

# **Environmental Policy and Transboundary Externalities**

Coordination and Commitment in Open Economies

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## Abstract

This thesis consists of an introductory chapter and four papers, which relate to environmental policy in the presence of transboundary environmental damage.

Paper [I] concerns public policy in a multi-jurisdiction framework with transboundary environmental damage. Each jurisdiction is assumed large in the sense that its government is able to influence the world-market producer price of the externality-generating good. This gives rise to additional incentives of relevance for national public policy in the non-cooperative Nash equilibrium. With the uncoordinated equilibrium as the reference case, the welfare effects from coordinated changes in public policy variables are analyzed.

Paper [II] analyses welfare effects of coordinated changes in environmental and capital taxation in the presence of transboundary environmental externalities and wage bargaining externalities. In the wage bargaining between firms and labor unions, firms use the threat of moving abroad to moderate wage claims, which means that domestic policy influences wage formation abroad. The specific framework implies welfare effects of policy coordination that correspond to each of the respective international interaction mentioned above.

In paper [III], national governments face political pressure from environmental and industrial lobby groups, while pollution taxes are determined in an international negotiation. It is shown that a general increase in the environmental concern and the weight the governments attach to social welfare both tend to increase the pollution tax. However, allowing for asymmetries between the countries means that a general increase in the environmental concern has the potential to reduce the pollution tax.

Paper [IV] studies national environmental policies in an economic federation characterized by decentralized leadership. The federal government sets emission targets for each member country, which are implemented by the national governments. Although all national governments have commitment power vis-à-vis the federal government, one of them also has commitment power vis-à-vis the other member countries. This creates incentives to act strategically toward the federal government, as well as toward other members.

**Keywords:** environmental policy, transboundary externalities, lobbying, international negotiations, policy coordination, endogenous world-market prices, optimal taxation, economic federation



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Life as a PhD student has its ups and downs, but on the whole it is an amazing journey that you wouldn't miss for the world. One of the myriad benefits of being a PhD student (besides the delicious/free coffee) is that you have the pleasure of writing an acknowledgements section in your thesis where you can shower gratitude and praise on the people that made the amazing journey possible. Whether you like it or not, that's the section you're reading now. . .

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To our two-month old son – you have provided life one extra dimension!

Umeå, October 2008

Lars Persson

This thesis consists of a summary and the following four papers:

- [I] Aronsson, T., Persson, L. and Sjögren, T. (2008) Mixed Taxation, Public Goods and Transboundary Externalities: A Model with Large Jurisdictions. Umeå Economic Studies 747.
- [II] Aronsson, T., Persson, L. and Sjögren, T. (2008) Does Wage Bargaining Justify Environmental Policy Coordination? Umeå Economic Studies 754.
- [III] Persson, L. (2007) Environmental Policy Negotiations, Transboundary Pollution and Lobby Groups in Small Open Economies. Umeå Economic Studies 722.
- [IV] Persson, L. (2008) Environmental Policy, Decentralized Leadership and Horizontal Commitment Power. Umeå Economic Studies 753.



## **1 Introduction**

This thesis comprises four theoretical papers on transboundary environmental problems and optimal taxation. Paper [I] focuses on optimal taxation and public good provision in an economy where each jurisdiction (country) is large in the sense that its government is able to influence the world-market producer price of an externality-generating commodity. Paper [II] studies the welfare effects of environmental policy coordination in the presence of wage bargaining and international firm mobility. Paper [III] analyses pollution taxes determined in negotiations between countries, when each national government is subject to pressure from political interest groups. Finally, paper [IV] addresses transboundary environmental problems and optimal taxation from the perspective of a member state in an economic federation with decentralized leadership.

In addition to summarizing the four papers, this introductory chapter provides background to the relevant policy context. This chapter is also meant to give the reader a basic understanding of the theories used to describe environmental problems and economic policy.

