Green and producer lobbies offer political contributions to incumbent politicians in return for favorable environmental regulation policies. The incumbent government chooses a tax rate on polluting production to maximize a weighted sum of aggregate welfare and that of political contributions offered by interest groups *à la* Grossman and Helpman (1994). Following the seminal work of Yu (2005), we consider that the two lobbies can also engage in indirect lobbying to influence the perception of consumers on the environmental damage which is a part of social welfare and, upstream the stage of direct lobbying through political contributions. By contrast to Yu (2005), we specify the economic context characterized by imperfect competition, and where total welfare is derived explicitly from the producer surplus, the consumer surplus, and tax revenues. Further, making similar assumptions on the public persuasion function to Yu (2005), we endogenously derive the nature of strategic interactions between the lobbies in the indirect lobbying competition. In our setting, we show that the best response function of the green lobby is upward sloping, while that of the industrial lobby is downward sloping. This induces a complementarity between indirect and direct lobbying. Meanwhile, Yu (2005)'s result of substitutability between the two types of efforts results from his assumption on the nature of strategic interactions in indirect lobbying.

Our results show that public environmental awareness provokes a more aggressive be-

⁷Examples are provided in the introduction of chapter 1.

havior in public persuasion by the green lobby, compared to the producer lobby, while the opposite holds for the producer lobby. This consequently leads to a more stringent environmental policy. Conversely, an increase in the representativeness of the producer lobby does not necessarily lead to a less stringent environmental policy. Actually, this makes the green lobby more active in both direct and indirect lobbying, whereas it increases the direct and indirect political efforts of the industrialists only if the general public has a lower initial belief regarding environmental damage. Finally, a more benevolent government does not always set a more stringent environmental policy. In fact, the government is handling two market failures that pull in opposite directions: overproduction due to pollution and underproduction due to monopoly pricing. Consequently, a more benevolent regulator will set a more stringent environmental policy only if the general public is initially less concerned regarding environmental damage.

Chapter 2: Public and Private Politics: Green NGOs Fundraising Strategies under Political Lobbying Competition

This chapter finds its motivation in: first, the statement of Baron (2003) "*private politics often takes place in shadow of government*" and second, green NGOs activities are often financed by donations offered by donors interested in the climate cause. A way to link both of these developments is to elaborate a framework where a green NGO faces a polluting firm, on two different levels: the private politics and the public politics levels around an environmental issue. Specifically, this chapter aims at studying how the NGO's need to collect funds to finance its lobbying activities could strategically shape its and its opponent's actions in the private politics competition. We therefore, propose a model analyzing a fundraising game under a political competition context. We consider a three stages game in which a green NGO faces a polluting firm. In the first stage, the competition lies under the private politics arena. Inspired by Heyes et al. (2018), we model the private politics competition as a fundraising game between the NGO and the firm. Precisely, the NGO campaigns in order to expose the polluting actions of the firm to donors and therefore collect funds, and the

firm is trying to hide its pollution as a way to block the funds collected by the NGO. We give the firm the possibility to use greenwashing only or greenwashing and real abatement as blocking fundraising strategies, as they are supposed to reduce the salience of its polluting activities.⁸ The public politics concerns the two last stages of the game. In the second stage, the NGO and the firm decide about their political expenditures used to influence the policy-maker that decides about the level of emissions in the third stage.

The main results are the following: first, the intensity of the competition between the two SIGs regarding the lobbying stage depends on the convexity of the damage and the concavity of the benefit the two SIGs face, and hence on the nature of the polluting emissions. In fact, when the damage function from emissions has a less curvature than the benefit from those same emissions, the lobbying expenditures are strategic substitutes showing a less intense political lobbying competition. When the degree of the convexity of the damage is greater than the degree of the concavity of the benefit, the public politics competition is more aggressive since the lobbying efforts are strategic complements. Second in the private politics stage, the NGO always responds to the firm's greenwashing by more campaigning. Whilst the firm's response to the campaign of the NGO could be increasing or decreasing depending on the nature of the competition in the public politics game. As a result, the private politics competition between the two SIGs is aggressive when the public politics competition is less intense, revealing the existence of a substitutability effect between the public and the private efforts of both SIGs. Moreover, when the firm becomes more effective in greenwashing, the competition between the two SIGs is exacerbated: the NGO engages in more campaigning and the firm engages in more greenwashing. However, when the firm adds abatement to its fundraising blocking strategy, the overall campaigning strategy of the NGO becomes softer, because abatement decreases the emissions and hence the damage associated. Third, an increase in the effectiveness of the NGO in fundraising increases the total funds collected, this in turn guarantees installing a more stringent environmental policy. Whilst a more effective firm in blocking fundraising manage to reduce the stringency of the environmental

⁸Greenwashing is a well known advertising strategy used by polluting industries campaigning for their products as environmentally-friendly while they are not, in order to capture the environmentally concerned consumer and distract his attention and that of environmental groups from its polluting activity.

policy only if it adopts an abatement strategy.

Chapter 3: Trade and Strategic Environmental Policy: Can Allowing Lobbying be Welfare-Enhancing?

This last chapter adopts a quite different perspective as it attempts to study the impact of lobbying on social welfare. In fact, 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 impact of the political game on the social welfare of two countries linked by imperfect world markets, motivated by two important findings in the literature. The first states that imperfect competition in international markets creates strategic interactions between governments that can result in the use of inefficient environmental policies, used to increase the competitiveness of domestic firms vis-à-vis the foreign ones, or practicing ecodumping when pollution is transboundary (Kennedy, 1994). The second is that green lobbies could mitigate the inefficiency of uncoordinated environmental regulations by exerting political pressure for the implementation of more stringent environmental policies (Conconi, 2003).

We consider a reciprocal-markets model with two countries (Brander, 1995). In each country, there is monopoly producing a polluting good and the two firms compete in Cournot duopoly in the two countries. The production of the polluting good can in result in a cross-national environmental externality, so that the two countries are linked by both, trade and pollution. The two countries decide 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). In each country, a green lobby and producer lobby oppose each other on the stringency of domestic environmental policy and offer the government political contributions contingent on the chosen environmental policy.

The main result shows that, when pollution is global, lobbying increases domestic welfare in two countries if the influence of green lobbies is sufficiently strong relative to that of the producer lobbies. When the pollution is purely local, we find that competition for political

influence can also increase the welfare of both countries provided the influence of producer lobbies in the two countries is larger but similar to that of green lobbies.

Next, we push our analysis a step further by assuming that the domestic lobbies can cooperate and form international lobbies to pressure both governments regarding the setting of the environmental policies. We particularly consider three different scenarios of lobbying that we compare to the the domestic lobbying scenario. First, we assume that the green lobbies in each country can cooperate and form an international green lobby. Second, we assume the that the two domestic industrial lobbies manage to cooperate and form an international industrial lobby in order to influence the two governments in the political competition stage, while still competing in the market stage. And finally we assume that the two governments are influenced by an international green lobby and an international industrial lobby. To model international lobbying, we depart from a common agency relationship to a multiple principal-multiple agent relationship *à la* Prat and Rustichini (1999).

Our main results can be summarized in the following, first, we show that the formation an international green lobby is almost always beneficial when pollution is transboundary. It is also the case when pollution local if the international green lobby and the domestic lobbies have comparable strengths. Second, we show that cooperation between the domestic producer lobbies could be welfare enhancing only when pollution is transboundary and the domestic green lobbies are significantly more powerful than the international producer lobby. Finally, competition between an international green lobby and an international producer lobby over environmental regulation in both countries have similar results to the case where only an international green lobby is formed, revealing that the effect of cooperation between the greens dominates that of cooperation between the industrialists.

Generally speaking, the main contribution of this chapter is that allowing national and/or international lobbying could be Pareto-improving, under certain conditions on the strengths of the lobbies. This result is of particular interest since it shows that competition between lobbies can mimic the effect of International or Regional Environmental Agreements (IEA and REA), especially in a context where environmental policy coordination among sovereign countries is becoming increasingly difficult.

Chapter 1

Lobbying, Public Persuasion, and Environmental Policy under Imperfect Competition

Abstract:

Lobbies have always been major players in the political game. Their actions range from influencing consumer beliefs to applying pressure on policymakers. This study attempts to analyze the impact of direct and indirect lobbying through public persuasion by interests groups on the stringency of the environmental policy. Following Yu (2005), we propose a micro-founded model with imperfect competition for a polluting good and that allows to derive the total welfare, government's objective function, and resulting strategic interactions between interest groups. Our results reflect a more aggressive behavior in the public persuasion competition for the specialized green lobby. An increase in the representativeness of the green lobby leads to a more stringent environmental policy, but the opposite does not necessarily hold when the producer lobby becomes more powerful. Nevertheless, a more benevolent government sets a more stringent environmental policy only for lower values of the public's initial environmental concern, prior to the persuasion competition.

Keywords: Direct lobbying, public persuasion, indirect lobbying, environmental taxation, specialized lobbies.

Résumé :

Les lobbies ont toujours été des acteurs majeurs du jeu politique. Leurs actions vont de l'influence des croyances des consommateurs à la pression exercée sur les décideurs publics. Ce chapitre vise à analyser l'impact du lobbying direct et indirect par le biais de la persuasion publique par les groupes d'intérêts sur la sévérité de la politique environnementale. Suivant Yu (2005), nous proposons un modèle micro-fondé avec une concurrence imparfaite pour un bien polluant et qui permet de dériver le bien-être total, la fonction objectif du gouvernement, et les interactions stratégiques résultantes entre les groupes d'intérêts. Nos résultats reflètent un comportement plus agressif dans la compétition pour la persuasion du public pour le lobby vert spécialisé. Une augmentation de la représentativité du lobby vert conduit à une politique environnementale plus stricte, mais l'inverse n'est pas nécessairement

vrai lorsque le lobby des producteurs devient plus puissant. Néanmoins, un gouvernement plus bienveillant met en place une politique environnementale plus stricte uniquement pour des valeurs plus faibles de la préoccupation environnementale initiale du public, en amont de la compétition de persuasion.

Mots-clés : Lobbying direct, persuasion du public, lobbying indirect, fiscalité environnementale, lobbies spécialisés.

1.1 Introduction

Environmental non-governmental organisations (NGOs) have become increasingly important political actors over the last decade. At the same time, public awareness over environmental issues has drastically increased in developed countries. In this paper, we provide an explanation for the concomitant nature of these two developments. Using a political economy framework, we show that the awareness of consumers about the environmental damage caused by production elicits a more aggressive behavior from the specialized green lobby in the public persuasion stage.

There is an increasing evidence that both green and polluting-industry lobbies invest in social and mass media campaigns to support their stakes/preferences in front of the general public, whose final belief might be significantly influential in the final policy outcome. We provide two examples that have a particular interest to this study as they reflect the ability of environmentalists to change the public opinion and hence significantly influence political decisions. The first example concerns the construction of the The Grand Ouest Airport, commonly known as the "Notre Dame des Landes" Airport in Britany, France.¹ This project has been the center of public debate for more than 50 years since its announcement in the late 1960s, making it a subject of many postponements and relunches. The engagement of environmentalists against the project started to actually occur in the 2000s, and it reached its peak in 2008-2009² as the site of the project was made the first climate camp in France. This quite strong engagement of the greens made their environmental requests very salient to the rest of the country, leading to many support manifestations in many cities.³ In particular, the continuous pressure of the greens led Emmanuel Macron's government to reconsider the

¹The Grand Ouest Airport was a new airport project, to be situated 30 km to the north-west of the French city of Nantes in the commune of Notre Dame des Landes. In 2008, the project was declared of public utility, giving the corporation Vinci airports the approval to start construction in 2010.

²The environmental concerns of the project are the following: destruction of one of the department's last remaining areas of exceptional biodiversity, loss of significant agricultural land, acceleration of the urbanization of the region, and increase of greenhouse gas emissions due to transportation. The major opposing group "ACIPA" has engaged in a coordinating structure with a total of 34 organizations including Greenpeace, WWF, and the political party "les verts."

³In 2012, 10 000 protesters gathered in the city of Nantes. The number of protesters doubled in 2014, reaching its peak in 2016 with almost 50 000 protesters affirming their opposition to the project.

previous administration's decision to start the construction, resulting in officially cancelling the project in 2018.

The second example concerns the Keystone Pipeline System project.⁴ The project has endured many phases of approval and rejection from the same federal administration between 2010 and 2015. Although the Obama administration was initially in favor of this project, and approved the first three phases of its construction, it has rejected the construction of the fourth phase "over environmental concerns." The opposition from the federal administration is due to years of engagement from the environmentalists in public persuasion, through marches and protests and communication of information about environmental damages related to the project via their websites and social media platforms.⁵ In parallel, the corporate website of the pipeline was communicating information regarding the environmental safety of the project and its economic and social benefits. The battle between the environmentalists and the corporation ended up in the favor of the greens. In fact, a public opinion poll by Pew Research Center showed that the public's support of the pipeline project has fallen from 59% in 2013 to 42% in 2017. This result indicates a victory for the environmentalists over the pipeline corporation in persuading the general public.⁶

In addition to their interest in public persuasion, polluting industries and environmental groups engage in directly influencing policymakers through political contributions and transfer of information. It is well recognized that powerful industrial groups make important political donations, especially in US politics during election cycles. Environmental NGOs are also increasingly active in policy-making processes by meeting with legislators and regulators. For example, Coen et al. (2021) conducted an anonymized survey during the eighth legislature of the European Parliament (EP). The members of the EP report that they are more frequently contacted by NGOs than by other types of interest groups.⁷ Hence, our

⁴The Keystone Pipeline System is an oil pipeline system that runs from Alberta, Canada, to Texas and Illinois, USA.

⁵The Sierra Club and 350.org organized a protest in 2013 that gathered approximately 35 000 to 50 000 protesters in Washington, D.C., calling president Obama to reject the fourth construction phase of the pipeline.

⁶Poll website: <https://www.pewresearch.org/fact-tank/2017/02/21/public-divided-over-keystone-xl-dakota-pipelines-democrats-turn-decisively-against-keystone/>, (accessed september 2020).

⁷Polluting industries have always been considered as significant contributors to electoral campaigns in

work includes the possibility of directly influencing the environmental policy through political contributions. We use a common-agency model of domestic politics *à la* Grossman and Helpman (1994) over environmental policy. There is an industry with a monopoly position that produces a polluting good. Green and producer lobbies offer political contributions to incumbent politicians in return for favorable environmental regulation policies. The incumbent government chooses a tax rate on polluting production to maximize a weighted sum of aggregate welfare and that of political contributions offered by interest groups. The underlying justification is that political contributions can be used for campaign advertising, whereas a higher level of aggregate welfare increases the probability of reelection.⁸ Total welfare is partially based on consumer surplus and includes a disutility of environmental damage incurred by consumers. According to Yu (2005), the two lobbies can also engage in indirect lobbying to influence the perception of consumers on the environmental damage and, upstream the stage of direct lobbying through political contributions. We consider that the producer lobby is formed by a proportion of capitalists or firm owners that manage to overcome the collective action problem and get organized. Similarly, the green lobby is formed by a proportion of organized environmentalists. Further, we assume that the lobbies are "functionally specialized" (see, e.g., Aidt, 1998 and 2005; and Conconi, 2003). Basically, the green and producer lobbies are only concerned about the environmental damage and about the profit, respectively.

It is worth pointing out that environmental tax can only be "second-best" because of market failures – overproduction due to the environmental damage and under-production due to monopoly pricing – and the government failure – maximization of a weighted sum of social welfare and that of political contributions. Nonetheless, the green lobby pushes the incumbent government to increase the environmental tax, whereas the opposite holds for the industrial lobby. We first show that the green lobby adopts a more aggressive strategy in public persuasion compared to the industrial lobby. We then show that, when the political representativeness of the green lobby increases, the political game for influencing the gov-

the USA. For more details, see <https://www.opensecrets.org/industries/> (accessed September 2020).

⁸Since the prospects for reelection are not modeled, we could equally argue that "political contributions" represent bribes given to influence government policies (see, e.g., Fredriksson and Svensson, 2003).

ernment turns to the advantage of the green lobby. This is because the green lobby becomes more aggressive in both direct and indirect lobbying while the industrial lobby becomes less aggressive in both activities. This fact reveals a complementarity effect between the two types of lobbying. Conversely, when the political representativeness of the industrial lobby increases, this lobby does not necessarily increase its political effectiveness since it induces the green lobby to be again more active in direct and indirect lobbying.

However, an increase in the weight attached to general welfare by the incumbent government reduces both direct and indirect political activities of the green lobby and reduces those of the industrial lobby when the initial environmental belief of the general public is low, and increases them otherwise. This fact reveals again the complementarity between the two types of influence.

The rest of the paper is organized as follows. Section 1.2 surveys the related literature. Section 1.3 introduces the model. Section 1.4 reports the comparative statics results. Finally, Section 1.5 concludes the paper.

1.2 Related Literature

A large body of literature on the role of domestic politics in the making of environmental policy exists. Most analysis uses the common agency model of Grossman and Helpman (1994) wherein interest groups lobby directly politicians to push them to change policies in their preferred direction. However, interest groups can also use other channels to influence environmental regulations. In Yu's (2005) seminal analysis of direct (inside) and indirect (outside) lobbying, special interest groups, in addition to offering political contributions to policymakers, launch information campaigns to the general public to change their preferences (or those of the median voter), which in turn modifies government policies. As argued by Yu (2005), we can expect green lobbies to rely extensively on this channel relative to producer lobbies because they have, presumably, less financial resources.

Yu (2005) considers a reduced-form function for total welfare that enters into the objective function of the regulator, along with the political contributions received. He also

assumes that indirect lobbying efforts are strategic substitutes and that the green lobby has a cost advantage in sending messages. These assumptions drive his comparative static results on the greater effectiveness of the green lobby in public persuasion. Conversely, we specify the economic context characterized by imperfect competition, and where total welfare is derived explicitly from the producer surplus, the consumer surplus, and tax revenues. Further, making similar assumptions on the public persuasion function to Yu (2005), we endogenously derive the nature of strategic interactions between the lobbies in the indirect lobbying competition. In our setting, we show that the best response function of the green lobby is upward sloping, while that of the industrial lobby is downward sloping. This induces a complementarity between indirect and direct lobbying. Meanwhile, Yu (2005)'s result of substitutability between the two types of efforts results from his assumption on the nature of strategic interactions in indirect lobbying.

Prieur and Zou (2018) also develop a model with public persuasion *à la* Yu (2005), but without direct lobbying through political contributions. Their results show that the society in general can benefit from the outcome of this indirect lobbying game – as measured by a reduction of economic and environmental distortions – only if the public perception of the environmental damage is relatively close to that of industrialists, whereas the environmentalist group is radical in its ideology. Symmetrically, the game of political influence becomes detrimental to social welfare if industrial groups are very aggressive and people's concern is relatively close to that environmental groups. Overall, Prieur and Zou (2018) identify a strong asymmetry in the indirect lobbying game to the advantage of industrial groups. By contrast, in our setting with a competition for political influence in both direct and indirect lobbying, we show the existence of an asymmetry to the benefit of environmental groups. An other work that relates to the persuasion literature is that of Bramoullé and Orset (2018). They show that some industries might take the competition over public opinion to the extreme and invest in the supporting biased research, to create doubt around an already controverted issue (e.g., climate issue).

Finally, this paper is related to the literature on public persuasion in democratic societies. Persuasion is the act of changing others' beliefs or preferences and make them closer to

ours in order to induce a change in their behavior. Hence, it is typically modeled as a Bayesian mechanism that allows receivers of signals (information) to update their prior beliefs (Congleton, 1986). Grossman and Helpman (2001) popularize the use of public persuasion by lobbies for political influence. Since then, a growing literature has investigated in depth its mechanism and relationship with mass media. Petrova (2012) and Sobbrío (2011) examine the role of media in the persuasion of the median voter in favor of special interest groups (SIGs). They show how the media can serve as a filter between the lobbies and the targeted public.

Thus, the effort exerted by the interest groups in indirect lobbying is not translated immediately and effectively into gains as it depends mainly on the filtering capacity of the media and on its ability to update the prior beliefs of the targeted public. Shapiro (2016) confirms these findings through an empirical analysis. He shows that the public may remain uninformed about controversial issues (e.g., climate change) when the SIGs have high policy stakes and when media channels are biased. Kamenica and Gentzkow (2017) investigate the issue of Bayesian persuasion with multiple senders. They show that competition between senders tends to increase the amount of information revealed to the public. For simplicity, this discussion does not find its way into our model. Therefore, we limit our analysis to the notion that lobbies send messages to the general public in a way to influence their environmental awareness, without formalizing the process.

1.3 The Model

1.3.1 General framework

Let consider an economy with a perfectly competitive industry that produces a numeraire good using labor and a monopoly that produces a polluting good using labor and a specific factor, which is available in fixed supply. There are three types of agents: workers, capitalists or firm owners, and environmentalists. The population is normalized to 1. All individuals

have a labor income y , which is assumed to be exogenous and constant independent of the regulation implemented in the polluting sector. Thus, it is a partial equilibrium framework, and the assumption of fixed labor income can reflect the fact that the polluting sector is small compared to the numeraire good sector.⁹ The preferences of each consumer are represented by the following quasi-linear utility function:

$$U = u(x) + x_0 - D(x), \quad (1.1)$$

where x_0 and x are the individual consumption of the numeraire good and of the polluting good, respectively, and $u(\cdot)$ is an increasing concave function [$u'(\cdot) > 0$ and $u''(\cdot) \leq 0$]. We assume that the utility of consuming the polluting good is given by a quadratic function, i.e. $u(x) = x - (x^2/2)$.

As a unit mass of consumers exists, the total production of the polluting good is equal to individual consumption of this good. Furthermore, the firm producing the polluting good does not have access to an abatement technology. We further assume that each unit of production generates one unit of pollution. Consequently, $D(x)$ represents the individual disutility of pollution generated by the production in the polluting sector. Following Yu (2005), we also consider that consumers have a *subjective belief* regarding environmental damage. Thus we assume that $D(x) = \mu_p d(x)$, where μ_p is the common subjective weight attached to the environmental damage by consumers in their utility functions. We make the following assumption on the $d(\cdot)$ function.

A1: For all x , $d'(x) > 0$, $d''(x) \geq 0$ and $d'''(x) \leq 0$.

With fixed income, the inverse demand function is $p = u'(x) = 1 - x$, which yields the following indirect utility function of the representative consumer:

$$V = \frac{x^2}{2} + y - \mu_p d(x). \quad (1.2)$$

For simplicity, we assume that there are no fixed costs of production and that the marginal

⁹We thank the anonymous reviewer for pointing this out.

cost of production is constant so that we can set it to 0. Moreover, considering that the government set a tax t per unit of emission, the profit of the monopoly producing the polluting good is $\pi(x) = (p(x) - t)x$. Profit maximization yields $x(t) = (1 - t)/2$. Substituting into the profit function, we have

$$\pi(t) = \frac{(1 - t)^2}{4}. \quad (1.3)$$

The indirect utility function as a function of the environmental tax is given by

$$V(t) = \frac{(1 - t)^2}{8} + y - \mu_p d(x(t)). \quad (1.4)$$

Total welfare is the sum of consumer surplus, producer surplus, and tax revenues that is $W_P(t) = V(t) + \pi(t) + tx(t)$ or

$$W_P(t) = \frac{(1 - t)(3 + t)}{8} - \mu_p d(x(t)). \quad (1.5)$$

1.3.2 Direct political competition

Following Yu (2005), the formation of the environmental policy is driven by a three-stage game. The indirect competition between lobbies occurs in the first stage. In the second stage, green and producer lobbies present the incumbent policymaker with contributions, which are contingent on the environmental tax. Finally, in the third stage, the government chooses the environmental tax while production and consumption occur. We initially examine the last two stages, which is modeled as a common agency problem *à la* Grossman and Helpman (1994).

Two groups of individuals are politically organized: a proportion α_E of the environmentalists becomes organized and forms a green lobby and a proportion α_I of the capitalists who own the firm manages to overcome the collective action problem and forms a producer

lobby.¹⁰ We also assume that lobbies are "functionally specialized" (Aidt, 1998, 2005)¹¹. The producer lobby cares only about the profit; thus, its gross welfare is $W_I(t) = \alpha_I \pi(t)$. Similarly, the green lobby only concerns about environmental damage; thus, its gross welfare is $W_E(t) = B - \alpha_E d(x(t))$, where B is a constant that can represent exogenous donations received by the green lobby. Let $C_I(t)$ and $C_E(t)$ be the contingent-policy contribution functions of the industrial and the green lobbies. The objective of the industrial lobby is to maximize its (net) welfare given by¹²

$$W_I(t) - C_I(t), \tag{1.6}$$

while that of the green lobby is to maximize

$$W_E(t) - C_E(t). \tag{1.7}$$

The government concerns about total welfare and political contributions and chooses the tax rate on emissions to maximize

$$G(t) = bW_P(t) + C_I(t) + C_E(t). \tag{1.8}$$

Here, $b > 0$ represents the weight that the government attaches to social welfare relative to lobbies' contributions. To guarantee that the objective function of the government is always

¹⁰We follow Aidt (2005) by assuming the existence of three types of agents: workers/consumers, capitalists or firm owners, and environmentalists. Their proportions are $\bar{\alpha}_W$, $\bar{\alpha}_I$, and $\bar{\alpha}_E$, respectively. The total population is normalized to 1, with $\bar{\alpha}_W + \bar{\alpha}_I + \bar{\alpha}_E = 1$. Therefore, α_E is the proportion of the environmentalists $\bar{\alpha}_E$ ($\alpha_E \leq \bar{\alpha}_E$) that form the lobby group. If all environmentalists become organized, then $\alpha_E = 1$. Similarly, if all capitalists participate to the lobby group, then $\alpha_I = 1$. However, we consider that $\alpha_k < 1$. The underlying justification is that lobbying is a public good to firm owners and hence, subject to a collective action problem.

¹¹Functionally specialized lobbies are a type of SIGs that were initially introduced by Aidt (1998), based on empirical evidence given by Marshall (1999). These lobby groups care and advocate only for one aspect of their welfare, as the rest of their welfare dimensions are weighted negligibly (see also Aidt, 1998). The assumption of functionally specialized lobbies is now rather standard in the literature (see Fredriksson et al., 2005; Ovaere et al., 2013; Lefebvre and Martimort, 2020). This assumption has the advantage of, in addition to be more realistic, simplifying the theoretical analysis of the influence of interest groups.

¹²Members of each lobby group must pay collectively the full cost of direct or indirect lobbying, but are concerned only with a share of the full profit or the full environmental damage.

concave in t , we should assume that $b \geq 2$ (see Footnote 14).

Following Bernheim and Whinston (1986) and Grossman and Helpman (1994), we focus on "truthful" subgame perfect Nash equilibria wherein each lobby offers the government a (non-negative) "truthful contribution schedule." Such a contribution pays the government the true welfare effect of the policy, in excess of a certain reservation value. Formally, the truthful political schedule from lobby group j is given by $C_j^T(t, z_j) = \max[0, W_i(t) - z_j]$, where z_j is a constant.¹³ Following Lemma 1 of Yu (2005), the equilibrium of the direct competition for political influence can be characterized as follows.

Lemma 1 (Yu (2005)): (i) *The equilibrium level of environmental policy t^* satisfies*

$$t^* = \arg \max_t bW_P(t) + W_I(t) + W_E(t). \quad (1.9)$$

(ii) *The equilibrium level of political contributions for the green lobby is*

$$\begin{aligned} C_E(t^*) &= [W_I(t^I) + bW_P(t^I)] - [W_I(t^*) + bW_P(t^*)], \\ \text{where } t^I &= \arg \max_t bW_P(t) + W_I(t). \end{aligned} \quad (1.10)$$

(iii) *The equilibrium level of political contributions for the industrial lobby is*

$$\begin{aligned} C_I(t^*) &= [W_E(t^E) + bW_P(t^E)] - [W_E(t^*) + bW_P(t^*)], \\ \text{where } t^E &= \arg \max_t bW_P(t) + W_E(t). \end{aligned} \quad (1.11)$$

Proof: See the Proof of Lemma 1 in Yu (2005). \square

The intuition behind the equilibrium political contributions is the following. Let consider the equilibrium contribution of the green lobby given by (1.10). This lobby takes the political contribution of the industrial lobby as given and knows that, if it does not enter into the

¹³For a detailed discussion of truthful contribution schedules, see Dixit et al. (1997)

political game, the government will choose the policy t^I that maximizes the sum of aggregate welfare and producer surplus. Therefore, if the green lobby intends to affect the policy outcome with environmental tax given by t^* , it must offer a contribution that provides the government with at least what the government could achieve by ignoring the green lobby's preferences. That is, one must have $C_E(t^*) + C_I(t^*) + bW_p(t^*) \geq C_I(t^I) + bW_p(t^I)$. The green lobby does not contribute more than necessary to induce the environmental policy t^* . Consequently, the equilibrium contribution of the green lobby – characterized by (1.10) – is exactly equal to the difference between what the government and the industrial lobby could jointly achieve when the green lobby's interest is ignored and when it is considered. The same reasoning applies for the political contribution of the industrial lobby.

From Lemma 1, the equilibrium value of the tax t^* is determined by the following first-order condition:

$$bW'_P(t) + W'_I(t) + W'_E(t) = 0. \quad (1.12)$$

With (1.3) and (1.5) and since $x(t) = (1-t)/2$, $W_I(t) = \alpha_I \pi(t)$ and $W_E(t) = B - \alpha_E d(x(t))$, t^* is given by¹⁴

$$-t^*(b - 2\alpha_I) - (b + 2\alpha_I) + 2(\alpha_E + b\mu_p)d'(x(t^*)) = 0, \quad (1.13)$$

Similarly, the environmental tax t^I that maximizes the joint welfare for the government and the industrial lobby solves the following first-order condition:

$$-t^I(b - 2\alpha_I) - (b + 2\alpha_I) + 2b\mu_p d'(x(t^I)) = 0. \quad (1.14)$$

Finally, the environmental tax t^E that maximizes the joint welfare for the government and the green lobby solves the following first-order condition:

$$-bt^E - b + 2(\alpha_E + b\mu_p)d'(x(t^E)) = 0. \quad (1.15)$$

¹⁴The second derivative of the left-hand-term of (1.13) is negative if $-(b - 2\alpha_I) - (\alpha_E + b\mu_p)d''(x(t^*)) \leq 0$. Since $d''(\cdot) \geq 0$, a sufficient condition for the above inequality to be satisfied is that $b \geq 2$.

We obtain the following intuitive result.

Lemma 2: *We have $t^I < t^* < t^E$.*

Proof: See Appendix A.1. \square

The jointly optimal environmental tax for the green lobby and the government is greater than the equilibrium tax. It is also greater than the jointly optimal tax for the industrial lobby and the government. This is the reason why the lobbies offer political contributions to government to push for an environmental policy in their preferred direction.

1.3.3 Indirect political competition

We now discuss the first stage of the policy game wherein lobbies engage in indirect political competition by sending messages to the general population to change their subjective belief regarding the environmental damage. Thus, we now consider that μ_p is the prior belief of the public for the scale of environmental damage. People update their belief based on the messages received from the lobbies. Thus, following Yu (2005), μ_p is a function of the number of messages sent by the industrial lobby – denoted by m_I – and the number of messages sent by the environmental lobby – denoted by m_E – that is, $\mu_p \equiv \mu(m_E, m_I)$. Using subscripts as partial derivatives of the persuasion function with respect to the number of messages sent either by the environmental lobby (E) or the industrial lobby (I), we make the following assumptions:

A2: $\forall (m_E, m_I) \in \mathbb{R}_+^2$ (i) $\mu_1(m_E, m_I) > 0$, $\mu_2(m_E, m_I) < 0$ (ii) $\mu_{11}(m_E, m_I) \leq 0$, $\mu_{22}(m_E, m_I) \geq 0$, and $\mu_{12}(m_E, m_I) \geq 0$; and (iii) $\mu(m_E, m_I) = \mu_0 > 0$, when $m_E = m_I = 0$ or $m_E = m_I$.

Thus, from (i), the belief of the public for the scale of environmental damage is increasing (or decreasing) in the number of messages sent by the green (or industrial) lobby. Property (ii) indicates that there are decreasing to scale for sending messages and that they can be complements or substitutes. Property (iii) states that the general public has a prior belief $\mu_0 > 0$ for the environmental damage (i.e. before receiving messages from lobbies). Property

(iii) also states that the posterior and prior beliefs are the same in the specific case where the two lobbies send the same number of messages.

Let the cost of sending messages be $c_j(m_j)$, with $c'(m_j) > 0$, $c''(m_j) \geq 0$, and $c(0) = 0$ for $j = I, E$. The green lobby chooses m_E to maximize

$$L^E(m_E, m_I) = B - \alpha_E d(x(t^*)) - C_E(t^*, t^I) - c_E(m_E). \quad (1.16)$$

Similarly, the industrial lobby chooses m_I to maximize

$$L^I(m_E, m_I) = \alpha_I \pi(t^*) - C_I(t^*, t^E) - c_I(m_I). \quad (1.17)$$

Substituting (1.10) and (1.11) into (1.16) and (1.17), we have

$$L^E(m_E, m_I) = [B - \alpha_E d(x(t^*)) + \alpha_I \pi(t^*) + bW_P(t^*)] - [\alpha_I \pi(t^I) + bW_P(t^I)] - c_E(m_E), \quad (1.18)$$

and

$$L^I(m_E, m_I) = [B - \alpha_E d(x(t^*)) + \alpha_I \pi(t^*) + bW_P(t^*)] - [B - \alpha_E d(x(t^E)) + bW_P(t^E)] - c_I(m_I). \quad (1.19)$$

Using the envelop theorem, (m_E^*, m_I^*) must solve the following first-order conditions

$$L_1^E = \mu_1(m_E^*, m_I^*) b [d(x(t^I)) - d(x(t^*))] - c'_E(m_E^*) = 0, \quad (1.20)$$

and

$$L_2^I = -\mu_2(m_E^*, m_I^*) b [d(x(t^*)) - d(x(t^E))] - c'_I(m_I^*) = 0. \quad (1.21)$$

We have the following lemma.

