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# Vorwort

Die vorliegende Arbeit wurde in den Jahren 2004 bis 2010 im Rahmen meiner Tätigkeit als wissenschaftliche Mitarbeiterin am Institut für Volkswirtschaftslehre der Universität Kiel erstellt. Ich habe am Lehrstuhl für Mikroökonomie von Professor Horst Raff, PhD eine äußerst lehrreiche und interessante Zeit verbringen können. Die Verbindung von wissenschaftlicher Forschung auf der einen, und Lehrtätigkeiten und Betreuung von Studierenden auf der anderen Seite war eine herausfordernde und anregende Aufgabe, die mir immer viel Freude bereitet hat.

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Barbara Stoschek

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# Abstract

This dissertation deals with two different aspects of environmental policies in a globalized world.

First, the impact of exogenous environmental regulations on a domestic polluting sector's international competitiveness is investigated. The applied model framework considers the government's re-election incentives and the interrelation between environmental and industrial policies.

Second, the impact of strategic competition for internationally mobile capital on the level of environmental policies in the competing countries is examined. Also here, a second policy instrument, a corporate-profit tax, is available. Furthermore, the adverse welfare effects of a non-cooperative policy choice and different approaches of international cooperation to overcome such suboptimal policy outcome are discussed.

The results of both parts of the analysis suggest that frequently expressed public concerns as well as the predictions of many economic analyses may be too pessimistic. In particular, neither does the imposition of stricter environmental regulations necessarily weaken the international competitiveness of a domestic polluting sector, nor does competition for foreign investments necessarily lead to an erosion of environmental-policy levels. Finally, even if countries do not achieve agreement on completely cooperative policy-making, partial cooperation in one instrument may serve as a politically feasible means to help them approach the socially optimal welfare level.

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# List of Abbreviations

AETR	Average Effective Tax Rate
CS	Consumer Surplus
ETS	Emissions Trading System
EU	European Union
FDI	Foreign Direct Investment
GHG	Greenhouse Gases
IEA	International Environmental Agreement
IG	Interest Group
ITA	International Tax Agreement
LHS	Left Hand Side
MNE	Multinational Enterprise
NAP	National Allocation Plan
OECD	Organization for Economic Co-Operation and Development
PHH	Pollution Haven Hypothesis
PR	Performance Requirements
RHS	Right Hand Side
ROW	Rest of the World
RtB	Race to the Bottom
RtT	Race to the Top
UK	United Kingdom
US	United States
WTO	World Trade Organization
WTP	Willingness to Pay

# Part I

## Introduction

## 1.1 Motivation

*“Wettbewerbsfähigkeit gefährdet. Deutschland hat ein Wettbewerbsproblem (...). Klimaschutz darf deshalb nicht zu weiteren Wettbewerbsverschlechterungen des Standortes führen. In praktisch allen Staaten außer Deutschland wird das Thema Klimawandel auch unter wirtschaftspolitischen Kalkül betrachtet. Dieses muss auch für Klimapolitik in Deutschland gelten.”*

Bundesverband der Deutschen Industrie (BDI), 2005.<sup>1</sup>

*“Finally, globalization is creating new challenges in the field of tax policy. Tax schemes aimed at attracting financial and other geographically mobile activities can create harmful tax competition between States, carrying risks of distorting trade and investment and could lead to the erosion of national tax bases. (...) Such harmful tax competition diminishes global welfare and undermines taxpayer confidence in the integrity of tax systems.”*

Communique issued by the Heads of State of the G7 countries in 1996.<sup>2</sup>

The public perception of the term “globalization” is rather vague. This might be the reason why the continuing integration of world markets worries many people and frequently triggers concerns on its presumably adverse impacts. The statements cited above stand exemplary for numerous similar arguments invoked in the public debate all over the world.

The first quotation hints at one aspect often associated with globalization: the increasing competition domestic firms face when markets are opened up for international trade. Not only among industry representatives, but also within the general public, the following notion predominates: Local governments should support domestic industries particularly exposed to international competition in order to secure domestic production, employment and welfare. In this context, it is not surprising that there is a widespread opposition against policy measures that apparently worsen domestic firms’ international competitive position. Environmental regulations constitute one example of particular current relevance. For instance, the number of multilateral environmental agreements has been rising rapidly in recent years. Once a government has ratified such agreement, it is committed to the negotiated environmental goals and has to implement the necessary policy measures. However, whenever politicians announce the intention to introduce novel environmental restrictions, they trigger intense debates and opposition.

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<sup>1</sup>Cited from a German industry lobby’s position paper on climate policies. In English: “International competitiveness in danger. Germany has a competitiveness problem (...). Climate-protection policies thus must not further weaken the country’s competitive position. Practically all states except for Germany address the issue of climate change under consideration of economic policy aspects. This has to be ensured also in Germany.” Source: <http://www.bdi.eu/Klima-und-Umwelt.htm>.

<sup>2</sup>This Communique was issued at the G7 Summit in Lyon, 1996. Cited from OECD (1998).

The second quotation hints at another aspect associated with globalization: the international mobility of firms. This so-called “footlooseness” induces governments to engage in strategic policy-competition in order to attract foreign direct investment (FDI in the following) to their country and increase domestic welfare. The prevalent public concerns and debates in this respect can be subsumed under the heading “harmful tax competition”. Those concerns issue from the belief that market integration intensifies international policy competition and so induces a so-called “Race to the Bottom” (RtB) with detrimental rather than beneficial social-welfare consequences. In particular, governments concerned about deterring FDI may relax environmental- or corporate-tax policies. Accordingly, FDI competition is believed to harm the environment in addition to the adverse welfare impact of suboptimally low tax levels.

Since also many economic analyses find support for both the “international-competitiveness”- and the “environmental-RtB” concerns, the current dissertation aims at challenging this pessimistic perception of globalization. The subsequent papers show that the negative notion on the globalization/environmental-policy relationship may be owed to the ignorance of different aspects relevant for governmental decision-making. Most importantly, both approaches followed in this dissertation have in common that they analyze the interrelation between two policy instruments rather than considering only one (i.e. environmental policy). The purpose is to approach the theoretical models to the actually observable policy conditions and by this means derive conclusions more relevant for “real-world” policy-making. Each of the two approaches focusses on one of the above-mentioned specific aspects.

The first topic, international competitiveness, is investigated from a unilateral perspective. The applied model incorporates political-economy aspects of policy-making: As the ultimate goal of governments is to be re-elected, they have an incentive to maximize political support from different interest groups when choosing environmental- and industrial policies. Politicians therefore care for the international competitiveness of domestic industries. Broadly speaking, the main determinant of policy outcomes in this approach is the trade-off between different lobby groups’ utility levels.

The second topic, international capital mobility, is investigated in a two-country model of strategic environmental- and corporate-tax-policy competition for FDI. Here, the strategic interactions between competing countries constitute the main determinant of policy-outcomes. The analysis also discusses the welfare implications of globalization in some detail. In particular, alternative ways of international cooperation with the aim of overcoming the suboptimal non-cooperative policy regime are introduced: the conclusion of an international agreement on environmental- or on corporate-tax policy.<sup>3</sup> How do such treaties perform in improving on social welfare, if the social optimum (attained by cooperation in both instruments) is not feasible?

Both papers indeed derive conclusions that are, in many respects, contradicting public concerns and many economic one-policy analyses on the one hand, and, on the other

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<sup>3</sup>In the following, IEA stands for “International Environmental Agreement” and ITA for “International Tax Agreement”.

hand, more consistent with empirically observable “real-world” policy patterns. The results suggest a much more optimistic view on the globalization/environmental-policy relationship. Two crucial findings of this dissertation can be roughly summarized as follows: First, stricter environmental regulations do not necessarily weaken, but may even enhance the domestic polluting industry’s international competitive position. Second, strategic policy competition for FDI does not necessarily induce an environmental RtB. Furthermore, continuing market integration (in terms of declining trade costs) does not come at the cost of laxer environmental-policy levels. On the contrary, the intensity of FDI competition even declines.

Note, however, that these positive results do not hold in normative terms: Tax competition for FDI clearly exerts an adverse impact on the competing countries’ social-welfare levels relative to the optimal policy combination a social planner would implement. However, both international one-policy agreements constitute a “step into the right direction”– the ITA even more than the IEA– in terms of improving on aggregate social welfare.

## 1.2 Outline

The subsequent Parts II and III contain the main analysis of this dissertation.

Part II deals with the “international-competitiveness aspect” of environmental-policy making in a globalized world. Chapter 1 motivates the research issue, provides an illustrative example to demonstrate the practical relevance of the paper’s conclusions, and reviews the related literature. Chapter 2 introduces the small-open-economy model. A political-support-function approach is applied to examine the overall impact of exogenous environmental regulations on the international competitiveness of a domestic polluting sector. The main contribution of Chapter 3 is to show that restrictive environmental policies do not necessarily harm the affected industry, if a government’s reelection incentives and the availability of an additional policy instrument are taken into account. In the political equilibrium, the polluting industry is even granted industrial-policy compensation in excess of its initial environmental-policy loss.

Part III addresses the “capital-mobility aspect” of the globalization/environmental-policy relationship. A brief introduction to the issue and an overview of the related literature in Chapter 5 are followed by the positive analysis in Chapter 6: A simple two-country model of strategic FDI competition is used to investigate the interrelation between corporate-profit- and emissions taxes. The focus is on the question whether FDI competition results in a RtB in environmental policies. Furthermore, the effects of market integration and changes in environmental preferences are examined. The main result is that countries rely on the profit, rather than the environmental tax as instrument in strategic policy competition. FDI competition does therefore not harm the environment. Chapter 7 complements the positive results by a normative analysis of the model. Two alternative means to improve on aggregate social welfare are discussed:

The countries may either cooperate on corporate-tax, or on environmental policies. Both one-policy agreements turn out to raise welfare compared to the non-cooperative policy regime, but do not yield the maximum possible welfare level associated with the social optimum (i.e. under complete cooperation in both instruments).

Finally, Part IV joins all main chapters. Its purpose is to derive common conclusions and general implications concerning the research issues and “real-world” observations introduced in Part I to motivate the analysis carried out in this dissertation.



## Part II

# The Political Economy of Environmental Regulations and Industry Compensation

## Abstract

This paper uses a political-economy framework to analyze what consequences the exogenous introduction of a quantitative restriction on total emissions in a small open economy has on the strength of domestic industrial policy. The question is whether and to what extent the government, if it takes different lobby groups' interests into consideration, has an incentive to compensate the polluting industry for stricter environmental regulations by granting higher protection to it.

It turns out that the government will indeed increase subsidization of the industry affected by environmental regulation. This compensation will even be more than complete if environmental interests are taken into account. Hence, contrary to what might be expected, the polluting sector realizes a net benefit if stricter environmental regulations are introduced.

# Chapter 1

## Introduction

### 1.1 Motivation and Outline

Whenever a government announces its intention to introduce novel environmental-policy measures, often driven by the aim to fulfil the obligations associated with some international treaty, it triggers intense public debates. In particular, representatives of the affected polluting industries articulate their concerns about losing in terms of international competitiveness, if stricter environmental regulations are imposed on them.<sup>1</sup> This concern is supported by many economic analyses like those belonging to the literature on the “pollution haven hypothesis”.<sup>2</sup>

On the other hand, governments are, for political reasons like e.g. re-election concerns, obviously not immune to the interests of important lobby groups like industry. We can thus expect policy concessions that help the affected groups accept the environmental restrictions imposed on them.

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<sup>1</sup>In what concerns the term “competitiveness” which is often used in the public debate, there are diverse views on how to measure this appropriately. At the firm level like in this paper, possible indicators besides profits/profitability include market share, productivity or a composite measure of all (see e.g. Triebswetter (2003)). Furthermore, many different measures at a national level exist (for a discussion see e.g. Mulatu (2004) or OECD (2006)). In the following, the term “competitiveness” is used as synonym for “profit”.

In what concerns the sectoral-competitiveness impacts of different environmental-policy measures, OECD (2006) provides some theoretical and empirical case studies e.g. for the steel sector. OECD (2009) summarizes the (indecisive) key findings of recent theoretical and empirical studies on the competitiveness effects of environmental policies.

<sup>2</sup>According to the pollution haven hypothesis (PHH), countries with relatively lax environmental regulations (in general assumed to be represented by the group of developing countries) gain comparative advantage in the production of “dirty” goods. They therefore attract pollution-intensive industries and by this means become “havens” for dirty industries that intend to escape the stricter environmental regulations in the developed world. Copeland/Taylor (2003) provide an extensive survey of theoretical pollution-haven models. For reviews on the empirical literature on the PHH, see e.g. Rauscher (1995) or Levinson (2002).

This paper examines whether and to what extent a government of a small open economy tends to compensate domestic industries for unilaterally introduced environmental regulations by moving to more protectionist industrial-policy patterns. Specifically, it addresses the impact of an exogenously introduced binding cap on sector-wide emissions on the political choice of a compensating production subsidy to that sector. This allows to shed light on the question whether environmental regulations really lead to a loss of competitiveness (measured in terms of profit) in the domestic polluting sector. In particular, I argue that this may not be the case, if endogenous industrial-policy reactions are taken into account.<sup>3</sup>

This issue is relevant for example in connection with the introduction of the European Emissions Trading Scheme (EU-ETS) for  $CO_2$  on January 1st, 2005, which is targeted at achieving the reductions in Greenhouse Gases (GHGs) agreed on in the Kyoto-protocol in 1997: Aggregated over all EU member countries, GHG emissions have to be reduced by 8% up to the year 2012, compared to the base year 1990.<sup>4,5</sup> For countries that ratified the Kyoto-protocol, the negotiated emissions reductions become binding. Hence, the introduction of a cap on total emissions can be considered as exogenous.<sup>6</sup>

Before the EU-ETS was actually introduced, an intense debate on the economic consequences of such a measure went on in the EU member countries. Industry representatives expressed their concerns about the economic costs of such a trading scheme and feared a loss of international competitiveness compared to countries not participating in the ETS. For instance, in November 2005, the Federation of German Industries (BDI) in a position paper claimed that unilateral European climate policy would have only little

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<sup>3</sup>The output-based production subsidy to the polluting sector considered in this paper can equivalently be interpreted as industrial- or trade-policy measure because an open economy is analyzed. In the following, the term “industrial policy” will be used.

<sup>4</sup>Klepper/Peterson (2004) and PEW Center (2005) describe the basic mechanisms of the EU-ETS. For details on the Kyoto-protocol see [http://unfccc.int/essential\\_background/items/2877.php](http://unfccc.int/essential_background/items/2877.php) (latest access in July, 2010).

<sup>5</sup>Although not only the EU countries alone, but altogether 191 countries (up to July, 2010) have ratified the protocol, the EU can be seen as the only ratifying region so far which has actually implemented binding policy restrictions in order to achieve the emissions target. At least, the EU-ETS is singular in the world so far in terms of its economic scale (i.e. the value of traded allowances), like e.g. PEW Center (2005), Grubb/Neuhoff (2006) or Demailly/Quirion (2006) argue. Environmental policy can thus be considered as unilateral in this case. Of course, the EU-ETS is only an illustrative example; many other environmental regulations applied in any country can be thought of instead.

<sup>6</sup>Those policies are only exogenous at the moment of their introduction; during the preceding treaty negotiations, each country exercised influence to achieve an outcome which is most consistent with its own domestic interests. However, as soon as some environmental objective is set by the overall number of member countries, each can be assumed to comply with it. This is reasonable despite of a lacking worldwide monitoring-institution for environmental issues, since, besides the “hard” economic dimension of policy decisions, countries also consider the “soft” political dimension: Complying with treaty obligations demonstrates stability and reliability to the international community and so serves to build up a good reputation. Therefore, in order not to jeopardize current and future opportunities for international cooperation, countries prefer to countervail the potential negative economic effects of their environmental-treaty membership by means of alternative policy measures rather than by non-compliance.

impact on global warming while seriously harming the competitiveness of European industries. Not surprisingly, this interest group prefers voluntary industry commitments, like e.g. pursued by the United States, to legal emission restrictions for the second period of the Kyoto-protocol, 2008-12.<sup>7</sup> In the UK, as another example, the public debate on the competitiveness effects of environmental policy preceding the introduction of the EU-ETS caused a significant delay of the country's 2005-07 national allocation plan (NAP) submission to the European Commission (see PEW Center (2005) or Smale et al. (2006)).<sup>8</sup>

How may a government react to such political pressures from industrial lobby groups? This paper refers to industrial policy. In doing so, one has to consider that industrial policies are usually restricted within the international institutional framework. In the EU, for instance, subsidies are granted in terms of "State Aid". Though generally prohibited, the EU rules provide many exceptions concerning e.g. Aid for regional development purposes or the so-called "horizontal objectives" including support for small and medium sized enterprises, employment, R&D etc.<sup>9</sup> Hence, governments may well implement the ETS, while at the same time compensating the affected sectors in terms of increased output subsidies.<sup>10</sup> The next section illustrates a recent example for such phenomenon.

To analyze the issue, a simple small-open-economy model with sector-specific capital in two sectors is applied. The import-competing sector produces a polluting good by using labor, capital and an environmental factor (i.e. emissions), whereas the export sector produces a clean numeraire good with only labor and capital. The economy

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<sup>7</sup>For a number of position papers on issues related to climate-change mitigation policies and the EU-ETS see the BDI's website <http://www.bdi.eu/Klima-und-Umwelt.htm> (latest access in July, 2010).

<sup>8</sup>The above-mentioned debate is also discussed by e.g. Demailly/Quirion (2006) or Grubb/Neuhoff (2006).

<sup>9</sup>Although data on subsidy payments have to be interpreted with caution due to incompleteness and differing definitions/measurement methods depending on their source (for details on those data issues see WTO (2006)), the latest data (provided by the EU Commission's "State Aid Scoreboard" in December 2009) show the following evolution of State Aid patterns in the EU (27) countries: Total annual Aid remained at rather stable levels of 67-69 billion Euros, or 0.5-0.6 percent of EU-wide GDP, between 2003 and 2007. Owing to the world-wide economic and financial crisis, State Aid rose rapidly, up to an amount of 280 billion Euros (2.2 percent of GDP), in 2008. If crisis measures are excluded, total Aid in 2008 amounted to 67.4 billion Euros or 0.5 percent of GDP. The industry and services sectors received 78 percent of total Aid in 2008. This corresponds to an amount of 52.9 billion Euros or 0.42 percent of GDP. Also in these sectors, Aid receipt remained rather stable since the year 2003. Hence, the Commission's declared target of substantially reducing State-Aid levels appears to be hard to meet in aggregate terms. There are, however, large disparities between different member countries. For details see the EU Commission's website on State Aid [http://ec.europa.eu/competition/state\\_aid/overview/index-en.html](http://ec.europa.eu/competition/state_aid/overview/index-en.html) (latest access in July, 2010).

<sup>10</sup>In what concerns a government's motive for adjusting production subsidies, WTO (2006) points out that one potential objective is income redistribution. Similarly to the framework in the current paper, subsidies to declining industries in the course of structural transformation are mentioned as an example. In addition, different case studies in OECD (2006) illustrate how compensation for losses of competitiveness is actually granted to polluting sectors in case of restrictive environmental policies.

consists of households supplying either labor or one of two types of specific capital. A household's utility is simply measured in terms of its income. In addition, an environmental interest group<sup>11</sup> derives disutility from environmental damage. I assume that a binding exogenous cap on total emissions is introduced, lowering productivity in the polluting sector. As a reaction to this cap, the government adjusts the level of an output subsidy to the polluting sector. This endogenous industrial-policy reaction is analyzed in a political-economy framework, in which the government maximizes a political support function over all interest groups.

The main results of this study are the following: First, governments indeed tend to compensate industries which are affected by restrictive environmental regulations. Second, as it turns out that compensation is more than complete in the presence of an environmental IG, polluting industries will experience a net gain, rather than a loss, in profits. The environmental interest's political weight has a positive impact on the extent of industry compensation or, put differently, environmental interests work in the direction of more protectionist trade regimes although they are not directly affected by industrial policy.<sup>12</sup>

The rest of this paper is organized as follows: The next sections provide an illustrative example of how governments might compensate domestic polluting industries for environmental regulations, and a review of the related literature. Chapter 2 presents the basic model by introducing all relevant interest groups and the political framework under which government decisions are taken. Chapter 3 derives the political equilibrium with respect to the industrial-policy variable first in general and then as a reaction to exogenous environmental policy. Both direction and magnitude of the policy adjustment as well as the latter's determining factors are discussed. Finally, Chapter 4 concludes.

## 1.2 Example: Costless Emissions Permits

As mentioned in the introduction, governments can be expected to make certain policy concessions to interest groups (here: industries) adversely affected by environmental restrictions. With respect to the introduction of the EU-ETS, an immediate example for such behavior pattern is the costless allocation of emissions permits through the member countries' NAPs. Such free allocation comprises two elements of a subsidy

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<sup>11</sup>In the following, the term "interest group" is also referred to as "IG".

<sup>12</sup>Hillman/Ursprung (1994) derive an opposing result, though in a different framework: In their partial-equilibrium model, two parties engage in political competition. The foreign industry acts as a lobby group in the domestic country, lobbies pay campaign contributions to the parties, and markets are subject to imperfect competition. The authors find that, if environmentalists do not care about the foreign environment (i.e. they are "greens" rather than "super-greens") and pollution is caused by production (rather than consumption), assumptions that also hold in this paper, the environmental IG will favor freer trade over protection. Under general conditions, however, environmentalists favor protectionist trade policy regimes like in the current paper.