## **2 Environmental Externalities**

In line with the concern for environmental problems in general, and climate change in particular, it is safe to say that environmental policy is currently of great interest. Concern for the environment has inspired a substantial amount of research in economics for a long time. As a point of reference, Pigou analyzed externality correction as early as 1920. The concept of environmental quality is multi-dimensional and refers to a variety of issues such as air and water quality, climate change, the willingness to preservation of wildlife and old growth forests for future generations, conservation of biodiversity, etc. In an economic context, the value individuals attach to environmental quality can be measured - at least in principle - by their willingness to pay for the utility the environment provides. Based on the value of these services, economic policy - such as taxes, quotas and emission permits - provides a useful set of tools for handling environmental challenges.

From an optimal-policy point of view, it is important to distinguish between local and transboundary environmental damage. As for local environmental damage, it here affects residents within a specified region or jurisdiction (coun-

try), whereas transboundary environmental damage also affects the well-being of residents in other regions or jurisdictions (countries). Because national governments can be expected to act in their own self-interest, national policies typically fail to internalize transboundary environmental damage. The reason is that each national government underestimates its social costs of the domestic contribution to the global environmental problem. This suggests that international environmental policy coordination is generally required to fully internalize transboundary environmental damage.

The observations above constitute the point of departure for the present thesis, which aims to explore different aspects of economic policy in economies with transboundary environmental problems. The rest of Section 2 provides a short introduction to optimal taxation in the presence of environmental damage, whereas Section 3 discusses strategic behavior among large actors, policy coordination, international bargaining over environmental policy and economic federations, respectively. Section 3 also summarizes the four papers.

## **2.1 Optimal Taxation and Environmental Externalities**

In the environmental economics literature, the natural environment is often thought of as a public good. Accordingly, since the utility of such goods accrues to all agents in society, the standard efficiency condition of setting the private marginal cost of the good equal to the private marginal benefit is not applicable. Instead, the presence of a public good argues for governments (or supranational authorities) to provide these goods efficiently. Clean air is subject to deterioration via air pollution, which is caused by the actions of individual agents' - both consumers and producers (e.g., decisions of car travel, production technology etc). That is, the choice of consumption and/or production of pollution-generating goods by individual agents will be of importance for the air quality (the provision of clean air). However, a pollution-generating agent typically considers his/her contribution to the environmental deterioration to be so small that it does not matter for the whole.<sup>1</sup> In other words, the individual agent takes the total level of pollution (environmental deterioration) in society as exogenously given when deciding about his/her private actions. This outcome argues for a use of policy instruments to change the behavior of the

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<sup>1</sup>The economic literature uses the term 'externality' when the private actions of one agent directly affect the well-being of other agents - without any transactions between the parties.

pollution-generating agent. By using corrective taxes, it is possible to adjust the ‘price’ of the externality-generating activity and thereby change the behavior of agents. As mentioned above, Pigou (1920) introduced the idea of taxing externality-generating activities. This intuitive idea has, thereafter, been used in a variety of studies and is referred to as a Pigouvian tax.<sup>2</sup>

The early literature dealing with externality correction typically rests on the assumption that the externality of interest is the only distortion in the economy. This gives an intuitive understanding of the market failure arising from the particular externality, as it keeps the analysis close to the benchmark of perfect competition. However, from the perspective of real world economies, the assumption of one single distortion is, of course, unrealistic. Due to informational asymmetries and for political and administrative expediency, lump-sum taxes are typically not available in real world public policy, meaning that other ‘distortionary’ taxes must be used for redistribution and revenue collection. That is, environmental policy is not performed in isolation and needs to be analyzed simultaneously with other public policies. In the environmental economics literature, second-best economies typically rest on this idea.<sup>3</sup>

The early literature dealing with environmental problems to some extent neglects the difficulties arising from transboundary externalities. A starting point is the seminal contribution by Sandmo (1975), who sets out a rather stylized model showing that the Pigouvian principle holds even though the government uses distortionary taxes (besides the environmental tax) to satisfy its revenue constraint. Another influential contribution is the paper by Bovenberg and Goulder (1996), who analyze how optimal tax rates on intermediate inputs deviate from the Pigouvian principle. Their results show that the optimal tax on the externality-generating input depends on the marginal cost of public funds, which reflects how costly it is to raise additional tax revenue when taking into account the distortionary effect of increased taxation. Specifically, it is shown that the traditional Pigouvian correction becomes optimal only if the marginal cost of public funds equals unity, which means that public funds are no more

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<sup>2</sup>For a critique of the traditional Pigouvian approach, see e.g. Baumol (1972).