Lemma 3: *If $c''_I(\cdot) \gg 0$ or $\mu_{11} \gg 0$, then a Subgame Perfect Nash equilibrium exists, where the equilibrium numbers of messages (m_E^*, m_I^*) , in the indirect competition of the political process, are implicitly given by (1.20) and (1.21).¹⁵*

¹⁵We assume that $|L_{11}^E L_{22}^I| \geq |L_{12}^E L_{21}^I|$ to guarantee the stability of the subgame perfect Nash equilibrium

Proof: See Appendix A.2. \square

As shown in the Appendix, the second-order condition for L^E is always satisfied, but that for L^I requires that the cost function of sending message for the industrial lobby is sufficiently convex, – i.e. $c_I''(.) \gg 0$ – and/or that the marginal impact of m_I on μ_p is decreasing sufficiently rapidly – i.e., $\mu_{11} \geq 0$ –.

As in every policy games, the nature of strategic interactions between policy actors is crucial for the outcome of the policy game. We have the following result.

Lemma 4: (i) *The best response function of the green lobby in indirect lobbying is upward sloping and that of the industrial lobby is downward sloping for $\mu_{12}(m_E, m_I) \geq 0$. Meanwhile, for $\mu_{12}(m_E, m_I) < 0$, the nature of strategic interactions in indirect lobbying is ambiguous.*

Proof: See Appendix A.3. \square

Lemma 4 shows that the nature of strategic interactions in sending messages by the industrial and green lobbies depends on the sign of the cross derivative of $\mu_p(m_E, m_I)$ – i.e., on the sign of μ_{12} . As we do not explicitly define the persuasion process, we must discuss the sign of this cross derivative. In fact, its sign is not evident, and there are convincing reasons for μ_{12} being negative as there are for μ_{12} being positive. One can think for example that the general public is less sensitive to the messages sent by one lobby as the number of messages received by the other lobby is relatively large, wherein case $\mu_{12} \leq 0$.¹⁶ However, one can equally think that the public is all the more careful to the messages sent by the green lobby as its opponent is more active in public persuasion, wherein case $\mu_{12} \geq 0$. In the latter case, Lemma 4 shows that the nature of strategic interactions in sending messages between the lobbies is unambiguously known. In any case, the result of the present analysis shows that the nature of strategic interactions in the indirect political game depends crucially on the

in the general framework. This condition can be easily verified with the specific functional forms proposed in Section 4.

¹⁶Further, excessive communication can be counter-productive. Lyon and Montgomery (2013) show that excessive green self-promotion by producers might backfire when it gets noticed by environmental activists.

assumption made on the effect of the messages sent by one lobby on the effectiveness of the public persuasion of the other lobby's messages – i.e., crucially dependent on the sign of the cross derivative μ_{12} –.

The strategic substitutability defined by Yu (2005) in the game for indirect political influence follows directly from the assumption made on the cross derivative – i.e., $\mu_{12} = 0$ – suggesting that the messages sent by the two lobbies have independent effects on the perception regarding environmental damage by the general public. Adopting the same assumption to the present framework, we find that the best response function of the green lobby is upward sloping, while that of the industrial lobby is downward sloping. In other words, if the industrial lobby increases its number of messages, then the best response function of the green lobby is also to increase its number of messages to the general public. Meanwhile a larger number of messages sent by the green lobby induces a reduction of messages sent by the industrial lobby.

This reflects a fundamental asymmetry between the two lobbies in the indirect policy game. Specifically, the green lobby shows a more aggressive response in the public persuasion competition.¹⁷ To understand this, let us return to social welfare as a function of the environmental tax. Recall that the environmental tax is set to correct for two market failures as the market is characterized by both under-production due to monopoly pricing and over-production due to the negative pollution externality. The producer surplus given by (1.3) and the gross consumer surplus given by the first term of (1.4) are decreasing with the environmental tax. That is, the interest of the (organized) capitalists aligns with that of the general population as consumers (i.e., without considering the disutility from the environmental damage) for inciting the regulator to decrease the environmental tax. This urges the environmental lobby to be very aggressive in public persuasion to counteract this incentive by significantly increasing μ_p in the government's objective function.

¹⁷We follow the pioneering work of Bulow et al. (1985), by referring to the upward best-response function of a player as an aggressive behavior.

1.4 Comparative Static Results

The equilibrium levels of political contributions, political messages and environmental policy are only implicit. In order to obtain additional results on how political representativeness affects the political equilibrium, we now propose simple specific functional forms for the damage function, cost functions of sending messages, and the function that maps the number of messages to the prior belief of the public for the scale of the environmental damage. Let $d(x) = x$, $c(m_k) = m_k$ for $k = E, I$ and $\mu_p(m_E, m_I) = \mu_0 + \sqrt{m_E} - \sqrt{m_I}$, implying that $\mu_{12} = 0$. Here, μ_0 is the prior belief of the general public regarding environmental damage, and it is supposed to be between 0 and 1. This parameter is particularly interesting because it helps in interpreting most of the comparative statics results.

Following the literature on lobby formation, we assume that the environmentalists and capitalists encounter a collective action problem. This problem is captured by the upper limit of α_E and α_I ; the proportion of the environmentalists and capitalists that manage to get organized and form, respectively, the green and industrial lobbies is lower than 1. Moreover, to draw clear and conclusive results, we push further this reasoning by setting the upper limit of α_E and α_I at $1/2$.¹⁸

We present the new expressions of the equilibrium outcomes. We first characterize the environmental taxes (t^*, t^E, t^I) . Using (13), (14) and (15), we have:

$$t^*(\mu_p) = \frac{2[b\mu_p + \alpha_E] - (b + 2\alpha_I)}{b - 2\alpha_I}, \quad (1.22)$$

and

$$t^I(\mu_p) = \frac{2b\mu_p - (b + 2\alpha_I)}{b - 2\alpha_I}, \quad (1.23)$$

¹⁸In fact, in a paper by Grier et al. (1991), who empirically investigate the relationship between the political participation of firms (given by the percentage of firms with a political action committee [PAC]) and the industry concentration (given by the four-firm industry concentration ratio, measured as the proportion of the total sales of the four largest firms to the total industry sales). They found that the relationship between the two is quadratic and the political participation reaches a maximum of 20% at a concentration ratio of 0.45.

and

$$t^E(\mu_p) = \frac{2[b\mu_p + \alpha_E] - b}{b}. \quad (1.24)$$

Next, we characterize the equilibrium outcome of the subgame in political contributions, we then have:

$$C_E = \frac{\alpha_E}{2(b - 2\alpha_I)}, \quad (1.25)$$

and

$$C_I(\mu_p) = \frac{2\alpha_I^2[\alpha_E - b(1 - \mu_p)]^2}{b(b - 2\alpha_I)^2}. \quad (1.26)$$

Finally solving the system of the first order conditions given by (1.20) and (1.21), we characterize the equilibrium of the subgame in public persuasion (m_E^*, m_I^*) . The following Proposition describes the political equilibrium.

Proposition 1: *If $\mu_0 \in (\underline{\mu}, \bar{\mu})$ – with $0 < \underline{\mu} < \bar{\mu}$ – there exist a unique (local) political equilibrium, with the following characteristics:*

- *The equilibrium number of messages $(m_E^*, m_I^*) \in \mathbb{R}_+^2$ and the equilibrium perception of the environmental damage $\mu_p^* \equiv \mu_p(m_E^*, m_I^*) \in (0, 1)$ are given by*

$$m_E^* = \left[\frac{b\alpha_E}{2(b - 2\alpha_I)} \right]^2, \quad (1.27)$$

$$m_I^* = \left[\frac{\alpha_I [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E]}{2(b - 2\alpha_I) [b(1 - \alpha_I) - 2\alpha_I]} \right]^2, \quad (1.28)$$

$$\mu_p^* = \frac{b(\alpha_E - 2\alpha_I) + 2\alpha_I\alpha_E + 2\mu_0(b - 2\alpha_I)}{2[b(1 - \alpha_I) - 2\alpha_I]}. \quad (1.29)$$

- *The equilibrium political contribution of the green lobby is given by (1.25), i.e. $C_E^* \equiv C_E$, while that of the industrial lobby is given by substituting (1.29) into (1.26), i.e. $C_I^* \equiv C_I(\mu_p^*)$.*
- *The equilibrium tax is obtained by substituting (1.29) into (1.22), i.e. $\hat{t}^* \equiv t^*(\mu_p^*)$.¹⁹*

¹⁹Expressions of $\underline{\mu}$, $\bar{\mu}$, C_I^* , and \hat{t}^* are given in the Appendix.

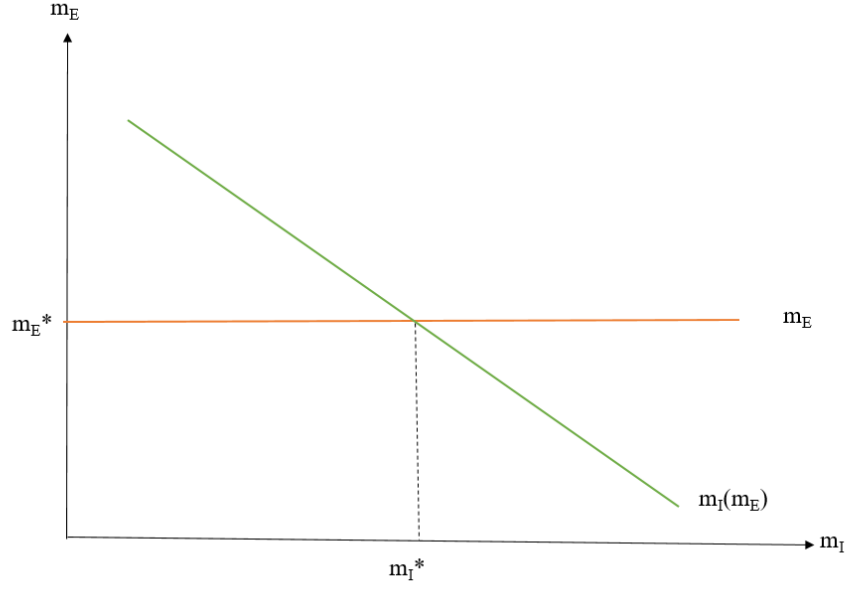
Proof: See Appendix A.4. \square

Let analyze the strategies of the environmental lobby. This lobby has a dominant strategy in the indirect lobbying competition (Figure 3). Indeed, with $\mu_{12} = 0$ and a linear damage function, the best-response function of the green lobby only depends on the difference between taxes t^* and t^I (see (1.20), (1.22), and (1.23)). This difference does not depend on μ_p and, hence, does not depend on m_I . This feature is due to the fact that the political contributions of the environmentalists are independent of the public persuasion outcome μ_p (as shown by (1.25)). Anticipating this, the green lobby has no incentive to use public persuasion as a strategic device for influencing the game in the direct political competition. Consequently, the green lobby's strategy in the game for public persuasion reflects its true preferences independent of those of the industrial lobby.

This outcome is driven by the set of assumptions behind the proposed functional forms. If, for example the public persuasion function would feature a complementary effect between the messages sent by the two lobbies – i.e., $\mu_{12} > 0$ – then the best response function in the messages of the green lobby would be upward sloping (see Lemma 4). As already explained, this would reflect an "aggressive" behavior of the green lobby in the public persuasion stage.

Next, considering the strategies of the industrial lobby. Both its direct and indirect strategies depend on μ_p . In fact, anticipating that its political contributions will depend on the outcome of the public persuasion competition, this lobby acts strategically in the indirect political game to influence the outcome of the subgame in political competition. Hence, the capitalists' lobby can only best respond to the green lobby's preferences by sending less messages as the number of messages sent by the green lobby increases.

Figure 3: Reaction functions of indirect lobbying



Let analyze the impact of an increase in the proportion of organized environmentalists on the equilibrium number of messages, equilibrium political contributions, and equilibrium environmental tax. We then have the following proposition:

Proposition 2: *An increase in the proportion of organized environmentalists α_E :*

- *Increases both the equilibrium number of messages m_E^* and the political contributions C_E^* of the green lobby.*
- *Decreases both the equilibrium number of messages m_I^* and the political contributions C_I^* of the industrial lobby.*
- *Increases the equilibrium environmental tax \hat{t}^* .*

Proof: See Appendix A.5. \square

Thus, as the size of the environmental lobby increases, the two lobbies will adopt opposite strategies in both direct and indirect competition. The green lobby becomes more aggressive

by investing additional resources in public persuasion and offers more political contributions to the regulator. Conversely, the industrial lobby best responds to an increase in the political representativeness of its antagonist by investing less resources in the two types of competition. Hence, it offers less political contributions to the regulator and sends less political messages to the general public. Consequently, the environmental policy becomes more stringent. An increase in the representativeness of the environmentalists induces a complementarity effect of direct and indirect lobbying strategies for the two interest groups.

Subsequently, let analyze the impact of an increase in the size of the organized capitalists on the equilibrium number of messages, equilibrium political contributions and equilibrium environmental tax.

We then have the following proposition:

Proposition 3: *An increase in the proportion of organized capitalists α_I*

- *Increases both the equilibrium number of messages m_E^* and the political contributions C_E^* of the green lobby.*
- *There exists $\bar{\mu}_1 \in (\underline{\mu}, \bar{\mu})$ such that it increases both the equilibrium number of messages m_I^* and the political contributions C_I^* of the industrial lobby for $\mu_0 \in (\underline{\mu}, \bar{\mu}_1]$ and decreases them for $\mu_0 \in [\bar{\mu}_1, \bar{\mu})$.*
- *There exists $\bar{\mu}_2 \in (\underline{\mu}, \bar{\mu})$, with $\bar{\mu}_2 \leq \bar{\mu}_1$, such that it increases the equilibrium environmental tax \hat{t}^* for $\mu_0 \in (\underline{\mu}, \bar{\mu}_2]$ and decreases it for $\mu_0 \in [\bar{\mu}_2, \bar{\mu})$.²⁰*

Proof: See Appendix A.6. \square

Unlike an increase in the size of the green lobby, an increase in the size of the industrial lobby makes its rival more aggressive in both types of lobbying. Specifically, the green lobby reacts to an increase in α_I by investing further in public persuasion efforts and political

²⁰Expressions of $\bar{\mu}_1$ and $\bar{\mu}_2$ are given in the Appendix.

contributions. This initial results show the complementarity effect of an increase in the size of organized capitalists on direct and indirect lobbying strategies of the green lobby.

The effect of an increase in the size of the industrial lobby on its own equilibrium strategies also reflects the complementarity effect between the direct and indirect lobbying strategies. However, it depends on the prior belief of the general public μ_0 . For lower values of μ_0 (i.e., lower environmental awareness), both equilibrium strategies of the industrial lobby increase with α_I . However, they start decreasing with α_I as the environmental awareness exceeds the threshold level $\bar{\mu}_1$.

To understand this result, recall that the competition in public persuasion results in the equilibrium level μ_p^* . From (1.29), we can see that the equilibrium environmental belief is decreasing in α_I (i.e., $\partial\mu_p^*/\partial\alpha_I < 0$)²¹ and at a lower rate as μ_0 increases (i.e., $\partial^2\mu_p^*/\partial\alpha_I\partial\mu_0 > 0$). Therefore, for lower values of μ_0 , the effect of α_I on μ_p^* is more important, inducing the industrial lobby to invest even further in its indirect lobbying strategy. As μ_0 reaches $\bar{\mu}_1$, the industrial lobby can now reduce its public persuasion efforts because increasing them is not profitable anymore as the effect of α_I on the public environmental belief becomes less important.

Finally, the impact of a larger industrial lobby on the final policy outcome depends also on the values of the prior environmental belief μ_0 . For lower values of the initial environmental belief ($\mu_0 \leq \bar{\mu}_2$), the competition between the two lobbies ends in the favor of the green lobby as the equilibrium environmental tax increases. For $\bar{\mu}_2 \leq \mu_0 \leq \bar{\mu}_1$, the competition shifts into the favor of the industrial lobby, leading to a decrease in the equilibrium environmental tax. Interestingly, the tax continues to decrease even when the capitalists' lobby decreases its direct and indirect efforts.²²

In the final analysis, we are interested in investigating the effect of b , which is the parameter that reflects the degree of benevolence of the regulator on the equilibrium number of

²¹The derivative of μ_p^* with respect to α_I is given by

$$\frac{\partial\mu_p^*}{\partial\alpha_I} = -\frac{b[b(2(1-\mu_0)-\alpha_E)-4\alpha_E]}{b[b(1-\alpha_I)-2\alpha_I]^2}$$

²²The comparison result of the two threshold values shows that $\bar{\mu}_1$ is greater than $\bar{\mu}_2$.

messages, equilibrium political contributions and equilibrium environmental tax. We then have the following proposition.

Proposition 4: *An increase in the degree of benevolence b of the regulator*

- *Increases both the equilibrium number of messages m_E^* and the political contributions C_E^* of the green lobby.*
- *There exists $\bar{\alpha}_E \in [\alpha_I, 1/2]$ and $\bar{\alpha}_I \in [1/3, 1/2]$ such that, if $\alpha_E \geq \bar{\alpha}_E$ and $\alpha_I \leq \bar{\alpha}_I$, then it always increases the equilibrium number of messages m_I^* of the industrial lobby and decreases the equilibrium environmental tax \hat{t}^* ; otherwise, there exists $\bar{\mu}_3 \in (\underline{\mu}, \bar{\mu})$, such that it decreases m_I^* and increases \hat{t}^* for $\mu_0 \in (\underline{\mu}, \bar{\mu}_3]$, and increases m_I^* and decreases \hat{t}^* for $\mu_0 \in [\bar{\mu}_3, \bar{\mu})$.*
- *There exists $\bar{\mu}_4 \in (\underline{\mu}, \bar{\mu})$ such that it decreases the equilibrium political contributions C_I^* of the industrial lobby for $\mu_0 \in (\underline{\mu}, \bar{\mu}_4]$, and increases them for $\mu_0 \in [\bar{\mu}_4, \bar{\mu})$.²³*

Proof: See Appendix A.7. \square

A higher degree of benevolence (b) of the regulator induces a complementarity effect on the equilibrium strategies of the green lobby as it decreases both its equilibrium messages m_E^* and its equilibrium political contributions C_E^* . The equilibrium political contributions decrease because their weight becomes relatively less important in the regulator's objective function, as it provides more importance to the general welfare, compared to the contributions. A decrease in the equilibrium number of messages m_E^* comes directly from the fact that the green lobby has a dominant strategy in the indirect political competition, as given by (1.27). When adjusting its strategy to a more benevolent regulator, this lobby does not consider the effect of b on the equilibrium environmental belief of the general public μ_p^* . Its reasoning internalizes only the fact that a greater b increases the relative weight of the damage in the objective function of the regulator. Therefore, this lobby can afford to reduce its indirect competition efforts.

²³Expressions of $\bar{\mu}_3$ and $\bar{\mu}_4$ are given in the Appendix.

Meanwhile, the reaction of the industrial lobby to a more benevolent regulator is not so clear cut. In fact, for a sufficiently large proportion of organized environmentalists (i.e., $\alpha_E \geq \bar{\alpha}_E$) and a sufficiently low proportion of organized capitalists (i.e., $\alpha_I \leq \bar{\alpha}_I$), a more benevolent regulator always induces a more aggressive behavior from the industrial lobby in the public persuasion competition, as this lobby increases its equilibrium number of messages m_I^* . Otherwise, the effect of an increase in b depends on the values of the initial belief of the general public regarding environmental damage. If the general public has a sufficiently low environmental initial concern regarding pollution (i.e., $\mu_0 \in (\underline{\mu}, \bar{\mu}_3]$), then the industrial lobby can afford to reduce its indirect lobbying efforts when the government becomes more benevolent. However, if the general public is already relatively highly concerned about the environmental damage (i.e., $\mu_0 \in [\bar{\mu}_3, \bar{\mu})$), the industrial lobby further invests in public persuasion with an increased degree of benevolence of the government in order to compensate for the initial higher environmental awareness of the general public.

The political contributions of this lobby first decrease for a lower initial environmental concern of the general public ($\mu_0 \in (\underline{\mu}, \bar{\mu}_4]$) as the government becomes more benevolent. The industrial lobby can afford to reduce its political contributions when the general public is initially less concerned regarding environmental damage. However, if the environmental awareness becomes greater than the threshold value $\bar{\mu}_4$, this lobby should strengthen its position by offering even more political contributions to the regulator even if the latter becomes more benevolent and is less concerned regarding monetary contributions.

Finally, in the presence of a more benevolent government, the environmental policy changes in opposite way to the change in the indirect political efforts of the industrial lobby m_I^* , regardless of the reaction of the green lobby to this increase in b . Hence, a more benevolent regulator will install a more stringent environmental policy when the equilibrium indirect lobbying efforts of the industrial lobby decrease and a less stringent environmental policy when the same efforts increase. An interesting conclusion can be drawn from the previous result: the effect of a more benevolent regulator on the final policy outcome does not depend on the direct political competition, but it depends only on what happens in the public persuasion stage. Therefore, the effect of b on the stringency of the environmental

policy can be directly deduced from the effect of this same parameter on indirect lobbying efforts of the industrial lobby.

1.5 Conclusion

This study aims to investigate the impact of direct and indirect strategies adopted by opposing interests groups on the stringency of the environmental policy set by a semi benevolent government. Using a common agency model of domestic politics similar to the one adopted by Yu (2005), and considering two specialized lobbies, we show that public environmental awareness provokes a more aggressive behavior in public persuasion to the green lobby, compared to the producer lobby. Certainly, as the proportion of environmentalists become more important, it becomes more active in both direct and indirect lobbying, while the opposite holds for the producer lobby. This consequently leads to a more stringent pollution tax. Conversely, an increase in the representativeness of the producer lobby does not necessarily lead to a less stringent environmental policy. Actually, this makes the green lobby more active in both direct and indirect lobbying, whereas it increases the direct and indirect political efforts of the industrialists only if the general public has a lower initial belief regarding environmental damage. Finally, a more benevolent government does not always set a more stringent environmental policy. In fact, the government is handling two market failures that pull in opposite directions: overproduction due to pollution and underproduction due to monopoly pricing. Consequently, a more benevolent regulator will set a more stringent environmental policy only if the general public is initially less concerned regarding environmental damage.

In future work, verifying whether the same results hold when we relax the assumptions on the market structure while considering a micro-founded model would be interesting. One also might find it interesting to explore the impact of public persuasion on the outcome of an open economy with trade relations between countries.

Appendix

A.1 Proof of Lemma 2

Using (1.13) and (1.14), we have

$$2b\mu_p \left[d'(x(t^I)) - d'(x(t^*)) \right] = 2\alpha_E d'(x(t^*)) + (t^I - t^*)(b - 2\alpha_I). \quad (\text{A1})$$

If $t^I \geq t^*$, then the Right-Hand-Term of (A1) is positive because $b - 2\alpha_I \geq 0$, but then the Left-Hand-Term is negative since $d'(x(t^I)) \leq d'(x(t^*))$. Then (A1) can be satisfied only for $t^I \leq t^*$.

Similarly, using (1.13) and (1.15), we have

$$2(\alpha_E + b\mu_p) \left[d'(x(t^E)) - d'(x(t^*)) \right] = -2\alpha_I(1 - t^*) + b(t^E - t^*). \quad (\text{A2})$$

If $t^E \leq t^*$, then the Right-Hand-Term of (A2) is negative, but then the Left-Hand-Term is positive since $d'(x(t^E)) \geq d'(x(t^*))$. Then, (A2) can be satisfied only for $t^E \geq t^*$.

A.2 Proof of Lemma 3

From (1.20), the second derivative of $L^E(m_E, m_I)$ with respect to m_E is

$$L_{11}^E = b\mu_{11} \left[d(x(t^I)) - d(x(t^*)) \right] + \frac{b}{2}(\mu_1)^2 \left[d'(x(t^*)) \frac{\partial t^*}{\partial \mu_p} - d'(x(t^I)) \frac{\partial t^I}{\partial \mu_p} \right] - c_E''(m_E). \quad (\text{A3})$$

From (13) and (14) and using the implicit function theorem, we have

$$\frac{\partial t^*}{\partial \mu_p} = \frac{2bd'(x(t^*))}{b - 2\alpha_I + (\alpha_E + b\mu_p)d''(x(t^*))}, \quad (\text{A4})$$

and

$$\frac{\partial t^I}{\partial \mu_p} = \frac{2bd'(x(t^I))}{b - 2\alpha_I + b\mu_p d''(x(t^I))}, \quad (\text{A5})$$

which are both positive.

We have $d'(x(t^*)) \leq d'(x(t^I))$ because $t^* > t^I$, $x'(t) < 0$, and $d''(\cdot) \geq 0$. The numerator of $\partial t^*/\partial \mu_p$ is thus lower than that of $\partial t^I/\partial \mu_p$. If $d'''(\cdot) \leq 0$, the denominator of $\partial t^*/\partial \mu_p$ is also larger than that of $\partial t^I/\partial \mu_p$. As a result $\partial t^*/\partial \mu_p \leq \partial t^I/\partial \mu_p$ and thus the second term of (A3) is negative. The first term is also negative since $\mu_{11} \leq 0$ because $d(x(t^I)) > d(x(t^*))$. It follows that $L_{11}^E(m_E, m_I)$ is always negative.

From (1.21), the second derivative of $L^I(m_E, m_I)$ with respect to m_I is

$$L_{22}^I(m_E, m_I) = b\mu_{22} [d(x(t^E)) - d(x(t^*))] + \frac{b}{2}(\mu_2)^2 \left[d'(x(t^*)) \frac{\partial t^*}{\partial \mu_p} - d'(x(t^E)) \frac{\partial t^E}{\partial \mu_p} \right] - c_I''(m_I). \quad (\text{A6})$$

Using (1.15), we have

$$\frac{\partial t^E}{\partial \mu_p} = \frac{2bd'(x(t^E))}{b + (\alpha_E + b\mu_p)d''(x(t^E))}. \quad (\text{A7})$$

We have $d'(x(t^*)) \geq d'(x(t^E))$ because $t^* < t^E$, $x'(t) < 0$ and $d''(\cdot) \geq 0$. The numerator of $\partial t^*/\partial \mu_p$ is thus larger than that of $\partial t^E/\partial \mu_p$. If $d'''(\cdot) \leq 0$, the denominator of $\partial t^*/\partial \mu_p$ is also *strictly* lower than that of $\partial t^E/\partial \mu_p$. As a result $\partial t^*/\partial \mu_p > \partial t^E/\partial \mu_p$ and the second term of (A6) is strictly positive. The first term of (A5) is negative because $\mu_{22} \geq 0$ and $d(x(t^E)) < d(x(t^*))$. It follows that $L_{22}^I \leq 0$ if either the cost function is sufficiently convex i.e. $c_I''(\cdot) \gg 0$ or if $\mu_{22} \gg 0$.

A.3 Proof of Lemma 4

We now determine the strategic interactions in indirect lobbying. Using (20), the cross derivative of $L^E(m_E, m_I)$ with respect to m_E and m_I is given by

$$L_{12}^E(m_E, m_I) = b\mu_{12}[d(x(t^I)) - d(x(t^*))] + \frac{b}{2}\mu_1\mu_2 \left[d'(x(t^*)) \frac{\partial t^*}{\partial \mu_p} - d'(x(t^I)) \frac{\partial t^I}{\partial \mu_p} \right]. \quad (\text{A8})$$

Again, $d'(x(t^*)) \leq d'(x(t^I))$, and if $d'''(\cdot) \leq 0$, we also have $\partial t^*/\partial \mu_p \leq \partial t^I/\partial \mu_p$. Therefore, the second term in the RHS of (A8) is positive since $\mu_1\mu_2 < 0$. If in addition $\mu_{12} \geq 0$, we have that $L_{12}^E(m_E, m_I) \geq 0$, while its sign is ambiguous for $\mu_{12} < 0$.

Similarly, using (21), the cross derivative of $L^I(m_E, m_I)$ with respect to m_I and m_E is given by

$$L_{21}^I(m_E, m_I) = b\mu_{12}[d(t^E) - d(t^*)] + \frac{b}{2}\mu_1\mu_2 \left[d'(x(t^*))\frac{\partial t^*}{\partial \mu_p} - d'(x(t^E))\frac{\partial t^E}{\partial \mu_p} \right]. \quad (\text{A9})$$

Again, $d'(x(t^*)) \geq d'(x(t^E))$, and if $d'''(\cdot) \leq 0$, we also have $\partial t^*/\partial \mu_p > \partial t^E/\partial \mu_p$. Therefore, the second term in the RHS of (A9) is *strictly* negative since $\mu_1\mu_2 < 0$. If in addition $\mu_{12} \geq 0$, we have that $L_{21}^I(m_E, m_I) < 0$, while its sign is ambiguous for $\mu_{12} < 0$.

A.4 Proof of Proposition 1

With linear damage and cost functions, (m_E^*, m_I^*) must solve

$$L_1^E = \mu_1(m_E^*, m_I^*)\frac{b}{2}[t^*(m_E^*, m_I^*) - t^I(m_E^*, m_I^*)] - 1 = 0, \quad (\text{A10})$$

and

$$L_2^I = -\mu_2(m_E^*, m_I^*)\frac{b}{2}[t^E(m_E^*, m_I^*) - t^*(m_E^*, m_I^*)] - 1 = 0. \quad (\text{A11})$$

Using $\mu_p(\mu_0, m_E, m_I) = \mu_0 + \sqrt{m_E} - \sqrt{m_I}$, (A10) and (A11) can be rewritten as

$$L_1^E = \frac{b\alpha_E}{2(b - 2\alpha_I)\sqrt{m_E^*}} - 1 = 0, \quad (\text{A12})$$

and

$$L_2^I = \frac{\alpha_I[b(1 - \mu_0 - \sqrt{m_E^*} + \sqrt{m_I^*}) - \alpha_E]}{(b - 2\alpha_I)\sqrt{m_I^*}} - 1 = 0. \quad (\text{A13})$$

Solving this system, we obtain the equilibrium levels of public communication, in the sub-game for indirect political influence, (m_E^*, m_I^*) given by (27) and (28).

The second derivative of L^E with respect to m_E is clearly strictly negative. Let verify under which condition the second derivative of $L^I(m_E, m_I)$ with respect to m_I is also strictly

negative at the equilibrium (m_E^*, m_I^*) . One must have

$$L_{22}^I = -\frac{\alpha_I [b(1 - \mu_0 - \sqrt{m_E^*}) - \alpha_E]}{2m_I^{*3/2}(b - 2\alpha_I)} < 0, \quad (\text{A14})$$

which is verified for $b(1 - \mu_0 - \sqrt{m_E^*}) - \alpha_E > 0$ or

$$\frac{b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E}{2(b - 2\alpha_I)} > 0. \quad (\text{A15})$$

We have that the numerator of (A15) is positive if

$$\mu_0 < \frac{b^2(2 - \alpha_E) - 2b(\alpha_E + 2\alpha_I) + 4\alpha_I\alpha_E}{2b(b - 2\alpha_I)} \equiv \bar{\mu}. \quad (\text{A16})$$

One must verify that $\bar{\mu}$ is positive. The numerator of $\bar{\mu}$ is quadratic and convex in b , so that $\bar{\mu} > 0$ if

$$b > \frac{\alpha_E + 2\alpha_I + \sqrt{\alpha_E^2 - 4(1 - \alpha_E)\alpha_E\alpha_I + 4\alpha_I^2}}{2 - \alpha_E} \equiv \bar{b}. \quad (\text{A17})$$

Clearly, \bar{b} is increasing in α_E and in α_I and reaches a maximum in $\alpha_E = \alpha_I = 0.5$, in which case we have $1 + 1/\sqrt{3} < 2$. Therefore, $\bar{\mu}$ is always strictly positive for any $b \geq 2$.

We also need to verify that the equilibrium perception of the environmental damage $\mu_p(\mu_0, m_E^*, m_I^*)$ given by (1.29) is (strictly) positive. The denominator of (1.29) is positive if $b \geq 2\alpha_I/(1 - \alpha_I)$. The right-hand-term of this inequality is increasing in α_I and thus reaches a maximum at $\alpha_I = 0.5$, in which case it is equal to 2. Therefore, the inequality $b \geq 2\alpha_I/(1 - \alpha_I)$ is always verified for $b \geq 2$. The numerator is also positive if

$$\mu_0 > \frac{b(2\alpha_I - \alpha_E) - 2\alpha_I\alpha_E}{2(b - 2\alpha_I)} \equiv \underline{\mu}. \quad (\text{A18})$$

We now also verify that $\mu_p(m_E^*, m_I^*) \leq 1$ for any $\mu_0 \leq \bar{\mu}$. The inequality $\mu_p(m_E^*, m_I^*) \leq 1$ reduces to

$$\mu_0 < \frac{b(2 - \alpha_E) - 2\alpha_I(2 + \alpha_E)}{2(b - 2\alpha_I)} \equiv \hat{\mu}. \quad (\text{A19})$$

Comparing the threshold values in (A16) and (A19), we obtain

$$\hat{\mu} - \bar{\mu} \equiv \frac{\alpha_E [b(1 - \alpha_I) - 2\alpha_I]}{2(b - 2\alpha_I)}, \quad (\text{A20})$$

which is positive if $b \geq 2\alpha_I/(1 - \alpha_I)$. Again, this inequality is verified for any $\alpha_I \leq 0.5$ and $b \geq 2$. Therefore, the relevant upper bound for μ_0 is $\bar{\mu}$.