(see Johnston (2006)): The first is the value of the allowances themselves. Industries receive them for free, although they have a positive market price as soon as emissions are traded. The second element is the ability of producers to pass through, to a certain extent, the opportunity cost of holding an allowance to the price of their product. Rogge et al. (2006) term the resulting rents “windfall profits”.<sup>13</sup> Whether the costless provision of emissions allowances constitutes a lump-sum or rather a (distortive) unit-subsidy, depends on the specific allocation method applied: Pure grandfathering of permits (i.e. a distribution independent of current output/emission behavior) corresponds to a lump-sum subsidy whereas an output-based allocation corresponds to a production subsidy. In reality, most countries follow a strategy “in-between” that contains elements of both allocation methods (for details see Demailly/Quirion (2006)), so that the current approach, interpreting industrial policy as a production subsidy, provides an appropriate model framework.

The view that the costless allocation of emissions permits constitutes an implicit subsidy, or, more specifically, in the EU case, an element of State Aid, is commonly held in the literature. For instance, Grubb/Neuhoff (2006) characterize the phenomenon, in analogy to this paper, as “compensation for forgone profits due to the environmental regulation”. Smale et al. (2006) argue in a similar way. Johnston (2006), by taking a legal perspective to approach the issue, comes to the same conclusion and finds strong arguments supporting the notion that free allowances involve elements of State Aid. Even the EU Commission adopts this view, which became obvious in its assessment of the French NAP for the first trading period 2005-07 (“phase 1”).

In phase 1, the EU Commission allowed an auctioning of up to 5 percent of total emissions permits. However, only few countries made use of this option (Denmark sold 5, Hungary 2.5, Lithuania 1.5 and Ireland 0.75 percent), while all other EU members did not auction any permit but allocated the whole amount for free. In the second trading period 2008-12 (“phase 2”), up to 10 percent of total emissions permits are allowed to be auctioned. Then again, only some of the member states have chosen this allocation method. None of these countries, however, completely exhausts its 10-percent share. Furthermore, there are even countries (Hungary and Ireland) that reduced their share compared to phase 1 (for an overview table see Appendix A.1).

A look at European NAPs also supports this paper’s finding that domestic polluting industries are not only compensated in exchange for environmental restrictions but even granted *excess* compensation: In the period 2005-07, many European countries allocated more emission certificates to their industries than those actually needed (which

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<sup>13</sup>Besides this most obvious kind of industry subsidization, many other elements of NAPs may provide the potential for implicit industry subsidization or compensation. Examples are new-entrant- or plant-closure rules, the permission to make use of external credits via “Joint Implementation (JI)”- or “Clean Development Mechanism (CDM)”-rules, the possibility of banking emissions allowances to future periods or the provision of opt-out rules. For an overview of NAP-features in the first trading period 2005-07 that might constitute some form of a subsidy see e.g. Betz et al. (2004), for the second trading period 2008-12 Rogge et al. (2006).

they could thus sell on the market). The level of this over-allocation (measured as the share of allocated emissions permits that were not used up in total allocation) ranges from 5 percent in Germany to 26 percent in Finland.<sup>14</sup>

The permit prices can give an impression of the monetary value of this subsidization: An allowance for the emission of one ton of  $CO_2$  on the spot market (“EUA Daily Future”)<sup>15</sup> has been traded at around 13 Euros in the first months of the year 2010. The number of costless emissions allowances in a country corresponds to its cap on total  $CO_2$  emissions according to the NAP. Germany, for instance, provided 499 million tonnes of costless emissions in the period 2005-07. From 2008-12, a total of 456 million tonnes of  $CO_2$  emissions are permitted, out of which 40 million allowances are auctioned.<sup>16</sup> Hence, the value of the remaining 416 million costless allowances in phase 2 thus far can be roughly estimated as 5.41 billion Euros on average.

### 1.3 Related Literature

The conceptual basis for the current paper goes back to Hillman (1982). He introduced a political-support-function approach to analyze a government’s incentives– motivated by self-interest rather than by “social-justice” considerations– for protecting declining industries (i.e. sectors that suffer from decreasing world-market prices).

Bommer/Schulze (1999) have taken up Hillmans model and applied it to an issue frequently subject to public and economic debate: As market integration is often claimed to harm the environment, they investigate, which impact trade liberalization has on a government’s environmental-policy choice. The authors do not consider trade policy explicitly in their two-sector specific-factors model, but address an exogenous change in the relative price of the economy’s export good, as e.g. caused by a country’s joining a free-trade agreement. When trade is liberalized, the resulting increase in the relative price of a “dirty” export good induces a redistribution of income between the owners of specific capital in that sector and a clean import-competing one. In order to sustain maximum political support from all relevant interest groups (besides industry, the group of workers and environmentalists are considered), the government adjusts the level of its environmental-policy instrument, a quantitative emissions limit. This endogenous policy reaction directly affects the export sector’s productivity, since this industry uses the environment as input in addition to the “traditional” factors. Implied by the general-equilibrium setting, also the other interest groups’ utilities are affected– either directly as in case of the environmentalists, or indirectly, via an inter-sectoral

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<sup>14</sup>For data see [http : //assets.panda.org/downloads/wwf\\_can\\_table.pdf](http://assets.panda.org/downloads/wwf_can_table.pdf) (latest access in July, 2010).

<sup>15</sup>Among many others, those “European Union Allowances” are a standard product traded at the European Climate Exchange (ECX). For further details, data and recent developments see [http : //www.ecx.eu/](http://www.ecx.eu/) (latest access in July, 2010).

<sup>16</sup>See the website of the German Environmental Ministry, BMU at [http : //www.bmu.de/emissionshandel/aktuell/aktuell/1201.php](http://www.bmu.de/emissionshandel/aktuell/aktuell/1201.php) (latest access in July, 2010).



labor reallocation, as in case of the clean sector and workers. Bommer/Schulze (1999) find that trade liberalization will make domestic environmental policies more restrictive: In order to re-establish the political-support equilibrium after opening up for free trade, the government redistributes part of the export sector's gain to the losing import-competing sector in terms of tighter environmental regulations. Consequently, contrary to what is often claimed, trade liberalization does not only not harm, but even benefit the environment.

The current paper is closely related to the latter, but it reverses the question posed: Whereas in Bommer/Schulze (1999), trade policy is exogenously given via a country's membership to an international trade agreement and the government chooses environmental policies, the current paper features exogenous environmental restrictions via a country's membership to an environmental treaty and the government chooses trade policy. There are also differences with respect to some less substantial features. For instance, the polluting sector in the current model is the import-competing one rather than the export sector. This corresponds to industry characteristics in the EU (whereas the model in Bommer/Schulze (1999) is more suited to reflect the economic characteristics of the US): The EU-ETS so far involves firms in the energy-producing and energy-intensive sectors like the production of metals, the mineral industry and pulp, paper and board production. Within those sectors, the EU typically is a net importer.<sup>17</sup> Within a political-support-function framework with a government intending to maximize a weighted aggregate of the individual voter groups' welfare, however, this distinction does not alter the results: As long as the compensating subsidy is directly targeted at the polluting sector subject to environmental restrictions, it does not matter whether this sector is import-competing or exporting. In both cases, it will be affected by the regulations in an equivalent way, thus giving the government an equivalent incentive for more protectionist behavior in terms of increased subsidy payments.<sup>18,19</sup>

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<sup>17</sup>As data from EUROSTAT show, the EU-27 countries' net energy imports have been continuously increasing since the year 2000. In 2007, they amounted to 988 million tonnes (those are the latest numbers available in July, 2010; see [http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables)). According to data from the European Commission's website, this amount corresponds to an "import dependency" (defined as net imports in relation to the sum of bunkers and gross consumption) of 53 percent (see [http://ec.europa.eu/energy/publications/statistics/statistics\\_en.htm](http://ec.europa.eu/energy/publications/statistics/statistics_en.htm); latest access in July, 2010).

<sup>18</sup>This is different in Bommer/Schulze (1999), since they analyze the impact of trade liberalization (represented by a change in the relative price of the export good) on the environmental-policy choice. In that case, it is of course relevant whether the polluting sector is the importing or exporting one, as the former loses and the latter benefits from freer trade.

<sup>19</sup>Similarly, a further difference is owed to the different empirical perspectives: With regard to the means of lobbying activities, Bommer/Schulze assume that interest groups exert political influence by paying campaign contributions to the government (which then itself uses these contributions to organize campaigns to influence the voter). In Europe, campaign contribution payments are not a common practice like in the US. Direct lobbying of the government is a rather complicated process, in which money payments are officially not prevalent (see [http://www.europarl.eu.int/workingpapers/pana/pdf/w5en\\_en.pdf](http://www.europarl.eu.int/workingpapers/pana/pdf/w5en_en.pdf) (latest access in July, 2010) for de-

Similarly to Bommer/Schulze (1999), also Bommer (1996) applies a political-support-function approach to analyze the impact of trade liberalization on environmental policies. In doing so, he focusses on the example of European integration, known as the establishment of the “Common Market”. The methodological approach, however, differs from mine and that of Bommer/Schulze (1999): Rather than investigating a political-support-maximizing government’s unilateral policy choices, he considers strategic environmental-policy competition between two countries with imperfectly competitive markets (specifically, one domestic and one foreign firm supply the domestic market). Governments aim at providing most favorable policy conditions to their domestic producers in terms of international competitiveness (i.e. profits). The results of both approaches coincide, but rely on different mechanisms. Also Bommer (1996) finds that trade integration, under certain conditions,<sup>20</sup> facilitates the introduction of more stringent environmental standards. In his model, however, this conclusion is due to a convergence of the two countries’ non-cooperative environmental-policy levels induced by declining tariffs. As a consequence, policy harmonization to a more stringent level, and thus the overcoming of a Prisoners’ Dilemma situation in the initial equilibrium, becomes feasible. Accordingly, also his paper confutes the claim that trade liberalization is “bad for the environment”.

Yet another political-support-function approach to analyze an environmental-policy issue is Rauscher (1997). His research question, however, differs from the previous papers’: Which bias from socially optimal environmental-policy levels does an industry- and an environmental lobby group’s influence cause? Rather than modeling trade policy explicitly, the author considers environmental policy as an implicit substitute. The model is very general in that it allows for many possible variations: For instance, pollution may be caused by production and consumption of a good, there are different policy instruments available, and the environmental lobby can exhibit different characteristics. Rauscher (1997) finds that, depending on the specific case under consideration and on parameter values, the preferences of both lobbies may coincide. That is, strict environmental regulations may be consistent with the domestic industry’s profit-maximizing interest— a result which is consistent with the previous papers’ findings.

Besides those theoretical papers, there are also empirical approaches to the issues the current paper deals with. Specifically, they attempt to find explanations for the weak existing empirical evidence of the hypothesis that environmental regulations affect trade patterns (also known as the pollution haven hypothesis; see above). Those papers suspect that the imposition of stricter environmental regulations on a polluting sector is accompanied by compensating policy adjustments in other areas, so that the overall effect on a country’s production- and trade patterns is canceled out or at least weakened. As an example, Eliste/Fredriksson (2002) use agricultural-sector data to analyze whether

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tails). This paper thus measures political influence in terms of an IG’s ability to influence voting decisions of the voters *directly*. This difference, however, is not crucial for the results, because neither paper models the lobbying process explicitly.

<sup>20</sup>That is, the country hosting the import-competing industry must be characterized by more expressed environmental preferences than the country hosting the exporting industry.

the imposition of stricter pollution taxes leads to increased government transfers in terms of a higher output subsidy to the affected sector. Their empirical results are based on a theoretical political-economy model applying the “Protection-for-Sale” approach by Grossman/Helpman (1994).<sup>21</sup> Environmentalists lobby for a low, and farmers for a large subsidy to the polluting agricultural sector. As all individuals are assumed to be tax payers (thus having to finance the subsidy) as well as recipients of pollution-tax revenue, there are respective additional negative and positive pressures on environmental-policy levels. Whether in the political equilibrium agricultural output is subsidized or taxed, depends on the weights of the lobby groups and social welfare in the governmental objective function. The direction of an endogenous output-subsidy adjustment to an exogenous increase in the pollution tax, however, is unambiguously positive: Transfers to the polluting agricultural sector will indeed increase if stricter environmental regulations are imposed. Furthermore, Eliste/Fredriksson (2002) show that trade patterns are not affected at all. That is, the rise in the agricultural-output volume induced by the compensating production subsidy exactly offsets its initial pollution-tax-induced decline. The theoretical predictions of the model are supported by the authors’ empirical results.<sup>22</sup>

In their solely empirical analysis, also Ederington/Minier (2003) suspect the governments’ compensation motives to explain the weak evidence of the pollution haven hypothesis. The underlying mechanism, however, differs from Eliste/Fredriksson (2002): Rather than using production policies as means of compensation for a sector adversely affected by exogenous environmental restrictions, their model predicts the government to apply endogenous environmental policy as second-best trade policy to compensate domestic import-competing sectors adversely affected by free trade (interpreted as exogenous trade policy).<sup>23</sup> They argue that the neglect of such environmental-policy endogeneity in existing empirical tests leads to an under-estimation of the PHH effects. As their hypothesis is indeed supported by the empirical results,<sup>24</sup> the authors conclude

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<sup>21</sup>Differently from the current paper, Grossman/Helpman (1994) use a partial-equilibrium model. The government’s objective function is a weighted aggregate of social welfare and the sum of campaign contributions paid by different lobby groups. The authors provide an endogenous derivation of the weights attributed to different lobby groups in a political support function. Hence, both approaches are closely related.

<sup>22</sup>The empirical model uses cross-country data from 62 countries for the year 1990. Both environmental stringency and the producer subsidy are measured by indices aggregating diverse policy indicators. The authors note, however, that the results have to be interpreted with caution, since not all transfers to the agricultural sector necessarily constitute a means of compensation for the adverse impacts of stricter environmental regulations.

<sup>23</sup>In particular, the use of trade policies is restricted because countries belong to a free trade area. There is no specific political-economy model underlying this analysis like in Eliste/Fredriksson (2002). Aspects of political economy are only incorporated implicitly in a political-economy-variable vector determining environmental stringency and the hypothesis that higher levels of imports are correlated with less stringent regulations (see below).

<sup>24</sup>The analysis also differs from Eliste/Fredriksson (2002) with respect to the empirical methodology and data. Ederington/Minier (2003) use time-series data from US-manufacturing industries for the period 1978 to 1992 to estimate the effect of environmental regulations (the stringency of which is

that, in order to prevent compensating environmental-policy reactions to international trade agreements and their adverse impact on global welfare, free-trade negotiations should be extended to cooperation on environmental issues.<sup>25</sup>

How do the conclusions of these empirical analyses relate to the current paper's findings? In what concerns the specific policy instruments, only Eliste/Fredriksson (2002) correspond to the current paper in considering compensation for exogenous environmental restrictions in terms of endogenous production policy. The argument of Ederington/Minier (2003), treating environmental policy as endogenous and trade policy as exogenous, is more in line with Bommer/Schulze (1999). Nevertheless, both papers find empirical evidence for the general hypothesis that governments, considering political support from different interest groups, compensate industries adversely affected by the exogenous introduction of some policy measures connected with the country's membership to an international agreement. Their general empirical findings are thus in line with the current paper's theoretical predictions. However, besides this qualitative result, the quantitative extent of industry compensation is not determined in the empirical analyses. Hence, the current paper contributes to the existing literature in providing insights into the *net* competitiveness-effects of exogenously introduced environmental regulations on the affected sector. The results derived are not restricted to the case of environmental policy; it is straightforward to transmit them to various other policy areas.

With respect to the general research issue, a number of additional papers relate to the current one in that they also deal with the analysis of the trade/environment relationship under consideration of political-economy aspects. Those papers ask, which impacts the presence of different lobby groups has on the determination of environmental (and trade) policies in open economies. Unlike Rauscher (1997), who addresses an analogous question within a political-support-function model framework (see above), this literature strand applies the "Protection-for-Sale" approach by Grossman/Helpman (1994). Depending on the specific model features, e.g. with respect to the type of the available policy-instruments,<sup>26</sup> of pollution externalities<sup>27</sup> or of the relevant lobbies,<sup>28</sup> it turns

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measured by the ratio of pollution abatement costs to total costs) on trade flows (i.e. net imports). In addition, the impact of political-economy effects (measured by a vector of political economy variables) on environmental regulations is estimated. The authors expect environmental regulations to be the more lenient, the larger a sector's net-import volume is. In a simultaneous estimation, Ederington/Minier (2003) find their hypotheses supported: If the endogeneity of environmental stringency is accounted for in the estimations, the correlation between environmental policies and trade flows is much larger than otherwise.

<sup>25</sup>As the authors note, this argument for international cooperation on domestic policies in addition to international (trade-)policies can be classified as "second-best argument".

<sup>26</sup>First of all, this distinction concerns the broad instrument category, i.e. whether trade-, environmental- or both policies are endogenous. Within those categories, one can distinguish between distortive instruments like taxes and non-distortive ones like quantitative emissions limits.

<sup>27</sup>Pollution can be generated by production, consumption or both. A further distinction is made between local and transboundary pollution.

<sup>28</sup>Some papers only consider industry lobbies, some only environmentalists, others both. Aidt (1998)

out that neither the presence of environmental lobbies unambiguously implies stricter environmental policies, nor that of industry lobbies weaker policies. Another common conclusion is that lobby influence induces socially suboptimal policy decisions: In the political equilibrium, the government chooses an environmental-policy level that deviates from the welfare-maximizing one.

A first subgroup within this literature applies a small-open-economy framework. Fredriksson (1997), in a model with two sectors and free trade, detects a positive or negative influence on the equilibrium emissions-tax rate exerted by environmentalists or industrialists respectively. The relative weights of the lobby groups in social welfare and the governmental objective function, however, have ambiguous effects on equilibrium policies.<sup>29</sup>

Aidt (1998), in a similar model with  $n$  sectors only partly organized as interest groups, supports the inefficiency-outcome with respect to the *level* of environmental policy: As a result of lobbying activities, the emissions tax is lower than the socially optimal one for organized, and higher for unorganized sectors. In what concerns the *type* of instrument, however, the political equilibrium yields an efficient decision: The government chooses the instrument directly targeted at the source of pollution, i.e. an input-tax on the use of raw materials rather than a tax on output.

Schleich (1999) further extends the model to investigate the consequences of lobby influence on environmental quality (which is determined by the government's policy choice). Differently from the previous papers, he adds trade policy to the set of a government's available instruments. In consistence with the related papers, he finds that in the political equilibrium, the government chooses the efficient policy instrument, but at an inefficient level. An industrial lobby's influence on environmental quality is ambiguous.<sup>30</sup> Furthermore, the author compares different policy regimes: In order to address a domestic pollution externality, a government may either dispose of both domestic (production- and consumption-) and trade policies, or only of one policy type. This allows for the key conclusion that (inefficient) trade policies alone may even yield better environmental quality than (efficient) domestic policies alone.<sup>31</sup>

Building on Fredriksson (1997) and Aidt (1998), only Fredriksson (1999) explicitly examines the effects of trade liberalization on pollution taxes and -levels. He considers

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further differentiates between "functionally specialized" lobbies (like e.g. environmentalists or industrialists) and "multiple-goal" lobbies. As already mentioned, Hillman/Ursprung (1994) distinguish "greens" from "super-greens".

<sup>29</sup>This is due to the corresponding changes in environmental-tax revenue, which is redistributed to all citizens and thus affects the groups' utilities indirectly.

<sup>30</sup>Specifically, the result depends on the shape of the environmental-damage function: Increasing- or constant marginal damage implies inefficiently low environmental-quality levels, whereas decreasing marginal damage may induce higher-than-optimal levels. An environmental IG's influence is not considered in this paper.

<sup>31</sup>The explanation is given by the higher "political cost" of trade policies as compared to production policies due to an additional distortion of the consumer price. Hence, a government interested in political support (i.e. contribution payments) will raise the producer price (and thus output and pollution) by less, if only trade policy is available.

the impact of an exogenous reduction in import tariffs on an environmental- and an industry lobby groups' incentives for influencing the government's pollution-tax choice. In particular, as declining tariffs imply a contraction of the domestic import-competing industry's output and pollution, the effects of pollution-tax changes become less important in the course of trade liberalization. This in turn reduces the political polarization between the two lobbies (measured by the difference in the intensity of their lobbying efforts). The overall environmental impact of tariff reductions depends on the relative magnitude of the changes in the different interest groups' lobbying efforts. If this change is sufficiently more expressed for the environmental, than for the industry group, declining tariffs may induce lower pollution taxes and thus higher environmental damage.<sup>32</sup> Fredriksson (1999) concludes that trade liberalization can no longer be considered as unambiguously welfare-enhancing, if endogenous environmental-policy adjustments are considered.

A second subgroup within the political-economy literature on the environment/trade relationship addresses analogous research questions in a large-open-economy framework. Differently from most small-country analyses (except for Schleich (1999)), those models endogenize trade policies and compare the outcomes of different policy regimes. In addition to the previously mentioned policy impacts, large-country governments have to consider the terms-of-trade effects of their decisions.

Schleich/Orden (2000), for instance, investigate the impact of industry lobbies on a country's production-tax- and/or trade-policy choice. Their paper extends the small-country analysis in Schleich (1999), and allows for transboundary pollution and cooperation between different countries.<sup>33</sup> Can such cooperative policy choice improve on environmental quality compared to the non-cooperative regime? The efficiency-results for restricted policy availability are consistent with the small-country case: Due to a non-cooperative government's political-support considerations, less efficient trade policies alone may lead to higher environmental quality than efficient domestic policies alone. Inter-governmental cooperation has an ambiguous effect: Environmental quality may be lower in a cooperative, than in a non-cooperative policy regime.<sup>34</sup>

Conconi (2000) in a similar two-country model modifies the research question and examines, whether there is something to be gained from international cooperation on environmental policies despite of a green lobby's presence (industry lobbies are not

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<sup>32</sup>This outcome arises if the pollution-tax decline is so strong that the total-pollution impact of the induced increase in pollution per unit of output outweighs the respective impact of the contraction in the volume of output.