<sup>3</sup>The basic idea of second-best was introduced in the economics literature by Ramsey (1927) and developed by Diamond and Mirrlees (1971). However, Lipsey and Landcaster (1956-7) formulated the ‘general theory of second-best’, saying that: if there is one Paretian condition not attainable for the policy maker, the other Paretian conditions are, in general, not desirable.

costly than private funds at the margin.<sup>4</sup> Pirttilä and Tuomala (1997) also contribute to this specific strand of literature by analyzing optimal tax policy in the presence of both externalities and asymmetric information between the government and the private sector.<sup>5</sup> It is shown that the presence of two ability-types (with respect to productivity) implies a social valuation of the environmental damage not only reflecting individuals' marginal willingness to pay to avoid the externality, but also influences redistribution via the self-selection constraint. Specifically, if environmental quality and leisure are complements, environmental deterioration makes high-ability types' mimicking of low-ability types less attractive from the high-ability type's point of view, which means that the externality becomes less harmful if the government wants to deter mimicking of low-ability types. Moreover, the set of tax policy instruments in Pirttilä and Tuomala (1997) refers to commodity and income taxes - commonly denoted as mixed taxation in the literature. In model-economies without environmental externalities, the mixed taxation problem has been used rather extensively in the literature; see e.g. the seminal papers by Mirrlees (1976), Atkinson and Stiglitz (1976) and Edwards et al. (1994).

## **2.2 Optimal Taxation and Transboundary Externalities**

Thus far, the focus in this section has been on domestically generated pollution that is within a country's borders. However, in the case of e.g. green house gas emissions, it becomes relevant to study optimal tax policy in the presence of transboundary pollution. In such cases, the implementation of Pigouvian taxes becomes a bit more complicated. As indicated above, national governments most likely underestimate the cost of the externality-generating activity from a global perspective and, thereby, implement a policy that may be suboptimal for society as a whole. The problem of transboundary pollution has, however, been analyzed in the economic literature. To begin with, Barrett (1990, 1994) addresses issues related to the implementation of international environmental

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<sup>4</sup> Another study in this particular area of research is Bovenberg and van der Ploeg (1998), who study welfare effects from an environmental tax reform in the presence of involuntary unemployment. The tax reform is designed so that the additional tax revenue from a raise in environmental taxes is used to reduce distortionary taxes on labor.

<sup>5</sup> Their paper builds on a framework developed in Boadway and Keen (1993) and Edwards et al. (1994). However, the idea of asymmetric information, two ability-types and self-selection was addressed earlier by e.g. Stiglitz (1982).

agreements (cooperative outcomes). The first of these two papers discusses cooperative solutions in general, while the second paper explores properties of so-called self-enforcing international environmental agreements.<sup>6</sup> Given some restrictive assumptions, it is shown that, if signatories of the international environmental agreement act as Stackelberg leaders, the agreement achieves a high degree of cooperation when the difference between a non-cooperative and a cooperative outcome (in terms of global benefits) is small. If the difference is large, the relatively few signatories abate much more while the non-signatories abate slightly less in comparison to the non-cooperative equilibrium. However, since there are so many non-signatories in the case with a large difference, the total free-rider effect becomes large and the agreement has little effect.

The subsequent literature considering transboundary externalities addresses a variety of important issues such as labor mobility, international trade and comparisons of cooperative and non-cooperative resource allocations. For instance, Aronsson and Blomquist (2003) study both cooperative and non-cooperative outcomes in a framework characterized by labor mobility, mixed taxation, two ability-types and transboundary environmental damage. One should also mention Cremer and Gahvari (2004) who pay explicit attention to the issue of tax competition when transboundary emissions arise via the production of so-called ‘dirty’ goods. They consider commodity and emission taxes (emissions arise in production) and find that a harmonization of emission taxes above their uncoordinated outcome would result in a reduction of aggregate emissions and a rise in overall welfare. Finally, the problem of transboundary externalities has also been analyzed within economic federations (see below).