Finally, we must verify that the admissible interval for μ_0 is non-empty. We have

$$\bar{\mu} - \underline{\mu} \equiv \frac{(b - \alpha_E) [b(1 - \alpha_I) - 2\alpha_I]}{b(b - 2\alpha_I)}, \quad (\text{A21})$$

which is positive.

Finally, the equilibrium political contributions C_E^* and C_I^* are given by

$$C_E^* = \frac{\alpha_E^2}{2(b - 2\alpha_I)}, \quad (\text{A22})$$

and (with the use of (1.29))

$$C_I^* = \frac{\alpha_I^2 [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E]^2}{2b(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2}. \quad (\text{A23})$$

Finally, using (22) and (29), the equilibrium tax rate is given by

$$t^* = \frac{-b^2 [1 - \alpha_E + \alpha_I - 2\mu_0] + 2b [\alpha_E + \alpha_I(\alpha_I - 2\mu_0)] - 4\alpha_I(\alpha_E - \alpha_I)}{(b - 2\alpha_I) [b(1 - \alpha_I) - 2\alpha_I]}. \quad (\text{A24})$$

The denominator is positive so that the sign of t^* is the same as the sign of its numerator which can be negative or positive. We also have

$$1 - t^* = \frac{b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E}{(b - 2\alpha_I) [b(1 - \alpha_I) - 2\alpha_I]}. \quad (\text{A25})$$

Observe that the numerator of (A25) is the same than the numerator of (A15). Hence, under the condition that $L^I(m_E, m_I)$ is locally concave with respect to m_I , we have $1 - t^* > 0$. One can also observe that C_I^* given by (A23) can be rewritten as $C_I^* = \alpha_I^2 [1 - t^*]^2 / 2b$.

A.5 Proof of Proposition 2

Clearly m_E^* and C_E^* are both increasing in α_E . We also have

$$\begin{aligned}\frac{\partial m_I^*}{\partial \alpha_E} &= -\frac{\alpha_I^2 [b(b+2) - 4\alpha_I] [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I \alpha_E]}{2(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2} \\ &= -\frac{\alpha_I^2 [b(b+2) - 4\alpha_I] [1 - t^*]}{2(b - 2\alpha_I) [b(1 - \alpha_I) - 2\alpha_I]},\end{aligned}\tag{A26}$$

and

$$\begin{aligned}\frac{\partial C_I^*}{\partial \alpha_E} &= -\frac{\alpha_I^2 [b(b+2) - 4\alpha_I] [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I \alpha_E]}{b(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2} \\ &= -\frac{\alpha_I^2 [b(b+2) - 4\alpha_I] [1 - t^*]}{b(b - 2\alpha_I) [b(1 - \alpha_I) - 2\alpha_I]},\end{aligned}\tag{A27}$$

which are both negative.

Finally, we have

$$\frac{\partial t^*}{\partial \alpha_E} = \frac{b(b+2) - 4\alpha_I}{(b - 2\alpha_I) [b(1 - \alpha_I) - 2\alpha_I]},\tag{A28}$$

which is positive.

A.6 Proof of Proposition 3

Clearly m_E^* and C_E^* are both increasing in α_I . We also have

$$\begin{aligned}\frac{\partial m_I^*}{\partial \alpha_I} &= \frac{b\alpha_I [\Omega(b, \mu_0, \alpha_E, \alpha_I)] [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I \alpha_E]}{2(b - 2\alpha_I)^3 [b(1 - \alpha_I) - 2\alpha_I]^3} \\ &= \frac{b\alpha_I [\Omega(b, \mu_0, \alpha_E, \alpha_I)] [1 - t^*]}{2(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2},\end{aligned}\tag{A29}$$

and

$$\begin{aligned}\frac{\partial C_I^*}{\partial \alpha_I} &= \frac{\alpha_I [\Omega(b, \mu_0, \alpha_E, \alpha_I)] [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E]}{(b - 2\alpha_I)^3 [b(1 - \alpha_I) - 2\alpha_I]^3} \\ &= \frac{\alpha_I [\Omega(b, \mu_0, \alpha_E, \alpha_I)] [1 - t^*]}{(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2},\end{aligned}\quad (\text{A30})$$

where

$$\begin{aligned}\Omega(b, \mu_0, \alpha_E, \alpha_I) &= b^3 [2(1 - \mu_0) - \alpha_E] - 2b^2 [\alpha_E(1 - \alpha_I^2) + 4\alpha_I(1 - \mu_0)] \\ &\quad + 4b\alpha_I [\alpha_E(2 + \alpha_I) + 2\alpha_I(1 - \mu_0)] - 8\alpha_E\alpha_I^2.\end{aligned}\quad (\text{A31})$$

Therefore, the signs of both $\partial m_I^*/\partial \alpha_I$ and $\partial C_I^*/\partial \alpha_I$ are of the same sign of $\Omega(\cdot)$. We have that $\partial \Omega(\cdot)/\partial \mu_0 = -2b(b - 2\alpha_I)^2 < 0$. Thus, $\Omega(\cdot)$ is decreasing in μ_0 , and is equal to 0 at

$$\mu_0 = \frac{b^3(2 - \alpha_E) - 2b^2[\alpha_E(1 - \alpha_I^2) + 4\alpha_I] + 4b\alpha_I[\alpha_E(2 + \alpha_I) + 2\alpha_I] - 8\alpha_E\alpha_I^2}{2b(b - 2\alpha_I)^2} \equiv \bar{\mu}_1. \quad (\text{A32})$$

We have

$$\bar{\mu} - \bar{\mu}_1 \equiv \frac{\alpha_I\alpha_E [b(1 - \alpha_I) - 2\alpha_I]}{(b - 2\alpha_I)^2} > 0, \quad (\text{A33})$$

which is positive for $\alpha_I \leq 0.5$ and $b \geq 2$.

We also have

$$\bar{\mu}_1 - \underline{\mu} \equiv \frac{[b(1 - \alpha_I) - 2\alpha_I] [b(b - \alpha_E - 2\alpha_I - \alpha_E\alpha_I) + 2\alpha_E\alpha_I]}{(b - 2\alpha_I)^2} > 0, \quad (\text{A34})$$

which is positive for $\alpha_I \leq 0.5$, $\alpha_E \leq 0.5$, and $b \geq 2$. Consequently, $\Omega(\cdot)$, $\partial m_I^*/\partial \alpha_I$, and $\partial C_I^*/\partial \alpha_I$ are positive for $\mu_0 \in (\underline{\mu}, \bar{\mu}_1]$, and negative for $\mu_0 \in [\bar{\mu}_1, \bar{\mu})$.

Finally, we have

$$\begin{aligned}
& -b^4 [2(1 - \mu_0) - \alpha_E] + 2b^3 [\alpha_E(3 - 2\alpha_I) - 4(1 - 2\alpha_I)(1 - \mu_0)] \\
& \quad + 4b^2 [\alpha_E(1 - 4\alpha_I) + 2\alpha_I(2 - \alpha_I)(1 - \mu_0)] \\
\frac{\partial t^*}{\partial \alpha_I} = & \frac{-8b\alpha_I [\alpha_E(2 - \alpha_I) + 2\alpha_I(1 - \mu_0)] + 16\alpha_E\alpha_I^2}{(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2}. \tag{A35}
\end{aligned}$$

The derivative of the numerator of (A35) with respect to μ_0 is equal to $2b(b+2)(b-2\alpha_I)^2 > 0$. Therefore, the numerator of $\partial t^*/\partial \alpha_I$ is increasing in μ_0 , and is equal to 0 at

$$\begin{aligned}
& b^4(2 - \alpha_E) + 2b^3 [2(1 - 2\alpha_I) - \alpha_E(3 - 2\alpha_I)] \\
& \quad - 4b^2 [\alpha_E(1 - 4\alpha_I) + 2\alpha_I(2 - \alpha_I)] \\
\mu_0 = & \frac{+8b\alpha_I [\alpha_E(2 - \alpha_I) + 2\alpha_I] - 16\alpha_E\alpha_I^2}{2b(b+2)(b-2\alpha_I)^2} \equiv \bar{\mu}_2. \tag{A36}
\end{aligned}$$

We have

$$\bar{\mu} - \bar{\mu}_2 \equiv \frac{b\alpha_E [b(1 - \alpha_I) - 2\alpha_I]}{(b+2)(b-2\alpha_I)^2} > 0, \tag{A37}$$

and

$$\bar{\mu}_2 - \underline{\mu} \equiv \frac{[b(1 - \alpha_I) - 2\alpha_I] [b^3 + 2b^2(1 - \alpha_E - \alpha_I) - 2b(\alpha_E(1 - \alpha_I) + 2\alpha_I) + 4\alpha_E\alpha_I]}{b(b+2)(b-2\alpha_I)^2} > 0, \tag{A38}$$

Consequently, $\partial t^*/\partial \alpha_I$ is negative for $\mu_0 \in (\underline{\mu}, \bar{\mu}_2]$, and positive for $\mu_0 \in [\bar{\mu}_2, \bar{\mu})$.

A.7 Proof of Proposition 4

Clearly m_E^* and C_E^* are both decreasing in b . We also have

$$\begin{aligned}
\frac{\partial m_I^*}{\partial b} &= \frac{\alpha_I^2 [\Psi(b, \mu_0, \alpha_E, \alpha_I)] [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E]}{(b - 2\alpha_I)^3 [b(1 - \alpha_I) - 2\alpha_I]^3} \\
&= \frac{\alpha_I^2 [\Psi(b, \mu_0, \alpha_E, \alpha_I)] [1 - t^*]}{(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2}, \tag{A39}
\end{aligned}$$

where

$$\begin{aligned}\Psi(b, \mu_0, \alpha_E, \alpha_I) &= b^2 [\alpha_E(1 + \alpha_I - \alpha_I^2) - 2\alpha_I(1 - \mu_0)] - 4b\alpha_I[\alpha_E - 2\alpha_I(1 - \mu_0)] \\ &\quad + 4\alpha_I^2[\alpha_E(1 - \alpha_I) - 2\alpha_I(1 - \mu_0)].\end{aligned}\tag{A40}$$

We have $\partial\Psi(\cdot)/\partial\mu_0 = 2\alpha_I(b - 2\alpha_I)^2 > 0$. Therefore, $\Psi(\cdot)$ is increasing in μ_0 and is equal to 0 at

$$\mu_0 = \frac{-b^2 [\alpha_E(1 + \alpha_I - \alpha_I^2) - 2\alpha_I] + 4b\alpha_I[\alpha_E - 2\alpha_I] - 4\alpha_I^2[\alpha_E(1 - \alpha_I) - 2\alpha_I]}{2\alpha_I(b - 2\alpha_I)^2} \equiv \bar{\mu}_3\tag{A41}$$

We have

$$\bar{\mu} - \bar{\mu}_3 \equiv \frac{\alpha_E [b(1 - \alpha_I) - 2\alpha_I] [b^2(1 + \alpha_I) - 4b\alpha_I + 4\alpha_I^2]}{2b\alpha_I(b - 2\alpha_I)^2}.\tag{A42}$$

The sign of $(\bar{\mu} - \bar{\mu}_3)$ is the same as the sign of the second term in $[\cdot]$ in the numerator. A sufficient condition for this term to be positive is that $b(1 + \alpha_I) \geq 4\alpha_I$, which is verified for any $\alpha_I \leq 0.5$ and $b \geq 2$. Consequently, we have $\bar{\mu} - \bar{\mu}_3 > 0$.

We also have

$$\bar{\mu}_3 - \underline{\mu} \equiv \frac{[b(1 - \alpha_I) - 2\alpha_I] [(2 - b)(\alpha_E - 2\alpha_I) - b\alpha_E\alpha_I]}{2\alpha_I(b - 2\alpha_I)^2}.\tag{A43}$$

The sign of $(\bar{\mu}_3 - \underline{\mu})$ is the same as the sign of the second term in $[\cdot]$ in the numerator of (A43), which can be positive as well as negative depending on (b, α_E, α_I) . This term is decreasing in α_E and is equal to 0 at

$$\alpha_E = \frac{2(b - 2\alpha_I)\alpha_I}{b(1 + \alpha_I) - 2\alpha_I} \equiv \bar{\alpha}_E.\tag{A44}$$

First, one can easily verify that $\bar{\alpha}_E \geq \alpha_I$, this inequality reducing to $b(1 - \alpha_I) - 2\alpha_I \geq 0$. Second, we must determine under which condition $\bar{\alpha}_E \leq 1/2$. This inequality reduces to $b - 3b\alpha_I - 2\alpha_I + 8\alpha_I^2 \geq 0$, which is verified (on the interval $[0, 1/2]$) only for $\alpha_I \leq (1/16)[2 + 3b - \sqrt{(b - 2)(9b - 2)}] \equiv \bar{\alpha}_I$. One can observe that $\bar{\alpha}_I$ is decreasing in b and

converges to $1/3$ as b goes to infinity. Therefore, if $\alpha_I \leq \bar{\alpha}_I$ – with $\bar{\alpha}_I > 1/3$ – there exists $\bar{\alpha}_E \in [\alpha_I, 1/2]$, given by (A44), such that $\mu_3 - \underline{\mu} = 0$. Thus, if $\alpha_I \leq \bar{\alpha}_I$, the second term in [.] in the numerator of (A43) is negative for any $\alpha_E \geq \bar{\alpha}_E$, and hence $\bar{\mu}_3 \leq \underline{\mu}$. This implies that $\Psi(\cdot)$ and $\partial m_I^*/\partial b$ are positive for any $\mu_0 \geq \underline{\mu}$. If however, $\alpha_I \geq \bar{\alpha}_I$ or $\alpha_E \leq \bar{\alpha}_E$, then $\bar{\mu}_3 \geq \underline{\mu}$. In this case, $\Psi(\cdot)$ and $\partial m_I^*/\partial b$ are negative for $\mu_0 \in (\underline{\mu}, \bar{\mu}_3]$, and positive for $\mu_0 \in [\bar{\mu}_3, \bar{\mu})$.

Calculating the derivative of C_I^* with respect to b , we obtain

$$\begin{aligned} \frac{\partial C_I^*}{\partial b} &= \frac{\alpha_I^2 [\Phi(b, \mu_0, \alpha_E, \alpha_I)] [b^2 [2(1 - \mu_0) - \alpha_E] - 2b [\alpha_E + 2\alpha_I(1 - \mu_0)] + 4\alpha_I\alpha_E]}{2b^2(b - 2\alpha_I)^3 [b(1 - \alpha_I) - 2\alpha_I]^3} \\ &= \frac{\alpha_I^2 [\Phi(b, \mu_0, \alpha_E, \alpha_I)] [1 - t^*]}{2b^2(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2}, \end{aligned} \quad (\text{A45})$$

where

$$\begin{aligned} \Phi(b, \mu_0, \alpha_E, \alpha_I) &= -b^4(1 - \alpha_I) [2(1 - \mu_0) - \alpha_E] + 2b^3 [2\alpha_I(1 - 2\alpha_I)(1 - \mu_0) + \alpha_E(3 - \alpha_I - \alpha_I^2)] \\ &\quad - 4b^2\alpha_I [\alpha_E(7 - 3\alpha_I) - 2\alpha_I(1 + \alpha_I)(1 - \mu_0)] \\ &\quad + 8b\alpha_I^2 [\alpha_E(5 - 3\alpha_I) - 2\alpha_I(1 - \mu_0)] - 16\alpha_E\alpha_I^3. \end{aligned} \quad (\text{A46})$$

We have that $\partial\Phi(\cdot)/\partial\mu_0 = 2b(b - 2\alpha_I)^2 [b(1 - \alpha_I) + 2\alpha_I] > 0$. Thus, $\Phi(\cdot)$ is increasing in μ_0 and is equal to 0 at

$$\begin{aligned} \mu_0 &= \frac{b^4(2 - \alpha_E)(1 - \alpha_I) - 2b^3[2\alpha_I(1 - 2\alpha_I) + \alpha_E(3 - \alpha_I - \alpha_I^2)]}{2b(b - 2\alpha_I)^2 [b(1 - \alpha_I) + 2\alpha_I]} + \frac{4b^2\alpha_I[\alpha_E(7 - 3\alpha_I) - 2\alpha_I(1 + \alpha_I)] - 8b\alpha_I^2[\alpha_E(5 - 3\alpha_I) - 2\alpha_I] + 16\alpha_E\alpha_I^3}{2b(b - 2\alpha_I)^2 [b(1 - \alpha_I) + 2\alpha_I]} \equiv \bar{\mu}_4 \end{aligned} \quad (\text{A47})$$

We have

$$\bar{\mu} - \bar{\mu}_4 = \frac{2\alpha_E [b(1 - \alpha_I) - 2\alpha_I] [b^2(1 + \alpha_I) - 4b\alpha_I + 4\alpha_I^2]}{b(b - 2\alpha_I)^2 [b(1 - \alpha_I) + 2\alpha_I]}. \quad (\text{A48})$$

The sign of $(\bar{\mu} - \bar{\mu}_4)$ is the same as the sign of the second term in [.] in the numerator, which is the same than the term determining the sign of $(\bar{\mu} - \bar{\mu}_3)$, given by (A42). Therefore, we can conclude that $\bar{\mu} - \bar{\mu}_4 > 0$.

We also have

$$\bar{\mu}_4 - \underline{\mu} = \frac{[b(1 - \alpha_I) - 2\alpha_I] \Delta(b, \mu_0, \alpha_E, \alpha_I)}{b(b - 2\alpha_I)^2 [b(1 - \alpha_I) + 2\alpha_I]}, \quad (\text{A49})$$

where

$$\Delta(b, \mu_0, \alpha_E, \alpha_I) = b^3(1 - \alpha_I) - b^2 [\alpha_E(3 + \alpha_I) - 2\alpha_I^2] + 2b\alpha_I [\alpha_E(4 - \alpha_I) - 2\alpha_I] - 4\alpha_E\alpha_I^2. \quad (\text{A50})$$

The sign of $(\bar{\mu}_4 - \underline{\mu})$ is the same as the sign of $\Delta(b, \mu_0, \alpha_E, \alpha_I)$. The derivative of this expression with respect to α_E is given by $-b^2(3 + \alpha_I) + 2b\alpha_I(4 - \alpha_I) - 4\alpha_I^2$, which is negative for any $b \geq 2$ and $\alpha_I \leq 1/2$. Thus, $\Delta(\cdot)$ is decreasing in α_E and is equal to 0 at

$$\alpha_E = \frac{b^3(1 - \alpha_I) - 2b(b - 2)\alpha_I^2}{b^2(3 + \alpha_I) - 2b\alpha_I(4 - \alpha_I) + 4\alpha_I^2} \equiv \tilde{\alpha}_E. \quad (\text{A51})$$

Calculating $\tilde{\alpha}_E - 1/2$, we obtain

$$\tilde{\alpha}_E - \frac{1}{2} = \frac{b(1 - \alpha_I) [2b - (3 + 4\alpha_I)] + 2b\alpha_I(4 - 5\alpha_I) - 4\alpha_I^2}{2 [b^2(3 + \alpha_I) - 2b\alpha_I(4 - \alpha_I) + 4\alpha_I^2]}, \quad (\text{A52})$$

Clearly, the denominator is positive. The derivative of the numerator with respect to α_I is given by $-b(2b^2 + b - 8) + 4\alpha_I(2b^2 - 5b - 2)$, which is negative because $4\alpha_I \leq b$ and $(2b^2 + b - 8) > (2b^2 - 5b - 2)$. Therefore, the numerator of (A52) reaches a minimum in $\alpha_I = 1/2$, in which case it is equal to $(1/2)(b - 2)(2b^2 - b + 1) > 0$. Consequently, we have $\tilde{\alpha}_E \geq 1/2$ for any $\alpha_I \leq 1/2$. It follows that for any $\alpha_E \leq 1/2$, $\Delta(\cdot)$ is positive implying that $\bar{\mu}_4 - \underline{\mu} \geq 0$. In conclusion, $\Phi(\cdot)$ and $\partial C_I^*/\partial b$ are negative for $\mu_0 \in (\underline{\mu}, \bar{\mu}_4]$, and positive for $\mu_0 \in [\bar{\mu}_4, \bar{\mu})$.

Finally, the derivative of t^* with respect to b is given by

$$\frac{\partial t^*}{\partial b} = \frac{-2\Psi(b, \mu_0, \alpha_E, \alpha_I)}{(b - 2\alpha_I)^2 [b(1 - \alpha_I) - 2\alpha_I]^2}, \quad (\text{A53})$$

where $\Psi(b, \mu_0, \alpha_E, \alpha_I)$ also determines the sign of $\partial m_I^*/\partial b$ and is equal to 0 at $\bar{\mu}_3$. Therefore, if $\alpha_I \leq \bar{\alpha}_I$ - with $\bar{\alpha}_I > 1/3$ - there exists $\bar{\alpha}_E \in [\alpha_I, 1/2]$ such that $\bar{\mu}_3 - \underline{\mu} = 0$. Thus, if

$\alpha_I \leq \bar{\alpha}_I$, the second term in [.] in the numerator of (A43) is negative for any $\alpha_E \geq \bar{\alpha}_E$, and hence $\bar{\mu}_3 \leq \underline{\mu}$. This implies that $\Psi(\cdot)$ is positive and $\partial t^*/\partial b$ is negative for any $\mu_0 \geq \underline{\mu}$. If however, $\alpha_I \geq \bar{\alpha}_I$ or $\alpha_E \leq \bar{\alpha}_E$, then $\bar{\mu}_3 \geq \underline{\mu}$. In this case, $\Psi(\cdot)$ is negative and $\partial t^*/\partial b$ is positive for $\mu_0 \in (\underline{\mu}, \bar{\mu}_3]$, while $\Psi(\cdot)$ is positive and $\partial t^*/\partial b$ is negative for $\mu_0 \in [\bar{\mu}_3, \bar{\mu})$.

Chapter 2

Public and Private Politics: Green NGOs Fundraising Strategies under Political Lobbying Competition

Abstract:

This paper attempts to establish a link between public and private politics in the sphere of environmental regulation. We develop a three stages game where two special interests groups (SIGs): a green NGO and a polluting firm compete on two levels. In the first stage, they compete over the salience of the pollution which generates donations to the NGO. In the second stage, they compete over the political influence regarding the environmental policy. In the third stage, the government set the environmental policy. Our first result shows that the intensity of the lobbying competition depends on the curvatures of the damage and benefit functions from the polluting emissions. Next, we give the firm the possibility of using both, real abatement and greenwashing as blocking fundraising strategies. We then show that when the firm uses only greenwashing, an increase in its effectiveness exacerbates the competition between the two SIGs. However, when abatement is used as well, the NGO does not necessarily become more aggressive in campaigning. Finally, we show that a more effective NGO in campaigning always collects more funds resulting in a more stringent environmental policy, whilst a more effective firm in blocking fundraising manage to reduce the stringency of the environmental policy only if it uses abatement.

Keywords: public politics, private politics, contests, fundraising, greenwashing, lobbies, salience.

Résumé :

Cet article tente d'établir un lien entre les politiques publiques et privées dans le domaine de la réglementation environnementale. Nous développons un jeu en trois étapes où deux groupes d'intérêts spéciaux (GISs) : une ONG verte et une firme polluante sont en compétition sur deux niveaux. Dans la première phase, ils sont en concurrence sur la salience de la pollution qui génère des dons à l'ONG. Dans un deuxième temps, ils se concurrencent sur l'influence politique concernant la politique environnementale. Dans la troisième étape du jeu, le gouvernement décide de la politique environnementale. Notre premier résultat

montre que l'intensité de la compétition de lobbying dépend des courbures des fonctions de dommage et de bénéfice liées aux émissions polluantes. Ensuite, nous donnons à l'entreprise la possibilité d'utiliser à la fois de l'abattement et du greenwashing comme stratégies de blocage de la collecte de fonds. Nous montrons ensuite que lorsque l'entreprise n'utilise que le greenwashing, une augmentation de son efficacité exacerbe la concurrence entre les deux SIG. Cependant, lorsque l'abattement est également utilisé, l'ONG ne devient pas nécessairement plus agressive dans sa campagne. Enfin, nous montrons qu'une ONG plus efficace dans sa campagne collecte toujours plus de fonds, ce qui se traduit par une politique environnementale plus stricte, tandis qu'une entreprise plus efficace dans le blocage de la collecte de fonds ne parvient à réduire la sévérité de la politique environnementale que si elle utilise de l'abattement.

Mots-clés : politique publique, politique privée, contests, collecte de fonds, greenwashing, lobbies, salience.

2.1 Introduction

Environmental NGOs have become major actors in the political decision around environmental and climate issues. They operate mainly on three levels: raising the general public environmental awareness, acting on nature and wildlife conservation and finally accompanying and influencing the policy making process. Nurse (2013) suggested that environmental NGOs could be categorized into three different types depending on their main area of action: campaigning NGOs, law enforcement NGOs and finally political lobbying NGOs. These NGOs could take action in all the three types of activities but they usually put the emphasis on one or two of them. Regardless of the nature of their actions, NGOs' strategies are crucially dependent on their financial resources, given the fact that they are not necessarily engaged in any monetary profit generating activities. In fact, the majority of their finances come from donations, hence the incentive to engage in fundraising strategies. According to the *Charity Navigator* website, fundraising expenses of most green NGOs range from 10 to 20% of their total expenditures, which reflects the huge importance of fundraising in NGOs' activities.

The funds collected by these NGOs are hence utilized in conducting wildlife conservation projects, raising environmental awareness or competing against the interests of polluting industries by influencing the policy-making process. Our framework concerns particularly NGOs that engage in lobbying activities. These NGOs have two main channels to do so. First, they can directly face polluting firms and force them to take effective actions against pollution. This channel is described in the literature by *private politics* (Baron, 2003). Second, they can make these industries internalize their polluting activities indirectly by influencing a third party. This third party could either be "legislators" through engaging in lobbying activities to which we refer in the literature by *public politics* and/or *direct lobbying*, or the "general public" by raising its environmental awareness which falls under *the public persuasion* literature, and more particularly under *indirect lobbying* literature when it influences indirectly the legislator's policy decision (Yu, 2005; Cheikbossian and Hafidi, 2022).

In this paper, we study the competition between two special interests groups (SIGs): an environmental NGO and a polluting firm, on two different levels: the private politics and the public politics levels around an environmental issue. As mentioned earlier, we are interested in NGOs that exercise influential pressure on regulators. In fact, according to the *Opensecrets* website, environmental lobby groups in the US have spent nearly 86 million dollars in 2014 as political contributions to parties and their candidates. Moreover, nearly all the biggest international environmental NGOs are permanently based in the EU decision-making capital, Brussels. They are heavily engaged in influencing the environmental and climate related regulation. According to the European Union Transparency Register, 382 meetings were held between the EU commissioners and environmental NGOs' representatives in 2014 only.¹ Therefore, we model lobbying as a rent-seeking contest between the two SIGs, which allow us to account for the fact that lobbying efforts could take the form of direct monetary contributions or information transfer to regulators. Regardless of the nature of the lobbying activities, SIGs will always need monetary resources to finance their activities. In the case of informational lobbying, the efforts could take the form of money and time needed to conduct research and collect relevant information about the issue, as well as hiring lobbyists who will transfer these information to legislators. The NGO in our setting is supposed to compete against a polluting firm that is also engaged in lobbying. Indeed, in an analysis conducted by Brulle (2018) about climate lobbying between 2000 and 2016, it was found that climate lobbying expenditures reached 2 billion dollars (pro and anti-climate lobbies combined). According to Brulle "*climate lobbying is big business*". Yet, environmental organisations constitutes only 3% of these total lobbying expenditures. Big corporations directly influenced by climate regulation, are the most involved in climate lobbying. Along the same line, Gullberg (2008) have concluded that environmental organisations lobby less than what would be considered optimal and argues that this might largely be explained by tight budget constraints.

Moreover, one of the main reasons that motivate our work in modeling political influence

¹These three environmental NGOs: World Wild Fund (WWF), Greenpeace and Transport & Environment made it into the Top 10 of organisations with most meetings in 2014.

as a combination of private and public politics is that the process of implementing political regulation by policy makers takes time and effort, so green NGOs might look for "quicker" alternatives such as campaigning against polluting industries in a way to expose them and induce them to self-regulate or at least "clean up" their pollution. The similar reasoning applies to polluting industries that might be tempted to stall the general public and put on the "green mask" just to escape to the policy sanctions, at least on the short term. The combination of both private and public politics strategies is no secret to the general public now. We quote from Andrew Linhardt, the deputy legislative director at the Sierra Club, statement about the automobile sector “*Ford may be trying to put on a good show, but behind closed doors, it has been working with Donald Trump and Scott Pruitt to roll back our single biggest defense against dangerous climate pollution*”².

A recent example that is of particular interest to our study, as it shows the intensity of the confrontation between a green NGO and a polluting firm, is that of TotalEnergies and Greenpeace. Recently, Greenpeace and two other NGOs (Friends of the Earth and Notre Affaire) succeeded to take TotalEnergies to court for "misleading commercial practices". This is a huge victory in itself to the green activists because it is an unprecedented action in Europe. The green NGOs have been trying to expose the greenwashing actions of the corporate, especially after the large-scale green advertising campaign that the firm launched in May 2021, following its name change from Total to TotalEnergies. According the NGO's lawyer Clara Gonzales, this advertising campaign is a "smokescreen" behind which the corporate is trying to hide its pollution actions.^{3,4}

Inspired by the discussion above, we propose a model analyzing a fundraising game under a political competition context. Particularly, the model aims at studying how the NGO's need to obtain funds to finance lobbying activities, can strategically shape its actions and those of its opponent in the private politics stage. We hence consider a three stages game

²This strategy is referred to by the "hybrid strategy" in rest of the paper.

³According to Clara Gonzales, fossil fuels still account for 90% of TotalEnergies business and 80% of its investments.

⁴The NGOs are also launching a petition calling for a ban on advertising for polluting companies similar to the ban on tobacco advertising. Moreover, the website of Notre Affaire is also using the exposing campaign of the greenwashing actions of TotalEnergies to collect donations.

in which a green NGO faces a polluting firm. In the first stage, the competition lies under the private politics arena. It concerns the salience of the pollution of the firm to potential donors which is supposed to be positively correlated with the fund collected by the NGO. The intuition behind this stage of the model is that, on one hand NGOs need to expose their opponents' polluting activities to be able to attract monetary support from donors. On the other hand, the polluting firms faces the obligation to hide their pollution in order to block the fundraising process. The public politics concerns the two last stages of the game. In the second stage, the NGO and the firm decide about their political expenditures used to influence the policy maker that decides about the level of emissions in the third stage.

Our framework offers general results that provide insightful conclusions about multitude of specific cases. First, regarding the lobbying stage, we show that the intensity of the competition between the two SIGs depends on the convexity of the damage function and the concavity of the benefit function that the two SIGs face. In fact, when the degree of the convexity of the damage is lower than the degree of concavity of the benefit from the polluting emissions, the lobbying expenditures are strategic substitutes showing a less intense political lobbying competition. When the damage has a more important curvature relative to the benefit, the public politics competition is more aggressive given that the lobbying efforts become strategic complements. Second, we distinguish two different cases regarding the private politics stage. In the first case, the firm does only greenwashing or hiding to face the NGO's exposing campaigns. In the second case, the firm has an access to an abatement technology, which is used in addition to the greenwashing to block the fundraising process of the NGO. Our results show that in the private politics stage, the NGO always responds to the firm's greenwashing by more campaigning. Whilst the firm's response to the campaign of the NGO could be increasing or decreasing depending on the nature of the competition in the public politics game. As a result, the private politics competition between the two SIGs is aggressive when the public politics competition is less intense, revealing the existence of a substitutability effect between the public and the private efforts of both SIGs. Moreover, when the firm becomes more effective in greenwashing, the competition between the two SIGs is exacerbated: the NGO engages in more campaigning and the firm engages

in more greenwashing. However, when the firm adds abatement to its fundraising blocking strategy, the overall campaigning strategy of the NGO becomes softer, because abatement decreases the emissions and hence the damage associated. Nevertheless, a more effective fundraising blocking strategy, that includes both greenwashing and abatement, does not always exacerbates the private politics competition (like it did in the absence of abatement). This is due the positive effect that the abatement has on the welfare of the NGO. Finally an increase in the effectiveness of the NGO in fundraising increases the total funds collected. This in turn guarantees installing a more stringent environmental policy. Whilst a more effective firm in blocking fundraising manages to reduce the stringency of the environmental policy only if it adopts an abatement strategy. In other words, the firm will have no influence on the environmental policy if it becomes more effective in blocking fundraising unless it uses real abatement.

The rest of the paper is organized as follows, section 2.2 reviews the related literature. Section 2.3 describes the general framework. Section 2.4 details the public politics competition, whilst section 2.5 details the private politics competition. And finally, section 2.6 concludes.