<sup>33</sup>Political cooperation here implies the maximization of two governments' joint surplus, i.e. a weighted sum of both countries' domestic objective functions.

<sup>34</sup>In particular, there are four cooperation-effects: First, cooperating governments abstain from using policies to influence their terms-of-trade (environmental effect indeterminate). Second, transboundary pollution externalities are accounted for (positive effect on environmental quality). Third, negative externalities from support for a domestic lobby on foreign lobbies are considered (positive effect on environmental quality due to lower output price). Finally, industry protection is available at lower welfarecosts (negative effect on environmental quality due to higher output price). The overall environmental impact of cooperation depends on the relative magnitude of these four effects.

considered). Differently from Schleich/Orden (2000), political cooperation here incorporates only trade policy (in terms of a free trade area like the WTO). Conconi (2000) finds that the reasonability of environmental-policy cooperation depends on whether countries already cooperate in trade policies: A green lobby's political pressure can serve as better substitute for an international environmental agreement, if the involved countries set their trade policies non-cooperatively. This finding is owed to the large-country setting: Domestic pollution taxes improve the foreign country's terms-of-trade and so induce an expansion of foreign output and pollution. If the countries belong to a free trade area, they cannot counteract those leakage-effects by appropriate trade-policy adjustments. Hence, the environmental lobby's interest in high domestic pollution taxes (and thus its contribution payments to the government) are weakened: Rather than biasing environmental policies upwards, in the cooperative policy regime, the green lobby causes the pollution-tax rate and environmental quality to be lower than in the non-cooperative regime. They may even fall short of their efficient (Pigouvian) levels.<sup>35</sup> Conconi (2003) further extends her model by introducing an additional industry lobby, allowing for cooperation between domestic and foreign green lobbies and for asymmetric countries. However, neither of these extensions changes her basic conclusion with respect to an environmental IG's policy impact.

To give a very broad summary of this political-economy literature's general conclusions on the trade/environment relationship, one can divide them into two groups: Whereas the political-support-function approaches detect positive environmental impacts of trade liberalization, the group of "protection-for-sale" approaches finds that trade integration may have adverse environmental effects. Especially the latter group's conclusions, however, rely heavily on the specific underlying assumptions and parameter values.

In what concerns the position of the current paper within the political-economy literature reviewed above, one can state the following: There is a broad literature on the trade/environment relationship that addresses the effects of an exogenous trade liberalization or an exogenously given trade regime (mostly free trade) on environmental-policy making and/or pollution. This is motivated by the empirical observation of numerous free trade agreements in the last decades. However, in recent years, also international environmental agreements have become an issue of considerable relevance. Nevertheless, approaches dealing with the exogenous introduction of environmental policies (reflecting a country's membership to an international environmental agreement) and the respective impacts on policy-making in other areas including trade policy, are quite rare. Hence, the current paper provides one step to fill this gap and account for recent "real-world" developments.

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<sup>35</sup>This is the case for pollution spillovers and leakage effects sufficiently large: For such parameter values, stricter domestic environmental policies increase environmental degradation, and are thus opposed by the green lobby. Such outcome contradicts the findings of the related literature building on small-country models (see above).

# Chapter 2

## The model

### 2.1 Production

In a small open economy with perfectly competitive goods- and factor markets, there are two sectors, I and II, both applying a constant-returns-to-scale technology. The import-competing “dirty” sector produces a good  $x^I$ , a substitute to the foreign good  $x^{imp}$ , by using sector-specific capital  $\bar{K}^I$ , mobile labor  $L^I$  and an environmental factor  $E$ .<sup>1</sup> Specifically, use of the environment (i.e. pollution) makes production more efficient (subscripts denote partial derivatives):

$$x^I = g(E)F(\bar{K}^I, L^I) \quad \text{with} \quad g(0) = 1, \quad g_E > 0, \quad g_{EE} < 0 \quad \text{and} \quad F_L^I > 0, \quad F_{LL}^I < 0. \quad (2.1)$$

Producers in sector I receive a subsidy  $s$  per unit of output. As a consequence, producer- and consumer prices do not coincide:<sup>2</sup> While consumers pay the world market price  $p^w$ , producers receive the domestic price  $p^p = p^w + s$ .

Sector I maximizes the return to its specific factor as follows:

$$\begin{aligned} \max_{L, E} \quad \Pi^I &= p^p x^I - wL^I = p^p g(E)F(\bar{K}^I, L^I) - wL^I \\ \text{s.t.} \quad L^I + L^{II} &= \bar{L} \\ K^I &= \bar{K}^I \\ E &\leq \bar{E}^I, \end{aligned} \quad (2.2)$$

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<sup>1</sup>Supply of specific capital is fixed as well as total labor supply:  $L^I + L^{II} = \bar{L}$ . Thus, an increase in labor employed in one sector must be accompanied by a respective decrease in the other sector:  $dL^I = -dL^{II}$ . Initially, use of the environmental factor  $E$  is also restricted by environmental policy to a level of  $E_0$ .

<sup>2</sup>Let  $p$  denote the relative price of good I, i.e. the price of good I in terms of the numeraire good II.



where  $w$  is the wage rate. This profit maximization yields, first, the common result that labor is paid its value marginal product:  $w = p^p g(E) F_L^I$ . Second, the environmental factor is employed to the maximum possible extent:  $E = E_0$ .

The “clean” sector produces the numeraire good  $x^{II}$  by using sector-specific capital  $\bar{K}^{II}$  and mobile labor  $L^{II}$ :

$$x^{II} = F(\bar{K}^{II}, L^{II}) \quad \text{with} \quad F_L^{II} > 0, \quad F_{LL}^{II} < 0. \quad (2.3)$$

The return to the specific factor in sector II is given by:

$$\Pi^{II} = x^{II} - wL^{II} = F(\bar{K}^{II}, L^{II}) - wL^{II}. \quad (2.4)$$

Here, profit maximization yields  $w = F_L^{II}$ , so that the wage rate is determined by:

$$w = p^p g(E) F_L^I = F_L^{II}, \quad (2.5)$$

and equal across sectors due to labor mobility. Profits in the two sectors thus are:<sup>3</sup>

$$\Pi^I = p^p g(E) [F(\bar{K}^I, L^I) - F_L^I L^I], \quad (2.6)$$

$$\Pi^{II} = F(\bar{K}^{II}, L^{II}) - F_L^{II} L^{II}. \quad (2.7)$$

## 2.2 Workers

A worker’s individual utility is determined by the level of income.<sup>4</sup> Each worker supplies one unit of labor and there is no unemployment. Thus, labor income is  $w$ . The subsidy to the polluting sector is financed via a lump-sum tax on workers: Each of them bears an equal share of the total transfer  $S = sx^I$ . A worker’s total individual income is thus given by:

$$I = w - \frac{sx^I}{L}. \quad (2.8)$$

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<sup>3</sup>In the following, the terms “profit” and “return to the specific factor” will be used as synonyms.

<sup>4</sup>One might annotate that also environmental damage should impact on a worker’s utility, since each consumer will exhibit some preference for a clean environment. In the political-support-function approach applied here, however, a government maximizes political support over different interest groups that represent their members’ common interests *with respect to a certain issue*. Workers are organized as a labor union which usually focuses on issues directly related to labor, mainly on income. The workers’ environmental concerns are incorporated in the environmental lobby’s utility (alternatively interpreted as “general environmental interest”; see below): The stronger environmental awareness in a country is, the higher will the political weight of the environmental lobby be. However, including environmental damage into a worker’s utility function would not alter the qualitative findings and influence the quantitative results in the same way a higher political weight of the environmental IG would do (see Section 3.2).

## 2.3 The Environment

Environmental damage positively depends on total domestic emissions  $E$  and is represented by the convex damage function

$$D(E) \quad \text{with} \quad D_E > 0 \quad \text{and} \quad D_{EE} > 0. \quad (2.9)$$

This function abstracts from transboundary pollution, as it neglects the adverse effects domestic (foreign) emissions have on the foreign (domestic) environment.<sup>5</sup>

## 2.4 The government

In representative democracies like e.g. the EU countries, governments are elected by voters. Re-election can be seen as an incumbent government's main goal. The support a government receives from different interest groups influences the probability of being re-elected. Political support can be interpreted as the lobbies' implicit or explicit (re-)election recommendations to voters.<sup>6</sup> For instance, a common appearance at public events organized by the governing party or the lobby group may constitute

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<sup>5</sup>In the model framework applied in this paper, no other assumption on environmental damage is sensible. Consider the case of global environmental problems in which it does not matter where emissions are produced for world-wide damage to arise. The domestic damage function would then be determined by world-wide emissions  $E^w$ :  $D = D(E^w)$  with  $E^w = E^d + E^{ROW}$  ( $d$  stands for "domestic" and  $ROW$  for "Rest of the World"). The effects of domestic environmental restrictions would only differ from those analyzed in this paper (see Chapter 3) if the induced external effects and thus the potential strategic reactions of the foreign country (ROW) are taken into account:

$$\frac{\partial D}{\partial E^d} = \frac{\partial D}{\partial E^w} \frac{\partial E^w}{\partial E^d} = \frac{\partial D}{\partial E^w} \left( 1 + \frac{\partial E^{ROW}}{\partial E^d} \right) \neq \frac{\partial D}{\partial E^w} \quad \text{if} \quad \frac{\partial E^{ROW}}{\partial E^d} \neq 0.$$

Depending on sign and magnitude of the term  $\frac{\partial E^{ROW}}{\partial E^d}$ , positive environmental effects of domestic policy (i.e. a decrease in emissions) may be strengthened, weakened, leveled out or even reversed. However, strategic interdependencies between different countries (and the corresponding leakage effects) are not in the scope of this model which focuses on the *unilateral* introduction of environmental restrictions, implicitly assuming policies in ROW to be given and fixed. Alternatively, without explicitly modeling the foreign policy-choice, one could simply *assume* some leakage effect. This, however, would not add further insights to the analysis as it could equivalently be expressed by modifying the damage function  $D$ . Consider, for instance, the economically plausible case  $-1 < \frac{\partial E^{ROW}}{\partial E^d} < 0 \Rightarrow \frac{\partial D}{\partial E^d} < \frac{\partial D}{\partial E^w}$ , i.e. the foreign reaction weakens the positive effects of domestic environmental policy. In terms of the current model, such scenario is equivalent to a change in marginal environmental damage. The implications of varying levels of marginal environmental damage for the results are discussed in Chapter 3.

<sup>6</sup>Note that, besides lobby recommendations, there are many more factors determining whether a voter elects a government or not. Among them are e.g. the potential alternatives (other parties/coalitions), a voter's personal satisfaction with current policy-making or his general party preferences/sympathies. However, an interest groups' political support is a substantial determining factor for a government's re-election.

an implicit recommendation to vote for the government (example: labor unions invite the president/chancellor). More explicit recommendations might take the form of position papers published by an interest group or positive public statements concerning a government position on some policy (example: an industry representative supports the government's tax policies in a newspaper article).

Accordingly, the government's aim is to maximize political support over different interest groups; its objective function  $G$  is a weighted aggregate of those groups' utilities. The relevant instruments are industrial- and environmental policies in terms of a production subsidy to the polluting sector and a quantitative cap on that sector's total emissions. When determining the level of those policies, the government has to consider tradeoffs between the opposing interests of the different lobbies: A policy measure which is beneficial for one of them and thus raises its political support may be harmful for another and decrease that group's support in turn.

Relevant interest groups in this model include workers, or labor ( $\bar{L}$ ), organized in a labor union. The function  $G$  incorporates their interests in terms of total income  $I$  according to eq. (2.8): The higher this income (and thus utility), the more do labor representatives support the government.

In addition, sectors I and II (that is, the owners of the respective specific factors) are organized as lobbies. As their goal is profit maximization, those groups' interests are represented by  $\Pi^I$  and  $\Pi^{II}$  (see eqs. (2.6) and (2.7)) in  $G$ . Their political support depends positively on the respective profits.

Finally, there is an environmental lobby, a group that only cares about domestic environmental quality.<sup>7</sup> Its goal is to minimize environmental damage caused by industry-I emissions. The support function incorporates the environmentalists' interest in terms of environmental damage: A rise in  $D$  decreases the environmental lobby group's political support (increases its political opposition, respectively).<sup>8</sup>

A general political support function considering all the above-mentioned groups is given by:  $G = G(I, \Pi^I, \Pi^{II}, D)$ . This function is twice continuously differentiable. Political support increases with rising utility at a diminishing rate whereas political opposition increases with rising disutility at an increasing rate. That is, the political support function is concave in all its arguments  $(-)V_i$ , where  $(-)V_i$  represents the level of (dis)utility of any group  $i$ , as illustrated in Figure 2.1:

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<sup>7</sup>This assumption implies that environmentalists do not care about foreign, or global pollution. Hence, "greens" rather than "supergreens" are considered here (according to the distinction made by Hillman/Ursprung (1994)).

<sup>8</sup>The term  $D$  in the support function may also be interpreted as general environmental awareness of the population.

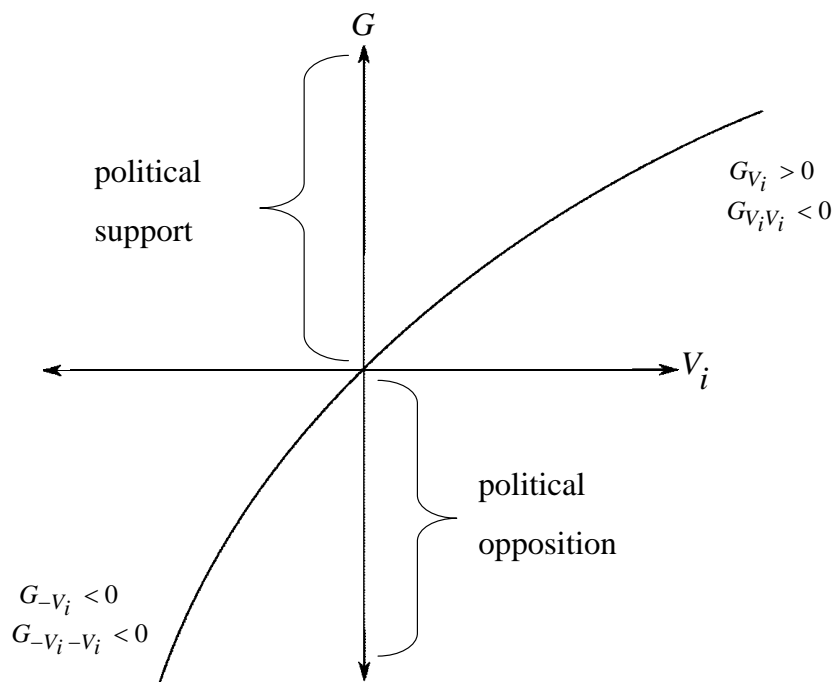


Figure 2.1: Properties of the Political Support Function

Within  $G$ , the government attaches different weights to the groups' utilities. Those depend on the lobbies' ability to influence the government itself on the one hand and, on the other hand, voter decisions (or "public opinion"). Since the government's ultimate goal is its own re-election, the former type of a lobby's political influence is following from the latter, which is thus decisive for the political weight. How powerful an interest group is in this respect depends on several factors, like its financial means or its presence in the media for example, but also on more subtle factors like the lobby's reputation and general public preferences. For instance, in countries characterized by high environmental awareness, the environmental IG can be expected to have a strong influence on public opinion; this should translate into a high political weight in the support function.

# Chapter 3

## The Political Equilibrium

As explained in Section 2.4, the government maximizes a political support function  $G$  over all interest groups. The first-order condition for the optimal choice of the subsidy to the polluting sector I is given by:

$$G_s = G_I I_s + G_{\Pi^I} \Pi_s^I + G_{\Pi^{II}} \Pi_s^{II} + G_D \underbrace{D_s}_{=0} \stackrel{!}{=} 0. \quad (3.1)$$

Equation (3.1) implies that there is a unique subsidy  $s^*$  which equates marginal political support from the policy winners to marginal political opposition from the policy losers. The environmental IG does not directly influence the government's choice since its utility does not depend on  $s$  (see Lemma 3.1 below).

Due to the small-country model framework and the focus on policy instruments not distorting consumer prices, the impacts of policy changes on the different interest groups' utilities (except for the environmental IG) can be measured solely by changes in their income.

The industrial-policy instrument is a subsidy  $s$  per unit of output to the polluting sector I, financed by a lump-sum tax on workers. Lemma 3.1 summarizes the impacts of this policy measure on the different IGs' utilities:

**Lemma 3.1** *When, for a given environmental-policy level, the production subsidy to the polluting sector is raised, the return to its specific factor rises ( $\Pi_s^I > 0$ ), the return to the clean sector's specific factor declines ( $\Pi_s^{II} < 0$ ), and the total income of a worker also declines ( $I_s < 0$ ). The environmental IG's utility is not affected ( $D_s = 0$ ).*

**Proof:** See Appendix A.2.  $\square$

Lemma 3.1 implies that the subsidized sector I raises output as the producer price of its good increases. This improves its own profits but detracts labor from sector II and induces a profit decline there. Although workers, due to the increased marginal product of labor, benefit from an increase in the wage rate, this positive income effect is outweighed by the higher subsidy payments to sector I they have to finance. Overall,

the workers' total income declines. The environmentalists' utility is solely determined by the domestic emissions level  $E$  which is not affected by industrial policy.

In order to analyze a government's incentive to compensate an industry for more restrictive environmental policies, this paper assumes that, departing from an initial emissions-allowance level  $E_0$ , a lower binding cap on total emissions in industry I,  $\bar{E}$ , is introduced.<sup>1</sup> This policy is exogenously determined. Lemma 3.2 summarizes the impacts environmental policy has on the different IGs' utilities:

**Lemma 3.2** *When, for a given industrial-policy level, environmental restrictions are strengthened, the return to the specific factor in the polluting sector declines ( $\Pi_E^I > 0$ ), the return to the clean sector's specific factor rises ( $\Pi_E^{II} < 0$ ), and the total income of a worker rises ( $I_E < 0$ ). The environmental IG's utility is also raised ( $D_E > 0$ ).*

**Proof:** See Appendix A.3.  $\square$

The intuition behind Lemma 3.2 is similar to that behind Lemma 3.1: A stricter emissions cap decreases labor productivity (and thus wages) in the polluting sector. Consequently, labor moves from there to the clean sector. Output and profits decline in sector I and rise in sector II. For workers, the negative wage effect is outweighed by the lower subsidy payments as output in the subsidized sector declines. Environmentalists obviously benefit from improved environmental quality.

### 3.1 The Direction of the Industrial-Policy Adjustment

As discussed above, the introduction of  $\bar{E}$  leads to losses in utility (and thus political support) for some groups and to respective gains for others.

The question to be answered now is how industrial policy has to be adjusted in order to keep total political support at its maximum level. Formally, sign and magnitude of  $\frac{ds}{dE}$  have to be determined. Total differentiation of eq. (3.1) yields:

$$\begin{aligned} G_{ss}ds + G_{sE}dE &= 0 \\ \Rightarrow \frac{ds}{dE} &= -\frac{G_{sE}}{G_{ss}}. \end{aligned} \tag{3.2}$$

The interpretation of eq. (3.2) is the following: How does the subsidy  $s$  have to be adjusted after a decrease in total emissions ( $dE$ ) in order to offset the induced change

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<sup>1</sup>Though it is not arguable that, in the presence of externalities, output-based emissions-control instruments like taxes are more efficient to correct a producer's suboptimal choice than emissions limits, quantitative restrictions are more often used in practice. Buchanan/Tullock (1975) e.g. provide an early theoretical political-economy explanation for this phenomenon. Many papers dealing with environmental-policy issues follow these findings and address standards rather than taxes (see the examples mentioned in the literature review, like e.g. Bommer/Schulze (1999)). Recent anecdotal evidence includes the Kyoto protocol (see Section 1.1) or the US Clean Air Act (last amendment in 1990; see [http : //www.epa.gov/lawsregs/laws/caa.html](http://www.epa.gov/lawsregs/laws/caa.html) (latest access in July, 2010) for detailed information).

in marginal political support ( $G_{sE}$ ) by a countervailing change ( $G_{ss}$ ) so that marginal political support ( $G_s$ ) remains at the optimal (zero-) level? Proposition 3.1 states the result:

**Proposition 3.1:** *If the government aims at sustaining a maximum level of total political support, the relationship between the policy variables  $E$  and  $s$  is negative, i.e. stricter environmental regulations induce increased protection for the domestic polluting industry. This result holds for non-convex utility functions.<sup>2</sup>*

**Proof:** The denominator of eq. (3.2), the term  $G_{ss}$ , must be negative in order to meet the second-order condition for  $s^*$  to yield a maximum of political support. Specifically, this term is given by:<sup>3</sup>

$$G_{ss} = G_{II}(I_s)^2 + G_{II}I_{ss} + G_{\Pi^I\Pi^I}(\Pi_s^I)^2 + G_{\Pi^I}\Pi_{ss}^I + G_{\Pi^{II}\Pi^{II}}(\Pi_s^{II})^2 + G_{\Pi^{II}}\Pi_{ss}^{II}. \quad (3.3)$$

As pointed out above, marginal political support is positive but diminishing, implying the first, third and fifth element of eq. (3.3) to be negative. Non-convexity of the utility functions thus constitutes a sufficient (though not necessary) condition for the remaining summands, and thus the whole term, to be negative.