### **3 The Environmental Policy Context**

This section aims to address relevant aspects of the real world environmental policy context, while also motivating and summarizing each paper in the present thesis.

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<sup>6</sup>‘Self-enforcing’ is meant to imply that no signatory country has any incentive to leave the agreement, and no no-signatory country has any incentive to join. Other examples within this strand of literature are Mäler (1989), Carraro and Siniscalco (1993) and Carraro (2003). See also Rubio and Ulph (2006) for an extended version of the framework developed in Barrett (1994).

### **3.1 Large Actors**

By looking at the real world policy context, it is obvious that actors such as the European Union, the US, Russia and China play important roles. From an economic-theory point of view, these actors are of particular interest since they typically represent a significant share of world markets, meaning that their actions are likely to influence world market prices of externality-generating goods. As for the existing literature on environmental policy, it typically focuses on cases where decisions by single countries do not have a significant impact on world-market prices - i.e., small open-economy models. However, considering the actors mentioned above (considered large actors in what follows) the price-taking assumption appears less realistic. Instead, these countries should be modeled as if they are able to affect world market prices. In such cases, a so-called emission leakage arises via the domestic environmental policies implemented by national governments.<sup>7</sup> The reason is that domestic policies with the aim of reducing pollution influence the world market price of externality generating goods and, thereby, affect (possibly increase) total pollution. It is, therefore, relevant to analyze environmental externalities and public policy in a world-economy comprised of large actors, whose governments recognize - and incorporate into their policy decisions - their influence on the world-market prices of externality-generating goods. To my knowledge, there are no previous studies dealing with mixed taxation (see the literature mentioned above) in the context of large open economies and transboundary pollution.

### **3.2 Policy Coordination**

From a global perspective, the best solution to transboundary externalities is to implement a cooperative equilibrium, in which all externalities are fully internalized at the global level. However, such equilibrium appears to be unrealistic from a practical policy point of view. It is more likely that countries agree upon smaller projects that improve the resource allocation in comparison to the

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<sup>7</sup>The leakage mechanism may arise in a variety of setups. For example, Gurtzgen and Rauscher (2000) introduce a model with an endogenous number of firms that are affected by domestic policies. The domestic environmental policy affects the number of firms, which, in the end, has an effect on the consumer prices and on foreign emissions - a leakage via market-structure effects. Similarly, Conconi (2003) introduces a model with international trade, large countries and interest-groups, where emission leakage arises via a terms of trade effect.

non-cooperative alternative. It is important to note that, although it has no domestic welfare effect, a marginal change in a domestic policy instrument influences welfare abroad via the transboundary externality. Because such a policy may be welfare improving from a global perspective, there might be reasons for national policy coordination.

### **Paper [I]: Mixed Taxation, Public Goods and Transboundary Externalities: A Model with Large Jurisdictions**

Paper [I] is based on a two-country model, where asymmetric information between the government and the private sector characterize each country. The information asymmetry is modeled in a self-selection framework with two ability-types, where the decision-maker observes income but not ability. Each national government faces a mixed tax problem where, in addition to public good provision, nonlinear income taxes as well as linear production and commodity taxes are implemented. Furthermore, the national governments behave as Nash competitors toward one another. It is assumed that one of the consumption goods gives rise to transboundary environmental damage and that the countries are 'large' in the sense that each national government recognizes - and incorporates into its policy decisions - how its policy decisions influence the world-market producer price of the externality-generating good. Given this framework, the countries interact via international trade and the environmental damage they impose on each other.