2.2 Related literature

This work relates to two major literature segments: the public politics or the political lobbying literature, and the relatively recent private politics literature. The term "private politics" was first introduced by Baron (2003). It basically refers to the resolution of conflicts without the need for regulation or law, but instead through self-regulation, usually between an activist NGO and a profit oriented organisation. The core idea behind this growing literature is that the NGO uses a confrontational strategy to apply social pressure in order to change the behavior of its target. These confrontational strategies include mass media and (more recently) social media campaigns, manifestations and consumers boycotts. The socially irresponsible firm (s) will receive "a take it or leave it" harmful proposition (threat), from the activist NGO. It will hence respond to that threat by conceding to the activists requests

and self-regulating or not conceding given the assumption of being rational (e.g., Baron, 2003; Baron and Diermeier, 2007 and Baron et al., 2012). Many papers have followed this pioneering framework (e.g., Lyon and Salant, 2013 and Daubanes and Rochet, 2019). Whilst others have used different approaches to address the same question, taking for instance Abito et al. (2014) who use a time continuous framework to model the game between a firm and an activist that threatens to harm the firm's reputation. The use of a continuous framework is justified by the fact that firms' reputation is supposed to change over time.

More recently, scholars begun to get interested in the private politics under the public regulation context, since many studies have shown that there must be an interaction between these two spheres of politics. Baron (2003) have stated that "*private politics often takes place in the shadow of government*". In line with this statement, Egorov and Harstad (2017) have shown that activists actions and firms attempts to self-regulate are influenced by the political regulation context, more precisely by the presence and the absence of an active regulator. An other work that gives an empirical evidence of the existence of this interaction in the context of climate change is Reid and Toffel (2009). They show that the presence of a regulation threat rises the probability that firms respond to the activists movement. Moreover, Zheng (2020) has argued that a boycott, which is the most common tool used by activists, is not always effective, especially when its cost is very high and it is against a very strong firm that manages to survive the campaign. In this specific case the intervention of a third party, the government, can play in the favor of activists.

Polluting industries are tempted to combine private and public politics. In fact, as long as an industry or a firm have a stake in low environmental standards, it will use its power to influence environmental regulation. This is illustrated by industries extensive climate lobbying efforts observed by Brulle (2018). Green NGOs might as well be tempted to adopt a public politics strategy in order to influence the adoption or the implementation of high environmental standards (Reid and Toffel, 2009), even if their political contributions are but a fraction of those given by the industries they generally oppose. Therefore, the combination of both strategies could be an option to both SIGs. As mentioned earlier, this paper relates to the lobbying literature or public politics literature. Political lobbying is usually modeled as

a common agency model where the regulator maximizes a weighted sum of the social welfare and the political contributions (monetary contributions) from the SIGs, initially developed by Grossman and Helpman (1994), based on the menu auction framework by Bernheim and Whinston (1986). Since then, many scholars have followed their paths and used the same framework to describe the political competition around environmental regulation (e.g., Fredriksson, 1997; Aidt, 1998 and 2005; Habla and Winkler, 2013 and Marchiori et al., 2017). Others consider that the influence process takes the form of informational lobbying in which SIGs provide regulators with relevant information in order to influence their policy decision (e.g., Potters and Van Winden, 1992; Schnakenberg, 2017), or a combination of both (e.g., Bennesen and Feldmann, 2006; Dahm and Porteiro, 2008 and Cotton, 2012). Finally, political lobbying is also approached as a rent-seeking contest (Tullock, 1980) in which SIGs compete for political influence, in order to affect the decision of the policy maker (e.g., Heyes, 1997; Liston-Heyes, 2001)⁵. We depart from the common agency approach and adopt a rent-seeking contest like in Cheikbossian (2008), where we consider that the environmental NGO and the polluting firm compete against each other in order to influence the regulator decision about the environmental policy (i.e., the level of emissions allowed in the economy). This approach allow us to account for the fact that the lobbying expenditures or the rent-seeking efforts could take the form of direct monetary contributions and/or relevant information transfer to legislators, which is more common among environmental NGOs.

Lyon and Salant (2013) show in their work how private politics alters incentives in the arena of public politics, and hence how an activist can take advantage of that in shaping and designing his campaigns against polluting industries. More precisely, an activist will prefer to target individual firms to force them self-regulate, and hence these becoming green firms lobby the government for the implementation of a stringent regulation. It is in this same context of literature that our article fits. We particularly study how the NGO's need to obtain funds to finance lobbying activities, can strategically shape its actions and those of its opponent. Despite the growing evidence about the existence of a relationship between private and public politics, few are the papers that have attempted to link them in a single

⁵See Gregor, 2011 for a full review of literature on lobbying contests.

framework. Our paper proposes to fill this gap and develops a model where the private politics competition between the firm and the NGO takes the form of a fundraising game that aims on one hand to make the firm clean its pollution, and on the other hand to increase the funds collected by the NGO (Heyes et al., 2018).⁶ There are two important differences between the framework of Heyes et al. (2018) and our analysis. First, we assume that the funds collected by the NGO serve as political expenditures in the public politics stage of the game. Second, we do not explicit the occurrence of salience in our model, salience is implicitly assumed, in the sense that an increase in the funds collected by the NGO is a result of an increase in the salience of the polluting activities of the firm due to the campaigning efforts of the NGO. The following section describes the framework in details.

2.3 The model

In the present setting we attempt to establish a link between private and public politics in the sphere of environmental regulation. To do so we consider a three stages game in which the NGO activists and the polluting firm compete at two levels. Private competition is about collecting funds by the NGO to finance public competition, that in turn influence the stringency of the environmental policy set by the regulator.

In the first stage, the NGO allocates resources toward campaigns against the firm in an attempt to induce it to "clean-up" its pollution. The firm can fight and resist to the campaigns through hiding or greenwashing, or concede and invest in real abatement actions to reduce the probability of getting exposed to the general public, which will affect negatively the funds collected by the NGO.

Given the outcome of the first stage, a contest game takes place in the second stage between the two actors over the public environmental regulation. The NGO is supposed to be financially constrained, its political efforts depend on the funds collected in the first stage.

The regulator gets a benefit from the emissions, but at the same time she suffers a dis-

⁶Heyes et al. (2018) give multiple examples that motivate the use of this approach to model fundraising.

utility from the damage caused by those same emissions. In that case, both the firm and the NGO have incentives to influence the decision of the policy maker and shift it toward their preferred direction.⁷ The game can be summarized as follows:

The first stage : Private politics competition between the firm and the NGO;

The second stage : Lobbying game between the firm and the NGO;

The third stage : The final policy outcome.

2.3.1 The private politics game

As discussed earlier, green NGOs finance their activities with donations, hence the incentive to engage in fundraising activities in order to keep the cash flowing. This paper is not directly related to the fundraising literature in the sense that it adopts a quite different approach to model this process. We follow Heyes et al. (2018)'s framework, in which they assume that donations are the direct result of exposing the firms' polluting activities to the public eye. The central idea of their paper is that public attention is limited, hence the activists and the firms need to act strategically to influence salience or exposure of the pollution. In other words, the more the polluting industry is salient the more the cash is flowing (the greater are the donations). In their paper, the authors adopt the timing of one of the pioneering papers in private politics (Baron and Diermeier, 2007). First the NGO commits to a mission supposed to be trusted by the firm, which is a common assumption in this type of models. Second the firm chooses its hiding or greenwashing efforts,⁸ in an attempt to reduce the probability of its salience. We further consider that the firm has an access to an abatement technology that will be used to block the fundraising process by the NGO. Third, the salience is realized or not and finally the NGO's income is realized (donations).

Yet, our model differs from that of Heyes et al. (2018) on two levels. First, their paper

⁷Moreover, a policy-maker might want to keep the regulational context under her sight and does not allow the industries to set their own environmental standards. An example that illustrates this statement is that of the Trump administration. In fact, this administration did not want to allow some firms from the automobile industry to set their own fuel efficiency standards, even if their standards were more stringent than the standards set by the administration, and preferred to keep these standards the same between all the firms of the industry: <https://www.theguardian.com/environment/2020/mar/31/trump-epa-obama-clean-car-rules-climate-change>.

⁸These two terms will be used interchangeably in the rest of the chapter.

does not include a public politics stage in which the firm and the NGO compete over the environmental regulation. Second, since the private politics game is only a subgame in our setting, we do not explicit the occurrence of salience. This can be supported by the fact that both the special interest groups (SIGs) are trying to outguess each other; if the campaign is going to be successful, the NGO should be able to expose the pollution caused by the firm and hence increase the funds collected, at the same time the firm is trying to block the fundraising process by hiding its polluting activities (*symbolic* actions) or doing some real abatement (*substantive* actions). The NGO commits to a campaign mission γ in order to raise funds, whilst the firm that anticipates this mission invests in the greenwashing efforts h and/or abatement efforts a .

Unlike Heyes et al. (2018) that consider two levels of donations : the highest level when salience is realized and the lowest level when salience is not realized. In our setting we consider that donations $m(\gamma, h, a)$ are a continuous function of campaigning γ , hiding efforts (h) and abatement efforts (a). Formally the hiding efforts and the abatement efforts are perfect substitutes for blocking the NGO's fundraising. However and unlike abatement, hiding or greenwashing efforts have no actual effect in the reduction of the polluting emissions. To be able to conduct comparative statics on the private politics variables in section 2.4.2, we study the total blocking fundraising efforts $T = a + h$ instead of studying the greenwashing (h) and the abatement (a) efforts separately. The donations function becomes $m(\gamma, T)$, with the following assumptions:

A1: (i) $\partial m / \partial \gamma > 0$, $\partial^2 m / \partial \gamma^2 \leq 0$ and $\partial m / \partial T < 0$, $\partial^2 m / \partial T^2 \geq 0$; and (ii) $m(\gamma, T) \geq m(0, 0) = \underline{m}$.

(ii) states that the NGO always receives a minimum amount of donations (\underline{m}) from loyal donors independently of γ and T .⁹ When $a = 0$, the fund function becomes $m(\gamma, h)$ with the same properties with respect to its arguments.

⁹The minimum level of donations could also take the form of grants from government entities.

2.3.2 The public politics game

Fundraising is an important factor in defining NGOs strategic behavior, since they are not directly engaged in any cash producing activities. The resources (budget) they allocate to their activities in favor of the environment are financed by donations from donors who are interested in the environmental cause. One of the main actions adopted by green NGOs is lobbying policy makers. Lobbying could take the form of direct monetary contributions like in Grossman and Helpman (1994) and many other papers that follow their paths, or the transfer of information to the regulators or both like in Bennedsen and Feldmann (2006). Budgets are hence a very important aspect of studying NGOs lobbying strategies. The polluting industries on the other hand may form coalitions to strengthen their financial position but they are not necessarily constrained by the budgets, at least in comparison to green NGOs.

The public politics competition takes place in the second stage of the game. This competition is modeled as a two stages rent-seeking contest. In the first stage, each lobby exerts pressure on the policy maker taking the other lobby's pressure as given. In the second stage, the regulator decides about the environmental policy (i.e., the level of emissions: E^*) by maximizing a weighted sum of the welfare of both SIGs like in Cheikbossian (2008). The political weights attached to the lobbies in the objective function of the government are denoted by α_G (NGO) and α_F (firm). They are determined by the level of rent-seeking expenditures (lobbying efforts) given by the following expression:

$$\alpha_j = \begin{cases} \frac{C_j}{C_j+C_k}, j \neq k & \text{if } C_j + C_k > 0 \\ \frac{1}{2} & \text{if } C_j + C_k = 0. \end{cases} \quad (2.1)$$

It is worth pointing out here that the rent-seeking expenditures of the NGO, whether they take the form of direct contributions to the policy maker or are used to collect information and transmit it to the policy maker, should never exceed the available funds collected in the private politics game. Hence, we will be studying two different cases :

Case 1: The two lobbies are unconstrained;

Case 2: The NGO is constrained and the firm is unconstrained.

2.4 The public politics competition

In this section, we solve the subgame in political influence. We consider that we have a lobbying/rent-seeking game between the two special interest groups, that result in the setting of a level of emissions (E^*) in the economy by the policy maker.

2.4.1 The final policy outcome

The firm derives a benefit from the production of a polluting good, and hence from the emissions : $W^F(E) = B(E)$. The benefit is increasing and concave in emissions ($B'(E) \geq 0$ and $B''(E) \leq 0$).

The members of the green NGO are subject to a disutility from the emissions, evaluated by a damage function $W^G(E) = -D(E)$. The damage function is increasing and convex in the emissions ($D'(E) \geq 0$ and $D''(E) \geq 0$).

As mentioned earlier, in this stage of the game, the regulator decides about the final policy outcome (the level of emissions E^*) by maximizing the weighted sum of the benefit and the damage functions. Let P be the objective function of the government, we have:

$$P(\alpha_G, \alpha_F, E) = \alpha_F B(E) - \alpha_G D(E), \quad (2.2)$$

where α_G and α_F are given by expression (2.1).

In the final stage, the policy maker decides about the level of emissions E by maximizing (2.2). The following FOC characterizes the equilibrium level of emissions $E^*(\alpha_G, \alpha_F)$:

$$\frac{B'(E^*)}{D'(E^*)} = \frac{\alpha_G}{\alpha_F} = \frac{C_G}{C_F}. \quad (2.3)$$

Using the implicit function theorem we obtain:

$$\frac{\partial E^*}{\partial \alpha_G} = \frac{D'(E^*)}{\alpha_F B''(E^*) - \alpha_G D''(E^*)} \leq 0, \quad (2.4)$$

and similarly:

$$\frac{\partial E^*}{\partial \alpha_F} = -\frac{B'(E^*)}{\alpha_F B''(E^*) - \alpha_G D''(E^*)} \geq 0. \quad (2.5)$$

Since $\alpha_F B''(E^*) - \alpha_G D''(E^*) \leq 0$, an increase in the weight attached to the damage function α_G which results from the increase in the lobbying expenditures of the NGO given those of the firm, decreases the equilibrium level of emissions leading to a more stringent environmental policy. In the same way, an increase in α_F increases E^* leading to a less stringent environmental policy.

Next, in the first stage of the context game, each lobby chooses the level of its political contributions independently by maximizing its net welfare. The welfare function of the NGO and the firm in the second stage of the game are respectively given by:

$$W^G(E^*) = -D(E^*) - C_G(E^*), \quad (2.6)$$

$$W^F(E^*) = B(E^*) - C_F(E^*). \quad (2.7)$$

The green NGO maximizes its welfare under its budget constraint. The constraint is stated as follows: $C_G^* \leq m$.

At first, we take the funds collected in the first stage as exogenous and we proceed by solving the subgame. We therefore distinguish two cases, first the NGO is supposed to have enough funds to cover its lobbying expenditures ($C_G^* \leq m$), second we assume that it collects an amount that is lower than what would be optimal for covering its lobbying expenditures ($C_G^* > m$).

2.4.2 Resources are unlimited

In this section, we study the case of "wealthy lobbies". We assume that the NGO is not financially constrained by the funds collected in the private politics stage.

The unlimited resources assumption is equivalent to consider the public competition subgame. In other words, we consider an exogenous available budget m^{UC} that always satisfies the following condition:

$$C_G^* \leq m^{UC} \quad (2.8)$$

This condition reflects the special case of rich green NGOs. However, NGOs and more precisely green NGOs, or at least the ones we are dealing with in this study, are likely to be struggling to survive bankruptcy, especially those who are funded by independent donors. These NGOs face a double problem. On one hand, NGOs are heavily constrained by the modesty of their available resources which are directly linked to the prevailing of the issues they advocate for to their donors (salience). On the other hand, they are struggling to increase the significance of the environmental issues to the public agenda.

The FOC of the NGO given by differentiating (2.6) with respect to C_G :

$$-\frac{\partial D(E^*)}{\partial C_G} = 1. \quad (2.9)$$

Similarly, the firm chooses its political contributions by maximizing its net welfare given by (2.7), we have the following FOC:

$$\frac{\partial B(E^*)}{\partial C_F} = 1. \quad (2.10)$$

The reaction functions of both SIGs in the political lobbying competition are implicitly given by (2.9) and (2.10). Using the implicit theorem function to study their slope, we identify three possible equilibria for the public politics game. The economy is characterized by one of these equilibria depending on the relationship between the following two ratios: $\frac{D''(E^*)}{D'(E^*)}$ and $-\frac{B''(E^*)}{B'(E^*)}$. More precisely, the best response of the NGO to the lobbying expenditures

of the firm is increasing if and only if $\frac{D''(E^*)}{D'(E^*)} \geq -\frac{B''(E^*)}{2B'(E^*)}$ and the best response of the firm to the NGO's lobbying expenditures is increasing if and only if $\frac{D''(E^*)}{D'(E^*)} \geq -\frac{2B''(E^*)}{B'(E^*)}$. These conditions are clearly depending on the level of emissions E^* . In order to provide a clear characterization of the equilibria, we rewrite the conditions with the use of elasticities.

According to the assumptions made on the damage function, the first derivatives $D'(E)$ and $B'(E)$ are linear functions of E . Let $E_{D'}$ be the elasticity of $D'(E)$ at the equilibrium emissions (E^*), such that $E_{D'} = \frac{D''(E^*)E^*}{D'(E^*)} \geq 0$. Similarly let $E_{B'} = \frac{B''(E^*)E^*}{B'(E^*)} \leq 0$ be the elasticity of $B'(E)$. Replacing in the conditions with the elasticities, we have the following lemma.¹⁰

Lemma 1 : *Assuming that $D'''(E^*) = B'''(E^*) = 0$, then the public competition game between the NGO and the firm is characterised by one of the following three different equilibria:*

1. *The reaction functions in the public competition of both lobbies are upward sloping when $E_{D'} \geq -2E_{B'}$: The political contributions of both lobbies are strategic complements.*
2. *The reaction functions in the public competition of both lobbies are downward sloping when $E_{D'} \leq -\frac{1}{2}E_{B'}$: The political contributions of both lobbies are strategic substitutes.*
3. *The reaction function of the NGO is upward sloping whilst that of the firm is downward sloping when $-\frac{1}{2}E_{B'} \leq E_{D'} \leq -2E_{B'}$.*

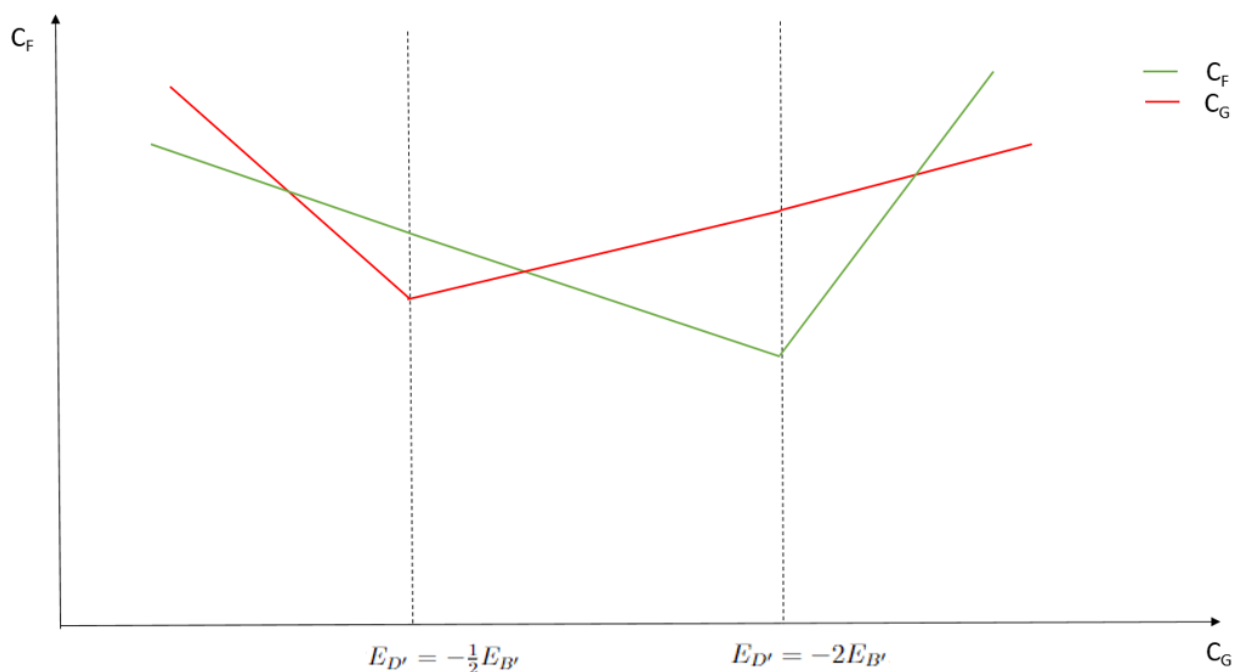
Proof: See Appendix A.1. \square

The elasticities $E_{D'}$ and $E_{B'}$ measure the curvature of the damage and the benefit functions. Thus when $E_{D'} \geq -E_{B'}$, the convexity of the damage function is more important than the concavity of the benefit function. From the two conditions in lemma 1: $E_{D'} = -\frac{1}{2}E_{B'}$ and $E_{D'} = -2E_{B'}$, we observe that the strategic interactions between the political lobbying expenditures of both SIGs depend on the relationship between the curvatures of the damage and the benefit functions. Depending on the nature of the strategic interactions in the

¹⁰We assume that the condition of stability for these equilibria $|W_{11}^G W_{22}^F| \geq |W_{12}^G W_{21}^F|$ is verified.

political expenditures of the two SIGs, the economy can be on one of the three equilibria described in figure 4.¹¹

Figure 4: The nature of the reaction functions of the NGO and the Firm in the public competition game.¹²



From the first ($E_{D'} = -\frac{1}{2}E_{B'}$) to the second ($E_{D'} = -2E_{B'}$) condition, we can see an increase in the convexity of the damage for a given level of the benefit's concavity. Hence, the public politics' equilibrium characterized by the two down slopping reaction functions occurs when the degree of the convexity of the damage function is lower than the degree of the concavity of the benefit. And the equilibrium characterized by the two upward slopping

¹¹The question of the convexity of the damage function from polluting emissions (especially greenhouse gas emissions) has captured the attention of many scholars since Nordhaus (1991). The reason behind this growing interest is that the degree of convexity of the damage functions has a big effect on the social cost of pollution and a significant impact on the growth rate and hence on the stringency and effectiveness of public climate policy (Bretschger and Pattakou, 2019).

¹²The reaction functions of the SIGs are not necessarily linear. For the sake of clarity, we chose to represent them by linear curves in order to show in a more readable way their slopes.

reaction functions occurs when the convexity of the damage is more important than the concavity of the benefit function. Depending on which of the three equilibrium the public competition between the two SIGs leads to, a level of emissions will be set by the regulator following (2.3).

This shows that the public competition intensity depends on the nature of the polluting emissions described by the damage and the benefit they generate. When the pollution is causing a less convex damage, the political lobbying expenditures are strategic substitutes reflecting a less aggressive competition for political influence. However, when the damage is relatively more convex, the political lobbying efforts become strategic complements revealing a more aggressive competition around the political influence of the environmental regulation. This result is in line with the observed lobbying behavior of SIGs. Environmental regulation of polluting emissions with very convex damage functions, like greenhouse gases emissions (Bretschger and Pattakou, 2019), are subject to very aggressive lobbying from interest groups (Brulle 2018).

2.4.3 Resources are limited

This case is actually more accurate and describes better the asymmetry between the Greens and their rich antagonists (the polluting industries). The fact that environmental groups are relatively less engaged in political lobbying, can be explained by their scarce resources. A concrete example is that of the NGO Friends of the Earth. In the beginning of the 1990s, the NGO was fighting against one of the highly contested projects in the history of the UK: the government's project of driving an extension to the M3 motorway through a protected landscape (Twyford Down). But it had at some point in 1992 to withdraw from the direct campaign because of a lack of financial resources. The NGO could not handle the costs of the campaign anymore.¹³

In this section, we assume that the NGO has less funds than what would finance its optimal political expenditures. We particularly assume that it has the lowest level of donations

¹³See Berny and Rootes (2018) for a more detailed discussion.

described in A1 (\underline{m}).

The two equilibrium conditions for the NGO and the firm respectively become:

$$C_G^* = \underline{m}, \quad (2.11)$$

$$B'(E^*) \frac{\partial E^*}{\partial C_F} = 1. \quad (2.12)$$

From these conditions we can deduce the effect of a relaxation of the budget constraint of the NGO on lobbying expenditures of the firm, which we formulate in the following proposition:

Proposition 1 : *In the case where the budget constraint of the NGO is binding. A relaxation of the budget induces the firm to decrease its equilibrium political contributions if and only if $\frac{D''(E^*)}{D'(E^*)} \leq -\frac{2B''(E^*)}{B'(E^*)}$ ($\equiv E_{D'} \leq -2E_{B'}$), and increases them otherwise.*

Proof: See Appendix A.2. \square

The explanation of this result is similar to that of lemma 1. A relaxation of the budget constraint of the NGO is confronted by an aggressive response from the firm if the damage function has a more important curvature than the benefit function.

Let now consider the case where the NGO can influence the fundraising in a way to collect an amount of donations that covers its optimal lobbying expenditures i.e. $m^* \geq C_G^*$. The following section deals in depth with this assumption.

2.5 Fundraising through private politics

This section aims at answering the following question: "What would be the optimal campaigning strategy of the NGO to cover its lobbying expenditures?". Therefore, to answer this question we give the NGO the ability to endogenously decide about its resources. Following Heyes et al. (2018), we make the assumption that the NGO can raise funds through campaigning against the polluting firm. We hence define a fund function that is increasing

in the campaigning efforts of the NGO and decreasing in the hiding efforts of the firm¹⁴.

Next, we shall explain more the behaviour of the firm. The hiding is known in the environmental marketing jargon as *greenwashing*. Greenwashing is a well known advertising strategy used by polluting industries campaigning for their products as environmentally-friendly while they are not, in order to capture the environmentally concerned consumer and distract his attention and that of environmental groups from its polluting activity.¹⁵ The main reason why these companies manage to get away with their greenwashing activities is the lack of regulation and precision around the definition of a green, eco-friendly and sustainable product which leads to the intentional or non intentional misleading use of these terms by the industries (Delmas and Burbano, 2011). Although greenwashing activities are often caught by green NGOs, the polluting firms keep investing in them. A possible explanation to this risky behavior is that clean technologies might not be available yet or very costly, hence the firms prefer to stall the public through cleaning ex-post i.e., "sweeping their pollution under the carpet" until they can afford the clean technology (ex-ante cleaning).

Following this reasoning, we distinguish two different cases. We first assume that the firm does only hiding. Second, we give the firm the possibility to do real abatement.

2.5.1 The "Sweeping under the carpet" strategy

We begin our model by studying the simplest case in which we assume that the firm does not have access to a real abatement technology yet. It decides then, to stall as much as it could the public by hiding its pollution. Note that the hiding efforts will not have any actual effect on the emissions and hence on the damage. Instead it just decreases the monetary funds collected by the NGO.

Given the timing of the game, the rational SIGs should in the first stage play in such a way that they anticipate the effect of the collected funds on the equilibrium of the second stage and therefore the outcome of the public politics competition E^* through (2.3).

¹⁴See A1 in section 2.3.1.

¹⁵Delmas and Burbano (2011) define greenwashing as: "*the intersection of two firm behaviors: poor environmental performance and positive communication about environmental performance*".

The NGO is trying to collect enough funds to cover its lobbying expenses. Its strategy consists of maximizing its net welfare under the constraint of collecting at least an equal amount to its equilibrium lobbying expenditures in the second stage of the game.

$$W^G(\gamma, h) = -D(\gamma, h) - C_G^* + m(\gamma, h) - c_\gamma(\gamma), \quad (2.13)$$

under the following constraint :

$$C_G^* \leq m(\gamma, h). \quad (2.14)$$

Following A1, we consider a linear fundraising function:

$$m(\gamma, h) = \underline{m} + k\gamma - bh.$$

With k being a parameter that measures the marginal effectiveness of the NGO's campaign and $-b$ measures the marginal effectiveness of the firm in blocking fundraising.

The NGO is deciding about its campaign efforts γ^* following this FOC:

$$W_\gamma^G(\gamma^*, h^*) = -kD'(E^*)\frac{dE^*}{dm} - c'_\gamma(\gamma^*) = 0 \quad (2.15)$$

In the same way the firm, given the strategy of the NGO, attempts to hide as much as possible its pollution in a way to affect negatively the fundraising strategy of its antagonist. The problem of the firm consists of maximizing its net welfare under the same constraint as the NGO:

$$W^F(\gamma, h) = B(\gamma, h) - C_F^* - c_h(h) \quad (2.16)$$

Using the envelope theorem, the equilibrium value of hiding efforts h^* satisfies the following FOC:

$$W_h^F(\gamma^*, h^*) = -b \left(B'(E^*)\frac{\partial E^*}{\partial m} - \frac{\partial C_F^*}{\partial m} \right) - c'_h(h^*) = 0 \quad (2.17)$$

We use a convex function to denote the firm's cost $c_h(h)$ required for hiding its pollution, and a linear function to denote the NGO's cost $c_\gamma(\gamma)$ required for fundraising.¹⁶

¹⁶Using a convex cost function for hiding is needed to ensure that the SOC of the firm is always negative.

Following the same analysis adopted for the previous section, we are interested in understanding the strategic interactions between the two SIGs' private politics efforts. Equations (A11) and (A12) in the appendix show that the reaction function of the NGO is always upward slopping whilst that of the firm is upward slopping when $\frac{D''(E^*)}{D'(E^*)} \leq \frac{-B''(E^*)}{2B'(E^*)}$, and downward slopping otherwise.

Combining the previous conclusion and lemma 1, we can state the following:

Lemma 2:

- *if $E_{D'} \leq -\frac{1}{2}E_{B'}$: the private politics efforts are strategic complements, whilst the public politics efforts are strategic substitutes;*
- *if $-\frac{1}{2}E_{B'} \leq E_{D'} \leq -2E_{B'}$: the firm's both public and private competition best responses are downward slopping, whilst those of the NGO are upward slopping;*
- *if $E_{D'} \geq -2E_{B'}$: the best response of the firm is downward slopping and that of the NGO is upward slopping in the private politics stage, whilst the public politics efforts are strategic complements.*

This lemma states that the best response of the NGO in the private politics game is always upward slopping, whilst that of the firm is upward slopping when the convexity of the damage is lower than the concavity of the benefit from emissions. More precisely, the firm reacts aggressively to an increase in the NGO's campaigning efforts only if the political efforts of both SIGs are strategic substitutes. Combining this result with that of lemma 1, we are able to state that when the degree of convexity of the damage function is lower than the degree of concavity of the benefit, the competition between the two SIGs is more intense in the private politics stage and less aggressive in the lobbying stage, revealing the existence of a substitution relationship between public and private politics for both SIGs.

This could be justified by the increase of the general public awareness around the climate issue. In fact, if the firm decides to do more hiding, it has to do it well to be convincing, and this could be by investing in more scientific research for example, which is translated by the convex cost function. One example that illustrates the high cost of green advertising is that of TotalEnergies, that spends nearly 30% of its marketing budget on its climate image, according to Greenpeace. By opposition to NGOs that can capture the the eye of the interested donor through a single post on Instagram or a tweet on twitter.

When the curvature of the damage function is greater than the curvature of the benefit function, the NGO adopts a more aggressive response in the public politics stage while still maintaining its aggressive behavior in the private politics stage. The firm on the other hand, responds by reducing its greenwashing efforts while maintaining a less aggressive response in the lobbying stage. If however, the convexity of the damage exceeds a certain level compared to the concavity of the benefit ($E_{D'} \geq -2E_{B'}$), the firm then adopts a more aggressive lobbying strategy.

At this point, we find it interesting to analyse the effect of a change in the parameters of the model k and b on the equilibrium efforts of the NGO and the firm. We then have the following proposition:

Proposition 2: *As the NGO becomes more effective in fundraising (i.e., k increases):*

- *The equilibrium campaigning efforts of the NGO could increase or decrease.*
- *The equilibrium hiding efforts of the firm increase if and only if $E_{D'} \leq -\frac{1}{2}E_{B'}$ and decreases otherwise.*
- *The equilibrium funds collected increase.*

Proof: See Appendix A.3. \square

The parameter k measures the effectiveness of the NGO in collecting funds. Some NGOs are more effective than others in fundraising.¹⁷ Recall that a change in this parameter (k) affects directly the amount of donations (m^*). This in turn affects the lobbying expenditures of both SIGs in the second stage ($C_G^* \leq m$ and $C_F^*(m^*)$). Finally and depending on the nature of the strategic interactions between the two public competition variables (figure 4), it eventually affects the amount of emissions allowed in the economy by the regulator. As a result, the firm and the NGO have a strong incentive to shape their private politics variables in a way to strategically influence the outcome of the public politics competition.

¹⁷This is the case of NGOs that have better reputation and hence are more heard and trusted by the donors. Moreover, some NGOs that are very good at exposing the polluting actions of the firms they oppose.

In this regard, proposition 2 shows that as the NGO become more effective in fundraising, the firm's reaction depends on the slope of the political expenditures function of the NGO and the firm, whether they are increasing or decreasing. More precisely, the firm increases its equilibrium hiding efforts only if the political expenditures of both SIGs are strategic substitutes. According to lemma 2, when the convexity of the damage function is lower than the concavity of the benefit function ($E_{D'} \leq -\frac{1}{2}E_{B'}$), the private and public efforts of the firm are strategic substitutes. A more effective NGO in fundraising emphasizes this substitution effect between the hiding efforts and the lobbying efforts for the firm since the equilibrium hiding efforts increase and the political expenditures decrease ($\frac{dC_F^*}{dk} = \frac{\partial C_F^*}{\partial m^*} \frac{dm^*}{dk} \leq 0$).