The numerator of eq. (3.2) is given by:

$$G_{sE} = G_{II}I_sI_E + G_{II}I_{sE} + G_{\Pi^I\Pi^I}\Pi_s^I\Pi_E^I + G_{\Pi^I}\Pi_{sE}^I + G_{\Pi^{II}\Pi^{II}}\Pi_s^{II}\Pi_E^{II} + G_{\Pi^{II}}\Pi_{sE}^{II}. \quad (3.4)$$

With respect to the sign of this expression, no unambiguous statements valid for all functional forms are possible. However, economic-plausibility considerations suggest  $G_{sE}$  to be negative as well as  $G_{ss}$ , because the term consists of analogous elements and  $G_{ss}$  must be negative for  $s^*$  to meet the second-order condition for maximum political support. If the above-mentioned sufficient conditions for this are fulfilled, it is economically plausible that also the respective conditions for  $G_{sE} < 0$  are met, since the policy variables  $s$  and  $E$  impact on profits and income in the same direction.<sup>4</sup>  $\square$

Proposition 3.1 implies that the government indeed has an incentive to compensate the industry subject to stricter environmental policies in terms of increased subsidization of its production (this, due to the open-economy framework, is equivalent to increased protection). Hence, part of the gain from environmental restrictions accrued by the clean sector, workers and the environmental IG is redistributed to the loser from environmental policy, the polluting sector.

<sup>2</sup>The term ‘‘utility’’ here generalizes the respective groups’ incomes/profits.

<sup>3</sup>Following Bommer/Schulze (1999), so-called envy effects are neglected:  $G_{V_i V_j} = 0 \quad \forall \quad i \neq j$ , i.e. marginal utility of one group is not affected by changes in another group’s utility level.

<sup>4</sup>Calculations in Appendix A.4 use the specific example of a Cobb-Douglas production function to show that both  $G_{ss} < 0$  and  $G_{sE} < 0$  are reasonable assumptions in a standard analytical framework.

## 3.2 Magnitude and Determining Factors of the Policy Adjustment

What remains to be discussed is the quantitative extent of the effect stricter environmental regulations have on industrial policy. The question is whether the interdependencies between environmental- and industrial policies induce overall losses or benefits for the different interest groups compared to the initial situation. For this purpose, I introduce the concept of “completeness”. This is interpreted in terms of the initial income distribution: Compensation of the environmental-policy loser is complete if the associated change in industrial policy retains the initial income distribution among industry I, industry II and workers. In that case, the increase in  $s$  is termed “proportional” to the initial decrease in  $E$ . Most interesting for the general issue under consideration in this paper is the net impact of the policy mix on the polluting sector’s profits (i.e. competitiveness). Proposition 3.2 states the rather unexpected result:

**Proposition 3.2:** *Compensation of sector I for losses caused by environmental policy is more than complete if the environmental interest (group) is attached some political weight. In other words, the increase in the polluting sector’s utility due to more generous subsidy payments is larger than that sector’s initial loss due to the lower emissions allowance. Hence, the polluting sector benefits from stricter environmental regulations.*

**Proof:** See Appendix A.5.  $\square$

Proposition 3.2 implies that the polluting sector is granted excess compensation for the introduction of stricter environmental policies. Figure 3.1 illustrates this finding:

The iso-distribution curve shows all combinations of policies  $s$  and  $\bar{E}$  that induce the same distribution of income among industries I and II and workers. This curve is convex, since the underlying utility functions are concave (i.e. characterized by diminishing marginal utility and rising marginal disutility).<sup>5</sup> The iso-support locus depicts all combinations of  $s$  and  $\bar{E}$  that induce the same level of overall political support. This curve incorporates the environmental IG’s support level: Since the subsidy does not influence the environmentalists’ utility, a vertical line through the emissions level represents an indifference curve of this lobby. A graphical combination of the iso-distribution- and the environmental indifference curve yields an iso-support curve somewhere in-between, i.e. steeper than the iso-distribution locus.

If the environmental group had no influence at all, the iso-distribution- and iso-support curves would coincide, and compensation for the introduction of  $\bar{E}$  would be complete (i.e. the government would raise  $s$  to a level that retained the initial income distribution). However, in the presence of an environmental interest, in order to keep political support constant after the decrease in  $E$ ,  $s$  has to be raised by more (i.e. from  $s_0$  to  $s'_1$ ) than required to simply reverse the initial income re-distribution (i.e. from  $s_0$  to  $s_1$ ). The figure also illustrates that industry I is better off in the presence of an

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<sup>5</sup>For details on the slope of the iso-distribution curve see Appendix A.6.



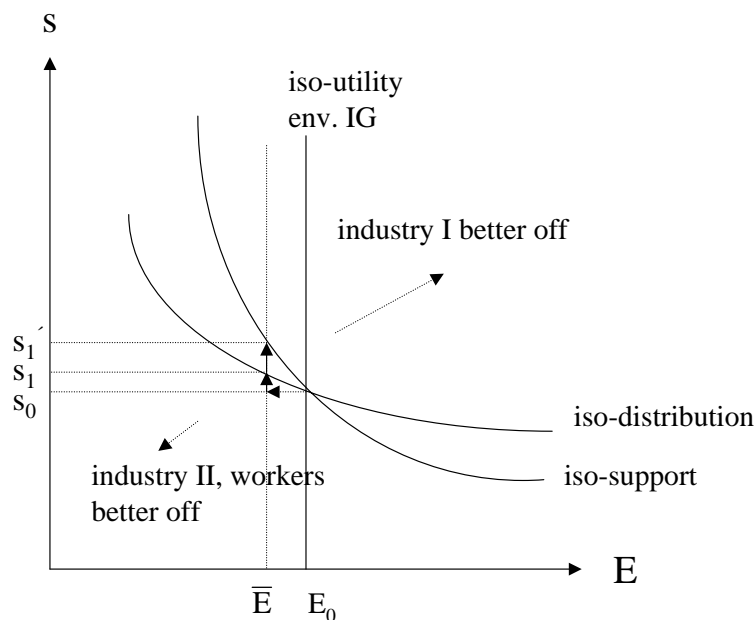


Figure 3.1: Iso-Support- versus Iso-Distribution Curves

environmental IG than it would be without it, while industry II and workers are worse off.

What is the intuition behind these results? In addition to its impacts on income distribution and in contrast to industrial policy, environmental policy (respectively the associated environmental improvement) has a value in itself. As a consequence, a given level of overall political support can be attained by lower support from IGs other than the environmental one if a country improves on its environmental performance. That is, the initial income-redistribution caused by  $\bar{E}$  does not have to be reversed completely by an adjustment in  $s$ . Hence, the new political equilibrium yields a net reduction in aggregate political support from industries I and II and workers: Declines in support from the industrial-policy losers (industry II and workers) outweigh the rise in support from the polluting industry I.<sup>6</sup> This net decline is compensated by increased support from the environmental IG. The result implies that the government has an interest in protecting the polluting industry from international competition. Only in the presence

<sup>6</sup>Due to the properties of the political-support function, such a net reduction is obtained if subsidization of sector I is increased more than proportionally. See Appendix A.5 for further discussion.

of an environmental IG, however, it is possible to do so without losing overall political support.<sup>7</sup>

So far, the analysis has shown that compensation will be more than complete. What remains to be discussed are the factors that determine the extent of this excess compensation. The following Proposition summarizes the results:

**Proposition 3.3:** *The extent of the polluting industry’s excess compensation is positively related to the level of marginal environmental damage  $D_E$  (or, equivalently, to the absolute pollution level) and the political weight of the environmental interest. The political weight of the clean industry and workers (i.e. the losers from protection) has a negative influence on the extent of compensation. The impact of the polluting industry’s own political weight is indeterminate.*

**Proof:** See Appendix A.7.  $\square$

The first part of Proposition 3.3 implies that, since a high level of marginal environmental damage is associated with severe pollution, the political propensity to compensate an industry for environmental restrictions is the higher, the “dirtier” this industry is. Furthermore, environmental awareness (reflected by the environmental IG’s weight) has a positive impact on industrial policy favoring the polluting sector, although environmental damage is not affected by this policy.

In Figure 3.1, the extent of excess compensation, or, respectively, the extent to which industry I is better off in the new equilibrium, corresponds to the difference in the absolute values of the iso-support- and iso-distribution curves’ slopes in the initial situation  $(E_0, s_0)$ :

$$\underbrace{\left| \frac{s_0 - s'_1}{E_0 - \bar{E}} \right|}_{\text{slope of iso-support curve at } E_0} \approx \left| \frac{ds}{dE} \right|_{\bar{G}, E_0} > \underbrace{\left| \frac{ds}{dE} \right|_{\text{dist.}, E_0}}_{\text{slope of iso-distribution curve at } E_0} \approx \left| \frac{s_0 - s_1}{E_0 - \bar{E}} \right|. \quad (3.5)$$

The more those slopes deviate from one another, the more will sector I be over-compensated. The slope-differential in turn is determined by the change in the environmental IG’s political support induced by environmental restrictions:

$$\underbrace{\left. \frac{ds}{dE} \right|_{\bar{G}}}_{<0} = \underbrace{\left. \frac{ds}{dE} \right|_{\text{dist.}}}_{<0} + \underbrace{\frac{dG}{dD} \frac{dD}{dE}}_{<0} < \underbrace{\left. \frac{ds}{dE} \right|_{\text{dist.}}}_{<0}. \quad (3.6)$$

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<sup>7</sup>Also other papers belonging to the political-economy literature like e.g. Ederington/Minier (2003) find that governments support domestic industries exposed to international competition (i.e. the import-competing sector). The empirical observation that trade protection is positively related to the degree of import-penetration (see the theory of endogenous protection, e.g. in Treffer (1993)) is inter alia explained by risk-sharing motives of support-maximizing governments: Supporting import-competing industries passes through part of their potential losses to society (in this paper consisting of the relevant interest groups).

The intuition behind the first part of Proposition 3.3 is that when facing severe pollution, the environmental IG's utility and political support react rather sensitively to environmental policy. The introduction of  $\bar{E}$  thus increases their political support by relatively much. As a consequence, the government's potential to accept decreases in support from other groups is also relatively large.

The second result concerning the clean industry and workers is immediately apparent as these groups benefit from environmental, and lose from industrial policy: If the government attaches a higher political weight to them, its propensity to compensate the polluting industry declines.

Part three of Proposition 3.3 implies that the polluting industry's own political weight may have an adverse impact on the extent of compensation. Such outcome arises if the environmental-policy impact on profits is relatively weak compared to the respective industrial-policy impact. Consequently, if industry I was aware of this interrelation, it should not demonstrate too much political influence to the government in order to avoid being attached a political weight that implies this industry being worse off in the new political equilibrium.

Expressed graphically, the iso-support curve is flatter for larger political weights of industry II and/or workers, whereas the respective impact of industry I is indeterminate. The iso-distribution locus is independent of the political weights. Hence, the degree to which the different groups are worse/better off in the presence of an environmental interest than without it varies with the political weights.

# Chapter 4

## Conclusions

This paper has, in a small-open-economy framework, examined the impacts of exogenous environmental regulations on a political-support-maximizing government's choice of industrial policy and the consequences for the international competitiveness of a polluting sector.

It turned out that the government has an incentive to compensate the polluting industry for the introduction of restrictive environmental policies by granting higher output subsidies. In other words, as a reaction to the imposition of exogenous environmental restrictions, the country becomes more protectionist.

In contrast to what might be expected and to what is often claimed by industry representatives in the public debate, the polluting sector even realizes a net gain in international competitiveness, as compensation is more than complete. This outcome is owed to an environmental interest group whose political support is positively affected by stricter environmental regulations, whereas independent of industrial policy. As a consequence, its utility-gain from the initial decrease in the emissions allowance is not touched by the following increase in the subsidy. The government can therefore retain a maximum level of overall political support even if support from the other interest groups declines. The corresponding new political equilibrium is attained by increasing the polluting industry's output subsidization and thus profits (competitiveness) by more than its initial loss induced by the environmental restriction (and by more than in case the environmental IG did not exist).

What do these findings imply for the public debate on the economic consequences of the Kyoto-protocol or the EU-ETS? The analysis revealed that industry concerns about losses in competitiveness are, if a government's political incentives and the availability of different policy instruments are considered, unjustified. In contrast to public claims, the polluting sector can even expect to be better-off after the implementation of exogenous environmental restrictions. This outcome yields two general conclusions: First, interest groups adversely affected by some policy measure should be aware that compensation for potential income losses may be granted in terms of a different policy instrument, if the instrument directly under discussion is restricted exogenously. Second, lobbies

should consider that the government's decision problem includes all relevant groups' interests, and that it aims at maximizing their lobbies' *overall* political support. The government's trading-off of the different groups' gains and losses even creates the chance for single IGs of being granted excess compensation for potential initial losses. To summarize, this paper's findings suggest that industry expectations concerning adverse (environmental-)policy impacts tend to be too pessimistic.

This paper's findings suggest the following policy implications: The frequent public debates preceding the implementation of various presumable harmful policy measures could be diluted by much, if the affected interest groups were made aware of the government's political-support considerations and incentives to compensate "policy losers" indirectly, i.e. in terms of other policy instruments. Those features of policy-making should be communicated clearly to industry representatives in order to weaken or even avoid their opposition. As a consequence, not only the implementation of policy measures a country is committed to due to its membership to an international treaty could be facilitated by much. These implications are not limited to the environmental-policy case, but carry over to any instrument that, considered from an isolated viewpoint, harms some interest group (the reference to international competitiveness constitutes only one example) at the same time as benefitting other groups.

Building on the analysis carried out in this paper, some propositions for future research arise. First, especially as the model is tailored to the example of the European Union, a large-country model could be applied: Do the terms-of-trade effects of environmental- and/or industrial policies change the results? Note that in a large-country setting, also consumer prices are affected by domestic policy measures. An appropriate model setup should therefore explicitly incorporate consumer preferences.

Second, the model could allow for international capital mobility: What does an explicit location decision of firms imply for a government's incentives and policy choice? To answer that question, a framework of policy interactions between different countries competing for capital/FDI makes sense. Similarly, this paper's assumption of unilaterally introduced environmental restrictions ignores that other countries might react to domestic policies or, in other words, that countries interact strategically. A model of strategic international policy competition in environmental- and industrial policies (though without considering political-economy aspects) is examined in Part III of this dissertation.

## Part III

# FDI Competition in Emissions- and Corporate Taxes

# Chapter 5

## Introduction

### 5.1 Motivation and Outline

The notion that the continuing integration of international goods- and capital markets (often referred to as “globalization”) might lead to an intensification of international policy-competition between countries is widespread in the public debate as well as among economists. In particular, governments concerned about deterring FDI may be tempted to reduce corporate taxes or environmental policies. There is also a growing public fear that this “Race to the Bottom” may cause adverse welfare effects.

The analysis in this chapter attempts to shed light on the issue from a positive as well as from a normative perspective. Chapter 6 focuses on the question whether the public concerns are theoretically justified. Specifically, the paper investigates whether FDI competition really induces an environmental RtB, if the interactions between different policy instruments (that is, between environmental- and corporate-tax policies) are taken into account. The analysis also considers the impact of trade liberalization and changes in environmental conditions on the results.

Building on the positive findings, Chapter 7 addresses the welfare effects of FDI competition and introduces alternative ways of international policy-cooperation that aim at improving on aggregate welfare of the region. In particular, an International Tax Agreement is compared to an International Environmental Agreement: Which performs better in overcoming the adverse welfare effects of FDI competition?

### 5.2 Related Literature

The subsequent chapters primarily relate to two literature strands: The applied model combines elements from the literature on international tax-competition for mobile capital/FDI and the literature on environmental-policy competition.

The *tax-competition literature* can be divided into two groups, with the first one taking a mainly public-finance/continuous-investment perspective on the issue. Capital flows are analyzed in a perfect-competition framework with many countries. Governments aim at raising tax revenue in order to provide some public good that creates utility for domestic consumers. A basic model goes back to Zodrow/Mieszkowski (1986). Literature surveys are provided e.g. by Wilson (1999) or Haufler (2001) on a theoretical- and by Devereux/Griffith (2002) on an empirical basis. Due to the specific assumptions, however, public-finance approaches are more suited to analyze inter-jurisdictional competition for portfolio, rather than for discrete investment (FDI).<sup>1</sup>

The tax-competition literature also comprises approaches that incorporate environmental issues. These “*integrated approaches*” introduce environmental-policy competition into the “traditional” tax-competition models: Governments aim at maximizing a representative agent’s utility, which is not only determined by consumption and the provision level of some public good, but additionally by environmental quality. To do so, they simultaneously choose a capital tax and some environmental-policy instrument.<sup>2</sup>

Rauscher (2001) provides a comprehensive theoretical overview of the different related model categories, their properties and respective conclusions. One basic model was introduced by Oates/Schwab (1988). Building on this and on the basic tax-competition model by Zodrow/Mieszkowski (1986), further approaches were developed, e.g. by Bayindir-Upmann (1995), Kim/Wilson (1997), Chao/Yu (1997) or Bjorvatn/Schjelderup (2002).

Concerning the research question, those “integrated approaches” correspond to the current paper: Both intend to find out whether competition for capital/FDI induces a RtB in environmental policy, and whether the governments’ multiple-policy choice is efficient.<sup>3</sup> Most of these “integrated approaches”, however, do not model the strategic interactions between the competing countries explicitly.

Implied by those studies’ perfect-competition setting, their general finding is that non-cooperative policy choices are efficient. If, however, distortions on one or more other markets arise, also environmental-policy levels will be inefficient, as the environmental instrument then serves as a correction device. Oates/Schwab (1988) quite generally consider the case of inefficient capital taxes and attribute this distortion and the implied RtB in environmental policies to “some exogenous reason”. In a more specific manner, Kim/Wilson (1997) predict an environmental RtB to result from distortions on the labor market.<sup>4</sup> Analogously, in Bjorvatn/Schjelderup (2002), an inefficiently low level of

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<sup>1</sup>This argument is also put forward in related papers like e.g. Fumagalli (2003).

<sup>2</sup>Most approaches assume lump-sum environmental-policy instruments like a quantitative emissions-limit or -ratio. Kim/Wilson (1997) even incorporate a third policy instrument, a tax on labor, in their model.

<sup>3</sup>The benchmark policy-level to detect a RtB and to define an efficient policy-choice, however, differs from that applied in the environmental-policy-competition literature and the current approach (see below): The marginal (rather than discrete) analysis of capital flows implies the Pigouvian tax level (i.e. the level of environmental policy inducing production patterns that equalize marginal environmental damage and marginal abatement cost) to serve as appropriate concept.

<sup>4</sup>The distortion is due to the existence of positive inter-jurisdictional labor-market externalities not



environmental quality is caused by the governments' neglect of positive international spillovers of this public good's provision. Bayindir-Upmann (1995) find that both an environmental RtB or a RtT ("Race to the Top") may coincide with inefficient levels of some public good's provision. The results of Chao/Yu (1997) differ from those of the other studies: Due to a government that aims at maximizing an objective function that includes, besides consumer utility, also revenue generated for its own spending (i.e. a Niskanen government), environmental-policy levels may differ from the Pigouvian ones even in the absence of further distortions. Only if private utility and government spending are attributed equal weight, environmental policy will be efficient. Indirectly, this finding implies that an environmental RtB is triggered by a government putting more weight on its own spending than on consumer utility (and vice versa).

More relevant for the current analysis is the second group within the tax-competition literature: It concentrates on the analysis of international FDI competition through tax-/subsidy incentives in a two-country-, imperfect-competition setting.<sup>5</sup> Those papers contain both positive and normative elements in their analyses. In general, they address the consequences of strategic tax-policy choices on the FDI decision of a foreign investor and on welfare.

Haaland/Wooton (1999) use a general-equilibrium model with symmetric countries to examine the effects of subsidy competition for FDI on MNE (Multinational Enterprise) location patterns and on domestic welfare in the two countries. Most common within the FDI-competition literature, however, are partial-equilibrium models with two asymmetric countries. Asymmetry occurs with respect to different aspects, most often country size. Haufler/Wooton (1999) constitutes one example. In addition to tax policy, the "losing" country's government in their model may also apply a tariff on imports from the neighboring FDI host. Barros/Cabral (2000) extend the pattern of asymmetry by assuming that there is unemployment in the smaller country. Fumagalli (2003) introduces asymmetry with respect to the potential host countries' technological advancement and the possibility of inter-firm technology spillovers. Differently from the before-mentioned papers, the assumption of technology differences here involves the existence of one domestic firm in each of the competing countries. Bjorvatn/Eckel (2006) finally combine elements of the latter two papers: In their model, countries also differ with respect to size and technological advancement. In addition, unemployment may occur in each of the countries, whereas a domestic firm is only present in the larger

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considered by domestic governments: Stricter environmental standards in one jurisdiction indirectly raise wages, and so benefit consumers, in the neighboring jurisdiction.