By comparison with small open (price-taking) economies, the assumption of endogenous world-market prices creates additional incentives of relevance for national public policy. It is shown that the endogenous world-market price creates additional incentives when determining income taxation, commodity taxation and public good provision. For instance, the marginal value that the government attaches to reduced environmental damage constitutes mechanisms that refer to the endogenous world market price; the world market price influences the self-selection constraint as well as the value of net exports. The welfare effect of international policy coordination - where the non-cooperative Nash equilibrium constitutes the reference case - is studied in a case where the utility is weakly separable in the public good and in the environmental damage, and where the domestic welfare is increasing in the producer price of the dirty good.<sup>8</sup> The

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<sup>8</sup>The domestic welfare affect of an increase in the producer price is made up of a self-selection effect, a terms of trade effect and a demand effect on the dirty good.

results suggest that a coordinated increase in the production tax accompanied by a budget-balancing change in public production leads to increased welfare - holding hours of work, disposable income and the commodity tax constant. This result is driven by the endogenous world-market producer price, which is increasing in the production tax and the reallocation of resources to public production. Specifically, if the additional tax revenues are used to increase public production - while the hours of work and disposable income is held constant - the world-market producer price increases via the reduced supply of the dirty good.

By focusing on a special case of the model where, in addition to the assumptions made above, the non-cooperative Nash equilibrium is symmetric and the self-selection constraint does not bind, the analysis of policy coordination is taken a step further. It is shown, among other things, that: (i) it can be welfare improving to increase the production tax, and/or the commodity tax, while spending the additional tax revenues on public good production, and (ii) it can be welfare improving to increase the average income tax, while spending the additional tax revenues on public good production. Each such policy reform would reduce environmental damage via the world-market producer price.

### **3.3 Wage Bargaining and Transboundary Externalities**

Transboundary externalities may also arise from activities other than those associated with the environment, such as wage bargaining between firms and trade unions in open economies where firms can move production abroad. In this case, it is reasonable to assume that firms use the threat of moving production abroad to moderate wage claims. This, in turn, means that policies affecting profits also affect the credibility of the threat. The basic intuition is that a larger potential 'outside' profit contributes to lower wage rates, since the firm's rent in the bargaining most likely increases with the threat. Policies undertaken by any national government, therefore, may give rise to transboundary externalities via the above-described wage bargaining mechanism. As a national government is unlikely to consider its own influence on the outcome of wage bargaining abroad, the uncoordinated equilibrium is inefficient from a global perspective. Aronsson and Sjögren (2004) address this wage bargaining externality in a setup without environmental externalities. They study welfare effects arising from policy coordination with respect to the marginal taxation of labor income, unemployment

benefits and a public good. The results suggest that a coordinated decrease in the hours of work and a coordinated reduction of unemployment benefits tend to increase welfare. The increase in welfare is possible because even though the fall-back outcome is affected by domestic policies, the fall-back profits facing domestic firms are treated as exogenous by the national governments.

Given the arguments above, where firms have the ability to move production abroad, it appears reasonable to assume that some inputs in production (e.g. capital) are internationally mobile. However, international mobility may give rise to international tax competition and, therefore, inefficiently low tax rates and inefficiently low public spending in a non-cooperative equilibrium.<sup>9</sup> On the other hand, Koskela and Schöb (2002) study optimal labor and capital income taxation in the presence of unemployment and find that mobile capital should be taxed at a higher rate than immobile labor. The intuition behind this result is that, in a situation with unemployment, labor supply becomes locally infinitely elastic.<sup>10</sup> However, since none of the earlier studies have incorporated the wage bargaining externality explained above to a framework with (transboundary) environmental damage, paper [II] mainly contributes to the literature by studying the welfare effect from coordinated changes in environmental and capital taxes in such a context.

### **Paper [II]: Does Wage Bargaining Justify Environmental Policy Coordination?**

Paper [II] studies public policy in a multi-country framework characterized by a transboundary environmental externality and a labor market imperfection arising via wage bargaining between a labor union and a firm. Within each country, competitive firms produce a single output using labor, capital and energy. The use of energy is assumed to create a negative transboundary environmental externality. Paper [II] analyses welfare effects of coordinated changes in environmental and capital taxation, where the pre-reform resource allocation is a non-cooperative Nash equilibrium. From a global perspective, the uncoordinated equilibrium is inefficient both because of the transboundary environmental externality and because of the wage bargaining externality explained above. Specifically, national governments do not take into account that their behav-

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<sup>9</sup>See e.g. Zodrow and Mieszkowski (1986) and Wildasin (1989).