Meanwhile, the reaction of the NGO to becoming more efficient in the fundraising game is not so clear cut. The NGO's equilibrium campaign efforts do not depend only on the nature of the competition in political lobbying between the two SIGs. In fact, the effect of an increase in k is not that straightforward and it depends first, on the effect of k on the marginal benefit of the NGO and second, on the convexity of the greenwashing cost function of the firm. If k increases the marginal benefit of the NGO in the first stage (i.e., $W_{\gamma k}^G \geq 0$) and the best response of the firm to the NGO's political expenditures is increasing ($E_{D'} \geq -\frac{1}{2}E_{B'}$), then the NGO strategically reduces its campaigning efforts when it becomes more effective in collecting funds. In fact, even if an increase in k affects positively the marginal benefit of the NGO in the first stage, the fact that it could induce the firm to act more aggressively in the second stage makes the NGOs soften its campaign against the firm in the first stage. The same result holds if $W_{\gamma k}^G \leq 0$ and the political contributions are strategic substitutes.

However, if none of the previous two cases occurs, the effect of k on the equilibrium campaign of the NGO depends also on the convexity of the hiding cost function.¹⁸ A less convex cost function could induce the polluting firm to do more greenwashing, which influences negatively the equilibrium funds collected by the NGO (all else being equal). As a response, the NGO strengthens its campaign by increasing its fundraising expenditures when

¹⁸ $c_h''(h) \leq \frac{b^2 LD'(E^*) \frac{dE^*}{dm}}{k\gamma G + D'(E^*) \frac{dE^*}{dm}}$.

it becomes more effective in fundraising, which is captured by the positive term in (A20) in the Appendix.

Finally, an increase in k will definitely increase the equilibrium funds collected, even if the firm can sometimes reacts aggressively to a more efficient campaigning NGO.

Now that we have some insights on how the NGO and the firm shape their equilibrium strategies as a response to an increase in the NGO's efficiency in campaigning, we shall analyse how an increase in the effectiveness of the firm's greenwashing affects the same equilibrium variables. We then have the following proposition:

Proposition 3: *As the firm becomes more effective in greenwashing (i.e., b increases):*

- *The equilibrium campaigning efforts of the NGO increase;*
- *The equilibrium hiding efforts of the firm increase.*
- *The equilibrium funds collected remain unchanged.*

Proof: See Appendix A.4. \square

This proposition states that an increase in the effectiveness of the firm in greenwashing exacerbates the competition in the private politics stage since equilibrium efforts of both SIGs increase.

As the firm becomes more efficient in hiding its pollution, the NGO reacts by increasing its equilibrium campaigning efforts. In fact, by becoming more effective in greenwashing, the firm becomes more effective in blocking the fundraising of the NGO. This becoming powerful greenwasher firm, increases the marginal benefit of the NGO which induces it to become more aggressive in campaigning.

The reaction of the firm to an increase in its greenwashing efficiency is to become even more aggressive. First, b has an ambiguous effect on the marginal benefit of the firm (W_{hb}^F given by (A17) in the appendix, could be positive or negative). More precisely, the direct effect of this parameter is positive (given by the RHS of (A17): $-h^* B'(E^*) \frac{\partial E^*}{\partial m}$) and this follows directly from the assumptions made on the functional form of the funds.

The indirect effect depends on the nature of the competition in the public politics stage as captured by the LHS of (A17).¹⁹ It is positive if $E_{D'} \leq -\frac{1}{2}E_{B'}$ and negative otherwise. Regardless of its sign, this indirect effect is somehow offset by the increase in the campaigning efforts of the NGO, and only the positive effect of b on the marginal benefit of the firm remains, leading to an increase in its equilibrium greenwashing activity. This behavior is indeed common among polluting industries seeking the avoidance of salience of their non-green actions, we particularly recall the example of the textile industry which is considered as one of the most polluting sectors.²⁰ One striking example is that of the Swedish fast fashion company H&M that is succeeding in painting itself green in the last 10 years through some successful greenwashing activities, starting with the claim that the brand uses mainly organic cotton and bio degradable materials in the garments, to the introduction of the conscious collection and finally the recycling claims.²¹ The strategy of this giant textile firm confirms the second part of the proposition, since it shows that the more the firm becomes successful in hiding (i.e., the more it becomes effective in staling the public and hiding its polluting actions through greenwashing),²² the more it invests in it. Finally, a more efficient firm in greenwashing fails to reduce the equilibrium funds collected, because it is always faced by more campaigning from the NGO. This aggressive reaction of the NGO offset the negative effect that b could have on the equilibrium funds, and therefore the equilibrium funds collected remain unchanged.²³

2.5.2 The "hybrid strategy"

The "hybrid strategy" consists of adopting a lighter shade of green by the polluting industries instead of committing to a full rich green strategy. One can argue that this could be the most

¹⁹We call it indirect effect because it depends on the public politics stage. By opposition to the direct effect that depends on the functional form of the fund function.

²⁰A 2016 report by The International Energy Agency estimates that the textile industry generated 1.2 billion tons of greenhouse gas emissions in the same year, which is translated to a carbon footprint larger than international flights and maritime shipping combined.

²¹According to the Economist, recycling hardly concerns less than 25% of the total garments.

²²The success of each of these greenwashing strategies reflects in a way or an other the efficiency of HM in hiding: which is indicated in the model by an increase in b .

²³This result is essentially driven by the assumptions made on the cost function of both NGOs.

common case. Most of the time, firms engage in hybrid strategies as a transitional phase toward full green engagement. Note that in this section, we do not investigate whether it is rational for the firm to do abatement or not. At the equilibrium the firm must invest in abatement. Therefore we have $a^* > 0$ by assumption and we compare this case to the one presented in the previous section.²⁴

Firms are very concerned about their image and their reputation, as a result real abatement is voluntarily used by polluting firms in order to signal their socially responsible behaviour to consumers, activists and policy makers. In fact, firms' voluntary abatement essentially takes the form of private self-regulatory standards, labels and certifications.²⁵ Moreover, firms opt for self-regulatory actions even if they are subject to public environmental regulation (e.g., the standard *ISO-14001* is voluntarily adopted by industries that are subject to heavy environmental regulation (Di Ubaldo et al., 2019)).

We consider that the firm adopt a voluntary environmental standard, which is captured by $a^* > 0$, but it also does greenwashing along side that.²⁶ The fact that firms use real abatement to avoid being targeted by NGOs does not exclude the possibility of using greenwashing as well to serve the same purpose (Lyon and Maxwell, 2011).²⁷

Here, we consider that the firm does abatement as a response to the campaign of the NGO. Therefore it is used to block the fundraising process of the NGO. Note that hiding has no actual effects on the reduction of the emissions and therefore the reduction of the environmental damage suffered by the NGO, by contrast to real abatement. Abatement

²⁴If $a^* = 0$, the firm uses only greenwashing. This case is detailed in the previous section.

²⁵The self-regulatory standards are usually created via collaborations between NGOs and private businesses. Nevertheless, the collaboration between NGOs and firms to effectuate private standards does not rule out the presence of controversy (Wijen and Chiroleu-Assouline, 2019). Taking for instance the fishing industry which, and as mentioned in the general introduction, is essentially subject to private environmental governance. One of the most important private standards in this sector is the Marine Stewardship Council (MSC) label, that was the result of collaboration between the World Wild Fund (WWF) and Unilever in 1996. Adopting this label however, did not protect fisheries from campaigns by other NGOs (e.g., the campaign of Greenpeace in 2014 against the french tuna fishery Saupiquet which has already obtained the MSC).

²⁶An example of a hybrid strategy is when companies commit to being environmentally friendly in only a part of the production process while still marketing the product as green. This strategy involves both real abatement (substantive action) and greenwashing (symbolic action).

²⁷According to de Jong et al. (2020), greenwashing comes in different shades. Firms can disclose lies or half lies about their environmentally responsible behavior to the general public.

might hence be used strategically by the firm in order to make the NGO softens its campaigns.

To proceed, we shall introduce the following funds function:

$$m(\gamma, h, a) = \underline{m} + k\gamma - b[a + h] = \underline{m} + k\gamma - bT.$$

The amount of donations $m(\gamma, h, a)$ depends on an additional parameter which is the real abatement effort a .²⁸ The funds are hence increasing in the campaigning effort γ and decreasing in the hiding and abatement efforts h and a . In order to derive conclusions from the comparative statics with respect to the parameters k and b , we study the total blocking fundraising $T = a + h$ instead of h and a separately.²⁹

Therefore, b becomes the total effectiveness of both actions of the firm (hiding and abatement) in blocking fundraising.

The FOC of the NGO is given by:

$$W_\gamma^G(\gamma^*, h^*, a^*) = -kD'(E^* - a^*)\frac{dE^*}{dm} - c'_\gamma(\gamma^*) = 0. \quad (2.18)$$

Comparing (2.15) and (2.18), it is straightforward that the NGO does less campaigning this time than the when the firm does not have access to an abatement strategy, for the same level of equilibrium emissions E^* . This conclusion comes from the fact that the marginal benefit in (2.18) is lower than the marginal benefit in (2.15) for any positive values of abatement a^* .

Using the envelope theorem, the FOC of the firm is thus given by:

$$W_T^F(\gamma^*, h^*, a^*) = -b \left(B'(E^* - a^*)\frac{\partial E^*}{\partial m} - \frac{\partial C_F^*}{\partial m} \right) - B'(E^* - a^*) - c'_T(T^*) = 0; \quad (2.19)$$

$c_T(T)$ being the general convex function to denote the firm's cost required for both abatement and hiding.

In order to compare the hybrid and the "sweeping under the carpet" strategy, we consider

²⁸Note that $m(\gamma, h, a) = m(\gamma, h)$ when $a = 0$.

²⁹This specification is purely for simplification purposes. The use of general forms makes the mathematical computation very complicated.

that the firm decides about $T = a + h$, which is the total blocking fundraising strategy. We proceed by the same way as in the previous section and we attempt to derive insightful conclusions about the effect of an increase in the effectiveness of the NGO in campaigning and the effectiveness of the blocking fundraising strategies of the firm on the private politics efforts, but this time with abatement available to the firm.

We then have the following result:

Proposition 4: *An increase in the effectiveness of the fundraising campaign of the NGO (i.e., k increases):*

- *Could increase or decrease the equilibrium campaigning efforts of the NGO;*
- *Could increase or decrease the equilibrium blocking fundraising efforts of the firm;*
- *Always increases the equilibrium funds collected by the NGO.*

Proof: See Appendix A.5. □

Results presented in this proposition are coherent with those presented in proposition 2. As a response to an increase in the effectiveness of the NGO in campaigning, the firm could either increase or decrease its hybrid strategy efforts. This is due to the fact that an increase in equilibrium blocking fundraising efforts could be through an increase in abatement efforts and/or hiding efforts. The increase in abatement efforts will definitely have a negative effect on the funds gathered by the NGO (all else being equal), but it also has a negative effect on the benefit of the firm unlike greenwashing. The decision of the firm will thus depends on which of these effects is more important.

The NGO response to an increase in k is not straightforward and is more complicated to understand. Now that the firm does real abatement, blocking the fundraising of the NGO, by using abatement only or in part does not always have a negative effect on the marginal benefit of the NGO, since doing abatement reduces the real emissions and therefore reduces the environmental damage that the NGO faces.

Similarly to the "sweeping under the carpet" strategy, a more effective NGO is fundraising always manage to collect more funds at equilibrium.

Moving to the effect of a more efficient firm in blocking fundraising, we have the following proposition:

Proposition 5: *An increase in the total effectiveness of the blocking fundraising of the firm (i.e., b increases):*

- *Always increases the equilibrium blocking fundraising efforts of the firm;*
- *Could increase or decrease the equilibrium campaigning efforts of the NGO;*
- *Always decreases the equilibrium funds collected by the NGO.*

Proof: See Appendix A.6. □

The first result of this proposition is coherent with the result of proposition 3 on the equilibrium greenwashing efforts. As the firm becomes more effective in blocking fundraising activities, it will invest further in them at the equilibrium. The NGO this time, however, does not always react by becoming more aggressive. This could be explained by the fact that an increase in the abatement efforts has this double effect on the marginal benefit of the NGO, on one side it decreases the funds collected and hence affect the public politics competition outcome, and on the other side it decreases the actual emissions and hence the damage faced by this NGO. Thus the reaction is ambiguous. It is unclear whether it becomes more or less aggressive as a response to an increase in the effectiveness of the firm in blocking the fundraising process.

Finally, a more efficient firm in blocking fundraising always decreases the equilibrium funds collected by the NGO. This is mainly due to the fact that the NGO does not always react by becoming more aggressive in private politics, and even if it does, the increase in its campaigning efforts is less important than the case where the firm does only greenwashing, clearly because of the positive effect that the abatement have in decreasing the damage.

Therefore, the NGO is, in the hybrid strategy case, unable to counteract or even offset the effect of an increase in the efficiency of the firm in blocking its fundraising process (as it did in the "sweeping under the carpet" case), resulting in a decrease in the equilibrium funds collected.

Finally, we are interested in knowing how the variation of the model's parameters affect the public competition outcome (i.e., the level of emissions E^* or the stringency of the environmental policy) both in the presence and the absence of real abatement. We therefore have the following proposition:

Proposition 6:

- *In the absence of abatement: an increase in k results in setting a more stringent environmental policy, whilst an increase in b has no effect on the environmental policy;*
- *In the presence of abatement: an increase in k results in setting a more stringent environmental policy, whilst an increase in b results in setting a less stringent environmental policy.*

Proof: See Appendix A.7. \square

Whether the firm uses abatement or not, if the NGO becomes more effective in campaigning, the public politics competition results in setting a more stringent environmental policy. This is because a more effective NGO always manages to collect more funds, which increases its political contributions and leads to a decrease in the equilibrium emissions.

Conversely, a more effective firm in blocking fundraising manages to influence the environmental policy only when it uses abatement. This result comes from the fact that when the firm uses only greenwashing, the NGO becomes more aggressive in campaigning which offset the negative effect that this more effective firm can have on the equilibrium funds, and therefore the environmental policy remains unchanged.

2.6 Conclusion

In this paper, we attempt to link two of the main levels of action of green activists, the private politics level which consists of a game between a green NGO and a polluting firm, and the public politics level which calls for a third party: the government. We particularly analyse the fundraising strategies of the green NGO in a public politics context. The motivation behind this work is that the activities of green NGOs are financed through donations from donors interested in the environmental cause, which makes them highly dependent on these donations and therefore constrained in their lobbying, public awareness and environmental conservation activities. We therefore develop a model that study how the NGO's need to obtain funds to finance lobbying activities, could strategically shape their actions and those of their opponents. In our model, we restrict the use of funds collected by the NGO to lobbying the government. At first, we develop a simple two stages contest game between the two interest groups, when the budget of the NGO is an exogenous variable to the public competition game. Our first result shows that the strategic interactions between the two lobbies' political expenditures depend on the concavity of the benefit function of the firm relative to the convexity of the damage function of the NGO and hence on the nature of pollution. When the degree of the convexity of the damage function is lower than the degree of the concavity of the benefit function, the political lobbying efforts are strategic substitutes revealing a less aggressive competition between the two SIGs. When the damage is more convex relative to the benefit, the competition between the two SIGs is more intense as their lobbying expenditures become strategic complements.

In the second part of this paper, we endogenize the budget of the NGO by adding a stage prior to the public competition game. In this first stage, the NGO competes against the firm in a fundraising game. The game is designed as follows, the NGO campaigns against the firm to expose its polluting activities and make them salient to donors which is supposed to increase the donations made to the NGO. The firm, on the other side, is trying to hide its polluting activities by investing in hiding/greenwashing activities which are supposed to decrease the funds collected by the NGO. We further give the firm access to an abatement

strategy so that both abatement and greenwashing are used to negatively affect the collection of funds by the NGO.

The main results of the comparative statics suggest that the effect of the effectiveness of the NGO in fundraising on the hiding efforts of the firm depends on the strategic interactions between the political expenditures of the two SIGs in the second stage. Moreover, we find that a more effective NGO will induce the firm to respond aggressively in the private politics competition (greenwashing). On the other side, a more effective firm in hiding always exacerbates the private politics competition between the two SIGs when the firm does not invest in an abatement strategy.

The introduction of abatement into the model shows that the NGO decreases its overall campaigning efforts, because of the actual effect of abatement on the reduction of the environmental damage faced by the NGO. Finally, a more efficient NGO in fundraising leads to setting a more stringent environmental policy, whilst a more efficient firm in blocking fundraising results in setting a less stringent environmental policy only when it uses abatement.

Appendix

A.1 Proof of lemma 1

We first verify the SOC:

$$-D'(E^*)\frac{\partial^2 E^*}{\partial C_G^2} - D''(E^*)\left[\frac{\partial E^*}{\partial C_G}\right]^2. \quad (\text{A1})$$

The second part of the expression is always negative, we now verify the sign of $\frac{\partial^2 E}{\partial C_G^2}$. We have :

$$\frac{\partial E^*}{\partial C_G} = \frac{D'(E^*)}{B''(E^*)C_F - D''(E^*)C_G}.$$

With $D'''(E^*) = B'''(E^*) = 0$, we have the following results:

$$\frac{\partial^2 E^*}{\partial C_G^2} = \frac{2D'(E^*)D''(E^*)}{[B''(E^*)C_F - D''(E^*)C_G]^2} \geq 0.$$

We conclude that the SCO (A1) is always verified. Similarly we verify the SOC_F for the Firm:

$$B'(E^*)\frac{\partial^2 E^*}{\partial C_F^2} + B''(E^*)\left[\frac{\partial E^*}{\partial C_F}\right]^2. \quad (\text{A2})$$

The second part of the SCO is always negative, we now verify the sign of $\frac{\partial^2 E^*}{\partial C_F^2}$:

$$\frac{\partial^2 E^*}{\partial C_F^2} = \frac{2B''(E^*)B'(E^*)}{[B''(E^*)C_F - D''(E^*)C_G]^2} \leq 0.$$

Therefore we conclude that the SOC (A2) for the firm is always verified.

Now we study the reaction functions of both lobbies. The reaction function of the green NGO is implicitly giving by the following expression (using the implicit function theorem):

$$\frac{\partial C_G}{\partial C_F} = -\frac{1}{SOC_G} \left[-D'(E^*)\frac{\partial^2 E^*}{\partial C_F \partial C_G} - D''(E^*)\frac{\partial E^*}{\partial C_G} \frac{\partial E^*}{\partial C_F} \right]. \quad (\text{A3})$$

The sign of the reaction function of the NGO can be positive or negative depending mainly of the sign of $\frac{\partial^2 E^*}{\partial C_F \partial C_G}$:

$$\frac{\partial^2 E^*}{\partial C_F \partial C_G} = \frac{-[D''(E^*)B'(E^*) + B''(E^*)D'(E^*)]}{[B''(E^*)C_F - D''(E^*)C_G]^2}. \quad (\text{A4})$$

Which is of an ambiguous. Hence :

$$-D'(E^*)\frac{\partial^2 E^*}{\partial C_F \partial C_G} - D''(E^*)\frac{\partial E^*}{\partial C_G} \frac{\partial E^*}{\partial C_F} = \frac{D'(E^*)[2D''(E^*)B'(E^*) + B''(E^*)D'(E^*)]}{[B''(E^*)C_F - D''(E^*)C_G]^2}. \quad (\text{A5})$$

The sign of equation (A5) is that of the term between the brackets:

$$\begin{aligned} [2D''(E^*)B'(E^*) + B''(E^*)D'(E^*)] &\geq 0 \\ \Leftrightarrow \frac{D''(E^*)}{D'(E^*)} &\geq -\frac{B''(E^*)}{2B'(E^*)}. \end{aligned}$$

(A5) is positive if and only if $\frac{D''(E^*)}{D'(E^*)} \geq -\frac{B''(E^*)}{2B'(E^*)}$ and negative otherwise.

Similarly, we study the reaction function of the firm to the NGO political contributions.

Using the implicit function theorem we have:

$$\frac{\partial C_F}{\partial C_G} = -\frac{1}{SOC_F} \left[B'(E^*) \frac{\partial^2 E}{\partial C_G \partial C_F} + B''(E^*) \frac{\partial E^*}{\partial C_F} \frac{\partial E^*}{\partial C_G} \right]. \quad (\text{A6})$$

We hence have:

$$B'(E^*) \frac{\partial^2 E^*}{\partial C_G \partial C_F} + B''(E^*) \frac{\partial E^*}{\partial C_F} \frac{\partial E^*}{\partial C_G} = -\frac{B'(E^*)[D''(E^*)B'(E^*) + 2B''(E^*)D'(E^*)]}{[B''(E^*)C_F - D''(E^*)C_G]^2}. \quad (\text{A7})$$

The sign of equation (A7) is opposite to that of the term inside the brackets:

$$\begin{aligned} [D''(E^*)B'(E^*) + 2B''(E^*)D'(E^*)] &\geq 0 \\ \Leftrightarrow \frac{D''(E^*)}{D'(E^*)} &\geq -\frac{2B''(E^*)}{B'(E^*)} \end{aligned}$$

(A7) is positive if and only if $\frac{D''(E^*)}{D'(E^*)} \leq -\frac{2B''(E^*)}{B'(E^*)}$ and negative otherwise.

A.2 Proof of proposition 1

Using the implicit function theorem we have:

$$\frac{\partial C_F}{\partial C_G} \Big|_{C_G=\underline{m}} = -\frac{1}{SOC_F} \left[B'(E^*) \frac{\partial^2 E}{\partial \underline{m} \partial C_F} + B''(E^*) \frac{\partial E^*}{\partial C_F} \frac{\partial E^*}{\partial \underline{m}} \right], \quad (\text{A8})$$

which is of a positive sign if and only if $\frac{D''(E^*)}{D'(E^*)} \leq -\frac{2B''(E^*)}{B'(E^*)}$ and negative otherwise.

A.3 Proof of proposition 2

At the first stage, the equilibrium emissions can be expressed as follows:

$$E^*(C_G^*, C_F^*) = E^*(m(\gamma, T), C_F^*(m(\gamma, T))) = E^*(\gamma, T).$$

Therefore, the effect of γ and T on E^* occurs through m and the equilibrium of the second stage, i.e., m^* and C_F^* .

More precisely, $\frac{\partial E^*}{\partial \gamma} = \frac{dE^*}{dm} \frac{\partial m}{\partial \gamma} = k \frac{dE^*}{dm}$ and $\frac{\partial E^*}{\partial T} = \frac{dE^*}{dm} \frac{\partial m}{\partial T} = -b \frac{dE^*}{dm}$.

With $\frac{dE^*}{dm} = \frac{\partial E^*}{\partial m} + \frac{\partial E^*}{\partial C_F^*} \frac{dC_F^*}{dm}$. Its sign depends on that of $\frac{\partial C_F^*}{\partial m}$. It is always negative when $\frac{dC_F^*}{dm} \leq 0$ ($\frac{D''(E^*)}{D'(E^*)} \leq \frac{-2B''(E^*)}{B'(E^*)}$). But is also negative when $\frac{dC_F^*}{dm} \geq 0$. In fact:

$$\begin{aligned} \frac{dE^*}{dm} &= \frac{2D'(E^*)B''(E^*) - B'(E^*)^2 D''(E^*) - 2B'(E^*)D'(E^*)B''(E^*)}{2B''(E^*)[B''(E^*)C_F - D''(E^*)C_G]} \leq 0 \\ &\Leftrightarrow 2D'(E^*) \frac{B''(E^*)}{B'(E^*)} \leq 2D'(E^*)B''(E^*) + B'(E^*)D''(E^*), \end{aligned}$$

and this is always true for $\frac{D''(E^*)}{D'(E^*)} \geq \frac{-2B''(E^*)}{B'(E^*)}$.

The second derivative $\frac{d^2 E^*}{dm^2}$ is given by:

$$\frac{d^2 E^*}{dm^2} = \frac{\partial^2 E^*}{\partial m^2} + \frac{\partial^2 E^*}{\partial C_F^{*2}} \left(\frac{dC_F^*}{dm} \right)^2 + 2 \frac{\partial^2 E^*}{\partial C_F^* \partial m} \frac{dC_F^*}{dm}.$$

The SCOs of the NGO and the firm are given by (A9) and (A10) :

$$W_{\gamma\gamma}^G(\gamma, h) = -k^2 \left[D''(E^*) \left(\frac{dE^*}{dm} \right)^2 + D'(E^*) \frac{d^2 E^*}{dm^2} \right]. \quad (\text{A9})$$

We replace the term inside the brackets by G in the rest of the appendix. It is always positive to ensure that the SOC of the NGO in the private politics stage is always negative.

$$W_{hh}^F(\gamma, h) = b^2 \left[B''(E^*) \left(\frac{\partial E^*}{\partial m} \right)^2 + B'(E^*) \frac{\partial^2 E^*}{\partial m^2} \right] - c''(h). \quad (\text{A10})$$

Similarly, we replace the term inside the brackets by L . The SOC of the firm in the

private politics stage is always satisfied if $\frac{D''(E^*)}{D'(E^*)} \leq \frac{-B''(E^*)}{2B'(E^*)}$. Otherwise, it is sufficient to assume that the cost is sufficiently convex to ensure that (A10) is always negative.

At this point we are interested in knowing the strategic interaction between this two decision variables at the equilibrium. We have the following result :

$$W_{\gamma h}^G(\gamma, h) = kbG, \quad (\text{A11})$$

$$W_{h\gamma}^F(\gamma, h) = -kbL. \quad (\text{A12})$$

Totally differentiating the FOCs given by (2.15) and (2.17) in section 2.5.1 of the text yields:

$$\begin{pmatrix} W_{\gamma\gamma}^G & W_{\gamma h}^G \\ W_{h\gamma}^F & W_{hh}^F \end{pmatrix} \begin{pmatrix} d\gamma^* \\ dh^* \end{pmatrix} = - \begin{pmatrix} W_{\gamma k}^G \\ W_{hk}^F \end{pmatrix} dk - \begin{pmatrix} W_{\gamma b}^G \\ W_{hb}^F \end{pmatrix} db \quad (\text{A13})$$

Let $|D^{NA}| = W_{\gamma\gamma}^G W_{hh}^F - W_{\gamma h}^G W_{h\gamma}^F = c''(h)k^2G > 0$ be the determinant of the system.

The partial derivatives in the system are given by:

$$W_{\gamma k}^G = -D'(E^*) \frac{dE^*}{dm} - \gamma kG, \quad (\text{A14})$$

$$W_{hk}^F = -\gamma bL, \quad (\text{A15})$$

$$W_{\gamma b}^G = hkG, \quad (\text{A16})$$

$$W_{hb}^F = hbL - B'(E^*) \frac{\partial E^*}{\partial m}. \quad (\text{A17})$$

Calculating the impact of fundraising effectiveness of the NGO (k) on the equilibrium levels of campaigning and hiding efforts, we have:

$$\frac{d\gamma^*}{dk} = \frac{W_{\gamma h}^G W_{hk}^F - W_{hh}^F W_{\gamma k}^G}{|D^{NA}|}, \quad (\text{A18})$$

and

$$\frac{dh^*}{dk} = \frac{W_{h\gamma}^F W_{\gamma k}^G - W_{\gamma\gamma}^G W_{hk}^F}{|D^{NA}|}. \quad (\text{A19})$$

The numerator of equation (A18) is given by :

$$D'(E^*) \frac{dE^*}{dm} [b^2 L - c_h''(h)] - k\gamma c_h''(h)G, \quad (\text{A20})$$

which is of an ambiguous sign.

The numerator of equation (A19) is given by :

$$kbLD'(E^*) \frac{dE^*}{dm}, \quad (\text{A21})$$

which is positive if $\frac{D''(E^*)}{D'(E^*)} \leq \frac{-B''(E^*)}{2B'(E^*)}$ and negative otherwise.

A.4 Proof of proposition 3

Calculating the impact of greenwashing effectiveness of the firm (b) on the equilibrium levels of campaigning and hiding efforts, we have

$$\frac{d\gamma^*}{db} = \frac{W_{\gamma h}^G W_{hb}^F - W_{hh}^F W_{\gamma b}^G}{|D^{NA}|}, \quad (\text{A22})$$

and

$$\frac{dh^*}{db} = \frac{W_{h\gamma}^F W_{\gamma b}^G - W_{\gamma\gamma}^G W_{hb}^F}{|D^{NA}|}. \quad (\text{A23})$$

The numerator of equation (A22) is given by :

$$kG \left[-bB'(E) \frac{\partial E^*}{\partial m} + hc''(h) \right], \quad (\text{A24})$$

which is always positive.

The numerator of equation (A23) is given by :

$$-k^2GB'(E) \frac{\partial E^*}{\partial m}, \quad (\text{A25})$$

which is always of a positive sign.

A.5 Proof of proposition 4

Following the reasoning of the previous section we are interested in studying the strategic interactions between the decision variables of the NGO and the firm. We denote $T = h + a$, the total blocking fundraising efforts (hiding and real abatement).

From which follows that $a = T - h$, $h = T - a$ and that will be used in the expression of the objective function of the firm in order to derive the derivatives with respect to T . From this change of variables operation, it follows that, to calculate the impact of fundraising effectiveness on the campaigning efforts of the NGO, we use the following system of total derivatives:

$$\begin{pmatrix} W_{\gamma\gamma}^G & W_{\gamma T}^G \\ W_{T\gamma}^F & W_{TT}^F \end{pmatrix} \begin{pmatrix} d\gamma^* \\ dT^* \end{pmatrix} = - \begin{pmatrix} W_{\gamma k}^G \\ W_{Tk}^F \end{pmatrix} dk - \begin{pmatrix} W_{\gamma b}^G \\ W_{Tb}^F \end{pmatrix} db \quad (\text{A26})$$

The determinant of the system is give by: $|D^A| = k^2 G_a [c_T''(T) - B''(E^* - a)] + k^2 D''(E^* - a) \frac{dE^*}{dm} [bL_a + B''(E^* - a) \frac{\partial E^*}{\partial m}]$.

The SOC of the NGO is given by:

$$W_{TT}^F = b^2 \left[B''(E^* - a) \left(\frac{\partial E^*}{\partial m} \right)^2 + B'(E^* - a) \frac{\partial^2 E^*}{\partial m^2} \right] + bB''(E^* - a) \frac{\partial E^*}{\partial m} + B''(E^* - a) - c_T''(T). \quad (\text{A27})$$

We denote the term inside the brackets by L_a .

We then have the following cross derivatives:

$$W_{T\gamma}^F = -kbL_a - kB''(E^* - a) \frac{\partial E^*}{\partial m}, \quad (\text{A28})$$

$$W_{\gamma T}^G = kbG_a + kD''(E^* - a) \frac{dE^*}{dm}. \quad (\text{A29})$$

Derivatives with respect to k and b are given by:

$$W_{\gamma k}^G = -D'(E^* - a) \frac{dE^*}{dm} - k\gamma G_a, \quad (\text{A30})$$

$$W_{\gamma b}^G = k[a + h]G_a, \quad (\text{A31})$$

$$W_{Tk}^F = -b\gamma L_a - \gamma B''(E^* - a) \frac{\partial E^*}{\partial m}, \quad (\text{A32})$$

$$W_{Tb}^F = b[a + h]L_a + [a + h]B''(E^* - a) \frac{\partial E^*}{\partial m} - B'(E^* - a) \frac{\partial E^*}{\partial m}. \quad (\text{A33})$$

From (A26), the effects of k on the equilibrium campaign efforts and total blocking fundraising efforts are given by the following expressions:

$$\frac{d\gamma^*}{dk} = \frac{W_{\gamma T}^G W_{Tk}^F - W_{TT}^F W_{\gamma k}^G}{|D^A|}, \quad (\text{A34})$$

and

$$\frac{dT^*}{dk} = \frac{W_{T\gamma}^F W_{\gamma k}^G - W_{\gamma\gamma}^G W_{Tk}^F}{|D^A|}. \quad (\text{A35})$$

The numerator of equation (A34) is given by:

$$\begin{aligned} & [c_T''(T) - B''(E^* - a)] \left[D'(E^* - a) \frac{dE^*}{dm} + k\gamma G_a \right] \\ & + \frac{dE^*}{dm} \left[bL_a + B''(E^* - a) \frac{\partial E^*}{\partial m} \right] [bD'(E^* - a) - k\gamma D''(E^* - a)], \end{aligned} \quad (\text{A36})$$

and it is of ambiguous sign.

The numerator of (A35) is given by:

$$kD'(E^* - a) \frac{dE^*}{dm} \left[bL_a + B''(E^* - a) \frac{\partial E^*}{\partial m} \right], \quad (\text{A37})$$

and it is of ambiguous sign.

A.6 Proof of proposition 5

From (A26), the effects of b on the equilibrium campaign efforts and total blocking fundraising efforts are given by the following expressions:

$$\frac{d\gamma^*}{db} = \frac{W_{\gamma T}^G W_{Tb}^F - W_{TT}^F W_{\gamma b}^G}{|D^A|}, \quad (\text{A38})$$

$$\frac{dT^*}{db} = \frac{W_{T\gamma}^F W_{\gamma b}^G - W_{\gamma\gamma}^G W_{Tb}^F}{|D^A|}. \quad (\text{A39})$$

The numerator of equation (A38) is given by:

$$kG_a \left[-bB'(E^* - a) \frac{\partial E^*}{\partial m} + [a + h]c_T''(T) \right] + kD''(E^* - a) \frac{dE^*}{dm} \left[b[a + h] - B'(E^* - a) \frac{\partial E^*}{\partial m} \right]. \quad (\text{A40})$$

Witch is of an ambiguous sign. The left-hand term shows the effect of b on the equilibrium campaigning efforts of the NGO γ^* via greenwashing and it is positive. While the right-hand term shows the effect of b on γ^* via abatement and it is of an ambiguous sign.