<sup>5</sup>Recently, Davies/Eckel (2010) have combined both types of tax-competition approaches: They incorporate the governments' objective to provide a public good into an imperfect-competition model by assuming that firms are heterogenous with respect to their labor requirement to cover fixed costs. As a consequence, even the high-tax/low-cost location attracts some firms, generates tax revenue and is thus able to provide the public good. Strategic policy competition between the two countries induces a RtB in capital taxes, inefficiently low levels of public-good provision, and an overabundance of firms. Hence, aggregate regional welfare falls short of its socially optimal level (i.e. the level attained by harmonized tax rates set in a way that equalizes the marginal value of income between the public and the private sector).

one. Haufler/Wooton (2003) extend the typical model framework by introducing an additional country. In their model, two symmetric countries, forming a region, and a third outside-country compete for FDI from the ROW. Asymmetry is thus restricted to a possible size-differential between countries within, as compared to outside the region. Though the specific models applied in the tax-competition literature differ in many details, their main conclusions can be summarized as follows: The positive analyses of non-cooperative policy patterns reveal that countries indeed engage in (downward) tax competition for FDI. Ferrett/Wooton (2009) even show that this result is independent of the international distribution of firm ownership.<sup>6</sup> In normative terms, it turns out that a non-cooperative policy regime is not necessarily detrimental for welfare. On the contrary, FDI competition may induce a more efficient location choice of the MNE, leading to an increase in aggregate regional welfare.

The explanation for such positive welfare effects clearly lies in the assumption of asymmetric countries: Without FDI competition, the foreign firm would prefer the larger market as location. This choice, however, is inefficient from a regional-welfare perspective, as the smaller country (depending on the specific model features e.g. due to unemployment or technological backwardness) gains more from attracting the investment. Hence, because in a non-cooperative scenario, the country with the highest willingness to pay (WTP in the following) for the FDI will win the competition, a relocation of the MNE to the smaller country, and thus more efficient allocation patterns, may result.

Note, that welfare-related results are not unambiguous. Depending on the specific model features, also negative relocation effects may arise. Potential sources are e.g. an increasing competitive pressure on domestic firms, and/or employment losses in the “losing” country that outweigh the corresponding gains in the “winning” country, if size asymmetry is sufficiently large.

It is unambiguous, however, that FDI competition solely implies a waste of regional resources, and thus a decrease in aggregate regional welfare, if the competing countries are identical like in Haaland/Wooton (1999), Haufler/Wooton (1999) and Haufler/Wooton (2003).<sup>7</sup> Hence, this lack of potential efficiency gains from FDI competition also characterizes the model applied in the current analysis. Chapter 7 will establish the result that the region as a whole loses from FDI competition in aggregate-welfare terms. The focus of the analysis is then on showing up different possibilities to overcome such

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<sup>6</sup>The results obtained by Ferrett/Wooton (2005) constitute an exception in this respect. Their divergent finding is, however, driven by a different model framework in which countries compete for two rather than one foreign firm. The authors find no evidence for a RtB in lump-sum corporate taxes. For small levels of asymmetry in country size, the competitive equilibrium is even characterized by full profit extraction, i.e. by maximum levels of taxation.

<sup>7</sup>Due to the extended model framework in Haufler/Wooton (2003), the regional-welfare loss is not solely attributable to a RtB in corporate taxes inducing a waste of resources. The competitive equilibrium in their model may also be characterized by too high tax levels: FDI competition then results in a RtT in corporate taxes. In such scenario, the countries within the region could improve on their aggregate welfare by cooperatively lowering taxes and so attract additional investment that would otherwise accrue to the extra-regional third country.

adversarial situation.

The *literature on environmental-policy competition* for FDI can be seen as an application of the strategic-tax-competition literature to environmental policy. In a similar manner as the general tax-competition literature, it addresses governments' strategic environmental-policy choices and the consequences for FDI and welfare in a two-country, imperfect-competition model framework.<sup>8</sup> Specifically, this literature strand focuses on the question whether FDI competition induces a RtB in environmental policy and is hence detrimental for environmental quality. The normative aspects of the issue are often addressed indirectly by investigating, whether internationally coordinated (centralized), or rather unilaterally chosen (decentralized) environmental policies yield higher levels of aggregate regional welfare.<sup>9</sup>

In order to provide a suitable framework for the analysis of environmental-policy competition, the general tax-competition models are extended by a pollution externality associated with the domestic and/or foreign firms' production process. As this implies an additional negative welfare impact of FDI, the politicians' decision problem becomes more complex than without the environmental component. Hence, differently from the general tax-competition literature and owing to the higher complexity of its models, the environmental-policy-competition literature relies on symmetric-country models.

Surveys on the environmental-RtB literature are e.g. provided by Wilson (1996) and Oates (2001). One prominent and often cited paper on the issue is Markusen et al. (1995). They introduce a model that was subsequently modified in many ways— either by simplifying its structure or by extending it with additional features. The authors assume local pollution, absence of domestic firms, intra-regional transport- and plant-level fixed costs. A foreign MNE, considering the potential host-countries' environmental policies, chooses between three options: build two plants in the region (i.e. one in each country), build one plant, or none (i.e. serve the region by exports). The competing countries' optimal pollution- (i.e. production-) tax choice depends on the cost parameters (and thus the consumer surplus ( $CS$ ) generated by the foreign firm) and on domestic environmental damage associated with the investment. Markusen et al. (1995) find that FDI competition may cause an environmental RtB as well as a RtT. That is, when facing the international mobility of foreign investments, countries de- or increase their environmental-policy efforts as compared to the non-strategic levels. Even the often cited "NIMBY" (Not In My Backyard) outcome may arise: For very high pollution and fixed costs, environmental taxes are increased to a level that induces the MNE to completely cease production in the region (i.e. choose the export option). Concerning the normative aspect, it turns out that FDI competition is detrimental for aggregate regional welfare in any case.<sup>10</sup>

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<sup>8</sup>Rauscher (1995), by applying a n-country model framework, constitutes an exception in what concerns the number of countries.

<sup>9</sup>See e.g. Hoel (1997) or Oates (2001).

<sup>10</sup>The authors derive their results with the help of simulations for certain constellations of parameter values. For the RtB-scenario, the welfare loss is driven by an overall decline in the sum of net environmental-tax revenue and  $CS$  as the MNE increases production (and thus pollution) and switches

Rauscher (1995) extends the Markusen-et-al. model in some respects. Most importantly, he allows for transboundary pollution in a region consisting of  $n$  potential FDI host countries. On the other hand, he simplifies the foreign firm's investment decision by ignoring intra-regional trade costs. Hence, a multiple-plant strategy is excluded.

Hoel (1997) is also closely related to the Markusen-et-al. model and similar to Rauscher (1995).<sup>11</sup> Unlike Markusen et al., Hoel ignores trade costs. On the other hand, the paper introduces some additional features to the basic model: Besides the "standard" case of symmetric countries and one foreign investor, it also investigates versions with asymmetric countries and many foreign firms. In the asymmetric scenario, the potential host countries differ with respect to environmental damage.

Ulph/Valentini (2001) base their model on Hoel (1997). Differently from most other papers within this literature strand, here the environmental-policy instrument is not an emission/output tax, but a quantitative emission limit. Hence, the governments generate no environmental-tax revenue adding to social welfare. Furthermore, there are two foreign firms deciding about their investment within the region. Hence, the resulting market structure is oligopolistic rather than monopolistic. The main distinguishing feature of the paper, however, is its consideration of two alternative move structures in the FDI-competition game: In the "standard" model versions (termed as "location games"), countries move first by choosing environmental policies, which determine the foreign firms' investment decision in the second stage. Alternatively, Ulph/Valentini (2001) analyze a so-called "market-share game" in which firms decide on their location *before* the governments set environmental policies. The latter is to represent a situation in which firms are less mobile ("footloose") than under the standard assumptions.

Similarly as Ulph/Valentini (2001), also de Santis/Stähler (2009) modify the basic Markusen-et-al. model with respect to the order of moves. In their version of a market-share game, there are also two firms. Differently from the Ulph/Valentini model, those firms are domestic— one settled in each country within the region. In the first stage of the game, the firms decide about becoming a multinational, i.e. whether to invest in the neighboring country or not. In the second stage, governments determine their output-tax level.

Though differing in a number of specific assumptions, the environmental-policy-competition literature yields quite uniform conclusions. All papers agree on the finding that environmental-policy competition for FDI induces countries to deviate from their optimal no-competition policy choice.<sup>12</sup> Whether strategic policy-levels undercut or ex-

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from a one- to a two-plant strategy, which involves additional fixed costs. For the RtT-/NIMBY scenario, the welfare loss is due to a parameter constellation (i.e. environmental damage and fixed costs high, but not too high) that makes the region as a whole better-off with one plant rather than none, although each individual country has an incentive to prevent investment in its domestic market.

<sup>11</sup>See also Hoel (1994) for a former version of his paper.

<sup>12</sup>Which no-competition policy level serves as reference point to investigate the consequences of FDI competition, depends on how the authors define the term RtB/RtT. There is one group of papers considering environmental-policy levels that maximize aggregate regional welfare as a benchmark. Those rather normatively oriented approaches thus detect a RtB/RtT if strategic environmental-policy levels fall short of, or exceed the socially efficient ones. Examples include Rauscher (1995), Hoel

ceed their no-competition counterparts, i.e. whether a RtB or a RtT in environmental policy occurs, however, depends on parameter values (most relevant in this respect is of course the extent of environmental damage).<sup>13</sup>

Those papers that also provide a normative analysis, by analogy with Markusen et al. (1995), consistently detect detrimental aggregate-regional-welfare effects of FDI competition—no matter, whether this results in an environmental RtB or in a RtT. This coincidence is mainly driven by the common application of identical-country models within this literature. Like stated above, such framework prevents potential efficiency gains from the relocation of firms to arise—be it through up- or downward tax-adjustments. On the contrary, the induced waste of regional resources leads to a decline in aggregate welfare.<sup>14</sup>

Differently from most of the above-cited literature, the current approach excludes a RtT-scenario “per se” by assuming environmental-tax rates to take on non-prohibitive levels in equilibrium.<sup>15</sup> The motivation for doing so is inspired by “real-world” observations: This paper intends to focus on situations with FDI competition actually occurring, i.e. with countries actually attempting to attract an investment (for details see Chapter 6). As a consequence, the one-policy scenario always yields an outcome with strategic environmental-policy levels falling short of their optimal non-strategic levels. If, however, a second policy instrument, a tax on foreign profit, is introduced, results change: In spite of the “non-prohibitiveness assumption”, no environmental RtB occurs when countries compete for FDI. Hence, considering interactions between different policy

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(1997), or Ulph/Valentini (2001). Another group follows a rather positive approach by considering the countries’ unilateral non-strategic policy choices as a benchmark. Hence, down-/upward-deviations of environmental-policy levels from these unilaterally efficient ones are interpreted as a RtB/RtT. Examples include Ulph (1994), Markusen et al. (1995), or de Santis/Stähler (2009).

<sup>13</sup>These findings have recently been supported by a number of empirical analyses on strategic environmental-policy interactions between neighboring countries. In particular, those papers examine, whether and how one country’s policy choice (represented by some environmental-stringency index like e.g. that developed by Levinson (1999)) reacts to its neighbors’ policies. For instance, Fredriksson/Millimet (2002), Levinson (2002) and Fredriksson et al. (2004) estimate the respective reaction functions of US states between 1977 and 1994. As the slopes of these reaction functions take on significantly positive values, the authors find the common theoretical hypothesis empirically validated: States interact strategically when choosing environmental policy. The results, however, do not ascertain to which direction the strategic policy levels deviate from their (efficient) non-strategic values, i.e. whether policy competition induces an environmental RtB or a RtT.

In *directly* addressing policy interactions, these studies distinguish themselves from another related group of empirical papers that estimate the effect of decentralized environmental-policy-making with data on emissions and pollution-abatement expenditures. List/Gerking (2000) and Millimet (2003) for instance find evidence for an environmental RtT in the US states in the 1980s and 1990s.

<sup>14</sup>Levinson (2002) in his literature survey lists six theoretical conditions under which decentralized environmental-policy making (resp. intra-regional FDI competition) would lead to efficient (i.e. aggregate-regional-welfare maximizing) outcomes. All of these conditions to be fulfilled simultaneously, however, is implausible and not consistent with “real-world” observations. Indeed, none of the introduced papers takes the respective assumptions.

<sup>15</sup>A similar assumption is e.g. taken in Davies/Ellis (2007), who label it “assumption of beneficial FDI”.

instruments yields results that distinguish the current paper from its environmental-tax-competition-literature relatives.

By a similar motivation, Davies/Ellis (2007) attempt to explain the empirical evidence of persistently strict performance requirements (PRs) going along with downward FDI-competition in capital taxes. They rely on a rather simple two-policy model structure. Environmental policy in their paper constitutes one out of several possible interpretations of a PR—implying that, differently from the current analysis, this instrument is non-distortive as well as the capital tax. Hence, a country's domestic welfare is strictly increasing in the level of *both* instruments. As the foreign firms' (of which there are two) profit is assumed to contribute to the host country's domestic welfare as well, a government has to consider two tradeoffs less than in the current model: the ambiguous welfare-impact of changes in the distortive environmental-policy instrument on the one hand, and the profit-shifting property of changes in the capital tax on the other hand. Hence, the competing countries' decision problem is much less complex than in the current model. An additional simplification of Davies/Ellis (2007) is that they derive their basic results without considering intra-regional spillovers.

In spite of these (and further) differences, the paper's positive conclusions correspond to the current one's: Even when competing for FDI with a neighboring country, governments apply PRs to correct for domestic inefficiencies of the firms' choices.<sup>16</sup> Only the capital tax is subject to a RtB which proceeds until the complete FDI surplus is channeled to the firms. The normative result, however, differs from this paper's finding: In the competitive equilibrium, aggregate welfare in the region amounts to the socially optimal level.<sup>17</sup> Hence, there are no aggregate-welfare gains to be realized when countries decide to cooperate in policy-making.

To sum up, the contribution of the current paper is to integrate the approaches on strategic corporate-tax- and environmental-policy competition for FDI into one model in order to consider the interdependencies between both policy instruments. The aim is to provide a theoretical framework yielding results more in line with actually observed policy patterns than many single-instrument approaches.<sup>18</sup> With respect to the

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<sup>16</sup>Differently from the current paper, Davies/Ellis (2007) assume the individual firms' neglect of inter-firm spillovers (like e.g. R&D-spillovers) to be the source of those domestic inefficiencies.

<sup>17</sup>This is clearly due to the authors' above-mentioned assumption of foreign profit contributing to domestic welfare, and to the neglect of intra-regional spillovers. If the latter assumption is relaxed, Davies/Ellis (2007) find results more in line with the current paper's conclusions.

<sup>18</sup>Devereux et al. (2008) and Egger/Raff (2009) also investigate strategic policy-competition in two instruments; the former paper from a portfolio investment-, the latter from a discrete-FDI perspective. Both approaches focus on an empirical investigation of the competing governments' two-dimensional reaction functions. They do not, however, relate to environmental issues like pollution externalities and the consequences for policy-making, but to alternative instruments of capital taxation. Devereux et al. (2008) find strong evidence for their hypothesis that countries compete in both instruments: They predict a RtB in statutory tax rates (with the aim of shifting foreign profit to the domestic country) as well as in effective marginal tax rates (with the aim of attracting capital). Similarly, Egger/Raff (2009) find the empirical observation of two-dimensional policy competition in corporate-tax rates and appreciation allowances confirmed. Both approaches provide purely positive analyses. They neither assess the welfare implications of strategic policy competition, nor the potential benefits from regional

research question, an additional contribution of the current paper is to provide insights on issues that go beyond those analyzed in the existing literature. Specifically, the analysis of the effects that changes in the environmental conditions and market integration (respectively trade liberalization) have on the optimal policy choice and thus on the environmental-policy level may contribute to the ongoing debate on the effects of globalization.

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cooperation in one or both policy areas.

Amerighi/de Feo (2009) provide a complementary normative analysis of strategic two-dimensional policy competition. They apply an imperfect-competition model framework like Egger/Raff (2009), and allow the foreign MNE to shift profit between jurisdictions (e.g. by using appropriate transfer-pricing methods) like Devereux et al. (2008). Amerighi/de Feo (2009) find that FDI competition in corporate-tax rates (expressed in a tax system discriminating between domestic and foreign firms) and lump-sum subsidies may raise aggregate regional welfare under certain conditions (the basic mechanism behind this result is driven by the asymmetric-country assumption and corresponds to that introduced above in connection with the general tax-competition literature).

Also the empirical analysis by Fredriksson et al. (2004) addresses multi-dimensional policy competition: The authors estimate intra- and inter-policy reaction functions for even three instruments including environmental policy (measured by Levinson's (1999) index; see above). Corresponding to the results of the above-mentioned papers, they find strong evidence for both types of strategic interactions. For instance, increases in one US state's governmental-spending level or decreases in its tax level induce decreases in a neighboring state's environmental-policy stringency.

## Chapter 6

# Positive Analysis: Will There Be an Environmental Race to the Bottom?

### Abstract

This paper uses a simple two-country model to analyze, how countries will set output-based emissions taxes and corporate taxes to compete for FDI. Will this competition result in a “Race to the Bottom” in environmental taxes, in corporate taxes, or both? The paper also investigates the effects of changes in environmental conditions and market integration on equilibrium policies.



## 6.1 Introduction

The widespread public concern that competition for FDI may trigger a RtB in environmental policies is supported by the environmental-policy competition literature. Within this literature strand, there is broad consensus on the finding that FDI competition induces countries to deviate from their optimal no-competition policy levels.

This paper investigates whether this RtB-result is sustainable, if it is considered that governments have more than one policy instrument at their disposal. Specifically, I analyze the interrelation between emissions- and corporate-tax policies in a framework where countries compete for internationally mobile capital in form of FDI: How does a country's optimal policy combination look like? Will emissions and profit be taxed at a positive rate or will they rather be subsidized? How does the policy choice depend on the intensity of FDI competition? Will FDI competition result in a RtB in environmental policy?<sup>1</sup>

Building on the results, the paper also investigates, how exogenous changes in environmental- and market conditions affect equilibrium policies. Specifically, the impacts of changes in the domestic and international environmental conditions and of market integration (i.e. declining trade costs) are examined: How is the intensity of FDI competition and thus, indirectly, the optimal environmental-policy choice affected? Do any adverse or beneficial impacts on the environment arise?

The issues to be analyzed in the current paper are of considerable practical relevance. On the one hand, there is plenty of recent anecdotal evidence for an intensification of international tax-competition. On the other hand, a public debate on environmental-

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<sup>1</sup>The model framework implicitly assumes that corporate-tax- and environmental policies are decisive determinants for a MNE's location choice. It should be mentioned here that this view is not uncontroversial:

In what concerns the impact of capital taxation, some authors argue that other factors like e.g. the economic fundamentals, a country's political, jurisdictional and financial stability or market size are more relevant (see e.g. Oman (2000); Devereux/Griffith (2002), Gordon/Hines (2002) and OECD (2007b) provide reviews of empirical studies on the impact of taxes on capital location). However, potential FDI host countries, especially if located within the same region like assumed in this paper (think of the EU as an example), become increasingly similar with respect to those factors. Hence, tax-level differentials gain importance as a distinguishing factor in FDI competition (a similar argument is e.g. made by Bjorvatn/Eckel (2006)).

In what concerns the locational relevance of environmental regulations, the arguments are basically the same. Theoretical analyses that directly address the issue (see e.g. Markusen et al. (1993), Motta/Thisse (1994), or Ulph (1994)) in general find a negative impact of environmental-policy stringency on investment decisions. However, other factors like country size, trade costs etc. may weaken or even reverse the results. Dijkstra et al. (2006), for example, derive conditions under which environmental regulations constitute an incentive for, rather than an obstacle to FDI. Rauscher (1995) argues that the issue is more an empirical one, investigated by the literature on the pollution haven hypothesis (see Chapter 1.1 for a definition and some exemplary references). Though this literature does not yield uniform conclusions, there is sufficient theoretical and empirical evidence justifying the assumption that strict environmental regulations constitute an obstacle to FDI—irrespective of potential other determining factors.

policy erosion, presumably caused by this increased competition and by market integration, goes on in many industrialized countries. This debate, however, does not match with the actually observable policy-patterns in the competing countries, which hint at persistently high, rather than declining environmental-policy efforts.<sup>2</sup>

The development of investment incentives, offered by different country groups, over time has been investigated e.g. by Oman (2000) and UNCTAD (1996). For the period between the 1980s and 1990s, they find evidence for an increasing use, both in range and in the number of countries, of financial and fiscal incentives. Most often, corporate-tax-rate reductions are applied. Charlton (2003) extensively surveys recent world-wide examples of incentive-bidding cases.<sup>3</sup>

Recent OECD data (see OECD (2007a)) show that this downward trend in corporate-tax rates is still continuing: The average statutory corporate-income-tax rate in the 30 member countries declined from an average of 33.6% in 2000 to 28.4% in 2006. Reduc-

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<sup>2</sup>With respect to the environment, recent anecdotal evidence for continuously intense, rather than declining policy levels is mainly provided by examples related to the issue of climate change. In mid-2007, the G8 countries on their yearly summit agreed to continue negotiating on a “post-Kyoto”-agreement on GHG emissions. Although the process has not been terminated yet, at the UN climate change conference in Copenhagen in December, 2009, the participating countries at least achieved agreement on the “Copenhagen Accord”. This document refers to climate change as “one of the greatest challenges of our time” and highlights the urgency of taking collective action to combat this phenomenon by cutting world-wide GHG emissions drastically. In the “Copenhagen Accord”, countries for the first time commit to the aim of preventing increases in global temperature of more than two degrees Celsius (for details see [http://unfccc.int/kyoto\\_protocol/items/2830.txt.php](http://unfccc.int/kyoto_protocol/items/2830.txt.php) and [http://unfccc.int/files/meetings/cop\\_15/application/pdf/cop15\\_cph\\_aav.pdf](http://unfccc.int/files/meetings/cop_15/application/pdf/cop15_cph_aav.pdf); latest access in July, 2010).