<sup>10</sup>A study dealing with policy coordination in the presence of unemployment is Fuest and Huber (1999).

ior potentially gives rise to transboundary environmental damage and that the profit earned by domestic firms constitutes the fall-back profit in other countries.

The welfare effect of a coordinated increase in the emission and capital tax becomes indeterminate in the general framework. However, it is shown that the welfare effect of each reform is made up of two parts, each corresponding to the respective externality discussed above. By assuming quasi-linear utility functions and a Cobb-Douglas production technology, it is, however, possible to derive conditions under which the welfare effects are possible to sign. As for a coordinated increase in the emission tax, it improves welfare if the ratio of the net tax revenue<sup>11</sup> and the wage is smaller than the output elasticity of labor. This result can be interpreted as a ‘double-dividend’ because both the environmental externality and the wage bargaining externality are reduced. If, on the other hand, the ratio of the net tax revenue and the wage is larger than the output elasticity of labor, the welfare effect is ambiguous. The reason is that a coordinated increase in the emission tax may reinforce the international wage bargaining externality. The welfare effect from a coordinated increase in the capital income tax becomes zero if utility functions are quasi-linear and production technology is characterized by Cobb-Douglas. However, if these assumptions are relaxed the total welfare effect becomes ambiguous.

### **3.4 International Negotiations and Interest-Groups**

In addition to the increasingly important international perspective on environmental policy, national governments also face political pressure from interest groups (referred to as ‘lobby-groups’ in what follows).<sup>12</sup> The reason for lobbying is that governmental use of economic policy tools (such as taxes) affects individual agents, which create incentives for influencing the use of these tools. In the economic literature, lobbying is commonly studied within the menu auction model developed by Grossman and Helpman (1994).<sup>13</sup> In the menu auction model, lobby-groups offer an incumbent government a set of campaign contri-

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<sup>11</sup>The net tax revenue is defined as the sum of the lump-sum tax per employed worker and the unemployment benefit.

<sup>12</sup>Examples of interest groups that are concerned with environmental issues are Greenpeace and the Swedish Society for Nature Conservation (Naturskyddsforeningen).

<sup>13</sup>The model developed by Grossman and Helpman (1994) originates from Bernheim and Whinston (1986). The term ‘menu auction’ refers to a situation where bidders announce a ‘menu’ of offers - associated with specific actions - to an ‘auctioneer’.

butions in return for particular policies. The incumbent government recognizes that the probability of re-election depends on the amount spent on campaigning and voters' utility derived from current governmental policies.

The literature dealing with the combination of lobbying and environmental policy has mainly focused on policies decided upon at the national level. For instance, Fredriksson (1997) supports, to some extent, the expected intuition that 'green lobbying' leads to a stricter environmental policy at the national level when pollution remains within country borders. However, Aidt (2005) shows that an increase in environmentalism may lead to lower pollution taxes and increased worldwide pollution. This particular result, however, rests on the assumption that pollution is immobile and environmentalists care sufficiently about pollution that arises abroad. The intuition is that if environmentalists are very concerned with pollution abroad, the lobby group is willing to accept more pollution at home in return for less pollution abroad, which means a lower domestic tax on pollution.