The numerator of equation (A39) is given by:

$$-k^2 G_a B'(E^* - a) \frac{\partial E^*}{\partial m}, \quad (\text{A41})$$

which is of a positive sign.

A.7 Proof of Proposition 6

a. Sweeping under the carpet strategy

The effect of k on the equilibrium environmental policy, i.e., the level of emissions E^* is given by the following expression:

$$\frac{dE^*}{dk} = \frac{dE^*}{dm^*} \frac{dm^*}{dk}. \quad (\text{A42})$$

From (A20) and (A21) we have:

$$\frac{dm^*}{dk} = -kD'(E^*) \frac{dE^*}{dm} c_h''(h), \quad (\text{A43})$$

which is of a positive sign.

Therefore, an increase in m always result in a more stringent environmental policy. As a result and from (A42) we can conclude that an increase in the effectiveness of the NGO

in campaigning leads to setting a more stringent environmental policy, since the level of equilibrium emissions E^* decreases.

The effect of an increase of the greenwashing effectiveness b is given by the following expression:

$$\frac{dE^*}{db} = \frac{dE^*}{dm^*} \frac{dm^*}{db}. \quad (\text{A44})$$

From (A24) and (A25) we have:

$$\frac{dm^*}{db} = 0. \quad (\text{A46})$$

Therefore, an increase in the effectiveness of the firm in greenwashing has no effect on the stringency of the environmental policy since the level of equilibrium donations remains unchanged.

b. hybrid strategy

The effect of k on E^* is given by (A42). But the introduction of a to the model changes $\frac{dm^*}{dk}$, that becomes:

$$kD'(E^* - a) \frac{dE^*}{dm} [B''(E^* - a) - c_T''(T)], \quad (\text{A47})$$

and it is always positive. Thus an increase in k leads to a more stringent environmental policy.

The effect of b on E^* is given by (A44). But similarly, the introduction of a to the model changes $\frac{dm^*}{db}$, that becomes:

$$Tk^2G_aB''(E^* - a), \quad (\text{A48})$$

which is always negative. Thus, an increase in b leads to a less stringent environmental policy.

Chapter 3

Trade and Strategic Environmental Policy: Can Allowing Lobbying be Welfare-Enhancing?

Abstract:

This paper focuses on the impact of domestic and international lobbying on the social welfare of two countries linked by both, trade and pollution. We consider a micro-founded reciprocal-markets model with two countries (Brander 1995). In each country, there is a monopoly producing a polluting good, that can result in a cross-national environmental externality, and the two firms compete in a Cournot duopoly in the two countries. 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 allowing political pressure from domestic and/or international lobbies can help mitigate tax competition between the two countries, resulting in an improvement in social welfare. This Pareto-improving effect of political pressure depends on the relative strengths of the lobbies and the nature of the strategic interactions in taxes.

Keywords: Lobbying, transboundary pollution, international trade, international politics, Pareto-improvement.

Résumé :

Cet article se concentre sur l'impact du lobbying national et international sur le bien-être social de deux pays liés par le commerce et la pollution. Nous considérons un modèle de marchés réciproques micro-fondé avec deux pays (Brander 1995). Dans chaque pays, il existe un monopole produisant un bien polluant, qui peut entraîner une externalité environnementale transfrontalière, et les deux entreprises sont en concurrence dans un duopole de Cournot dans les deux pays. Chaque gouvernement, indépendamment, fixe une taxe sur la pollution sous la pression politique des lobbies verts et industriels *à la* Grossman and Helpman (1994). Nos résultats montrent principalement que le fait d'autoriser l'influence politique par lobbies nationaux et/ou internationaux peut contribuer à atténuer la concurrence fiscale entre les deux pays, ce qui se traduit par une amélioration du bien-être social. Cet effet Pareto-améliorant du lobbying dépend des forces relatives des lobbies et de la nature des interactions

stratégiques en matière de taxes entre les deux pays.

Mots-clés : Lobbying, pollution transfrontalière, commerce international, politique internationale, Pareto-amélioration.

3.1 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 some countries may also use environmental standards as protectionist tools or reinforce them to export polluting production since the consumer goods of this production can be imported. Yet, this incentive is only effective if the environmental damage is purely local. In case of global pollution, trade liberalization leads governments to practice environmental dumping, in accordance with the common sense.

Another common wisdom is that green lobbies could mitigate the inefficiency of uncoordinated environmental regulations by exerting political pressure for the implementation of more stringent environmental policies. Conconi (2003) examines the effect of green lobbying on pollution taxes by using a perfectly competitive model of trade between two large economies and where lobbying is modelled as a common agency relationship. She shows that the influence of green lobbying on pollution taxes depends crucially on the trade policy regime, the terms-of-trade effect of a domestic pollution tax, and the spillover effects. The literature on the impact of green lobbying on strategic environmental policy-making also emphasizes that a rise in the influence of green lobbies may be not sufficient to increase protection of the environment (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 impact of the political game on the social welfare 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 monopoly producing a polluting good and the two firms compete in Cournot duopoly in the two countries. The production of the polluting good can in result in a cross-national environmental externality, so that the two countries are linked by both, trade and pollution. The two countries decide 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). In each country, a green lobby and producer lobby oppose each other on the stringency of domestic environmental policy and offer the government political contributions contingent on the chosen environmental policy.

We first consider that pollution is perfectly transboundary and show that lobbying increases domestic welfare in two countries if the influence of green lobbies is sufficiently strong relative to that of the producer lobbies. The reason is that political competition mitigates the race to the bottom in environmental taxes. When the pollution is purely local, we find that competition for political influence can also increase the welfare of both countries provided the influence of producer lobbies in the two countries is larger but similar to that of green lobbies. If, however, the influence of one interest group is significantly different from that of the other, then the game for political influence is welfare decreasing as a consequence of a too low or too high pollution tax relative to the pollution tax that would maximize the joint welfare of the two countries. Hence, if green lobbies are strongly influential, this leads to a stricter environmental policies than that would have chosen the two governments cooperatively (and without lobbying). It is very beneficial for the environment, but it considerably worsens the market failure of under-production due to duopoly competition. In this case, the welfare gain of a lower environmental damage is more than offset by the welfare loss of a lower consumer surplus.

Finally, we analyze the situation where the two domestic lobbies form an international

lobbies exerting pressure together on the two governments. Specifically, the two domestic green lobbies form an international green lobby and the two domestic producer lobbies form an international producer lobby. In other words, we move from a common agency relationship to a multiple principal-multiple agent relationship *à la* Prat and Rustichini (1999). We particularly analyse three different situations: first, an international green lobby facing two domestic producer lobbies, second, an international producer lobby facing two domestic green lobbies and finally two international lobbies facing each other. Our main results can be summarized in the following, First, We show that the formation an international green lobby is almost always beneficial when pollution is transboundary. It is also the case when pollution local if the international green lobby and the domestic lobbies have comparable strengths. Second, we show that cooperation between the domestic producer lobbies could be welfare enhancing only when pollution is transboundary and the domestic green lobbies are significantly more powerful than the international producer lobby. Finally, competition between an international green lobby and an international producer lobby over environmental regulation in both countries have similar results to the case where only an international green lobby is formed, revealing that the effect of cooperation between the greens dominates that of cooperation between the industrialists.

The main message of the present analysis is the following. Lobbying creates a political distortion in that the preferences of the special interest groups are over-represented in the objective function of the governments. This inefficiency can interact with that of uncoordinated environmental policies to approach the policy outcome of an international environmental agreement maximizing the welfare of both countries. This is the case in case of transboundary pollution if green lobbies are sufficiently strong. This is also the case when pollution is purely local on the condition that producer and green lobbies in the two countries have similar influence. In fact, lobbying acts as strategic delegation mechanism by modifying the social welfare weights in the objective function of the governments. This mechanism can be Pareto-improving or Pareto-impairing depending on the relative strength of the two lobbies, and the nature of strategic interactions between governments that itself depends on the strategic interactions between firms and the pollution externality.

The rest of the paper is organized as follows. Section 3.2 surveys the related literature. Section 3.3 presents the general framework. In Section 3.4, we examine the impact of the influence of domestic producer and green lobbies on social welfare by using functional forms for the utility function of consumers and the damage function. In Section 3.5, we redo the analysis but for international lobbying and finally, Section 3.6 concludes the paper.

3.2 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 their 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 trans-boundary. 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 an 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 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 imperfect 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.

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

¹This 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.

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 lobbying on strategic environmental policies and with imperfect world markets.

3.3 The model: Political economy framework

Consider a reciprocal-markets model with two countries, Home (country 1) and Foreign (country 2). In each region there is a single firm producing a polluting product. Let q and q^* , the quantities consumed in the Home and Foreign markets respectively. Production results in polluting emissions, E and E^* respectively the Home and Foreign countries, that cause environmental damage.

Before specifying the political game, let us define a measure of welfare for each country as the sum of consumer surplus ($CS(q)$ or $CS(q^*)$), profit of the domestic firm (π or π^*), tax revenues ($T = te_1$ or $T^* = t^*e_2$) minus environmental damage ($D(E)$ or $D(E^*)$). For the Home country, let us write welfare as follows:

$$W = CS(q) + \pi + te_1 - D(E). \quad (3.1)$$

Similarly, welfare in the Foreign country is given by:

$$W^* = CS(q^*) + \pi^* + t^*e_2 - D(E^*) \quad (3.2)$$

In each country, a government decides over its own emissions tax rate (t and t^* respectively the Home and Foreign countries) 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 $C^P(t, t^*)$ and $C^{P^*}(t, t^*)$ for the Home and the Foreign firm respectively, contingent on the environmental tax set by the government of its country, given the tax rate set by the other country. 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 lobby in each country is denoted $C^G(t, t^*)$ and $C^{G^*}(t, t^*)$ for the domestic and foreign lobby respectively.

The population in each country is normalized to 1. We consider that there are three types of agents in each country: consumers, firm owners and environmentalists. Their proportions in the Home country are respectively: $\bar{\alpha}$, $\bar{\mu}$ and $\bar{\lambda}$, such that $\bar{\alpha} + \bar{\mu} + \bar{\lambda} = 1$ and $\bar{\alpha}^*$, $\bar{\mu}^*$ and $\bar{\lambda}^*$ in the Foreign country such that $\bar{\alpha}^* + \bar{\mu}^* + \bar{\lambda}^* = 1$. Following Aidt (2005), we assume that a proportion μ_L of the firm owners $\bar{\mu}$ and a proportion λ_L of the environmentalists $\bar{\lambda}$ form respectively the producer and the green lobby in the Home country. Similarly a proportion μ_L^* of the firm owners $\bar{\mu}^*$ and a proportion λ_L^* of the environmentalists $\bar{\lambda}^*$ form respectively the producer and the green lobby in the Foreign country.

We also assume that 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 $\mu\pi(t, t^*)$ and $\mu^*\pi^*(t, t^*)$, with $\mu = \frac{\mu_L}{\bar{\mu}}$ and $\mu^* = \frac{\mu_L^*}{\bar{\mu}^*}$. Similarly, the payoffs of the green lobbies in the two countries are $-\lambda D(E(t, t^*))$ and $-\lambda^* D(E^*(t, t^*))$, with $\lambda = \frac{\lambda_L}{\bar{\lambda}}$ and $\lambda^* = \frac{\lambda_L^*}{\bar{\lambda}^*}$.

Let us denote $W(t, t^*)$ and $W^*(t, t^*)$ the social welfare functions in the home and foreign countries respectively. Since the firms compete in both countries and consumers express demands in both the domestic and the imported good, expressions (3.1) and (3.2) depend on Home and Foreign tax rates (t and t^*).² Following Grossman and Helpman (1994), the two governments choose their tax rates simultaneously so as to maximize a weighted sum

²detailed explanation with the model specifications is available in section 3.4.

of the contributions received and social welfare given by respectively (3.1) for the Home country and (3.2) for the Foreign country. Therefore, the government in the Home country chooses the tax rate t on emissions to maximize:

$$G(t, t^*) = \theta W(t, t^*) + (1 - \theta)[C^P(t, t^*) + C^G(t, t^*)] \quad (3.3)$$

where $\theta \in [\frac{1}{2}, 1]$ (resp. $1 - \theta$) is the weight put on welfare (on contributions) and similarly, the government in the Foreign country chooses the tax rate t^* on emissions to maximize:

$$G^*(t, t^*) = \theta^* W(t, t^*) + (1 - \theta^*)[C^{P^*}(t, t^*) + C^{G^*}(t, t^*)] \quad (3.4)$$

where θ^* is the weight put on welfare in the payoff of government.³

As usual in the literature (Grossman and Helpman, 1994), we focus on "truthful" equilibria such that the marginal change in a lobby's contribution equal the marginal effect on its welfare. We thus have, for the Home country lobbies,

$$\begin{aligned} C_t^P(t, t^*) &= \mu \pi_t(t, t^*) \\ C_t^G(t, t^*) &= \lambda D'(E) E_t(t, t^*) \end{aligned} \quad (3.5)$$

and for the Foreign country lobbies,

$$\begin{aligned} C_{t^*}^{P^*}(t, t^*) &= \mu^* \pi_{t^*}^*(t, t^*) \\ C_{t^*}^{G^*}(t, t^*) &= \lambda^* D'^*(E^*) E_{t^*}^*(t, t^*). \end{aligned} \quad (3.6)$$

It follows that that the equilibrium tax rates t and t^* result from the following maximiza-

³By setting θ and θ^* equal or greater than $\frac{1}{2}$, we assume that governments value welfare at least as much as political contributions.

tion programs, for the Home country government

$$\max_t G(t, t^*; \theta, \mu, \lambda) = \theta[CS(t, t^*) + T(t, t^*)] + (\mu(1 - \theta) + \theta)\pi(t, t^*) - (\lambda(1 - \theta) + \theta)D(E(t, t^*)) \quad (3.7)$$

using $W(t, t^*) = CS(t, t^*) + \pi(t, t^*) + T(t, t^*) - D(E(t, t^*))$. Similarly, we obtain for the Foreign country government:

$$\max_{t^*} G^*(t, t^*; \theta^*, \mu^*, \lambda^*) = \theta^*[CS^*(t, t^*) + T^*(t, t^*)] + (\mu^*(1 - \theta^*) + \theta^*)\pi^*(t, t^*) - (\lambda^*(1 - \theta^*) + \theta^*)D(E^*(t, t^*)) \quad (3.8)$$

At a Nash equilibrium in tax rates, the following two conditions must hold:

$$\begin{aligned} G_t(t, t^*; \theta, \mu, \lambda) &= 0 \\ G_{t^*}^*(t, t^*; \theta^*, \mu^*, \lambda^*) &= 0 \end{aligned}$$

Totally differentiating this system, we have

$$\begin{pmatrix} G_{tt} & G_{tt^*} \\ G_{t^*t}^* & G_{t^*t^*}^* \end{pmatrix} \begin{pmatrix} dt \\ dt^* \end{pmatrix} = - \begin{pmatrix} G_{tx} \\ 0 \end{pmatrix} dx - \begin{pmatrix} 0 \\ G_{t^*x^*}^* \end{pmatrix} dx^*$$

where $x \in \{\theta, \mu, \lambda\}$ and $x^* \in \{\theta^*, \mu^*, \lambda^*\}$. It follows that

$$\begin{aligned} \frac{dt}{dx} &= - \frac{G_{t^*t^*}^* G_{tx}}{\Delta} \\ \frac{dt}{dx^*} &= \frac{G_{tt^*} G_{t^*x^*}^*}{\Delta} \end{aligned}$$

where $\Delta = G_{tt}G_{t^*t^*}^* - G_{tt^*}G_{t^*t}^* > 0$ by concavity and stability of the Nash equilibrium in taxes.

Observe that the stability condition and the concavity of the government objective functions in tax rates (i.e. $G_{tt} < 0$ and $G_{t^*t^*}^* < 0$) implies that $\frac{dt}{dx}$ has the same sign as G_{tx} . Note that $G_{t\mu} = (1 - \theta)\pi_t(t, t^*) < 0$ since the profit function decreases in tax rate t and furthermore, $G_{t\lambda} = -(1 - \theta)D'(E)E_t(t, t^*) > 0$ since $E_t(t, t^*) < 0$ and $D'(\cdot) > 0$. Intuitively,

the producer lobbies push for lower tax rates on emissions while green lobbies push for higher tax rates. Obviously, the sign of $G_{t^*\mu^*}^*$ and $G_{t^*\lambda^*}^*$ are similar in the Foreign country and this allows to state the following result.

Proposition 1. *An increase in the strength of the green lobby (producer lobby) in one country leads to raise (diminish) the domestic tax rate and to diminish (raise) the foreign tax rate if tax rates are strategic substitutes (i.e. $G_{tt^*} < 0$ and $G_{t^*t}^* < 0$). Conversely, an increase in the strength of the green lobby (producer lobby) in one country leads to raise (diminish) both tax rates in the two countries if tax rates are strategic complements (i.e. $G_{tt^*} > 0$ and $G_{t^*t}^* > 0$).*

Clearly, the nature of the tax competition game between the two regions is of utmost importance to explain the role of the different lobbies that compete in influence. As we will see in the next section, the nature of pollution, whether local or transboundary, is a key element in determining the nature of strategic interactions in taxes between governments.

Up to this level, the equilibrium in taxes is expressed with respect to three parameters: $\hat{t}(\theta, \lambda, \mu)$ and $\hat{t}^*(\theta^*, \lambda^*, \mu^*)$. To proceed with the rest of the analysis, we reduce the number of parameters to the following two: $\tilde{\lambda} = \frac{\theta+(1-\theta)\lambda}{\theta}$ and $\tilde{\mu} = \frac{\theta+(1-\theta)\mu}{\theta}$, they represent respectively the relative weight of the environmental damage and firm's surplus to the rest of the welfare components (i.e., consumer surplus and tax revenue).⁴ $\tilde{\lambda}$ ($\tilde{\mu}$) is at its minimal value for $\theta = 1$ and/or $\lambda = 0$ ($\mu = 0$) and it reaches its maximal value for $\theta = \frac{1}{2}$ and $\lambda = 1$ ($\mu = 1$). As a result $\tilde{\lambda} \in [1, 2]$ and $\tilde{\mu} \in [1, 2]$. This notation allow us to simplify the model and therefore derive clearer results.

With these new notations, the maximization programs introduced in (3.7) and (3.8) become:

$$\max_t G(t, t^*; \tilde{\mu}, \tilde{\lambda}) = [CS(t, t^*) + T(t, t^*)] + \tilde{\mu}\pi(t, t^*) - \tilde{\lambda}D(E(t, t^*)), \quad (3.9)$$

and

$$\max_{t^*} G^*(t, t^*; \tilde{\mu}^*, \tilde{\lambda}^*) = [CS^*(t, t^*) + T^*(t, t^*)] + \tilde{\mu}^*\pi^*(t, t^*) - \tilde{\lambda}^*D(E^*(t, t^*)) \quad (3.10)$$

⁴An increase in $\tilde{\mu}$ ($\tilde{\lambda}$) is due to an increase in μ (λ) and/or a decrease in θ .

3.4 Specification and Analysis

3.4.1 Preferences, production and market structure

Consider a reciprocal-markets model with two countries, Home (country 1) and Foreign (country 2). In each country there is a single firm producing a differentiated product, indexed by $i = 1, 2$. Let q_1 and q_1^* the production for respectively the Home and Foreign markets. Similarly, q_2 designates the quantity exported by the foreign firm to the Home country and q_2^* is the quantity produced for the Foreign market. We abstract from any transportation cost between the two regions.

Demand originates from a quadratic and quasi-linear utility function for a representative consumer in each region (Medrano and Vives, 2001), i.e., for country 1,

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

where m is the consumption of the numeraire good, $q = (q_1, q_2)$ where q_1 is the production of the home firm for local consumption and q_2 the quantity exported by the foreign firm to country 1. Also, $\beta \in [0, 1]$ is a measure of product differentiation. For simplicity, we assume that $\beta = 1$ so that the good is homogenous, and that $\alpha = 1$. The utility of the representative consumer in the foreign country is similar with q_i being replaced by q_i^* for $i = 1, 2$.

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

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

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

$$CS(q) = \frac{1}{2}(q_1^2 + q_2^2) + q_1 q_2. \quad (3.11)$$

Consumer surplus in the Foreign country is defined similarly as follows:

$$CS(q^*) = \frac{1}{2}(q_1^{*2} + q_2^{*2}) + q_1^* q_2^*. \quad (3.12)$$

Concerning production and for simplicity, let us assume that both firms share the same technology and that there are no fixed costs of production, and that the marginal cost of production is constant so that we can set it to 0. Production is polluting but emissions denoted e_i for $i = 1, 2$ can be reduced through some abatement technology. More precisely, the production cost is for firm i :

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

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 where t (resp. t^*) is the tax on emissions in the Home country (in the Foreign country). The home firm profit thus writes:

$$\pi(q_1, q_1^*; q_2, q_2^*) = p(q)q_1 + p^*(q^*)q_1^* - te_1 - c(a_1) \quad (3.13)$$

and the Foreign firm profit writes:

$$\pi^*(q_2, q_2^*; q_1, q_1^*) = p^*(q^*)q_2^* + p(q)q_2 - t^*e_2 - c(a_2). \quad (3.14)$$

We consider that the competition is Cournot 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 in quantities and abatement efforts:

$$\hat{q}_1 = \frac{1}{3}(1 - 2t + t^*); \quad \hat{q}_1^* = \frac{1}{3}(1 + t^* - 2t); \quad \hat{a}_1 = t \quad (3.15)$$

$$\hat{q}_2 = \frac{1}{3}(1 - 2t^* + t); \quad \hat{q}_2^* = \frac{1}{3}(1 + t - 2t^*); \quad \hat{a}_2 = t^* \quad (3.16)$$

Substituting these expressions into profit functions (3.13) and (3.14), we denote the equilibrium profits as $\pi(t, t^*) \equiv \pi(\hat{q}_1, \hat{q}_1^*; \hat{q}_2, \hat{q}_2^*)$ and $\pi^*(t, t^*) \equiv \pi^*(\hat{q}_2, \hat{q}_2^*; \hat{q}_1, \hat{q}_1^*)$. For further reference, we also refer to $T(t, t^*) \equiv t\hat{e}_1(t, t^*)$ as the equilibrium *tax revenue/burden* in the Home country and similarly $T^*(t, t^*) = t^*\hat{e}_2(t, t^*)$ for the Foreign country. We proceed similarly for equilibrium consumer surplus $CS(t, t^*)$ and $CS^*(t, t^*)$ obtained by replacing quantities by their equilibrium values in (3.11) and (3.12).

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 Home country and d a parameter that belongs to $\{0, 1\}$. When $d = 1$ then emissions are perfectly transboundary causing global pollution, and when $d = 0$ emissions are purely local causing local environmental damage. Similarly in the Foreign country, $E^* = e_2 + de_1$ is the pollution level with the same parameter d and we posit the same damage function specification. 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.

3.4.2 Benchmark frameworks

It will be useful in the analysis to follow to compare our tax competition game under lobbying with two benchmark frameworks. In this two benchmark frameworks, we consider that lobbies are not involved in the setting of the environmental policies. The difference between the two chosen benchmark frameworks, is the nature of interaction between the governments in setting their environmental taxes. We first consider that each government set its environmental tax non cooperatively, second, we consider the full cooperation between the Home and Foreign country in deciding about their environmental policies.

3.4.2.1 Non cooperative equilibrium

We first characterize the non cooperative tax equilibrium. The Home and the Foreign countries maximize $W(t, t^*)$ and $W^*(t, t^*)$ respectively.

At a Nash equilibrium in tax rates (\hat{t}, \hat{t}^*) , the following two conditions must hold:

$$\begin{aligned} G_t(\hat{t}, \hat{t}^*) &= \frac{1}{9} \left[(-4(\hat{t} + 14\hat{t}^* - 4)d^2 + (28(\hat{t} - 53\hat{t}^* + 10)d - 63\hat{t} + 13\hat{t}^* + 10) \right] = 0, \\ G_{t^*}(\hat{t}, \hat{t}^*) &= \frac{1}{9} \left[(-4\hat{t}^* + 14(\hat{t} - 4)d^2 + (28\hat{t}^* - 53(\hat{t} + 10)d - 63\hat{t}^* + 13\hat{t} + 10) \right] = 0. \end{aligned} \quad (3.17)$$

Solving the system of the FOCs yields the following environmental taxes:

$$\hat{t}^{NC} = \hat{t}^{*NC} = \frac{2(2d^2 - 5d - 5)}{10d^2 - 25d - 52}. \quad (3.18)$$

The environmental taxes are strategic substitutes and equal to $\hat{t}^{NC} = \hat{t}^{*NC} = \frac{16}{67}$ when the pollution is global ($d = 1$). They are strategic complements and equal to $\hat{t}^{NC} = \hat{t}^{*NC} = \frac{5}{26}$ when the pollution is local ($d = 0$).⁵

3.4.2.2 Cooperative equilibrium

Next, we study the cooperative equilibrium. The full cooperation between the two governments requires that the governments maximize the joint welfare of the Home and Foreign countries $W(t, t^*) + W^*(t, t^*)$. At the equilibrium in tax rates (\hat{t}, \hat{t}^*) , the following two conditions must hold:

$$\begin{aligned} G_t(\hat{t}, \hat{t}^*) &= \frac{1}{9} \left[(-53\hat{t} + 28\hat{t}^* + 10)d^2 + (56\hat{t} - 106\hat{t}^* + 20) - 64\hat{t} + 26\hat{t}^* + 8 \right] = 0, \\ G_{t^*}(\hat{t}, \hat{t}^*) &= \frac{1}{9} \left[(-53\hat{t}^* + 28\hat{t} + 10)d^2 + (56\hat{t}^* - 106\hat{t} + 20) - 64\hat{t}^* + 26\hat{t} + 8 \right] = 0. \end{aligned} \quad (3.19)$$

Solving the system of the FOCs yields the following environmental taxes:

$$\hat{t}^C = \hat{t}^{*C} = \frac{2(5d^2 + 10d + 4)}{25d^2 + 50d + 38}. \quad (3.20)$$

When pollution is local ($d = 0$), the taxes are strategic complements and are equal to $\hat{t}^C = \hat{t}^{*C} = \frac{4}{19}$. When pollution is global ($d = 1$), they are strategic complements and equal

⁵The cross derivatives are given by: $G_{tt^*} = G_{t^*t} = -\frac{1}{9} [1 + (2 - 7d)(2d - 7)]$.

to $\hat{t}^C = \hat{t}^{*C} = \frac{38}{113}$.⁶ The cooperative equilibrium tax is greater than the non cooperative equilibrium tax in absence of lobbies. Full internalization of the cross-national externality requires cooperation between the two governments regarding their environmental policies.

At this level, after characterizing the benchmarks, we shall return back to the political game that we will solve for both types of pollution: local and transboundary.

3.4.3 Global pollution: d=1

From (3.9) and (3.10), the equilibrium environmental tax rates (\hat{t}, \hat{t}^*) must satisfy the following maximization program:

$$\begin{aligned} \frac{1}{18}[2(4 - 41\hat{t} + 7\hat{t}^*) + 10(4 - 5\hat{t} - 5\hat{t}^*)\tilde{\lambda} + 2(25\hat{t} - 8\hat{t}^* - 8)\tilde{\mu}] &= 0 \\ \frac{1}{18}[2(4 - 41\hat{t}^* + 7\hat{t}) + 10(4 - 5\hat{t}^* - 5\hat{t})\tilde{\lambda} + 2(25\hat{t}^* - 8\hat{t} - 8)\tilde{\mu}] &= 0 \end{aligned} \quad (3.21)$$

Solving the maximization program given by (3.21) yields the following equilibrium environmental tax rates in the Home and the Foreign country:⁷

$$\hat{t} = \hat{t}^* = \frac{4(2\tilde{\mu} - 5\tilde{\lambda} - 1)}{17\tilde{\mu} - 50\tilde{\lambda} - 34}. \quad (3.22)$$

The environmental taxes are strategic substitutes.^{8,9}

In order to study the effect of lobbies on general welfare in each country, we calculate the difference between the equilibrium welfare in the presence of lobbies and the equilibrium welfare in the absence of lobbies and cooperation between the home and foreign governments:

$$\hat{W}(\hat{t}, \hat{t}^*) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{8(395\tilde{\mu} + 1065\tilde{\lambda} + 6781)(45\tilde{\lambda} - 22\tilde{\mu} - 23)}{4489(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2}. \quad (3.23)$$

The sign of the difference is that of the RHS of the numerator of (3.23), we thus have the following proposition.

⁶The cross derivatives are given by: $G_{tt^*} = G_{t^*t} = \frac{1}{9} [28d^2 - 106d + 26]$.

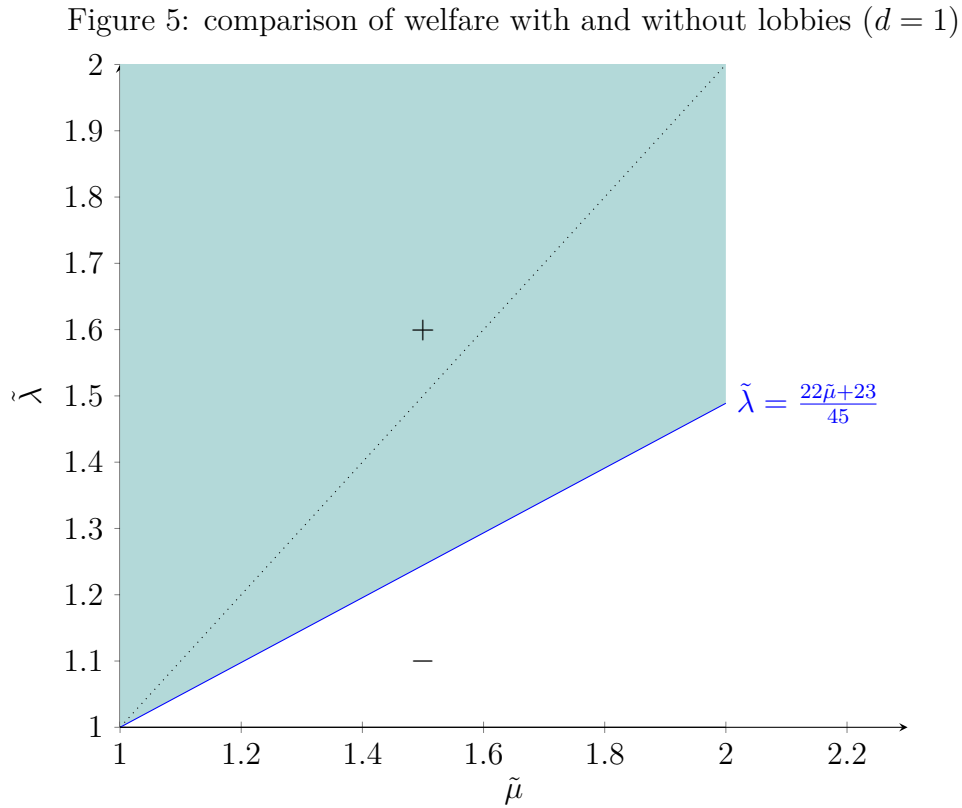
⁷The concavity of (3.9) and (3.10) for $d = 1$ is always verified.

⁸The cross derivative is given by: $G_{tt^*} = \frac{7-8\tilde{\mu}-25\tilde{\lambda}}{9} \leq 0$.

⁹The taxes are always lower than 1 which ensures positive equilibrium quantities

Proposition 2: *When the pollution is global and in the presence of domestic lobbies:*

- *The environmental taxes are strategic substitutes;*
- *The introduction of lobbies enhances the general welfare if and only if $\tilde{\lambda} \geq \frac{23+22\tilde{\mu}}{45}$ and deteriorates it otherwise.*



This result states that the introduction of lobbies could be welfare enhancing under certain conditions regarding the powers of the lobbies and the degree of benevolence of the government. 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 \hat{t}^{NC} and \hat{t}^{*NC} towards \hat{t}^C and \hat{t}^{*C} , then we will certainly witness an improvement in 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.¹⁰ According to the second part of proposition 2, if the green lobby is more powerful than the industrial lobby, which is captured by the condition $\tilde{\lambda} \geq \frac{23+22\tilde{\mu}}{45}$, the presence of lobbies push the environmental taxes in the desired direction (towards the cooperative taxes). As a result, overall pollution is reduced and social welfare is enhanced. By contrast, when $\tilde{\lambda} \leq \frac{23+22\tilde{\mu}}{45}$, which is true if $\tilde{\mu}$ is greater than $\tilde{\lambda}$.¹¹ Specifically, this condition states that, for a given value of θ (i.e., degree of benevolence of the policy maker), if the producer lobby is more powerful than the the green lobby, the environmental tax could fall bellow the non cooperative tax rate (i.e., \hat{t}^{NC} (\hat{t}^{*NC})), leading to more pollution in both countries and, consequently, a deterioration in social welfare.

Note that the tax in the presence of lobbies does not rise too much and does not exceed the cooperative tax. Indeed, setting a very stringent environmental policy is not the most 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 extremely powerful compared to the producer lobby (i.e., great values of $\tilde{\lambda}$), the environmental tax will not exceed the cooperative tax \hat{t}^C .