A related example are recent climate policies in the EU and in Germany: In 2007, the EU-member countries decided to “unilaterally” reduce union-wide  $CO_2$  emissions by 20 percent compared to 1990-levels up to 2020. Germany, conditional on the implementation of the above-mentioned EU-agreement, goes even farther and considers  $CO_2$ -reductions of 40 percent until 2020. In order to achieve this goal, a vast number of single policy instruments were implemented in 2008 (termed “integrated energy- and climate programme”). This German example is particularly interesting since within the same year, a corporate-tax reform and significant environmental-policy efforts were implemented.

<sup>3</sup>Recent anecdotal evidence of the intensity of FDI competition is provided by Germany’s effort to lead the US-American microchip-producer AMD to build a new plant at its established location in Dresden rather than in the State of New York in the US. Both regions were fiercely competing for the investment by offering considerable financial incentives. Finally, in the end of the year 2006, the US outbid the German government by providing an incentive of 650 million US-dollars to AMD. In 2007, AMD announced its plans to expand existing production facilities once again. Like before, the firm faced the choice between its locations in the US and in Germany. In the light of this new chance to attract the investment to Germany, the EU-Commission allowed the German government to provide financial incentives of another 262 million Euros. Regardless of those subsidies, however, AMD suffered substantial profit-losses during the current world-wide economic crisis, and was forced to outsource its microchip production-facilities. For that purpose, AMD founded a joint venture (“Globalfoundries”) together with an investor from Abu Dhabi in March, 2009. Their intention to expand production capacities in Dresden, however, is claimed to be untouched by this transaction.

A similar example is the investment of the British technology producer “plastic logic” in 2008. Also this company faced the choice between locations in Dresden, Singapur and the State of New York. Among other locational advantages, incentive payments were decisive for finally choosing Dresden.

tions occurred in 25 OECD countries while the remaining five kept their rates constant in that period. The variation across countries slightly increased.<sup>4</sup> Figure 6.1 illustrates this downward trend for the period between 1996 and 2009.<sup>5,6</sup>

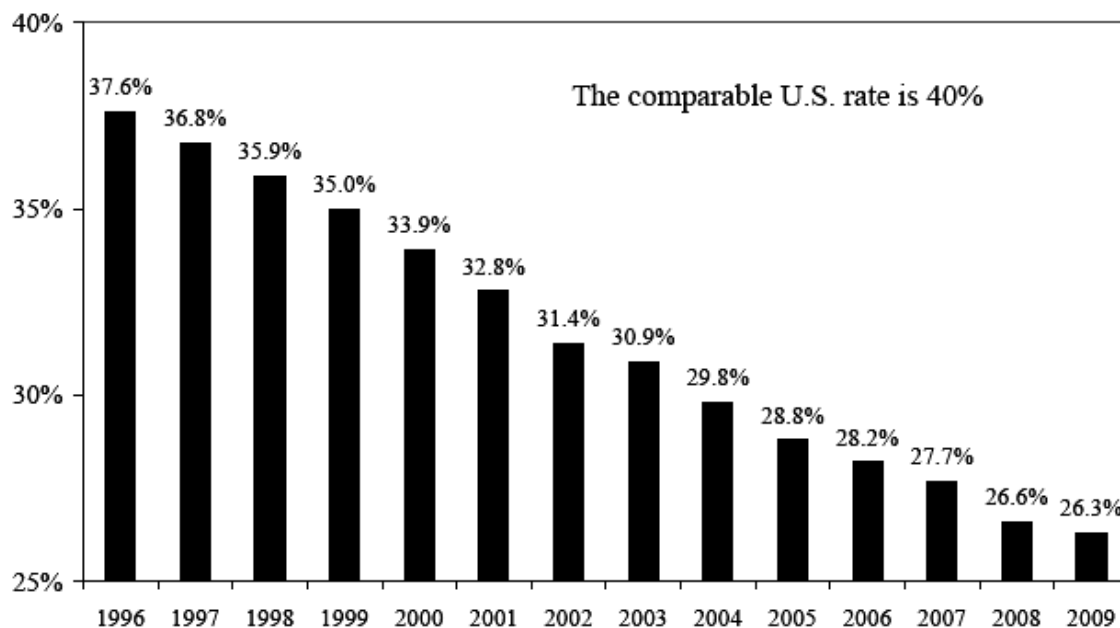


Figure 6.1: Average Top Corporate Tax Rate in 30 OECD Countries

In the context of these empirical observations, the aim of this paper is to theoretically reconcile the pessimistic environmental “predictions” of public debates and economic analyses and the more optimistic characteristics of actual policy-patterns. For that purpose, the interrelations between different policy instruments are considered rather

<sup>4</sup>The standard deviation rose from 6.58 to 6.85.

<sup>5</sup>The diagram is taken from the website

[http://www.cato.org/research/fiscal\\_policy/facts/tax\\_charts.html](http://www.cato.org/research/fiscal_policy/facts/tax_charts.html) (latest access in July, 2010).

<sup>6</sup>One has to be aware, however, that besides tax rates, there are many more (tax-related) factors determining a firm’s investment decision (above all, the relevant tax-base). As argued in OECD (2007a), the relevant determinant for a MNE’s discrete investment decision is the average effective tax rate (AETR), which measures the extent to which corporate profit is reduced by taxation. The AETR considers both *tax-rate*- and *tax-base* features. In 19 OECD countries for which the respective data is available, the AETR decreased from an average of 34.2% in 1982 to 24.4% in 2005. This implies that reductions in the capital-income tax rate had a stronger impact than the broadening of the tax base which simultaneously occurred during that period in many OECD countries. Hence, the latter observation does not conflict with the notion of interpreting the observed tax-rate reductions as indicator for an increase in tax competition.

than limiting the analysis to one single (environmental) instrument. This approach seems to be much more consistent with the actual policy-making conditions governments face.

Similarly, it is also current “real-world” developments that motivate investigating the impacts of market integration and changes in environmental preferences: On the one hand, a vast number of international and regional free-trade agreements are negotiated and concluded each year.<sup>7</sup> On the other hand, people’s preferences for a clean environment appear to follow an upward trend— particularly in the industrialized, but recently as well in many newly industrializing countries. This rise in environmental awareness is reflected e.g. in those countries’ increasing willingness to join the international negotiations on climate-change policies.<sup>8</sup>

To analyze the issue, a simple two-country model is applied: In a sequential three-stage game, identical neighboring countries engage in strategic environmental- and corporate-tax-policy competition for FDI from a third country. The foreign firm’s production process causes transboundary pollution. The available instruments to attract the investment are a (distortive) emissions tax and a (non-distortive/lump-sum) corporate tax on gross profit, chosen simultaneously and non-cooperatively in stage 1 of the game. The foreign investor makes his location choice in stage 2 by comparing the net-profit options in the two countries. In stage 3, the MNE chooses its profit-maximizing output levels.

The analysis yields the following main results: When competing for the investment of a foreign MNE, countries use corporate-profit- rather than environmental taxes as strategic policy instrument. In the non-cooperative policy equilibrium, the corporate-tax rate is smaller than its optimal value when there is no FDI competition (i.e. in a hypothetical benchmark scenario in which the MNE’s location is fixed). The environmental-tax rate is kept constant at the optimal no-competition level. Hence, there is no RtB in environmental policy and no adverse impact of FDI competition on the environment. Trade liberalization induces a decrease in the intensity of FDI competition via the profit tax, whereas environmental-policy levels, again, are unaffected.

This result is not restricted to the environmental-/corporate-profit-tax policy framework, and does not hinge on the simple structure of the underlying model. Rather, the results allow for a general conclusion: In their competition for FDI, countries set the distortive policy instrument in a way that induces the MNE to choose a production volume (emissions, respectively) that maximize the countries’ individual welfare. In particular, this strategy maximizes their net surplus from the FDI, and thus the available means to compete for the investment in terms of offering the most favorable conditions with respect to the second, non-distortive policy-instrument to the MNE. Hence, FDI competition induces a RtB in the lump-sum policy instrument, whereas the optimal choice of the distortive instrument is unaffected.

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<sup>7</sup>For an overview see e.g. <http://www.worldtradelaw.net/fta/ftadatabase/ftas.asp?table1=s:4>; (latest access in July, 2010).

<sup>8</sup>See e.g. the webpage <http://www.umweltbewusstsein.de> (latest access in July, 2010) for some studies on the evolution of environmental awareness in Germany in recent years.

The rest of this chapter is organized as follows: The next section introduces the model and explains the basic rationales behind governmental decision-making, which will constitute the basis for the subsequent analysis. As a preliminary step, Section 6.3 investigates strategic policy competition for FDI in only one instrument, the emissions tax. Section 6.4 then contains the main policy analysis considering the interrelations between environmental- and corporate-profit-tax policy. In both scenarios, conclusions build on a comparison of non-strategic (no-competition) policy equilibria to their strategic counterparts. Finally, Section 6.5 concludes.

## 6.2 The model

The research questions in this paper are analyzed within a simple two-country model framework. Identical neighboring countries constitute a region in which an investor from a third country has already decided to set up a plant. The investor has monopoly power in its market: One country becomes host for the foreign-owned monopolist, the other is served by exports from its neighbor. Due to the countries' symmetry, the MNE's decision of where to invest is solely determined by the countries' (tax-)policies. The host country (in the following referred to as "country  $i$ ") applies two policy instruments in order to address the distortions associated with the foreign firm's investment in its domestic market:<sup>9</sup> A source-based corporate tax  $s_i \in [-\infty, 1]$  per unit of foreign (gross-)profit  $\Pi_i$  generated in the host country, and an emissions tax  $\tau_i$  per unit of output produced in the host country for the domestic market ( $q_i$ ) or for exports to the neighboring country ( $q_j$ ; in the following, the importing country is referred to as "country  $j$ "). This implies that the policy bundle includes one distortive- and one non-distortive instrument in what concerns the MNE's output choice:  $s_i$  is thus equivalent to a lump-sum tax on profit. Both policy instruments only become effective, if country  $i$  actually hosts the FDI. Otherwise, domestic production and MNE profit are equal to zero.

The model takes the form of a sequential three-stage game. First, both countries in the region choose their profit- and emissions-tax rates simultaneously and non-cooperatively with the aim of attracting the foreign firm. Based on these policy conditions, in the second stage, the MNE decides where to locate. In the last stage of the game, the foreign firm chooses its output for domestic consumption and export.

### 6.2.1 Consumption

Consumption in country  $i$  is derived from a representative household's preferences. This household derives utility from the consumption of two goods,  $q$  and  $z$ , with  $z$  being the numeraire, and disutility from environmental damage  $D$ , which is considered

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<sup>9</sup>For details on these distortions see Section 6.2.5.

as exogenous. The utility function of a consumer in country  $i$  is quadratic:

$$U_i = q_i - \frac{1}{2}q_i^2 + z_i - D_i. \quad (6.1)$$

The budget constraint is given by:

$$I = \frac{T_i + S_i}{N_i} + M_i = p_i q_i + z_i. \quad (6.2)$$

$T_i = \tau_i(q_i + q_j)$  is environmental-tax revenue,  $S_i = s_i \Pi_i$  is profit-tax revenue (respectively subsidy payment if  $s_i < 0$ ),  $N_i$  denotes the number of households,  $M_i$  is an exogenous income-component,  $p_i$  is the domestic price for good  $q$ , and  $I$  is total income. Hence, total income consists of redistributed environmental- and profit-tax revenues and an exogenous component.

Utility maximization s.t. the budget constraint yields inverse demand

$$p_i = 1 - q_i. \quad (6.3)$$

## 6.2.2 Production

In both potential host countries, identical production technologies are available to the MNE. Capital is the only factor of production; its total supply equals population size, since each household owns one unit of capital. In the numeraire sector, one unit of capital generates one unit of output, so that the capital price can be normalized to one. Production in the other sector is characterized by constant and identical marginal cost  $c$ , with  $0 < c < 1$ . Intra-regional transport costs are  $t$  per unit of output, with  $0 < t < 1$ .<sup>10</sup> The foreign firm can price-discriminate between the regional markets.

With the investment located in country  $i$ , the MNE's gross profit  $\Pi_i$  consists of a domestic- and an export component:

$$\begin{aligned} \Pi_i &= q_i(p_i - c - \tau_i) + q_j(p_j - c - \tau_i - t) \\ \Rightarrow \Pi_i &= q_i(1 - q_i - c - \tau_i) + q_j(1 - q_j - c - \tau_i - t). \end{aligned} \quad (6.4)$$

Profit maximization with respect to  $q_i$  respectively  $q_j$  yields:

$$q_i = \frac{1 - c - \tau_i}{2}, \quad q_j = \frac{1 - c - \tau_i - t}{2}. \quad (6.5)$$

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<sup>10</sup>Plant-level fixed costs are omitted here, although their absence would usually imply that the MNE, in order to avoid transport costs, preferred locating in both, rather than in only one market. The "one-plant" decision is based on the implicit assumption that plant-level fixed costs are sufficiently high relative to intra-regional trade costs to prevent a double-plant strategy of the MNE. This is done for reasons of simplicity: Adding fixed costs would neither change the MNE's location decision nor its output decision. All relevant qualitative results with respect to the research questions would be unaffected.

Both  $c$  and  $t$  are assumed to be sufficiently small and, throughout the whole paper, parameter values are assumed to take on values such that the emissions-tax rate  $\tau$  will be non-prohibitive at its optimal level. In particular, this implies the environmental-damage parameter  $\delta$  being sufficiently small. These assumptions ensure positive output for both domestic and foreign consumption, i.e.  $1 - c - \tau_i > 1 - c - \tau_i - t > 0$ .<sup>11</sup>

Due to linear demand and constant marginal costs, foreign monopoly profit is:

$$\begin{aligned}\Pi_i &= q_i^2 + q_j^2 \\ &= \frac{(1 - c - \tau_i)^2}{4} + \frac{(1 - c - \tau_i - t)^2}{4}.\end{aligned}\tag{6.6}$$

The net-of-tax profit (“net profit” in the following) of the MNE is thus given by:

$$(1 - s_i)\Pi_i = (1 - s_i) \left( \frac{(1 - c - \tau_i)^2}{4} + \frac{(1 - c - \tau_i - t)^2}{4} \right).\tag{6.7}$$

### 6.2.3 The Environment

One unit of output produces one unit of emission, so that total emissions in the host country,  $E_i$ , are equal to the MNE’s total production-volume:  $E_i = q_i + q_j = Q_i$ . Environmental damage in the FDI host country  $i$  is a function of domestic emissions:

$$D_i = D_i(E_i(Q_i)) = \delta E_i = \delta Q_i \quad \text{with} \quad 0 \leq \delta \leq 1,\tag{6.8}$$

where  $\delta$  represents constant marginal environmental damage.

The model allows for pollution spillovers between the neighboring countries. Environmental damage in the importing country is given by the damage function:

$$D_j = D_j(E_i(Q_i)) = \mu E_i = \mu Q_i \quad \text{with} \quad 0 \leq \mu \leq \delta\tag{6.9}$$

and thus solely determined by emissions in the FDI host country. Parameter values  $\mu = 0$  and  $\mu = \delta$  characterize the “extreme” scenarios of purely local and global pollution respectively.

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<sup>11</sup>Similar assumptions are e.g. taken in Davies/Ellis (2007). Parameter values inducing prohibitive emissions-tax rates would yield the so-called “NIMBY”-case (see Markusen et al. (1995)) with pollution being so severe that countries prefer importing from abroad to production in their own country. This scenario is excluded by assumption in this paper, since it does not make sense to analyze the effects of FDI competition in a setting where countries actually do not wish to attract an investor.

### 6.2.4 Social Welfare

Social welfare consists of consumer surplus  $CS$ , environmental-tax revenue  $T$ , environmental damage  $D$  and profit-tax revenue (possibly negative in case of a subsidy):  $W = CS + T - D + S$ .

Specifically, consumer surplus in the host, respectively the importing country is given by:

$$CS_i = \frac{1}{2}q_i^2 = \frac{(1 - c - \tau_i)^2}{8}, \quad CS_j = \frac{1}{2}q_j^2 = \frac{(1 - c - \tau_i - t)^2}{8}. \quad (6.10)$$

Environmental-tax revenue in the host, respectively the importing country equals:

$$T_i = \tau_i Q_i = \tau_i(1 - c - \tau_i - \frac{t}{2}), \quad T_j = 0. \quad (6.11)$$

Analogously, environmental damage in country  $i$  respectively  $j$  is given by:

$$D_i = \delta Q_i = \delta(1 - c - \tau_i - \frac{t}{2}), \quad D_j = \mu Q_i = \mu(1 - c - \tau_i - \frac{t}{2}). \quad (6.12)$$

In the following, environmental-tax revenue and environmental damage will be aggregated as “net revenue”:

$$\text{net rev}_i = (\tau_i - \delta)(1 - c - \tau_i - \frac{t}{2}), \quad \text{net rev}_j = -\mu(1 - c - \tau_i - \frac{t}{2}). \quad (6.13)$$

Finally, extracted MNE-profit in country  $i$  yields a profit-tax revenue equal to:

$$S_i = s_i \Pi_i = s_i \left( \frac{(1 - c - \tau_i)^2}{4} + \frac{(1 - c - \tau_i - t)^2}{4} \right). \quad (6.14)$$

### 6.2.5 Governmental Decision-Making

The host country’s government applies two policy instruments to address three domestic distortions associated with the MNE’s presence:

Firstly, the profit tax serves to redirect foreign profit generated on the domestic market, which would otherwise go abroad, to the domestic country.

Secondly, the welfare-maximizing choice of the emissions-tax rate is determined by a tradeoff between two further domestic distortions of the MNE’s output choice to be corrected for: The *market distortion* due to the monopolistic market structure and the *pollution distortion* due to the environmental externality not considered by the firm.

The pollution distortion implies a positive tax on output as, from an environmental point of view, too much is produced. The market distortion, on the contrary, implies an incentive for a negative output tax, as, compared to the socially optimal output



level, the monopolist produces too little and sells at too high a price which leads to sub-optimally low  $CS$ .<sup>12</sup>

Whether the optimal emissions tax is positive or negative, depends on which of the two output distortions dominates. In particular, a positive tax will result, if marginal environmental damage is sufficiently high.

When choosing the optimal policy combination, governments have to consider the MNE's *participation constraint*. That is, the MNE's profit option net of corporate-tax payments on the domestic market must at least ensure that the firm is indifferent between producing in the market or leaving it.

In a scenario without FDI competition the participation constraint is equivalent to a zero-profit condition. In a competitive scenario<sup>13</sup> with an internationally mobile firm the participation constraint implies that net profit attainable on the domestic market must at least equal the MNE's outside-profit option, i.e. the net profit it could generate when moving to the neighboring country.

### 6.3 Preliminary Step: A Single-Policy Framework

Before analyzing FDI competition in two policy instruments, it is useful to first establish the respective results in a one-policy setting, where countries only use the environmental tax as strategic policy variable (i.e. where the corporate-tax rate is set to zero).

Will, in the model framework introduced in Section 6.2, such single-policy competition induce an environmental RtB and thus correspond with the predictions of the related literature mentioned above?

Comparing the resulting policy patterns to those arising in a multiple-policy scenario (where in addition to environmental- also corporate-tax policy is at the governments' disposal) will show: Conclusions with respect to the environmental-policy consequences of FDI competition may change drastically, if it is considered that governments usually apply more than one policy instrument in their efforts to attract foreign investments.

The analyses of both the single- and the multiple-policy cases in this, and the following section respectively, comprise two steps: First, a "no-competition" benchmark scenario without strategic FDI competition, i.e. with a fixed location of the MNE, is investigated. The results then serve as a reference point for the main analysis insofar as the non-strategic equilibrium policies will be compared to their strategic counterparts. This allows drawing conclusions with respect to the impact of FDI competition on

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<sup>12</sup>Even in the absence of any pollution distortion, the subsidy rate on output, however, would not suffice to induce the MNE produce at a level where price equals marginal cost: The positive externality on the neighboring country that results from part of the MNE's output being exported there is not considered by the host-country's government.

<sup>13</sup>Throughout the paper, the term "competitive" does not refer to the market structure, which is always a monopolistic one, but rather to the pattern of inter-governmental FDI competition.

environmental-policy levels, and hence answers the question of whether an environmental RtB occurs.