There are few studies dealing with transboundary externalities in combination with lobbying. One is Conconi (2003) who extends the lobby-group literature by introducing both international trade and transboundary pollution. In her paper, it is shown that such interactions between countries imply, among other things, that one country's increase in pollution taxes, triggered by lobbying, improves the terms of trade for the other country, which, in turn, leads to increased production and emissions. Although the environmental lobby-group literature - including Conconi (2003) - addresses a variety of interesting aspects, it has so far neglected international environmental policy. Paper [III], therefore, contributes to the literature by studying the combination of (i) lobbying at the national level and (ii) international environmental policy determined in negotiations between countries. Within such a context, paper [III] sheds some light on how environmental policies are affected by changes in lobbying activities as well as in government objectives.<sup>14</sup>

### **Paper [III]: Environmental Policy Negotiations, Transboundary Pollution and Lobby Groups in Small Open Economies**

In paper [III], national governments face political pressure from environmental

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<sup>14</sup>To isolate the mechanisms arising from the negotiation of environmental policy and the transboundary pollution, respectively, paper [III] disregards the international trade aspect addressed by Conconi (2003).

as well as industrial lobby groups. Environmental policies - here defined as pollution taxes - are determined in a negotiation between the national governments, and each country is assumed to be small in the sense of treating world market prices as exogenous. It is also assumed that the countries both generate and are affected by transboundary pollution. The political pressure on the national governments is modeled so that environmental and industrial lobby groups at the national level offer the incumbent domestic government a contribution schedule that depends on the pollution tax. The incumbent governments use these contributions to finance campaign spending and, thereby, increase the probability of re-election. The objective of each national government in the bargain with other countries is to maximize a weighted sum of aggregate campaign contributions and aggregate social welfare. Given the rents from the bargain between the national governments - here defined as the difference between the 'contract outcome' and the 'no-contract' outcome - the outcome will be pollution taxes that maximize the product of these rents.

It is shown that a general increase in environmental concern - here defined as an increase in the number of environmentalists in both countries (the number of countries is normalized to two) - as well as in the weight the governments attaches to social welfare, tends to increase the pollution tax in a symmetric equilibrium. On the other hand, an increase in the number of environmentalists in just one country may reduce the other country's pollution tax in a symmetric equilibrium. The underlying mechanism is that if one country is willing to 'accept' a higher domestic tax on pollution, the other country indirectly uses this to negotiate a lower tax on its own pollution. Moreover, allowing for asymmetries between the two countries gives rise to results that are potentially even more interesting. It is shown that a general increase in the environmental concern may reduce the pollution tax, since the increase in environmental concern tends to increase as well as decrease the pollution tax. The mechanism that tends to increase the pollution tax is more or less standard, but the mechanism that works to reduce the pollution tax is, perhaps, more counterintuitive. The intuition for the latter mechanism is that the government becomes more eager to reach an agreement when the domestic environmental concern increases, meaning that the pressure on the other country to implement a strict environmental policy reduces in the bargain. One conclusion from paper [III] is, therefore, that

an increase in the environmental concern does not necessarily lead to a stricter environmental policy for the global economy as a whole.

### **3.5 Environmental Policy and Economic Federations**

As indicated above, the literature on optimal taxation in the presence of transboundary environmental externalities typically focuses on tax and expenditure policies to implement non-cooperative and cooperative resource allocations, or welfare effects of policy coordination, without paying much attention on the institutional structure within which the public policy is decided upon. In a European context, however, the European Union (EU) plays an important role for environmental policy cooperation, suggesting that a fiscal-federalism-like framework may provide insights of relevance for environmental policy. For instance, the supranational (federal) level of the EU determines emission targets (maximum allowable emissions) for greenhouse gases in each member country, while each member country is responsible for the implementation of these targets. Given this observation, it is relevant to study a federal decision structure's influence on the incentives underlying national public policies implemented by member countries.

The economic literature characterizes economic federations as structures with several levels of governments, where each level has its own policy instruments and responsibilities. This characterization implies that countries - with their national and lower level governments - as well as supranational authorities with several member countries, are considered economic federations. Depending on which level of government has commitment power, economic federations may be thought of as either centralized or decentralized. A centralized federation is interpreted so that each lower level government acts as a follower vis-à-vis the federal level. That is, the federal government is able to commit to its policies, whereas the lower level governments are not. It has been argued that EU member countries have commitment power vis-à-vis the federal government and, therefore, act as first movers (denoted vertical leadership in what follows).<sup>15</sup> Hence, the EU is typically thought of as a decentralized economic federation.