3.4.4 Local pollution: $d=0$

The equilibrium environmental tax rates (\hat{t}, \hat{t}^*) must satisfy the following maximization program:

$$\begin{aligned} \frac{1}{18}[2(4 - 41\hat{t} + 7\hat{t}^*) + 14(2 - 7\hat{t} + 2\hat{t}^*)\tilde{\lambda} + 2(25\hat{t} - 8\hat{t}^* - 8)\tilde{\mu}] &= 0 \\ \frac{1}{18}[2(4 - 41\hat{t}^* + 7\hat{t}) + 14(2 - 7\hat{t}^* + 2\hat{t})\tilde{\lambda} + 2(25\hat{t}^* - 8\hat{t} - 8)\tilde{\mu}] &= 0. \end{aligned} \quad (3.24)$$

Solving the maximization program in (3.24) yields the following equilibrium tax rates:¹²

$$\hat{t} = \hat{t}^* = \frac{2(4\tilde{\mu} - 7\tilde{\lambda} - 2)}{17\tilde{\mu} - 35\tilde{\lambda} - 34}. \quad (3.25)$$

¹⁰The non cooperative tax \hat{t}^{NC} is greater than the tax with lobbies \hat{t}^* when the difference (3.23) is negative. The opposite holds when the difference is positive.

¹¹Note that the negative zone is located to the right of the first bisector in figure 5 (i.e., $\tilde{\mu} > \tilde{\lambda}$)

¹²The concavity of (3.9) and (3.10) for $d = 0$ is always verified.

The environmental taxes are strategic complements.¹³ Recall that in the absence of lobbies, the environmental taxes are also strategic complements. Therefore, allowing lobbies into the environmental policies setting does not change the nature of the strategic interactions between the governments regarding the pollution tax rates. Since the political pressure stage occurs before the tax competition between governments, we can expect lobbies to anticipate the nature of the strategic interactions and shape their lobbying strategies accordingly.¹⁴

In order to study the effect of lobbies on general welfare, we calculate the difference between the equilibrium welfare in the presence of lobbies and the equilibrium welfare in the absence of lobbies and cooperation between countries,

$$\hat{W}(\hat{t}, \hat{t}^*) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{(63\tilde{\lambda} - 41\tilde{\mu} - 22)(677\tilde{\mu} - 987\tilde{\lambda} + 622)}{676(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2}. \quad (3.26)$$

The discussion of the sign of the difference depends on the sign of the two terms of the numerator: $(63\tilde{\lambda} - 41\tilde{\mu} - 22)$ and $(677\tilde{\mu} - 987\tilde{\lambda} + 622)$. The difference is positive if the two expressions are of the same sign. More specifically, we have the following proposition.

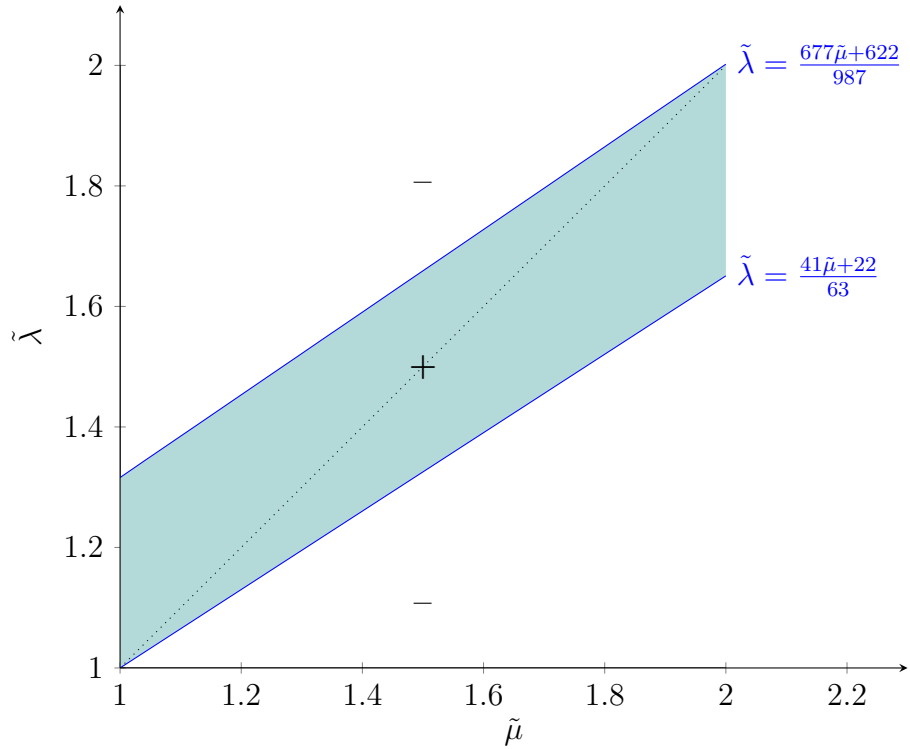
Proposition 3: *When the pollution is local and in the presence of domestic lobbies:*

- *The environmental taxes are strategic complements;*
- *The introduction of lobbies enhances the general welfare if and only if when $\frac{41\tilde{\mu}+22}{63} \leq \tilde{\lambda} \leq \frac{677\tilde{\mu}+622}{987}$.*

¹³The cross derivative is given by: $G_{tt^*} = \frac{7-8\tilde{\mu}+14\tilde{\lambda}}{9} \geq 0$.

¹⁴The taxes are always lower than 1 which ensures positive equilibrium quantities.

Figure 6: comparison of welfare with and without lobbies ($d = 0$)



To interpret the result of proposition 3, one must first understand what happens in the absence of lobbies with and without cooperation. When the Home country and the Foreign country set their environmental policies independently, each government considers only the pollution caused by local firms. It does not have to worry about the impact of its decision on the other country's pollution, because it does not suffer from it. Its reasoning is mainly focused on increasing the competitiveness of the domestic firm while minimizing 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, while depending on the degree of benevolence of the policymaker.

The condition in the second part of the proposition 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 is quite similarly influential to 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, the effect of a stronger green lobby on the environmental tax is greater than the effect of a more powerful industrial lobby (i.e., $\frac{\partial \hat{t}}{\partial \tilde{\lambda}} \geq |\frac{\partial \hat{t}}{\partial \tilde{\mu}}|$). Therefore, even if the environmental lobby is slightly less powerful than the industrial lobby, we can still witness the Pareto-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 ($\hat{t}^{NC} = \hat{t}^{*NC}$) toward the cooperative equilibrium environmental policies ($\hat{t}^C = \hat{t}^{*C}$). As presented in the RHS of figure 6, if the producer lobby is significantly more powerful than the the green lobby, the social welfare levels in both countries decline. We can also see from the LHS of figure 6 that the same result holds if the green lobby is significantly more influential than the producer lobby. The underlying explanation is that a more powerful industrial lobby relative to the green lobby, will induce a decrease in the environmental taxes bellow the non cooperative equilibrium taxes resulting in a deterioration of welfare.¹⁵ Similarly, 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. Indeed the home government here is not concerned by foreign pollution; If the domestic green lobby is very powerful, this could 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. Specifically, 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.¹⁶ 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.

¹⁵The environmental tax \hat{t} is lower than the non cooperative tax \hat{t}^{NC} for $\tilde{\lambda} \leq \frac{41\tilde{\mu}+22}{63}$, which is represented by the RHS non colored area in figure 6.

¹⁶The environmental tax \hat{t} is greater than the cooperative tax \hat{t}^C for $\tilde{\lambda} \geq \frac{14\tilde{\mu}+10}{21}$, which is represented by the upper part of the colored area and the non colored area in figure 2.

Comparing the welfare analysis for both types of pollution shows that when pollution is transboundary and the green lobby is more powerful than the producer lobby, we do not witness a loss of welfare in contrast to the case of local pollution. To understand this, let first recall that each government is facing two market failures that pull in opposite directions: under-production due to the duopoly pricing and over-production due to pollution, which is worsened when $d = 1$. Indeed, in 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-national pollution externality, could still be better than the non cooperative tax as it generates a greater welfare compared to the non cooperative benchmark. The loss in consumer surplus and the firm's profit can be offset by the reduction of the environmental damage until a certain level of the tax. If, however, the tax rises significantly above the cooperative tax, the reduction of pollution damage can no longer offset the losses in other welfare components because it worsens the under-production due to the duopoly pricing.

When pollution is global, we have shown in proposition 2 that the environmental taxes are strategic substitutes. An increase in domestic environmental tax causes a decrease in the environmental tax abroad, resulting in more damage from foreign pollution. Since the lobbying game takes place before the environmental policies setting by governments and the market game between the firms, lobbies decide about their lobbying strategies anticipating the nature of the strategic interactions in taxes between governments and in quantities between the firms. Specifically, the domestic green lobby does not pressure for a significantly strict environmental policy anticipating that the 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 one hand they do not suffer from foreign pollution and on the other hand the taxes are strategic complements.

3.5 International lobbying

In this section, we push our analysis a step further by assuming that the domestic lobbies can cooperate and form international lobbies to pressure both governments regarding the setting of the environmental policies. The reason behind this assumption is that domestic lobby groups are not only impacted by national government, but also by the decision of the other country. Therefore, they have incentive to cooperate under the form of international pressure groups to join forces, in an attempt to influence the other governments into adopting the desired environmental policies.

We consider three different scenarios of lobbying that we compare to the the previous section. First, we assume that the green lobbies in each country can cooperate and form an international green lobby. Second, we assume the that the two domestic industrial lobbies manage to cooperate and form an international industrial lobby in order to influence the two governments in the political competition stage, while still competing in the market stage. And finally we assume that the two governments are influenced by an international green lobby and an international industrial lobby. Similar to the previous section, the governments set their taxes unilaterally, no cooperation takes place between them.

Each international lobby is the result of merger between the two domestic lobbies, hence the net welfare of each international lobby is the sum of the gross welfare of the national lobbies minus the contributions offered to both governments:

$$W^{IG}(t, t^*) = -\lambda[D(E(t, t^*)) + D(E^*(t, t^*))] - C^{IG} - C^{*IG}, \quad (3.26a)$$

$$W^{IP}(t, t^*) = \mu[\pi(t, t^*) + \pi^*(t, t^*)] - C^{IP} - C^{*IP}, \quad (3.26b)$$

where C^{IG} (C^{IP}) and C^{*IG} (C^{*IP}) represent the political contributions offered by the international green lobby (IG) and the international producer lobby (IP) to the home and foreign governments. In the following sections, we use the superscripts IG ($*IG$) when the governments are influenced by an international green lobby and two domestic producer lobbies, IP ($*IP$) when they are influenced by an international producer lobby and two domestic

green lobbies and IL ($*IL$) when they are influenced by an international green lobby and an international producer lobby.

3.5.1 International green lobby

In this section, we consider the case of an international green lobby facing a domestic industrial lobby in each country. This setting is slightly different from the common agency model characterised in section 3.2. In fact, the international lobby (principal) offer contributions to both governments (two agents), and the domestic lobby (principal) offer contributions to the national government (agent). Formally, the game between the international lobbies and the governments is a multiple principal multiple agent game. The solution to this type of games was first characterized by Prat and Rustichini (1999).

From Proposition 1 of Prat and Rustichini (1999) and Lemma 3 of Aidt and Hwang (2008), the following characterization of a pure strategy in the home country is adopted.¹⁷

Proposition 4 (Prat and Rustichini, 1999 and Aidt and Hwang, 2008):

*A set of feasible non-negative contribution schedules $\{\hat{C}^{IG}, \hat{C}^{*IG}, \hat{C}^P\}$ and an environmental tax \hat{t}^{IG} constitute an equilibrium response to t^* if the following conditions are satisfied:*

Condition 1 (C1):

$$\hat{t}^{IG} = \arg \max_t W(t, t^*) + \frac{1 - \theta}{\theta} [C^P(t) + C^{IG}(t, t^*)], \quad (3.27)$$

where $W(t, t^*)$ is given in (3.1). This condition is the same as in proposition 1 of Grossman and Helpman (1994) and it states that the equilibrium environmental tax should maximize a weighted sum of the welfare international green lobby and that of the domestic producer lobby and social welfare.

Condition 2 (C2):

For the international green lobby, there cannot be a feasible contributions schedules $C^{IG}(t, t^)$,*

¹⁷The same applies for the foreign country.

$C^{*IG}(t, t^*)$ and an environmental tax \tilde{t}^{IG} such that: (i)

$$\tilde{t}^{IG} = \arg \max_t \theta W(t, t^*) + (1 - \theta) [C^P(t) + C^{IG}(t, t^*)], \quad (3.28a)$$

and (ii)

$$\begin{aligned} & -\lambda [D(E(\tilde{t}^{IG}, t^*)) + D(E^*(\tilde{t}^{IG}, t^*))] - C^{IG}(\tilde{t}^{IG}, t^*) - C^{*IG}(\tilde{t}^{IG}, t^*) \\ & > -\lambda [D(E(\hat{t}^{IG}, t^*)) + D(E^*(\hat{t}^{IG}, t^*))] - C^{IG}(\hat{t}^{IG}, t^*) - C^{*IG}(\hat{t}^{IG}, t^*) \end{aligned} \quad (3.28b)$$

For the domestic producer lobby, there cannot be a feasible contributions schedules $C^P(t)$ and an environmental tax \tilde{t}^P such that: (i)

$$\tilde{t}^P = \arg \max_t \theta W(t, t^*) + (1 - \theta) [C^P(t) + C^{IG}(t, t^*)], \quad (3.29a)$$

and (ii)

$$-\mu\pi(\tilde{t}^P, t^*) - C^P(\tilde{t}^P, t^*) > -\mu\pi(\hat{t}^P, t^*) - C^P(\hat{t}^P, t^*) \quad (3.29b)$$

This condition is the incentive compatibility and states that both the international green lobby and the domestic producer lobby cannot find a contribution schedule that provides higher payoff than its equilibrium schedule, given the equilibrium schedule of the other lobby.

Condition 3 (C3):

The international green lobby offers a cost minimizing contribution schedule to Home and Foreign governments, i.e., for $i \in \{H, F\}$:

$$W_i(\hat{t}^{IG}, t^*) + \frac{1 - \theta}{\theta} [\hat{C}_i^P(\hat{t}^{IG}) + \hat{C}_i^{IG}(\hat{t}^{IG}, t^*)] = \max_t \left[W_i(t, t^*) + \frac{1 - \theta}{\theta} C_i^P(t) \right] \quad (3.30)$$

This last condition is additional to the classic model of Grossman and Helpman (1994). It ensures that the marginal costs of buying influence from the Home and Foreign governments are equal.

Proof: See Lemma 3 in Aidt and Hwang (2008). \square

From **C1** and **C2**, we have that at the equilibrium the environmental tax rate t^{IG} must maximize both, the joint welfare of the international green lobby and the two governments that are subject to its influence and the joint welfare of the domestic producer lobby and the domestic government. As a result and given that the welfare of the international green lobby is given by (3.26a) and that of the domestic producer lobby is given by (3.5), the equilibrium \hat{t}^{IG} must maximize the following:

$$\begin{aligned} \hat{t}^{IG} = \arg \max_t & -\lambda [D(E(t, t^*)) + D(E^*(t, t^*))] - \hat{C}^{IG}(t; t^*) - \hat{C}^{*IG}(t^*; t) \\ & + W(t, t^*) + \frac{1-\theta}{\theta} [\hat{C}^{IG}(t; t^*) + \hat{C}^P(t)] + W^*(t, t^*) + \frac{1-\theta}{\theta} [\hat{C}^{*IG}(t^*; t) + \hat{C}^{*P}(t^*)] \end{aligned} \quad (3.31a)$$

$$\hat{t}^{IG} = \arg \max_t \mu \pi(t, t^*) - \hat{C}^P(t) + W(t, t^*) + \frac{1-\theta}{\theta} [\hat{C}^{IG}(t; t^*) + \hat{C}^P(t)] \quad (3.32b)$$

The FOCs associated with the previous maximization problem are:

$$-\lambda \frac{\partial(D + D^*)}{\partial t^{IG}} - \left[\frac{\partial \hat{C}^{IG}}{\partial t^{IG}} + \frac{\partial \hat{C}^{*IG}}{\partial t^{IG}} \right] + \frac{\partial W^*}{\partial t^{IG}} + \frac{1-\theta}{\theta} \left[\frac{\partial \hat{C}^{*P}}{\partial t^{IG}} + \frac{\partial \hat{C}^{*IG}}{\partial t^{IG}} \right] = 0 \quad (3.32a)$$

$$\mu \frac{\partial \pi}{\partial t^{IG}} - \frac{\partial \hat{C}^P}{\partial t^{IG}} = 0 \quad (3.32b)$$

Adding up the two previous FOCs results in:

$$\mu \frac{\partial \pi}{\partial t^{IG}} - \lambda \frac{\partial(D + D^*)}{\partial t^{IG}} + \frac{\partial W^*}{\partial t^{IG}} + \frac{1-\theta}{\theta} \frac{\partial \hat{C}^{*IG}}{\partial t^{IG}} - \left[\frac{\partial \hat{C}^{IG}}{\partial t^{IG}} + \frac{\partial \hat{C}^{*IG}}{\partial t^{IG}} + \frac{\partial \hat{C}^P}{\partial t^{IG}} \right] = 0 \quad (3.33)$$

The cost minimization condition in **C3** is such that the international green lobby offers contribution to both governments so that the implementation of \hat{t}^{IG} is minimized. From (3.30) The best response of the international green lobby to the given contribution of domestic producer lobby must satisfy:

$$\hat{C}^{IG}(t, t^*) = \left\{ \max_t \left[\hat{C}^P(t^{IG}) + \frac{1-\theta}{\theta} W(t^{IG}, t^{*IG}) \right] \right\} - \left\{ \hat{C}^P(t) + \frac{1-\theta}{\theta} W(t, t^*) \right\}, \quad (3.34)$$

the LHT is a constant evaluated at equilibrium. As a result the cost minimization imposes the following conditions on the international green lobby:

$$\begin{aligned}\frac{\partial \hat{C}^{IG}}{\partial t^{IG}} &= -\frac{\partial \hat{C}^P}{\partial t^{IG}} - \frac{\theta}{1-\theta} \frac{\partial W}{\partial t^{IG}}, \\ \frac{\partial \hat{C}^{*IG}}{\partial t^{IG}} &= -\frac{\theta}{1-\theta} \frac{\partial W^*}{\partial t^{IG}}.\end{aligned}\tag{3.35}$$

Substituting (3.35) into (3.33) we get:¹⁸

$$\frac{(1-\theta)\mu}{\theta} \frac{\partial \pi}{\partial t^{IG}} - \frac{(1-\theta)\mu}{\theta} \left[\frac{\partial(D+D^*)}{\partial t^{IG}} \right] + \frac{\partial W}{\partial t^{IG}} + \frac{\partial W^*}{\partial t^{IG}} = 0\tag{3.36}$$

Adopting the similar parameters' notations to the previous section, i.e., $\tilde{\mu} = \frac{(1-\theta)\mu+\theta}{\theta}$ and $\tilde{\lambda} = \frac{(1-\theta)\lambda+\theta}{\theta}$, it follows that the equilibrium tax rates of the Home and Foreign countries are characterized by the solution to the following system:

$$\begin{aligned}\tilde{\mu} \frac{\partial \pi(\widehat{t}^{IG})}{\partial t} - \tilde{\lambda} \frac{\partial [D(\widehat{t}^{IG}) + D^*(\widehat{t}^{IG})]}{\partial t} + \frac{\partial [CS(\widehat{t}^{IG}) + CS^*(\widehat{t}^{IG})]}{\partial t} + \frac{\partial [T(\widehat{t}^{IG}) + T^*(\widehat{t}^{IG})]}{\partial t} + \frac{\partial \pi^*(\widehat{t}^{IG})}{\partial t} &= 0, \\ \tilde{\mu} \frac{\partial \pi^*(\widehat{t}^{IG})}{\partial t} - \tilde{\lambda} \frac{\partial [D(\widehat{t}^{IG}) + D^*(\widehat{t}^{IG})]}{\partial t} + \frac{\partial [CS(\widehat{t}^{IG}) + CS^*(\widehat{t}^{IG})]}{\partial t} + \frac{\partial [T(\widehat{t}^{IG}) + T^*(\widehat{t}^{IG})]}{\partial t} + \frac{\partial \pi(\widehat{t}^{IG})}{\partial t} &= 0,\end{aligned}\tag{3.37}$$

where $\widehat{t}^{IG} = (\hat{t}^{IG}, \hat{t}^{*IG})$. 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, but we focus on the analysis from a social welfare perspective. To proceed with the welfare analysis, we shall stress the type of pollution like we did in section 3.4, i.e., specifying the value of $d = \{0, 1\}$.

¹⁸Substituting (3.35) into (3.32a) and (3.32b) shows that the contributions are indeed truthful, i.e., the marginal change in the political contributions resulting from a change in the environmental tax is exactly equal to the marginal change in the gross welfare of each lobby:

$$\begin{aligned}\frac{\partial \hat{C}^{IG}}{\partial t^{IG}} + \frac{\partial \hat{C}^{*IG}}{\partial t^{IG}} &= -\lambda \frac{\partial(D+D^*)}{\partial t^{IG}}, \\ \frac{\partial \hat{C}^P}{\partial t^{IG}} &= \mu \frac{\partial \pi}{\partial t^{IG}}.\end{aligned}$$

3.5.1.1 Global pollution: $d=1$

The pollution is global and uniformly distributed between the two countries, i.e., $d = 1$.

Using the model specifications given in section 3.4, the system described in (3.37) becomes:

$$\begin{aligned} \frac{1}{9}[\tilde{\mu}(-8\hat{t}^{IG} + 25\hat{t}^{*IG} - 8) - \tilde{\lambda}(5\hat{t}^{*IG} + 50\hat{t}^{IG} - 40) - 36\hat{t}^{IG} + 6\hat{t}^{*IG} + 6] &= 0, \\ \frac{1}{9}[\tilde{\mu}(-8\hat{t}^{*IG} + 25\hat{t}^{IG} - 8) - \tilde{\lambda}(50\hat{t}^{IG} + 50\hat{t}^{*IG} - 40) - 36\hat{t}^{*IG} + 6\hat{t}^{IG} + 6] &= 0, \end{aligned} \quad (3.38)$$

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

$$\hat{t}^{IG} = \hat{t}^{*IG} = \frac{2(4\tilde{\mu} - 20\tilde{\lambda} - 3)}{17\tilde{\mu} - 100\tilde{\lambda} - 30}. \quad (3.39)$$

These environmental taxes could be strategic substitutes or strategic complements.¹⁹ Comparing this result with the one presented in proposition 2 shows that the cooperation between the two domestic green lobbies can change the nature of the strategic interactions in taxes.²⁰ In order to study the effect of this type of lobbies on general welfare, we calculate the difference between the equilibrium welfare in the presence of lobbies and the equilibrium welfare in the absence of lobbies and cooperation between countries, we then have:

$$\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{2(180\tilde{\lambda} - 44\tilde{\mu} - 13)(790\tilde{\mu} + 4260\tilde{\lambda} + 8849)}{4489(17\tilde{\mu} - 100\tilde{\lambda} - 30)^2}, \quad (3.40)$$

which is always positive.

In order to compare the effect of domestic lobbying on social welfare and the effect of allowing an international green lobby, we calculate the difference between (3.40) and (3.23) which simplifies to $\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}(\hat{t}, \hat{t}^*)$:

$$-\frac{2(10\tilde{\mu}\tilde{\lambda} - 11\tilde{\mu} + 110\tilde{\lambda} + 14)(1462\tilde{\mu}^2 - 9510\tilde{\mu}\tilde{\lambda} + 12000\tilde{\lambda}^2 + 937\tilde{\mu} - 11970\tilde{\lambda} - 6818)}{(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2(17\tilde{\mu} - 100\tilde{\lambda} - 30)^2}. \quad (3.41)$$

¹⁹The cross derivative is equal to: $\frac{1}{9}(25\tilde{\mu} - 50\tilde{\lambda} + 6)$. It is positive for $\tilde{\lambda} < \frac{\tilde{\mu}}{2} + \frac{3}{25}$ and negative otherwise.

²⁰The taxes are always lower than 1 which ensures positive equilibrium quantities.

When the expression above is positive, forming an international green lobby is better than two domestic lobbies, each operating independently in one country.

Combining the results in (3.40) and (3.41) we have the following proposition:

Proposition 5: *When the pollution is global and an international green lobby is formed:*

- *The environmental taxes are strategic complements if $\tilde{\lambda} \leq \frac{15\tilde{\mu}-3}{25}$ and strategic substitutes otherwise;*
- *The social welfare is always enhanced compared to the non cooperative benchmark between governments without lobbies;*
- *The social welfare is improved compared to the case of two domestic green lobbies if the following sufficient condition is verified: $\tilde{\lambda}_1 \in [1, 1.98]$.*²¹

Cooperation between national green lobbies always enhances social welfare compared to the non cooperative benchmark case without lobbies. This improvement in social welfare is a direct result of an increase in the taxes towards the cooperative tax rates \hat{t}^C . The underlying explanation is that the international green lobby cares about the environmental damage in both countries and prefers more strict environmental policies, which is reflected in its political contributions schedules to the home and foreign governments. This create an asymmetry in the favor of the greens in the objective function of the two policy-makers. As a result, an international green lobby can induce the improvement of social welfare for certain values of $\tilde{\lambda}$ and $\tilde{\mu}$ that the domestic green lobbies cannot. Put differently, one international green lobby is more effective than two domestic green lobbies in raising the non cooperative taxes \hat{t}^{NC} toward the cooperative taxes \hat{t}^C .

²¹The difference in (3.41) is positive for $\tilde{\lambda} < \tilde{\lambda}_1(\tilde{\mu})$, where the expression of $\tilde{\lambda}_1(\tilde{\mu})$ is given by:

$$\tilde{\lambda}_1(\tilde{\mu}) = \frac{317\tilde{\mu}}{800} + \frac{399}{800} + \frac{\sqrt{202641\tilde{\mu}^2 + 1826934\tilde{\mu} + 4705449}}{2400}.$$

$\tilde{\lambda}_1$ is increasing in $\tilde{\mu}$, its minimum value is obtained at $\tilde{\mu} = 1$, i.e., $\tilde{\lambda} \geq \tilde{\lambda}_1(1) = 1.98$ and it reaches its maximum value $\tilde{\lambda}_1 = 2$ at $\tilde{\mu} = 1.04$. Therefore (3.41) is negative (i.e., competition between the greens is better than cooperation) if $\tilde{\lambda}_1 \in [1.98, 2]$, which is also equivalent to $\tilde{\mu} \in [1, 1.04]$.

From the condition stated in the last part of proposition 5, we can clearly see that cooperation between the two domestic green lobbies is almost always more profitable than competition. As discussed earlier, since the pollution is global, each domestic green lobby wants a more strict 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 \hat{t}^{IG} (\hat{t}^{*IG}) internalizes more efficiently the cross-national pollution externality. In other words, competition between the two domestic lobbies is more profitable than their cooperation only when the weight attached to the environmental damage is extremely high ($\tilde{\lambda} \in [1.98, 2]$). This is an extreme condition, because for it to be verified two things must be true: the green lobby must be extremely powerful, i.e., almost all environmentalists in both countries must be organized ($\lambda \approx 1$), and the governments must attribute the minimum possible weight to social welfare ($\theta \approx \frac{1}{2}$). Seen from the side of the industrialists, this extreme condition indicates that cooperation between the domestic green lobbies could be more welfare-improving than competition if domestic producer lobbies exist even if they hold limited power ($\tilde{\mu} \geq 1.04$).

In fact, the equilibrium \hat{t}^{IG} (\hat{t}^{*IG}) is stricter than the equilibrium with domestic green lobbies. Therefore for greater values of $\tilde{\lambda}$ ($\tilde{\lambda} \geq 1.98$) and extremely lower values of $\tilde{\mu}$ ($\tilde{\mu} \leq 1.04$), the taxes \hat{t}^{IG} (\hat{t}^{*IG}) rise much beyond the cooperative taxes \hat{t}^C (\hat{t}^{*C}) compared to the case with domestic lobbies, which certainly leads to lower environmental damage but at the expense of the other welfare components (consumer surplus and firm's profit). The result is a deterioration of social welfare compared to the case of competition between national green lobbies.

3.5.1.2 Local pollution: $d=0$

Using the model specifications given in section 3.4, the system described in (3.37) becomes:

$$\begin{aligned} \frac{1}{9}[\tilde{\mu}(53\hat{t}^{IG} - 28\hat{t}^{*IG} - 10) - \tilde{\lambda}(35\hat{t}^{*IG} + 35\hat{t}^{IG} - 28) - 36\hat{t}^{IG} + 6\hat{t}^{*IG} + 6] &= 0, \\ \frac{1}{9}[\tilde{\mu}(53\hat{t}^{*IG} - 28\hat{t}^{IG} - 10) - \tilde{\lambda}(35\hat{t}^{IG} + 35\hat{t}^{*IG} - 28) - 36\hat{t}^{*IG} + 6\hat{t}^{IG} + 6] &= 0, \end{aligned} \quad (3.42)$$

which yields the following environmental taxes:

$$\hat{t}^{IG} = \hat{t}^{*IG} = \frac{2(4\tilde{\mu} - 5\tilde{\lambda} - 3)}{17\tilde{\mu} - 25\tilde{\lambda} - 30}. \quad (3.43)$$

These taxes are strategic complements.²² Comparing this result with the one presented in proposition 3 shows that the cooperation between the two domestic green lobbies does not change the nature of the strategic interactions in taxes.²³ 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:

$$\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}^{NL}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{(677\tilde{\mu} - 705\tilde{\mu} + 142)(45\tilde{\lambda} - 41\tilde{\mu} + 2)}{676(17\tilde{\mu} - 25\tilde{\lambda} - 30)^2}. \quad (3.44)$$

This difference is positive for $\frac{41\tilde{\mu}-2}{45} \leq \tilde{\lambda} \leq \frac{677\tilde{\mu}+142}{705}$.

In order to compare the effect of domestic lobbying only and the effect of allowing an international green lobby, we calculate the difference between (3.26) and (3.44) which simplifies to $\hat{W}(\hat{t}^{IG}, \hat{t}^{*IG}) - \hat{W}(\hat{t}, \hat{t}^*)$:

$$\frac{4(2\tilde{\mu}\tilde{\lambda} + 11\tilde{\mu} - 5\tilde{\lambda} - 14)(476\tilde{\mu}^2 - 1452\tilde{\mu}\tilde{\lambda} + 1050\tilde{\lambda}^2 - 709\tilde{\lambda} + 855\tilde{\lambda} - 334)}{(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2(17\tilde{\mu} - 25\tilde{\lambda} - 30)^2}. \quad (3.45)$$

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

Comparing the results in (3.44) and (3.45), we have the following proposition:

²²The cross-derivative is given by: $\frac{1}{9}(-8\tilde{\mu} + 28\tilde{\lambda} + 6) > 0$.

²³The taxes are lower than 1, which ensures positive equilibrium quantities.

Proposition 6: *When the pollution is local and an international green lobby is 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 $\frac{41\tilde{\mu}-2}{45} \leq \tilde{\lambda} \leq \frac{677\tilde{\mu}+142}{705}$;*
- *The social welfare is improved compared to the case of two domestic lobbies if:*

$$- \tilde{\mu} < \frac{43}{28} \text{ and } \tilde{\lambda}_2 \leq \tilde{\lambda} \leq \tilde{\lambda}_3;$$

$$- \tilde{\mu} > \frac{43}{28} \text{ and } \tilde{\lambda}_3 \leq \tilde{\lambda} \leq \tilde{\lambda}_2.^{24}$$

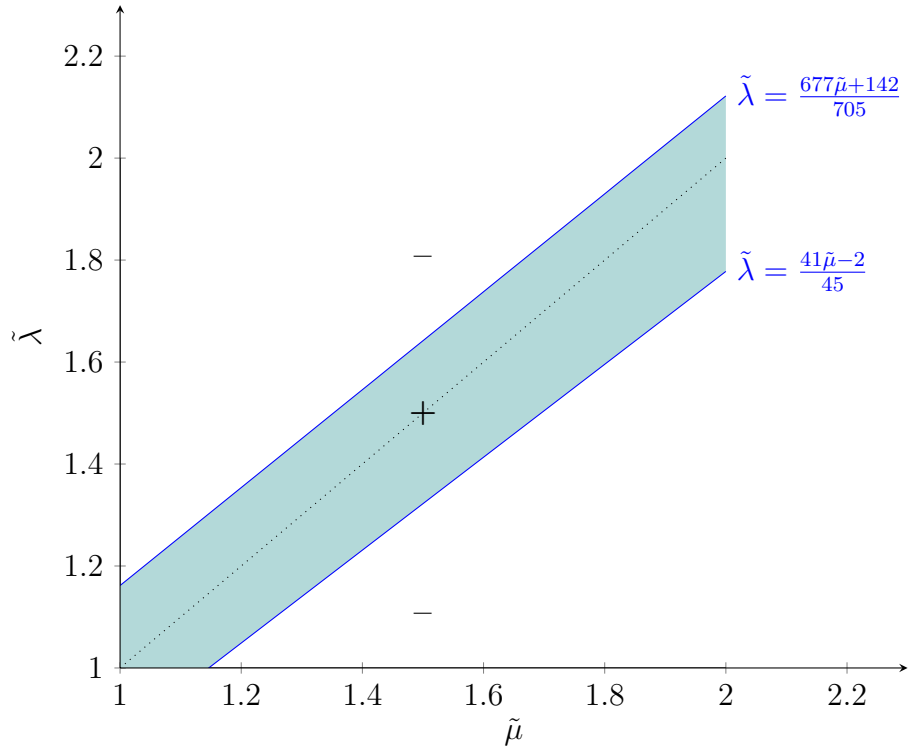
Cooperation between the domestic green lobbies does not change the nature of the strategic interactions in taxes between governments. Moreover, the effect of cooperation is the same as that of competition on social welfare. In fact, as shown in figure 7, there is an intermediate zone representing powers of lobbies for which Pareto-improvement takes place. This intermediate zone represents lobbies with comparable powers. Hence, the improvement of social welfare occurs when the international green lobby and the domestic producer lobbies are of similar strengths. If this last point is verified, the competition between the international green lobby and the domestic producer lobbies manages to push the non-cooperative taxes towards the cooperative taxes or even a little beyond it, without reducing welfare.