### 6.3.1 The “No-Competition” Benchmark-Scenario

Without having to compete for the investment, country  $i$ , hosting the foreign firm, will choose welfare-maximizing policies subject to the MNE’s participation constraint as stated in Section 6.2.5. In the scenario considered in this one-policy benchmark analysis, the host country’s welfare consists of  $CS$  and net environmental-tax revenue:

$$W_i^{FDI} = \underbrace{\frac{(1-c-\tau_i)^2}{8}}_{CS_i} + \underbrace{(\tau_i-\delta)(1-c-\tau_i-\frac{t}{2})}_{\text{net rev}_i}. \quad (6.15)$$

The MNE’s participation is ensured if it attains a gross-profit of at least zero:

$$\Pi_i = \frac{(1-c-\tau_i)^2}{4} + \frac{(1-c-\tau_i-t)^2}{4} \geq 0. \quad (6.16)$$

Hence, the maximum emissions-tax rate a country can charge amounts to  $\tau_i^{max} = 1-c$ .<sup>14</sup>

Differentiating eq. (6.15) with respect to  $\tau_i$  yields the optimal non-competitive emissions-tax rate which is unambiguously positive:

$$\tau_i^* = \frac{3}{7}(1-c-\frac{2}{3}t) + \frac{4}{7}\delta > 0. \quad (6.17)$$

The level of the output tax in this benchmark scenario is determined by three partly counteracting incentives the government faces: As mentioned in Section 6.2.5, the pollution distortion on the domestic market implies a positive, and the market distortion a negative tax rate. In addition, in this one-policy framework, the complete MNE profit goes abroad and thus no profit-tax revenue accrues to the domestic country. This evokes an additional profit-shifting motive of the host government wishing to appropriate at least part of the foreign profit in terms of positive output-tax revenue. Taken together, the incentives for a positive tax rate outweigh those for a negative rate in this scenario.<sup>15</sup> The participation constraint is not binding in equilibrium, implying that positive profit remains for the foreign firm.<sup>16</sup>

<sup>14</sup>Note that the terms in brackets in eq. (6.16), by definition, cannot become negative since this would correspond to negative output volumes. A tax rate of  $\tau_i = \tau_i^{max} = 1-c$  yields zero exports ( $q_j = 0$ ), just the same as a tax rate of  $\tau_i = 1-c-t$ . Hence, in order to ensure  $Q_i(\tau_i^{max}) \geq 0$ , the maximum emissions-tax rate amounts to a value of  $\tau_i^{max} = 1-c$ , implying both output components to be zero ( $q_i = q_j = 0$ ).

<sup>15</sup> $\tau_i^* > 0$  immediately follows from the assumption of parameter values such that both the firm’s domestic- and exported output volumes are non-negative (in particular:  $1-c-t > 0$ ). Formally:  $\tau_i^* > 0 \Leftrightarrow \delta > -\frac{3}{4}(1-c-\frac{2}{3}t)$ . This condition is unambiguously fulfilled.

<sup>16</sup>It is obvious that  $\tau_i^* < \tau_i^{max} = 1-c$  holds under the non-prohibitiveness assumption with respect to  $\tau_i$ .

### 6.3.2 The Non-Cooperative Equilibrium with FDI Competition

This section considers that the foreign firm is internationally mobile and thus bases its location decision on a comparison of gross-profit options in the two countries. In order to induce the MNE to invest/stay in the domestic market, country  $i$  must thus ensure  $\Pi_i(\tau_i) \geq \Pi_j(\tau_j)$ .

Differently from the no-competition case, a country's optimal emissions-tax rate is now determined in a non-cooperative policy competition and thus chosen as reaction to the other country's policy. If the resulting strategic tax rate  $\tau_i^N(\tau_j^N)$  falls short of its non-strategic value  $\tau_i^*$ , it can be concluded that FDI competition leads to an environmental RtB.

Intuitively, if there is a positive net surplus from FDI compared to importing in a situation with a fixed MNE location, introducing FDI competition will induce both countries to lower their tax rates in order to attract the investment. Hence, in environmental-policy competition for FDI, emissions-tax rates are strategic complements. Country  $i$ 's best-reply function is stated below:

$$\tau_i(\tau_j) = \begin{cases} \tau_j - \epsilon & \text{for } \tau_j > \tau_i^{min} \\ \tau_j & \text{for } \tau_j = \tau_i^{min}. \end{cases} \quad (6.18)$$

This FDI competition game can be interpreted as a special kind of Bertrand competition: Countries will undercut each other's tax rates by an infinitesimally small amount  $\epsilon$  until their maximum WTP for the FDI (i.e. the minimum necessary tax rate  $\tau_i^{min}$  to attain a net surplus from FDI of at least zero) is reached. In the resulting policy equilibrium, welfare in the FDI host country equals welfare in the importing country:  $W_i^{FDI} = W_j^{Imp}$ , since the complete surplus from FDI is "competed away", and thus transferred to the foreign firm (in terms of larger gross profit). The importing country's welfare is solely determined by (positive)  $CS$ - and (negative) pollution spillovers from the FDI host country. Proposition 6.1 summarizes the characteristics of the resulting single-policy equilibrium:

**Proposition 6.1:** *When countries compete for FDI by strategically setting emissions-tax rates, the MNE's output is taxed/subsidized at a rate of  $\tau_i^N = \delta - \mu - \frac{t}{4} \gtrless 0$ . For parameter values that induce non-prohibitive emissions-tax rates (i.e. for  $\tau_i^* < 1 - c - t \Leftrightarrow \delta < 1 - c - \frac{5}{4}t$ ), this tax rate falls short of its non-strategic counterpart:  $\tau_i^N < \tau_i^*$ . Hence, FDI competition induces an environmental RtB.*

**Proof:** The equilibrium emissions-tax rate is calculated by setting welfare of the host country equal to welfare in the importing country (which is equivalent to setting the net FDI surplus equal to zero). The importing country's welfare is given by:

$$W_j^{imp} = \underbrace{\frac{(1 - c - \tau_i - t)^2}{8}}_{CS_j} - \underbrace{\mu(1 - c - \tau_i - \frac{t}{2})}_{\text{net rev}_j}. \quad (6.19)$$

Hence:

$$\begin{aligned}
 & W_i^{FDI} - W_j^{imp} \stackrel{!}{=} 0 \\
 \Rightarrow & \underbrace{\frac{(1-c-\tau_i)^2 - (1-c-\tau_i-t)^2}{8}}_{\text{surplus in CS}} + \underbrace{(\tau_i - \delta + \mu)(1-c-\tau_i - \frac{t}{2})}_{\text{surplus/loss in net rev}} = 0. \quad (6.20)
 \end{aligned}$$

Solving for  $\tau$  yields:

$$\tau_i^N = \delta - \mu - \frac{t}{4} \gtrless 0. \quad (6.21)$$

Given the assumption of non-prohibitive optimal tax rates, the strategic emissions-tax rate given by eq. (6.21) is smaller than its non-strategic counterpart given by eq. (6.17):  $\tau_i^N < \tau_i^*$ . This follows from the FDI host country's welfare in the non-competitive benchmark equilibrium exceeding the respective welfare in the importing country:  $W_i^{FDI}(\tau_i^*) > W_j^{imp}(\tau_i^*)$ . This condition is fulfilled unambiguously under the assumption of non-prohibitive values of  $\tau_i^*$ :

Eq. (6.20) shows that a sufficient though not necessary condition for  $W_i^{FDI}(\tau_i^*) > W_j^{imp}(\tau_i^*)$  (implying the LHS of eq. (6.20) to exceed zero) is  $\tau_i - \delta + \mu > 0$ , since the surplus in *CS* (the first term on the LHS) is always positive as well as MNE output given by the term  $(1-c-\tau_i - \frac{t}{2})$ . After plugging in  $\tau_i^*$  and re-arranging, the condition becomes:  $\tau_i^* - \delta + \mu > 0 \Leftrightarrow \frac{3}{7}(1-c-\delta - \frac{2t}{3} + \mu) > 0$ . This in turn holds for non-prohibitive emissions-tax rates:  $\tau_i^* < 1-c-t \Leftrightarrow 1-c-\delta - \frac{5t}{4} > 0 \Rightarrow 1-c-\delta - \frac{2t}{3} + \mu > 0$ .  $\square$

Eq. (6.21) shows that the equilibrium emissions-tax rate lies within a range of  $(-\frac{t}{4}, \delta - \frac{t}{4})$ , depending on the extent of pollution spillovers. For the extreme case of global pollution, output is subsidized rather than taxed:  $\tau_i^N(\mu = \delta) = -\frac{t}{4} < 0$ . For the other extreme of purely local pollution, the strategic output-tax is at its maximum value:  $\tau_i^N(\mu = 0) = \delta - \frac{t}{4} \gtrless 0$ . Hence, FDI competition is the more intense, the larger environmental spillovers are. This result is intuitive, since the relative attractiveness of hosting the FDI compared to importing rises, if pollution spillovers increase: While (positive) *CS* in the importing country is not affected, (negative) environmental-tax revenue (corresponding to environmental damage) becomes larger.

The conclusion of the preceding preliminary analysis therefore is: If countries compete for FDI only in terms of environmental policy, they face incentives to lower emissions-tax rates below their non-strategic levels in order to attract the foreign firm. Hence, FDI competition induces an environmental RtB. This is the more pronounced, the larger transboundary pollution spillovers are.

These preliminary results motivate the research question, which is investigated in the following main sections: (How) does this prediction change, if an additional policy instrument (corporate profit taxation) is introduced?

## 6.4 Policy Analysis with Two Instruments

The following sections constitute this paper's main contribution. They derive the countries' optimal strategic policy patterns in case they have two instruments, (distortive) environmental- and (lump-sum) profit taxes, at their disposal. Like above, the non-strategic policy choices serve as reference point for the characterization of the competitive policy equilibrium.

### 6.4.1 The “No-Competition” Benchmark-Scenario

Without having to compete for the investment, the country hosting the foreign firm will choose welfare-maximizing policies subject to the MNE's participation constraint as stated in Section 6.2.5. The participation constraint is now given by:

$$(1 - s_i)\Pi_i \geq k, \quad k = 0, \quad (6.22)$$

where  $k$  is a parameter interpretable as the MNE's outside-profit option.

In the resulting “no-competition” policy equilibrium, the foreign MNE is taxed at the maximum feasible rate of  $s_i^* = 1$ , which is just sufficient to ensure the MNE's participation in the domestic market (i.e. that leaves the MNE indifferent towards the investment).

The intuition is straightforward: If there is no competition for FDI, all that has to be ensured to keep the firm in the domestic country is zero net profit (i.e. eq. (6.22) to hold with equality, which in turn implies that the participation constraint is binding). Hence, the profit-tax rate can be set equal to one and the complete foreign profit is shifted to the domestic country. This profit adds to welfare as if the foreign firm was a domestic one.

Domestic welfare is thus given by:

$$W_i^{FDI} = \underbrace{\frac{(1 - c - \tau_i)^2}{8}}_{CS_i} + \underbrace{(\tau_i - \delta)(1 - c - \tau_i - \frac{t}{2})}_{\text{net rev}_i} + \underbrace{s_i}_{=1} \underbrace{\left( \frac{(1 - c - \tau_i)^2}{4} + \frac{(1 - c - \tau_i - t)^2}{4} \right)}_{\Pi_i}. \quad (6.23)$$

Maximizing eq. (6.23) with respect to  $\tau_i$  yields an optimal non-strategic emissions-tax rate of:

$$\tau_i^* = -\frac{1}{3}(1 - c) + \frac{4}{3}\delta \gtrless 0. \quad (6.24)$$

Proposition 6.2 states a crucial result concerning the interrelation between environmental- and profit-tax policies:

**Proposition 6.2:** *If the participation constraint is binding, a country's optimal level of environmental policy is independent of its corporate-tax policy.*

**Proof:** Proposition 6.2 is straightforward to prove for any value of  $k \geq 0$ :<sup>17</sup> As  $k$  represents some fixed value, it can be used to eliminate  $s$  in the welfare function as follows: Re-arranging eq. (6.22) in its binding form yields:

$$(1 - s_i)\Pi_i = k \quad \Rightarrow \quad s_i\Pi_i = \Pi_i - k, \quad k \geq 0. \quad (6.25)$$

Using eq. (6.25), the host country's welfare function becomes

$$W_i^{FDI} = \frac{(1 - c - \tau_i)^2}{8} + (\tau_i - \delta)\left(1 - c - \tau_i - \frac{t}{2}\right) + \underbrace{\frac{(1 - c - \tau_i)^2}{4} + \frac{(1 - c - \tau_i - t)^2}{4}}_{s_i\Pi_i} - k. \quad (6.26)$$

Obviously, maximizing eq. (6.26) with respect to the emissions-tax rate yields the same value for  $\tau_i^*$  as in the case of  $s_i = 1$ .  $\square$

Eq. (6.25) illustrates the intuition behind the participation constraint: In order to ensure the MNE's participation in the domestic market, the share of foreign gross profit the host country can appropriate must not exceed the difference between the MNE's domestic and outside profit options.

We can conclude that, as long as the participation constraint is binding, the optimal environmental policy will be constant at a level of  $\tau_i^*$ , no matter how high the profit-tax rate is. Changes in  $k$  force a country to adjust its profit-tax rate in order to keep the participation constraint binding, but this adjustment will not affect its optimal environmental-policy choice.

In general terms, the respective conclusion is that in case of a binding participation constraint, FDI competition is carried out in terms of the non-distortive policy instrument. The distortive instrument is meanwhile kept constant at its welfare-maximizing "no-competition" level.

## 6.4.2 The Non-Cooperative Equilibrium with FDI Competition

Suppose now, the foreign firm is internationally mobile and thus bases its location decision on a net-profit comparison between its potential host countries. In order to

<sup>17</sup>In particular, the result with respect to the independence of environmental taxes does not hinge on this specific benchmark scenario, but holds in general, for any outside-profit option of the MNE.

induce the MNE to invest/stay in the domestic market, country  $i$  must ensure the following generalized participation constraint to hold:

$$(1 - s_i)\Pi_i \geq (1 - s_j)\Pi_j. \quad (6.27)$$

Hence, from country  $i$ 's point of view, intensified FDI competition, expressed by country  $j$  either lowering its profit, or its emissions-tax rate, is equivalent to a rise in  $k$ , the exogenous outside-profit option of the foreign firm. How will country  $i$  react, i.e. how will the policy equilibrium change, when competition for FDI intensifies?

The next subsection will establish the interrelation between the two policy instruments in the non-cooperative scenario and specify the main characteristics of the policy equilibrium. The following subsection then completes the equilibrium analysis by some comparative statics.

### The interrelation between environmental- and corporate-tax policies and the main characteristics of equilibrium policies

In analogy to the single-policy scenario investigated in Section 6.3, tax competition for FDI can be interpreted as a special kind of Bertrand competition: Two symmetric countries undercut each others' profit-tax rates until they reach their maximum WTP for the FDI. As a consequence, the participation constraint is binding in both countries. In such an equilibrium, welfare in the FDI host- equals welfare in the importing country:  $W_i^{FDI} = W_j^{Imp}$ , since the complete surplus from FDI is "competed away", generating larger net profit for the MNE.

As shown in the benchmark analysis, environmental policy is independent of  $k$  if the participation constraint is binding. In case FDI competition intensifies (that is, the MNE's outside profit  $k$  rises), governments use (non-distortive) corporate- rather than (distortive) emissions taxes in order to maintain the MNE's market-participation. This result yields the following Proposition:

**Proposition 6.3:** *For parameter values that induce non-prohibitive emissions-tax rates (i.e. for  $\bar{\tau}_i^* < 1 - c - t \Leftrightarrow \delta < 1 - c - \frac{3t}{4}$ ), a government will adjust its profit-tax rate downwards to a level of  $s_i^N(\bar{\tau}_i^*) < 1$  when facing intensified international competition for FDI, expressed by declining profit- or environmental-tax rates in the neighboring country. The environmental tax remains at its optimal no-competition level. Consequently, there are no adverse environmental effects when countries are enhancing their competition for FDI. Since  $s_i$  is a strategic complement to both  $s_j$  and  $\tau_j$ , the best-reply function of country  $i$  is the following:*

$$s_i(s_j, \tau_j) = \{s_i \mid (1 - s_i)\Pi_i(\bar{\tau}_i^*) = (1 - s_j)\Pi_j(\tau_j)\}. \quad (6.28)$$

Depending on the size of the environmental-spillover parameter, both a tax and a subsidy on profits may arise as equilibrium policy:  $s_i^N \gtrless 0$  for  $\mu \gtrless \tilde{\mu} = \frac{1}{3}(1 - c - \delta - \frac{3t}{4})$ .

**Proof:** See Appendix B.1.  $\square$

Proposition 6.3 implies that governments do not apply environmental policy as an instrument in strategic FDI competition, if they have an additional policy instrument (corporate taxes) at their disposal. Hence, the “Environmental-RtB result” of single-instrument analyses is not confirmed here. Furthermore, not only is environmental policy unaffected by FDI competition, but so is the absolute pollution level, too.

So far, the current paper has followed a rather technical approach to explain the results: The key mechanism driving the outcome is the finding that environmental policy, under the condition of a binding participation constraint in the policy equilibrium, is unaffected by changes in the intensity of FDI competition.

What is the rationale for governments exclusively relying on corporate-tax policy, when trying to attract a foreign firm?<sup>18</sup> In the Nash equilibrium, the countries in the region use the distortive tax instrument to induce the MNE produce an output volume corresponding to the socially optimal one: The emissions tax serves to correct for the market- and the pollution distortions in the domestic country. In other words, the welfare surplus the host country can generate if it succeeds in attracting the investment, is maximal, if it sets the emissions-tax rate equal to  $\tau_i^*$ . A maximum domestic-welfare level in turn implies that the country’s means available for FDI competition are maximized: The more surplus a country generates by an optimal output tax, the more favorable investment conditions can it offer to the MNE in terms of the non-distortive instrument. Hence, choosing  $\tau_i^*$  creates the largest possible chance of success in the countries’ competition for FDI. Offering investment incentives in terms of a low profit-tax burden constitutes the “least-cost” alternative of competing for FDI, since it does not involve any further welfare-reducing biases of the MNE’s output choice.

The Nash equilibrium characterized by Proposition 6.3 is unique. Specifically, there does not exist any environmental-policy choice in equilibrium that does not maximize the competing countries’ individual welfare: Given the neighboring country’s strategic policy-choice, any value for  $\tau_i$  with  $\tau_i \neq \tau_i^*$  would imply a suboptimal individual-welfare level, and cause a defeat in the FDI competition game, respectively a complete loss of the FDI surplus.

## Comparative Statics

How do the countries’ corporate-policy choices and, thus, the intensity of intra-regional FDI competition depend on the prevailing **environmental conditions** in the region? The first aspect to consider is the domestic perspective as characterized by the environmental-damage parameter  $\delta$ . Changes in  $\delta$  can either be interpreted as changes in the level of environmental damage associated with the production process, or as changes in environmental preferences.

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<sup>18</sup>The basic principle behind the following argument is inspired by Davies/Ellis (2007).



The following Proposition states the results concerning changes in domestic environmental conditions:

**Proposition 6.4:** *For parameter values that induce non-prohibitive emissions-tax rates  $\tau_i^*$ , the relationship between the optimal profit-tax rate in the non-cooperative policy equilibrium and marginal environmental damage in the FDI host country is negative:  $\frac{\partial s_i^N}{\partial \delta} < 0$ .*

*In the absence of any environmental externality (and thus pollution spillovers, i.e. for  $\delta = \mu = 0$ ), foreign profit is taxed at a positive rate of  $s_i^N(\tau_i^*, \delta = \mu = 0) \in (0, 1)$ .*<sup>19</sup>

**Proof:** See Appendix B.2.  $\square$

The first part of Proposition 6.4 implies that rising environmental damage associated with the MNE's production, or, equivalently, an increase in environmental preferences in the region, intensify FDI competition via the profit tax. Considered from country  $i$ 's welfare perspective, this finding is surprising at first sight, as one would rather expect hosting FDI to become relatively *less* attractive, and thus the WTP for FDI to decrease (resp.  $s_i^{min} = s_i^N$  to increase), if domestic pollution is (perceived as) more severe. Remember, however, that the host country already counters this increase in (the perception of) environmental degradation by adjusting its emissions-tax rate upwards. Since this increase in  $\tau_i^*$  is even larger than proportional to the change in environmental damage/-preferences ( $\frac{\partial \tau_i^*}{\partial \delta} = \frac{4}{3}$ ), there is indeed scope for an intensification of FDI competition via the profit-tax rate, i.e. for  $s$  to decline to a level below its initial equilibrium value.<sup>20</sup>

Note, however, that the environment will not suffer from FDI competition becoming more fierce. As the analysis in Section 6.4.2 has shown, the neighboring countries solely rely on the non-distortive policy instrument (the profit tax), when competing for the investment; a RtB in (distortive) environmental taxes does not occur.

The second part of Proposition 6.4 implies that, also in the absence of pollution, countries have an incentive to compete for the foreign investment by strategically choosing their profit-tax rates. The optimal tax rate is positive, even though the host country does not suffer from environmental damage caused by the MNE's production, but rather realizes a positive surplus in  $CS$  compared to the importing country. This surplus, however, is not sufficient to completely compensate for the output subsidy the

<sup>19</sup>In such no-pollution scenario, the policy instrument  $\tau_i$  is of course not interpreted as environmental tax. It rather represents an ordinary output-tax serving to correct for the domestic market distortion (see Section 6.2.5). In equilibrium, this tax constitutes a subsidy, since from a social-welfare perspective, the foreign monopolist produces too little:  $\bar{\tau}_i^*(\delta = 0) = -\frac{1}{3}(1 - c) < 0$ .

<sup>20</sup>When explaining the change in the countries' WTP for FDI in terms of the aggregate welfare effects of changes in  $\delta$ , one has to consider a number of direct and indirect channels through which the optimal profit-tax rate is determined. Specifically, those include the host country's relative  $CS$ - and net environmental-tax revenue surpluses (see eq. (B.1) in Appendix B.1). Whereas the former declines if pollution aggravates ( $\frac{\partial \Delta CS}{\partial \delta} = -\frac{1}{3}t < 0$ ) and thus causes an upward pressure on  $s_i^N$ , the latter may rise with pollution ( $\frac{\partial \Delta netrev}{\partial \delta} \geq 0$ ) and thus possibly decrease  $s_i^N$ . Both effects are endogenously determined by the upward adjustment of the equilibrium emissions-tax rate  $\tau_i^*$ .

host country needs to pay the MNE in order to correct for the domestic market distortion. Hence, additional profit-tax revenue is required to make the FDI-option attractive for a country. Such a positive profit-tax rate also illustrates the host country's profit-shifting motive, which gains relative weight in political decisions-making if pollution externalities are absent.