Silva and Caplan (1997), and Caplan and Silva (1999) characterize environmental policy outcomes in a federation which - depending on the level that makes credible commitments - is interpreted as either centralized or decen-

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<sup>15</sup>See e.g. Jones and Clark (2001, p. 2).

tralized. Their results highlight the importance of the distribution of policy instruments between the levels of government. Given model specific assumptions, it is shown that it is socially desirable to give regional governments the tax (price) instrument, while giving the central government a quantity instrument. With the EU as a source of inspiration, Aronsson et al. (2006) consider an economic federation comprising two lower level governments (countries) and a federal government. The federal government is assumed to decide upon an emission target for each country, which is to be implemented through national tax policies. The economic federation is characterized by decentralized leadership, modelled so that the national (lower level) governments are first movers vis-à-vis the federal government, and the environmental targets are, therefore, conditioned on the national tax policies. Their results show that decentralized leadership creates incentives for each national government to influence the emission targets decided by the federal government. This implies that each country implements commodity taxes that do not satisfy the additivity property, and that the marginal labor income tax is, in part, also used to relax the emission target.<sup>16</sup>

Returning once again to the EU, it also appears reasonable to view the member countries as heterogeneous among themselves with respect to horizontal commitment power, meaning that one of the countries may act as first mover vis-à-vis the others. For instance, it is plausible that large countries, such as Germany and France, can be more committed to national objectives than small countries such as Luxemburg and Sweden. This follows from the argument that relatively large countries play an important role for the economic development within the federation, and the smaller countries, therefore, act as if they are followers vis-à-vis the large countries. These arguments give a reason to extend the existing literature on environmental policy in economic federations, which has so far neglected the issue of horizontal commitment power. Paper [IV], therefore, deals with optimal taxation and transboundary environmental problems in a decentralized economic federation, where the member countries differ with respect to horizontal commitment power.

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<sup>16</sup> Apart from the problem of environmental externalities, there are studies addressing issues such as pure public good provision, tax competition and redistribution within federations characterized by decentralized leadership; see e.g. Caplan et al. (2000), Köthenburger (2004) and Aronsson (2007).

**Paper [IV]: Environmental Policy, Decentralized Leadership and Horizontal Commitment Power**

Given an economic federation where the federal government determines emission targets for each of the member countries, paper [IV] studies the optimal use of linear production taxes and non-linear income taxes at the national (member state) level. Taking Aronsson et al. (2006) as a starting point, the economic federation is assumed to be decentralized in the sense that each member country acts as a first mover vis-à-vis the federal government - interpreted so that the federal government chooses emission targets conditional on the national public policy. In addition, one of the two member countries, the horizontal Stackelberg leader, also acts as first mover vis-à-vis the other member country - the horizontal follower. That is, the horizontal Stackelberg leader chooses its policy while anticipating, and incorporating into its decision problem, how the horizontal follower and the federal government respond to its policy.

By primarily focusing on the horizontal Stackelberg leader, the results show that, in addition to the standard result that environmental taxation should reflect the marginal willingness to pay for reduced environmental damage, the heterogeneity with respect to commitment power between member countries creates additional incentives for influencing the environmental targets imposed by the federal government. Specifically, the horizontal Stackelberg leader uses its commitment power to loosen its own emission target, while tightening it for the horizontal follower. These results rest on how the federal government determines the emission targets implemented by the national governments. In equilibrium, the emission targets for each country is (in principle) chosen so that the value of the marginal product of the bad input equals the sum of marginal willingness to pay for reduced environmental damage, adjusted for differences in the marginal utility of income between the countries. For the horizontal Stackelberg leader, this creates an opportunity to influence the emission targets directly via the domestic choice of labor (reflected in the marginal income tax) and indirectly via its influence on the horizontal follower's behavior (reflected both in the production tax and the marginal income tax). However, it is important to bear in mind that these specific results presuppose that all member countries act as first movers vis-à-vis the federal government.

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