²⁴The expressions of $\tilde{\lambda}_2$ and $\tilde{\lambda}_3$ are given by:

$$\tilde{\lambda}_2 = \frac{14 - 11\tilde{\mu}}{2\tilde{\mu} - 5},$$

$$\tilde{\lambda}_3 = \frac{121\tilde{\mu}}{175} - \frac{57}{140} + \frac{\sqrt{109104\tilde{\mu}^2 + 494880\tilde{\mu} + 2133825}}{2100}.$$

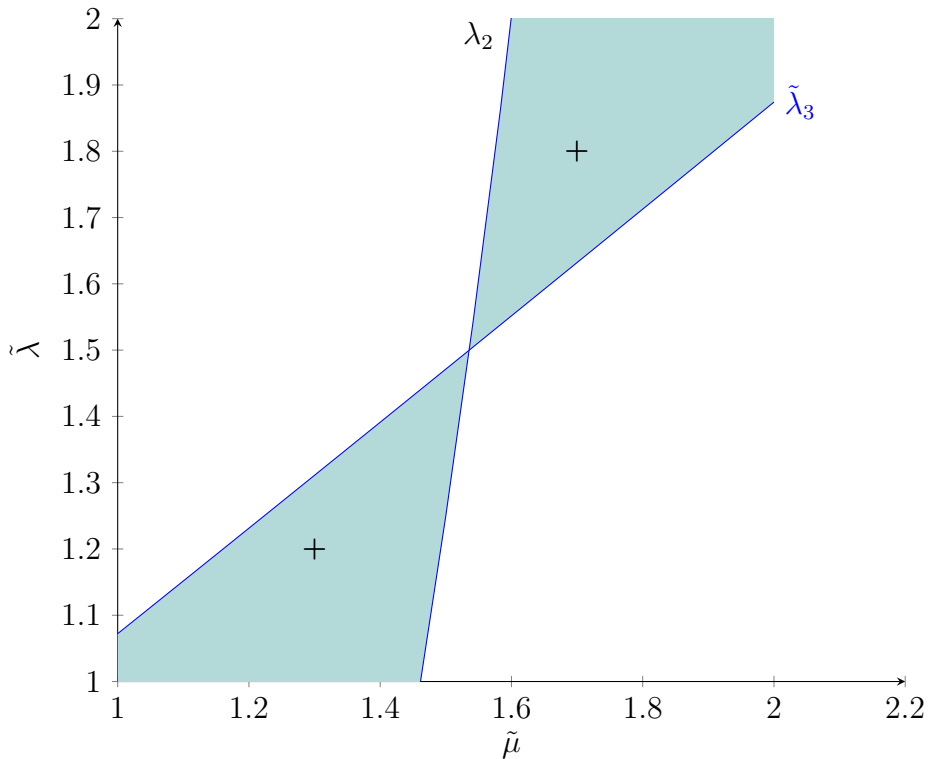
Figure 7: comparison of welfare with and without lobbies ($d = 0$)



What makes the difference between cooperation and competition between domestic green lobbies is that cooperation generates a downward shift in the intermediate (colored) zone representing welfare improvement (figure 6). To understand this, recall that even if pollution is local, each domestic green lobby wants a stricter environmental policy at home and abroad. The reason for this is the nature of the strategic interactions in taxes between governments. Indeed, as taxes are strategic complements, a stricter environmental policy abroad generates a similar result at home. Without cooperation between the greens, their interests are not represented in the foreign government political decision because they only lobby their national government. Therefore, with the formation of the international green lobby, each government takes into account the interests of the greens in the other country in its political calculus, as they are reflected in the political contributions offered by the international green lobby. This strengthens the position of the greens compared to the case where they do not coordinate their lobbying efforts. As a result, for the same level of influence/power $\tilde{\lambda}$, the effect of the international green lobby on the policy is greater than that

of the domestic green lobbies. Therefore, to prevent the taxes from raising far beyond the cooperative level and worsening the under-production externality leading to deterioration of welfare, the domestic producer lobbies need to be more influential than the case where the greens do not cooperate.

Figure 8: comparison of welfare with domestic lobbies and with an international green lobby



Finally, for cooperation between the green lobbies to be more welfare-improving than the competition, the international green lobby and the domestic producer lobby must be of comparable power as shown by the colored zones in figure 8. More specifically, cooperation is more profitable from a social welfare perspective when both the international lobby and the domestic producer lobbies are very weak or very strong.

3.5.2 International producer lobby

In this section we consider the case of an international producer lobby (IP) facing a domestic green lobby in each country. Allowing the two firms to cooperate at the lobbying level while

still competing at the market level is a reasonable assumption, as markets are often subject to antitrust laws that control or prohibit mergers in order to limit the power of producers on the markets. Following the same three conditions presented in the proposition 4, the equilibrium tax rates of the home and foreign countries $\widehat{t}^{IP} = (\hat{t}^{IP}, \hat{t}^{*IP})$ are characterized by the solution to the following system:

$$\begin{aligned} \tilde{\mu} \frac{\partial[\pi(\widehat{t}^{IP}) + \pi^*(\widehat{t}^{IP})]}{\partial t} - \tilde{\lambda} \frac{\partial D(\widehat{t}^{IP})}{\partial t} + \frac{\partial[CS(\widehat{t}^{IP}) + CS^*(\widehat{t}^{IP})]}{\partial t} + \frac{\partial[T(\widehat{t}^{IP}) + T^*(\widehat{t}^{IP})]}{\partial t} + \frac{\partial D^*(\widehat{t}^{IP})}{\partial t} &= 0 \\ \tilde{\mu} \frac{\partial[\pi(\widehat{t}^{IP}) + \pi^*(\widehat{t}^{IP})]}{\partial t} - \tilde{\lambda} \frac{\partial D^*(\widehat{t}^{IP})}{\partial t} + \frac{\partial[CS(\widehat{t}^{IP}) + CS^*(\widehat{t}^{IP})]}{\partial t} + \frac{\partial[T(\widehat{t}^{IP}) + T^*(\widehat{t}^{IP})]}{\partial t} + \frac{\partial D(\widehat{t}^{IP})}{\partial t} &= 0. \end{aligned} \quad (3.46)$$

3.5.2.1 Global pollution: $d=1$

Substituting in (3.46) by the specific functional forms described in section 3.4 for $d = 1$ we get:

$$\begin{aligned} \frac{1}{9}[\tilde{\mu}(29\hat{t}^{IP} - 16\hat{t}^{*IP} - 4) - \tilde{\lambda}(25\hat{t}^{*IP} + 2\hat{t}^{IP} - 20) - 15\hat{t}^{IP} + 39\hat{t}^{*IP} - 18] &= 0, \\ \frac{1}{9}[\tilde{\mu}(29\hat{t}^{*IP} - 16\hat{t}^{IP} - 4) - \tilde{\lambda}(25\hat{t}^{IP} + 25\hat{t}^{*IP} - 20) - 15\hat{t}^{*IP} + 39\hat{t}^{IP} - 18] &= 0. \end{aligned} \quad (3.47)$$

Solving the previous system results on the following environmental taxes:

$$\hat{t}^{IP} = \hat{t}^{*IP} = \frac{2(2\tilde{\mu} - 10\tilde{\lambda} + 9)}{13\tilde{\mu} - 50\tilde{\lambda} + 24} \quad (3.48)$$

These tax rates are always strategic substitutes.^{25,26}

In order to study the effect of this type of lobbies on general welfare, we calculate 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, we then have:

$$\hat{W}(\hat{t}^{IP}, \hat{t}^{*IP}) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{2(2086\tilde{\mu} - 2130\tilde{\lambda} - 9577)(10\tilde{\mu} - 90\tilde{\lambda} + 137)}{4489(13\tilde{\mu} - 50\tilde{\lambda} + 24)^2} \quad (3.49)$$

²⁵The cross derivative is given by: $\frac{-1}{9}(16\tilde{\mu} + 25\tilde{\lambda} - 39) < 0$ and it is always negative.

²⁶The taxes are lower than 1 which ensures positive equilibrium quantities.

The difference is positive for $\tilde{\lambda} \geq \frac{10\tilde{\mu}+137}{90}$;

In order to compare the effect of domestic lobbying only and the effect of allowing an international producer lobby, we calculate the difference between (3.49) and (3.23) which simplifies into $\hat{W}(\hat{t}^{IP}, \hat{t}^{*IP}) - \hat{W}(\hat{t}, \hat{t}^*)$:

$$\frac{2(6\tilde{\mu}^2 - 20\tilde{\mu}\tilde{\lambda} - 5\tilde{\mu} - 10\tilde{\lambda} + 86)(440\tilde{\mu}^2 - 3600\tilde{\mu}\tilde{\lambda} + 6000\tilde{\lambda}^2 + 6269\tilde{\mu} - 15750\tilde{\lambda} + 2998)}{(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2(13\tilde{\mu} - 50\tilde{\lambda} + 24)^2}. \quad (3.50)$$

When the difference is positive, the formation of an international producer lobby is socially more beneficial to the Home and Foreign countries.

From (3.49) and (3.50) we have the following proposition:

Proposition 7: *When the pollution is global and an international producer lobby is formed:*

- *The environmental taxes are strategic substitutes;*
- *The social welfare is enhanced compared to the non cooperative benchmark between governments without lobbies if and only if $\tilde{\lambda} \geq \frac{10\tilde{\mu}+137}{90}$;*
- *The social welfare is always deteriorated compared to the case of two domestic lobbies.*

The formation of an international producer lobby does not change the strategic interactions in taxes compared to the non cooperative without lobbies benchmark. Understanding the reason behind the welfare improvement requires analysing the strategies of both lobbies. First, each firm wants a strict environmental policy abroad and a low environmental policy at home. By forming an international producer lobby, the interests of each foreign firm become present in the political calculus of both governments. Second and as explained in section 3.4, each domestic green lobby wants a strict environmental policy at home, but because pollution is global and the taxes are strategic substitutes, the greens strategy is to not pressure for extremely high pollution taxes. Indeed, by pressuring the home government into setting a very high environmental policy, the foreign government best response is to

lower its tax which leads to more foreign pollution and thus more damage. As a result, the environmental tax \hat{t}^{IP} (\hat{t}^{*IP}) can exceed the non cooperative tax if the domestic green lobbies are very powerful ($\tilde{\lambda} \geq 1.63$), resulting in an improvement of welfare.²⁷ Similarly to the case of two producer domestic lobbies, the taxes \hat{t}^{IP} (\hat{t}^{*IP}) do not exceed the cooperative taxes \hat{t}^C (\hat{t}^{*C}).

The formation of the international producer lobby requires significant influence from the domestic green lobbies for the tax to move toward the cooperation and hence improve social welfare in both countries. As a result, we can state that the formation of an international producer lobby reduces the possibilities for welfare improvement compared to the case of two domestic lobbies. Therefore, competition between domestic producer lobbies is always better than cooperation.

3.5.2.2 Local pollution: $d=0$

Using the model specifications described in section 3.4 for $d = 0$, we get the following system of FOCs:

$$\begin{aligned} \frac{1}{9}[\tilde{\mu}(29\hat{t}^{IP} - 16\hat{t}^{*IP} - 4) - \tilde{\lambda}(-14\hat{t}^{*IP} + 49\hat{t}^{IP} - 14) - 36\hat{t}^{IP} + 6] &= 0, \\ \frac{1}{9}[\tilde{\mu}(29\hat{t}^{*IP} - 16\hat{t}^{IP} - 4) - \tilde{\lambda}(-14\hat{t}^{IP} + 49\hat{t}^{*IP} - 14) - 36\hat{t}^{*IP} + 6] &= 0. \end{aligned} \quad (3.51)$$

Solving this system yields the following environmental taxes:

$$\hat{t}^{IP} = \hat{t}^{*IP} = \frac{2(2\tilde{\mu} - 7\tilde{\lambda} - 3)}{13\tilde{\mu} - 35\tilde{\lambda} - 36}. \quad (3.52)$$

These tax rates could be strategic complements or substitutes.^{28, 29}

The difference between the equilibrium welfare in the presence of lobbies and the equilibrium

²⁷The expression $\frac{10\tilde{\mu}+137}{90}$ is increasing $\tilde{\mu}$, its minimum value is given at $\tilde{\mu} = 1$ and it is equal to $\tilde{\lambda} = 1.63$.

²⁸The cross derivative is given by: $\frac{1}{9}(-16\tilde{\mu} + 14\tilde{\lambda})$, which is positive for $\tilde{\lambda} \geq \frac{8\tilde{\mu}}{7}$.

²⁹The taxes are always lower than 1, which ensures positive equilibrium quantities.

welfare in the absence of lobbies and cooperation between countries is given by:

$$\hat{W}(\hat{t}^{IP}, \hat{t}^{*IP}) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{(63\tilde{\lambda} - 13\tilde{\mu} - 8)(169\tilde{\mu} - 987\tilde{\lambda} + 368)}{676(13\tilde{\mu} - 35\tilde{\lambda} - 36)^2}. \quad (3.53)$$

The difference is always negative.

In order to compare the effect of domestic lobbying only and the effect of allowing an international producer lobby, we calculate the difference between (3.26) and (3.53) which simplifies into $\hat{W}(\hat{t}^{IP}, \hat{t}^{*IP}) - \hat{W}(\hat{t}, \hat{t}^*)$:

$$\frac{20(2\tilde{\mu} + 1)(-7\tilde{\lambda} - 10 + 3\tilde{\mu})(50\tilde{\mu}^2 - 252\tilde{\mu}\tilde{\lambda} + 294\tilde{\lambda}^2 - 85\tilde{\mu} + 189\tilde{\lambda} - 106)}{(13\tilde{\mu} - 35\tilde{\lambda} - 36)^2(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2}. \quad (3.54)$$

Combining (3.53) and (3.54) we get the following proposition:

Proposition 8: *When the pollution is local and an international producer lobby is formed:*

- *The environmental taxes are strategic complements if $\tilde{\lambda} \geq \frac{8\tilde{\mu}}{7}$ and strategic substitutes otherwise;*
- *The social welfare is always deteriorated compared to the non cooperative without lobbies benchmark;*
- *The social welfare is improved compared to the case of two domestic lobbies if $\tilde{\lambda} \leq \tilde{\lambda}_4$.³⁰*

The impact of the formation of an international producer lobby on the social welfare is always negative compared to the non cooperative without lobbies benchmark. The reason behind this result is that the environmental tax \hat{t}^{IP} (\hat{t}^{*IP}) is always stricter than the cooperative tax that would fully internalize the cross-national externality. This result is due to two major reasons: first and as discussed earlier in section 3.4, since pollution is local, domestic green lobbies pressure aggressively the governments for stricter environmental policies. Second, since the two firms are competing, each one of them would like a

³⁰ $\tilde{\lambda}_4 = \frac{3\tilde{\mu}}{7} - \frac{9}{28} + \frac{\sqrt{96\tilde{\mu}^2 + 96\tilde{\mu} + 3273}}{84}$.

stricter environmental policy abroad, hence by forming the international producer lobby, each government internalizes the special interests of the foreign firm in its political calculus. Intuitively, the combination of these two reasons leads to stricter environmental policies in both countries. But surprisingly enough, these pollution taxes are greater than the cooperative taxes. Indeed, the two firms realize more profit if they cooperate instead of competing on the market stage, except that they cannot. But since the international producer lobby represents the interests of both firms, it uses lobbying to pressure for greater environmental taxes with the objective of simulating (mimicking) a result close or similar to what they could have achieved if the two firms had cooperated and resulted in a cartel or an international monopoly, which results in worsening the under-production externality, hence the deterioration in social welfare. Put differently, the international producer lobby uses environmental lobbying for greater taxes in both countries as a commitment device for the firms to (fully or partially) exert the monopoly pricing.

Cooperation between the two domestic producer lobbies cannot be more profitable than the competition unless the latter is more welfare deteriorating. In fact, when domestic producer lobbies are very powerful relative to the domestic green lobbies, the environmental tax falls way below the non cooperative tax leading to a deterioration in social welfare that is more important than the deterioration caused by the increase in the tax beyond the cooperative benchmark policy caused by cooperation between the industrialists. According to the condition stated in the last point of proposition 8, this case occurs when the international producer lobby are much more influential than the domestic green lobbies.

3.5.3 International green and producer lobbies

In this section, we analyze the case where both greens and industrialists cooperate and form, respectively, an international green lobby and an international producer lobby that compete against each other in both countries, hence lobbying is exclusively international (IL). Following the same three conditions presented in the section 3.5.1, the equilibrium tax rates of the home and foreign countries $\widehat{t^{IL}} = (\hat{t}^{IL}, \hat{t}^{*IL})$ are characterized by the solution to

the following system:

$$\begin{aligned} \tilde{\mu} \frac{\partial[\pi(\widehat{t}^{IL}) + \pi^*(\widehat{t}^{IL})]}{\partial t} - \tilde{\lambda} \frac{\partial[D(\widehat{t}^{IL}) + D^*(\widehat{t}^{IL})]}{\partial t} + \frac{\partial[CS(\widehat{t}^{IL}) + CS^*(\widehat{t}^{IL})]}{\partial t} + \frac{\partial[T(\widehat{t}^{IL}) + T^*(\widehat{t}^{IL})]}{\partial t} &= 0 \\ \tilde{\mu} \frac{\partial[\pi(\widehat{t}^{*IL}) + \pi^*(\widehat{t}^{*IL})]}{\partial t} - \tilde{\lambda} \frac{\partial[D(\widehat{t}^{*IL}) + D^*(\widehat{t}^{*IL})]}{\partial t} + \frac{\partial[CS(\widehat{t}^{*IL}) + CS^*(\widehat{t}^{*IL})]}{\partial t} + \frac{\partial[T(\widehat{t}^{*IL}) + T^*(\widehat{t}^{*IL})]}{\partial t} &= 0. \end{aligned} \quad (3.55)$$

3.5.3.1 Global pollution: $d=1$

Using the model specifications described in section 3.4 for $d = 1$, we get the following system of FOCs:

$$\begin{aligned} \frac{1}{9}[\tilde{\mu}(-16\hat{t}^{IL} + 29\hat{t}^{*IL} - 4) - \tilde{\lambda}(50\hat{t}^{*IL} + 50\hat{t}^{IL} - 40) - 40\hat{t}^{IL} + 14\hat{t}^{*IL} + 2] &= 0, \\ \frac{1}{9}[\tilde{\mu}(-16\hat{t}^{*IL} + 29\hat{t}^{IL} - 4) - \tilde{\lambda}(50\hat{t}^{IL} + 50\hat{t}^{*IL} - 40) - 40\hat{t}^{*IL} + 14\hat{t}^{IL} + 2] &= 0. \end{aligned} \quad (3.56)$$

Solving this system yields the following environmental taxes:

$$\hat{t}^{IL} = \hat{t}^{*IL} = \frac{2(2\tilde{\mu} - 20\tilde{\lambda} - 1)}{13\tilde{\mu} - 100\tilde{\lambda} - 26}. \quad (3.57)$$

These tax rates are strategic complements.^{31,32}

The difference between the equilibrium welfare in the presence of international lobbies and the equilibrium welfare in the absence of lobbies and cooperation between countries is given by:

$$\hat{W}(\hat{t}^{IL}, \hat{t}^{*IL}) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{2(2086\tilde{\mu} - 4260\tilde{\lambda} - 11707)(10\tilde{\mu} - 180\tilde{\lambda} + 47)}{4489(13\tilde{\mu} - 100\tilde{\lambda} - 26)^2}. \quad (3.58)$$

It is always positive.

In order to compare the effect of domestic lobbying only and the effect of allowing an international lobbying, we calculate the difference between (3.58) and (3.23) which simplifies

³¹The cross derivative is given by: $\frac{1}{9}(-16\tilde{\mu} - 50\tilde{\lambda} + 14) < 0$.

³²The taxes are always lower than 1, which ensures positive equilibrium quantities.

into $\hat{W}(\hat{t}^{LL}, \hat{t}^{*LL}) - \hat{W}(\hat{t}, \hat{t}^*)$:

$$\frac{6(2\tilde{\mu} - 10\tilde{\mu}\tilde{\lambda} - 5\tilde{\mu} - 30\tilde{\lambda} + 2)(440\tilde{\mu}^2 - 6770\tilde{\lambda}^2 + 12000\tilde{\lambda}^2 + 3099\tilde{\mu} - 14710\tilde{\lambda} - 7958)}{(13\tilde{\mu} - 100\tilde{\lambda} - 26)^2(17\tilde{\mu} - 50\tilde{\lambda} - 34)^2}. \quad (3.59)$$

Combining (3.58) and (3.59) we get the following proposition:

Proposition 9: *When the pollution is local and an international producer lobby and an international green lobby are formed:*

- *The environmental taxes are strategic substitutes;*
- *The social welfare is always enhanced compared to the non cooperative without lobbies benchmark;*
- *The social welfare is improved compared to the case of two domestic lobbies if $\tilde{\lambda} \geq \tilde{\lambda}_5$.*³³

The results in this proposition are very similar to those presented in proposition 4 (i.e., when an international green lobby faces a domestic producer lobby in each country). This shows that the effect of cooperation among the greens dominates that of cooperation among the industrialists.

Allowing cooperation between the greens and between the industrialists always enhances the situation compared to the non cooperative without lobbies, because it always allows the increase of the tax from the non cooperative equilibrium toward or even beyond the tax that would maximize the joint welfare and fully internalize the cross-national externality.

Finally and similarly to the case presented in section 5.1.1 cooperation is almost always better than competition between the lobbies, unless the international green lobby becomes extremely powerful and the international producer lobby is extremely weak (i.e., $\lambda \geq \tilde{1.98}$ and $\tilde{\mu} \leq 1.04$).

³³ $\tilde{\lambda}_5 = \frac{677\tilde{\mu}}{2400} + \frac{1471}{2400} + \frac{\sqrt{247129\tilde{\mu}^2 + 504214\tilde{\mu} + 5983681}}{2400} \in [1.98, 2]$.

3.5.3.2 Local pollution: $d=0$

Using the model specifications described in section 4 for $d = 0$, we get the following system of FOCs:

$$\begin{aligned} \frac{1}{9}[\tilde{\mu}(29\hat{t}^{IL} - 16\hat{t}^{*IL} - 4) - \tilde{\lambda}(-28\hat{t}^{*IL} + 53\hat{t}^{IL} - 10) - 40\hat{t}^{IL} + 14\hat{t}^{*IL} + 2] &= 0, \\ \frac{1}{9}[\tilde{\mu}(29\hat{t}^{*IL} - 16\hat{t}^{IL} - 4) - \tilde{\lambda}(-28\hat{t}^{IL} + 53\hat{t}^{*IL} - 10) - 40\hat{t}^{*IL} + 14\hat{t}^{IL} + 2] &= 0. \end{aligned} \quad (3.60)$$

Solving this system yields the following environmental taxes:

$$\hat{t}^{IL} = \hat{t}^{*IL} = \frac{2(2\tilde{\mu} - 5\tilde{\lambda} - 1)}{13\tilde{\mu} - 25\tilde{\lambda} - 26}. \quad (3.61)$$

These tax rates are strategic complements.^{34,35}

The difference between the equilibrium welfare in the presence of international lobbies and the equilibrium welfare in the absence of lobbies and cooperation between countries is given by:

$$\hat{W}(\hat{t}^{IL}, \hat{t}^{*IL}) - \hat{W}^{NC}(\hat{t}^{NC}, \hat{t}^{*NC}) = \frac{-(13\tilde{\mu} - 45\tilde{\lambda} + 26)(169\tilde{\mu} - 705\tilde{\lambda} + 650)}{676(13\tilde{\mu} - 25\tilde{\lambda} - 26)^2}. \quad (3.62)$$

It is positive for $\frac{13\tilde{\mu}+26}{45} \leq \tilde{\lambda} \leq \frac{169\tilde{\mu}}{705} + \frac{130}{141}$.

In order to compare the effect of domestic lobbying only and the effect of allowing an international lobbying, we calculate the difference between (3.62) and (3.26) which simplifies into $\hat{W}(\hat{t}^{IL}, \hat{t}^{*IL}) - \hat{W}(\hat{t}, \hat{t}^*)$:

$$\frac{12(2\tilde{\mu}^2 - 4\tilde{\lambda}\tilde{\mu} - 5\tilde{\mu} + 3\tilde{\lambda} + 2)(250\tilde{\mu}^2 - 1018\tilde{\mu}\tilde{\lambda} + 1050\tilde{\lambda}^2 - 183\tilde{\mu} + 421\tilde{\lambda} - 634)}{(13\tilde{\mu} - 25\tilde{\lambda} - 26)^2(17\tilde{\mu} - 35\tilde{\lambda} - 34)^2}. \quad (3.63)$$

Combining (3.62) and (3.63) we get the following proposition:

Proposition 10: *When the pollution is local and an international producer lobby and*

³⁴The cross derivative is given by: $\frac{1}{9}(-16\tilde{\mu} + 28\tilde{\lambda} + 14) > 0$.

³⁵The taxes are always lower than 1, which ensures positive equilibrium quantities.

an international green lobby are formed:

- The environmental taxes are strategic complements;
- The social welfare is enhanced compared to the non cooperative without lobbies benchmark if and only if $\frac{13\bar{\mu}+26}{45} \leq \tilde{\lambda} \leq \frac{169\bar{\mu}}{705} + \frac{130}{141}$;
- The social welfare is improved compared to the case of two domestic lobbies if $\tilde{\lambda} \leq \tilde{\lambda}_6$.³⁶

The effect of allowing two international lobbies on the social welfare is similar to that of a single international green lobby facing two domestic producer lobbies presented in figure 3, which in turn resembles the effect of two domestic lobbies in competition presented in figure 2. Again this indicates that the effect of an international green lobby dominates that of an international producer lobby. This indicates that interpretation of this result is hence similar to that of the second point of proposition 6. However, the cooperation between the greens and the industrialists generates a downward shift in the intermediate zone that shows the social welfare enhancement. Specifically, for the environmental tax not to significantly exceed the cooperative tax and lead to a deterioration in welfare, the international producer lobby need to be much more powerful compared to the international green lobby in order to keep the environmental tax below the cooperative tax or in the tolerable zone that still generates welfare improvement.

Cooperation between the greens and the industrialists is more beneficial than competition only when the international producer lobby is significantly more influential than the international green lobby. This is due to two reasons, first, when the lobbies cooperate, the tax is higher than the non-cooperative baseline tax, compared to the case when they compete, which opens up more opportunities for welfare improvement that competition could not. Second, as the international green lobby becomes more powerful, the tax increases well above the cooperative tax relative to the case where the lobbies are competing, leading to a deterioration in welfare.

³⁶ $\tilde{\lambda}_6 = \frac{-421}{2100} + \frac{509}{1050} + \frac{\sqrt{-13676\bar{\mu}^2 - 88556\bar{\mu} + 2840041}}{2100}$.

3.6 Conclusion

This chapter studies the influence of domestic and international environmental lobbying on environmental policy and social welfare in two countries linked by trade and pollution. Our results show that allowing lobbying around environmental policy can indeed be profitable from a social welfare perspective, as it helps mimicking the effect of an international environmental agreement, under certain conditions on the influence powers of the lobbies.

When only domestic lobbying is allowed, our results show that, first, when pollution is global, allowing domestic political pressure from domestic lobbies enhances social welfare in both countries if the influence of green lobbies is sufficiently strong relative to that of the producer lobbies. Second, when pollution is local, domestic lobbies can also ensure social welfare improvement if the producer lobby and the green lobby have comparable strengths, with the industrial lobby being slightly more powerful than the green.

When an international green lobby faces two producer lobbies, we show that when pollution is global, allowing an international green lobby always results in higher welfare than the case where no lobbies are allowed. Moreover, cooperation is almost always more profitable than competition between the green lobbies from a social welfare perspective. When pollution is local, the effect of cooperation between the green lobbies on social welfare is similar to that of the domestic lobbies.

Next, when an international producer lobby faces two domestic green lobbies, social welfare improvement is possible only when pollution is transboundary and the domestic green lobbies are significantly more powerful than the international producer lobby.

Finally, competition between an international green lobby and an international producer lobby over environmental regulation in both countries have similar results to the case where only an international green lobby is formed, revealing that the effect of cooperation between the greens dominates that of cooperation between the industrialists.

In future work, verifying whether the same results hold when we relax the assumptions on the market structure and on the model parameters would be interesting. One also might find it interesting to endogenize the formation of the international lobby into the model.

General conclusion

This PhD dissertation contributes to the economic literature concerning the competition between SIGs around environmental regulation. To do so, we propose three essays organized into three chapters, each approaching this research question from a different angle. More precisely, we model the different strategies used by environmental lobbies (green NGOs) and polluting industries lobby groups to influence environmental policies in their favor, with a focus on the welfare implications. Competition between those lobby groups can be recorded under the public politics or the private politics literature.

In order to avoid repetition, we will not explicitly state the totality of the results of each chapter of this thesis, since they are well detailed in the general introduction. Instead, we will focus on providing policy implications and perspectives for future research.

- **Lobbying without information provision is not always BAD!:** although it might go against what one may broadly think of lobbying,³⁷ we have shown in the third chapter of this thesis that allowing environmental lobbying from pro-environmental groups and anti-climate lobbies can improve social welfare. When countries, linked by trade and pollution, cannot cooperate regarding the setting of environmental policies (formally, joining an international environmental agreement: IEA), competition between lobbies can partially or completely simulate a similar outcome to cooperation between governments. Intuitively, this result is valid when the pollution is global, but surprisingly, it is also valid when the pollution is local. For the Pareto-improvement

³⁷Lobbying and especially environmental lobbying is often perceived as a "bad thing" by the general public as it is usually associated with "corruption". According to a study conducted by WWF France, 75% of french citizens think that lobbying is harmful to the environment (<https://www.wwf.fr/sengager-ensemble/relayer-campagnes/lobbying-a-decouvert>).

effect of lobbying to occur, some conditions on the influential strengths of the lobbies must hold. Lobbying should be a part of environmental politics. However, regulation of lobbying activities is necessary in order to avoid any drift to the detriment of the general interest and the efficiency of public policies (see, e.g., Chari et al., 2019).³⁸

- **International lobbying:** since environmental and climate problems are mostly global, it only seems natural that environmental and climate lobbying take an international dimension. In this thesis, we show that international lobbying can be beneficial from a social welfare perspective. Nevertheless, not all types of international lobbies can exhibit this Pareto-improving effect. Specifically, international green lobbies open more possibilities for welfare enhancement especially when pollution is global. Conversely, international industrial lobbies can significantly deteriorate social welfare. In fact, these lobbies could use environmental lobbying as a tool to make the industries (in oligopoly markets) they represent hold more market power, especially when pollution is local. Again, international environmental lobbying should be subject to serious regulation and more transparency is needed in order to avoid the misconduct of environmental regulation for other purposes.
- **Public persuasion tactics:** from the first and second chapters, we concluded that environmental NGOs use more aggressively strategies based on influencing the general public, whether to influence environmental policy or to induce polluting industries to adopt a pro-environmental behavior. These tactics are more favored by these lobby groups because they require less financial resources, and because they create change more rapidly. These strategies appear to be very effective, examples of success of these type of strategies are numerous, we particularly cite that of "Notre Dame des Landes airport" well detailed in chapter 1. This type of influence is to be privileged in the environmental politics arena, as it is supposedly less costly and does not creates asymmetries and biases in the favor of the wealthiest lobbies, the ones who can easily

³⁸The link <https://www.oecd.org/corruption/ethics/Lobbying-Brochure.pdf> to Transparency and integrity in lobbying report by OECD.

buy influence.

Research perspectives

This thesis could be extended in several directions. There are four particular points that seem relevant to investigate in further research.

- First, the second chapter uses general functional forms to investigate the nature of competition among lobbies in the public politics phase and how this competition might strategically shape the actions of lobbies in the private politics competition. Using a micro-founded model and specific functional forms to describe each of the equilibria presented in lemma 1 of the chapter would be a very interesting exercise to provide clearer economic interpretations.
- Second, all three essays are conducted in perfect information environment. One might wonder if the result presented in this dissertation hold if asymmetric information is introduced to the settings. For instance, in the first chapter, we can model the public persuasion stage under imperfect information between the environmental and the industrial lobbies.
- Third, some generalizations could be further developed concerning two aspects of these chapters: the market structure and the functionally specialized lobbies. Specifically, it may be interesting to check weather the main results of the three chapters remain robust if we relax the assumption of imperfect competition in the polluting good market and if we allow lobbies to be concerned with other components of social welfare.
- Fourth, it seems interesting to empirically verify the validity of the results presented in this dissertation. Specifically, one might find it interesting to empirically verify the positive impact of lobbying on social welfare as discussed in chapter 3. However, this might be difficult to conduct for two main reasons: the complexity of the theoretical settings presented in this chapter and the lack of data on lobbying.

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