Next, consider the effect of cross-country environmental spillovers on corporate-tax policy (representing the international aspect of environmental conditions). The following Proposition states the results concerning changes in the extent of pollution spillovers:

**Proposition 6.5:** *For parameter values that induce non-prohibitive emissions-tax rates  $\tau_i^*$ , the relationship between the optimal profit-tax rate in the non-cooperative policy equilibrium and environmental spillovers from the FDI host- to its neighboring country is negative:  $\frac{\partial s_i^N}{\partial \mu} < 0$ .*

*In the absence of any intra-regional pollution spillovers (i.e. for purely local pollution:  $0 = \mu \leq \delta$ ), foreign profit is taxed at a positive rate of  $s_i^N(\tau_i^*, 0 = \mu \leq \delta)\epsilon(0, 1)$ .*

**Proof:** See Appendix B.3.  $\square$

The first part of Proposition 6.5 implies that FDI competition is the more intense (i.e. the lump-sum-policy conditions offered to the MNE are the more favorable), the more pronounced transboundary pollution is. As already mentioned in Section 6.3.2, this finding is intuitive: FDI is the more attractive, the larger is the net surplus a country can generate from hosting the FDI compared to importing. The total net surplus consists of a (unambiguously positive) surplus in  $CS$  ( $\Delta CS > 0$ ) and a surplus/loss in environmental-tax revenue net of environmental damage ( $\Delta \text{net rev} \gtrless 0$ ). While the former is not affected by pollution spillovers, the latter positively depends on their level: In contrast to the host country, the importing neighbor only suffers from environmental damage without generating any tax revenue. Therefore, the difference in net-revenue levels between the competing countries rises with  $\mu$ . They will thus increase their efforts to attract the foreign investor by offering more favorable profit-taxes, the larger pollution spillovers are. However, the intensity of FDI competition does not exert any adverse impact on the environment, since environmental-policy levels are unaffected.

The second part of Proposition 6.5, in analogy to Proposition 6.4, implies that countries have an incentive to compete for the foreign investment, even if the surplus from net environmental-tax revenue is comparatively small under purely local pollution. Consequently, the additional  $CS$  a country can generate from hosting the MNE must be relatively large. However, FDI competition is not so fierce that negative profit-tax rates (i.e. subsidies on foreign profit) result as equilibrium policy. This finding is intuitive, as already in the no-pollution scenario (in which the relative attractiveness of FDI is even larger), positive profit-taxes are necessary to compensate the host country for the output subsidy it pays to the MNE (see above).

Another interesting aspect of the external conditions countries face when making their policy decisions concerns the size of trade barriers, when markets are more and more

integrating. The question is, how governments will react to **declining intra-regional trade costs**: Does this liberalization process induce FDI competition to become more, or rather less intense?

Unfortunately, general comparative-static results turn out to be quite hard to derive. Outcomes are ambiguous and depend on parameter values.

Nevertheless, clear-cut results for the special cases of “complete market integration” (i.e. for trade costs close to zero) and “autarky” (i.e. for trade costs close to prohibitive), as stated in Proposition 6.6, are possible to derive:

**Proposition 6.6:** *For parameter values that induce non-prohibitive emissions-tax rates  $\tau_i^*$  and regional markets being close to complete integration (i.e. free trade), the relationship between trade costs and the optimal profit-tax rate is negative:  $\frac{\partial s_i^N}{\partial t} \Big|_{t=0} < 0$ .*

*The same holds for markets close to autarky:  $\frac{\partial s_i^N}{\partial t} \Big|_{t=1-c} < 0$ .*

*A negative equilibrium tax rate  $s_i^N < 0$  (i.e. a subsidy on foreign profit) is more likely to arise in an autarky, than in a free-trade scenario.*

**Proof:** See Appendix B.4.  $\square$

These findings are intuitive: If trade costs fall, the surplus in  $CS$  the host country can generate compared to the importing country declines. Hence, FDI becomes relatively less attractive and country  $i$ 's minimum necessary profit-tax rate yielding a net FDI surplus of zero increases.<sup>21</sup>

In the “extreme” scenario of free trade without any intra-regional trade costs, the FDI host country cannot attain any surplus in  $CS$  compared to the importing country ( $\Delta CS = 0$ ). The only potential surplus comes from net environmental-tax revenue ( $\Delta netrev \gtrsim 0$ ). Hence, “free trade” is the scenario, in which FDI is c.p. the least attractive. As a consequence, the competing countries' incentives to offer favorable investment-conditions to the MNE are the least pronounced here; the equilibrium profit-tax rate will c.p. take on its maximum level.

Analogously, the other “extreme” scenario of prohibitively high intra-regional trade costs (autarky) ensures the FDI host country the largest attainable surplus from avoided trade costs:  $\Delta CS$  is maximal. Hence, the autarky scenario represents conditions, under which hosting the FDI is c.p. the most attractive. The competing countries will thus offer the most favorable investment conditions in terms of low profit-tax rates to the MNE; the

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<sup>21</sup>It should be mentioned that there are two additional channels through which changes in  $t$  influence the optimal profit-tax rate: The MNE's output and profit rise if  $t$  declines. Firstly, rising output increases the absolute value of the host country's relative surplus/loss in net environmental-tax revenue. Whether this effect constitutes an incentive for more or less intense FDI competition, depends on whether initially, the relative surplus was positive or negative. Secondly, a larger profit raises the host country's profit-tax base and thus the relative attractiveness of hosting the FDI, if  $s_i^N > 0$  initially. If in the initial situation, profits were subsidized ( $s_i^N < 0$ ), this effect works in the opposite direction. These two additional channels, however, are of relatively minor importance. For the special cases considered in Proposition 6.6, they can at most weaken the  $CS$ -effect quantitatively, but not change its direction.

probability that even a subsidy results as equilibrium policy is the most pronounced. In summary, these findings yield the conclusion that FDI competition is the less fierce, the more integrated markets are.

What do these results imply with respect to the common fear that “globalization is bad for the environment”? First, trade liberalization does not, as often claimed, lead to intensified international FDI competition. On the contrary: When trade costs decline, intra-regional trade more and more constitutes a substitute for the competing countries’ efforts to attract the FDI themselves. Second, environmental-policy levels are not affected by the liberalization process, because countries only use the corporate-profit tax as policy instrument in FDI competition.<sup>22</sup>

## 6.5 Conclusions

This paper has examined the impact of strategic FDI competition on a country’s optimal emissions-/corporate-tax policy combination in a framework explicitly considering the interdependencies between the two policy instruments. In the context of current public debates, the aim was to investigate whether FDI competition causes a RtB in environmental policies, as predicted by many one-policy approaches. Furthermore, also motivated by current “real-world” developments, the paper has discussed the impacts of changes in domestic and international environmental conditions and of economic integration on equilibrium policies.

It turned out that FDI competition does *not* induce an environmental RtB. Rather, environmental-policy levels are completely unaffected by FDI competition, since countries solely apply corporate-tax policies to attract the foreign investment. In the resulting non-cooperative policy equilibrium, profit-tax rates are smaller than their non-strategic value, whereas emissions-tax rates amount to their optimal non-strategic level. This implies that welfare-maximizing governments have no incentive to “misuse” environmental policy as a means to attract FDI, if they have an alternative, more directly targeted, policy instrument at hand.

This result is perfectly consistent with recent anecdotal evidence on corporate-tax- and environmental policies mentioned in the introduction: There are lots of examples for intense FDI-competition going hand in hand with strict environmental legislation. Hence, as compared to public concerns and the results of a large number of analyses within the (environmental-)tax-competition literature, the conclusions of this paper are rather optimistic.

The conclusions with respect to the effects of FDI competition are neither limited to

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<sup>22</sup>This does not exclude, however, adverse direct environmental impacts of market integration, as declining trade costs clearly raise the firm’s total output and thus total environmental damage: The MNE is induced to raise its output volume as exports become more profitable ( $\frac{\partial q_j}{\partial t} = -\frac{1}{2} < 0$ ). As a consequence, the absolute pollution level in the region, identical to the foreign firm’s total production, rises:  $\frac{\partial E_i(Q_i)}{\partial t} = \frac{\partial Q_i}{\partial t} = \frac{\partial q_j}{\partial t} < 0$  (see Section 6.2.3).

this paper's specific application to environmental- and corporate-profit-tax policies, nor to the applied model framework. On the contrary, the results yield rather general conclusions.

In particular, generalizations with respect to the model framework are conceivable e.g. in terms of the foreign firm's decision variable: This could, besides the volume of output as in this paper, represent any other firm choice relevant for the determination of domestic welfare. Examples include R&D- or pollution-abatement expenditures. Implied by alternative decision variables, also the externalities underlying the MNE's suboptimal choice (with respect to social welfare) and the nature of intra-regional spillovers could be of different kinds— either positive or negative.

Generalizations with respect to the policy framework implicitly follow from the assumptions on the externalities characterizing the regional markets. These determine the distortive policy instrument suitable to correct for suboptimal firm decisions by directing the MNE's choice to a socially optimal outcome. For the above-mentioned example of R&D- or pollution-abatement expenditures as choice variables, which certainly create positive externalities and spillovers, a conceivable policy instrument could be a subsidy per dollar spent.

By the same line of argument as for the distortive, generalizations with respect to the non-distortive policy-instrument are straightforward: Think of any lump-sum transfer to the foreign investor suitable to attract the MNE. It is irrelevant, so to say, how this transfer is termed. Quite common in the "real world" are e.g. "incentive packages" offered to a foreign firm in case it locates a plant in the domestic country. The RtB in profit taxes induced by FDI competition as in this paper would then correspond to a RtT in incentive payments.

To sum up, this paper's main conclusion with respect to the interrelation between environmental- and corporate-profit-tax policies in intra-regional FDI-competition carries over to a broad range of policy- and model frameworks. The results do not hinge on the specific, simple model structure applied here, since the basic and intuitive mechanism driving those results is a general one:

Suppose, governments have two policy instruments, one distortive and one non-distortive, at their disposal, and domestic markets exhibit suboptimal welfare levels due to some external effects associated with a foreign firm's investment. It is straightforward that the FDI host applies the distortive instrument to correct for those distortions and by this means generate a maximum level of domestic welfare. At the same time, the government maximizes its means available to offer to the foreign firm in terms of most investment-friendly conditions with respect to the non-distortive instrument. As a consequence, it achieves the given target of maximizing the MNE's domestic net-profit option in order to attract the FDI at the least possible cost. This cost may be interpreted in terms of the (potential) welfare loss associated with a policy intervention: Whereas policy competition via the distortive instrument would bias the MNE's (forcedly domestic-welfare maximizing) decision in addition to raising its net-profit option, competition via the lump-sum instrument directly targets at net profit without inducing further distortions and welfare losses.

The comparative-statics results with respect to the environmental conditions yield mixed conclusions in connection with the above-mentioned “real-world” observations and public concerns: The anecdotal evidence with respect to recent environmental-policy patterns in many countries may be interpreted as an indicator for an increasing environmental awareness. According to this paper’s findings, this induces an intensification of FDI competition, just as expected by the public and many economists. As this competition, however, is carried out in terms of corporate-tax, rather than environmental policy, adverse environmental(-policy) impacts are not to be expected. On the contrary: The domestic emissions-tax rate will, independently of FDI competition, be raised.<sup>23</sup>

The comparative-statics results with respect to trade costs suggest that the currently ongoing market integration leads to a weakening of the countries’ efforts to attract FDI. Hence, the public concern about “harmful” tax competition induced by globalization lacks theoretical support. Most relevant with respect to this paper’s motivation is the finding that the environmental-policy impact of market integration is equal to zero.

This comparative-static result is already stated in a rather general way. Following the preceding line of argument in more detail reveals, why also the conclusions with respect to the effects of regional integration on FDI competition are independent of the specific model framework applied: Transport costs are not relevant for the host country’s welfare-maximizing level of the distortive policy-instrument. They only affect equilibrium policies via the net surplus from FDI, which in turn determines the intensity of FDI competition in the non-distortive instrument, whichever form that has. Accordingly, results carry over to a much broader range of model settings.

Which potential extensions of the analysis in this paper appear sensible? In what concerns the theoretical model framework, for instance, introducing asymmetry with respect to environmental preferences in the competing countries might yield further interesting insights. Suppose, for example, the environmental-damage parameter in country A, and thus also its optimal emissions-tax rate, exceeds the respective values in country B. Then, in order to win the FDI-competition game, A has to offer a lower profit-tax rate than B. According to the arguments in this paper, the minimum rate that is reasonable is  $s_A^{min}$ , leading to a zero net surplus from FDI. Country B’s best reply would be a profit-tax rate yielding a net MNE profit exceeding the profit option in A by an infinitesimally small (and thus negligible) amount. The MNE locates in B. The generalized participation constraint, however, is binding in equilibrium. The basic conclusion of no environmental RtB occurring is thus unaffected. The equilibrium characteristic of identical welfare levels in the host- and the importing country under completely non-cooperative policy choices, however, need not hold for the asymmetric-

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<sup>23</sup>In contrast to transport costs, arguments concerning a more general interpretation of this environmental-variable comparative-statics results are not very useful, since already the existence of a pollution externality constitutes a rather specific assumption, driven by the underlying environmental-policy model framework. This is different with respect to transport costs, which should plausibly be part of any model specification on the issue of FDI competition— independently of the additional alternative model features.

country case. The less environmentally aware country B has to ensure the MNE's locational indifference, but this no longer requires to set  $s_B^N = s_B^{min}$ . For all profit-tax rates exceeding their minimum necessary value ( $s_B^N > s_B^{min}$ ), a positive net FDI surplus for the host country remains.

## Chapter 7

# Normative Analysis: What are the Welfare Effects and How Can They be Tackled?

### Abstract

This paper analyzes the welfare effects of international FDI competition in an emissions- and a corporate-profit tax. As a starting point, the competing countries' aggregate welfare in the non-cooperative policy equilibrium is compared to the maximum attainable level corresponding to the social optimum. The analysis then focusses on the question of how countries can improve their aggregate welfare, if the social optimum, requiring cooperation in both policy areas, is not feasible. The paper examines two alternative patterns of partial policy cooperation: an International Tax Agreement and an International Environmental Agreement.



## 7.1 Introduction

The preceding chapter has shown that FDI competition in environmental- and corporate-tax policies does neither induce an environmental RtB nor excessive pollution. This rather optimistic result does not immediately imply, however, that globalization does not have any adverse welfare impacts. In particular, it is highly questionable, whether the two-dimensional non-cooperative policy equilibrium is compatible with the aim of maximizing regional welfare. The subsequent normative analysis of the model therefore addresses the welfare effects of policy competition. In the light of the empirically observable attempts different groups of countries and regions undertake to overcome such “harmful policy competition” by negotiating international agreements on e.g. environmental- or tax-related issues, the paper also assesses alternative approaches to improve social welfare.

For that purpose, the analysis first establishes the (rather obvious) result that aggregate regional welfare in the Nash equilibrium falls short of its maximal attainable level in the social optimum. One reason is that a non-cooperative policy choice implies a country’s complete surplus from hosting the FDI (as compared to importing) being channeled to the foreign firm by means of a low profit tax. Second, although there is no FDI competition in environmental policy, the non-cooperative emissions-tax rate is not optimal from an aggregate regional perspective, since it does not consider intra-regional pollution- and consumer-surplus spillovers. The social optimum corresponds to a situation, in which intra-regional policy-cooperation is “complete” in the sense that both policy instruments are set to maximize aggregate regional welfare.

Subsequently, the paper investigates the welfare effects of “partial” policy cooperation, i.e. cooperation in only one of the two available instruments: How does an International Tax Agreement perform as compared to an International Environmental Agreement? This approach takes account of the fact that complete cooperation in the “real world” may often be infeasible, due to e.g. political or administrative obstacles. The focus of the analysis is to examine, whether such partial-cooperation options constitute appropriate means to attain welfare improvements relative to a completely non-cooperative situation, and so at least help approach the socially optimal welfare level. It turns out that both kinds of agreement are suitable to do so. The gains from cooperation on the lump-sum corporate-tax policy instrument (ITA), however, exceed those from cooperation on the distortive environmental-tax policy instrument (IEA).

Recently, there have been numerous attempts of different country groups to cooperate on environmental, as well as on corporate-tax policies. With respect to the environment, the “IEA database”, for instance, provides a list of IEAs worldwide, showing that since the year 2000, the large number of 151 IEAs has been concluded.<sup>1</sup> Current worldwide attempts of countries to find international solutions to the issue of global warming and climate change, as manifested in the negotiations on a follow-up of the Kyoto-protocol

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<sup>1</sup>See “International Environmental Agreements Database Project (Version 2010.2)” at [http : //iea.uoregon.edu/](http://iea.uoregon.edu/); access July, 2010.

(see Chapter 6), constitute the most prominent example.

With respect to corporate taxation, policy cooperation with two closely related aims has recently prevailed: A first example is the EU's "Common Consolidated Corporate Tax Base" (CCCTB) policy, introduced in 2001. This policy implies EU-wide harmonization of corporate-tax bases, and is pursued by a working group, meeting on a quarterly basis, most recently in April, 2008. The EU Commission presumes that such coordination of national tax systems has positive effects on regional (EU-wide) tax efficiency and thus, indirectly, on aggregate welfare.<sup>2</sup>

Second, international agreements with the aim of addressing "harmful tax competition" provide anecdotal evidence for cooperation efforts in corporate-tax policy. One prominent example is the "Code of Conduct for business taxation", set out by ECOFIN in 1997: EU-member countries commit to rolling back existing and refraining from introducing new tax measures, which have significant impact on business location and are classified as "harmful" according to a set of criteria.<sup>3</sup> In 1998, also the OECD founded the "Forum on Harmful Tax Practices", encompassing similar aims and measures as the Code of Conduct.<sup>4</sup>

Examples of agreements on international cooperation in *both* policy areas, however, are hardly observable: As achieving agreement on the determination of one policy instrument has already proven to be sufficiently difficult, it can be considered as politically infeasible to cooperate on multiple issues at the same time. Furthermore, if cooperation in more than one instrument should really be achieved, we can expect competition in still other instruments to be adjusted in turn. Hence, simultaneous cooperation in all available policy instruments (two in this paper's model framework) can plausibly be considered as infeasible.

The rest of the chapter is structured as follows: The next section characterizes equilibrium policy patterns in the non-cooperative Nash equilibrium (i.e. under no cooperation at all) and the social optimum (i.e. under complete cooperation) and compares the associated welfare levels. For reasons mentioned above (and elaborated below), the social optimum serves as a reference point for the normative welfare analysis rather than as "realistic" policy scenario. Section 7.3 investigates partial-cooperation scenarios in corporate- and environmental taxes and the associated welfare differentials to the Nash- and the socially optimal outcomes. The focus is on the question of whether welfareimprovements can be realized, and on the alternative agreements' relative performance in aggregate-welfare terms. Section 7.4 concludes.

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<sup>2</sup>For an overview of basic features and current progress of the CCCTB see [http://ec.europa.eu/taxation\\_customs/taxation/company\\_tax/common\\_tax\\_base/index\\_en.htm](http://ec.europa.eu/taxation_customs/taxation/company_tax/common_tax_base/index_en.htm) (latest access in July, 2010).

<sup>3</sup>For an overview of the main features see [http://ec.europa.eu/taxation\\_customs/taxation/company\\_tax/harmful\\_tax\\_practices/index\\_en.htm](http://ec.europa.eu/taxation_customs/taxation/company_tax/harmful_tax_practices/index_en.htm) (latest access in July, 2010).

<sup>4</sup>For further information see OECD (1998) and [http://www.oecd.org/topic/0,2686,en\\_2649\\_33745\\_1\\_1\\_1\\_1\\_37427,00.html](http://www.oecd.org/topic/0,2686,en_2649_33745_1_1_1_1_37427,00.html) (latest access in July, 2010).

## 7.2 Nash Equilibrium and Social Optimum: No versus Complete Cooperation

### 7.2.1 The Non-Cooperative Nash Equilibrium

In the non-cooperative policy regime, the countries in the region compete for FDI in both policy instruments. Lemma 7.1 replicates the resulting equilibrium policy patterns derived in the positive analysis in Chapter 6:

**Lemma 7.1:** *In the simultaneous non-cooperative policy equilibrium, environmental-tax rates equal their no-competition values  $\tau_i^N = \tau_i^* = -\frac{1}{3}(1-c) + \frac{4}{3}\delta$ . For parameter values that induce non-prohibitive emissions-tax rates, competition for FDI is exerted via downward adjustments of profit-tax rates to a level of  $s_i^N(\tau_i^N) < 1$ . This tax level yields a zero net surplus from FDI in the host country.<sup>5</sup>*

Policy patterns as described in Lemma 7.1 imply that the competing countries are offering their maximum WTP for the FDI in terms of charging the foreign firm with only the minimum necessary profit-tax rate to just ensure themselves a net FDI surplus of zero. Consequently, the complete surplus is redirected to the foreign country, leaving both with identical welfare levels corresponding to the importing country's welfare:  $W_i^{FDI,N} = W_j^{imp,N}$ .

### 7.2.2 The Cooperative Social Optimum

The maximum feasible welfare level associated with the social optimum serves as a reference point for an assessment of aggregate regional welfare attainable in the Nash equilibrium. A socially optimal policy regime here is interpreted from the regional perspective: Both the environmental- and the corporate-tax policy-instrument are chosen such that regional welfare  $W_{reg}$ , i.e. the sum of welfare levels in the FDI host- and the importing country, is maximized:

$$W_{reg} = W_i^{FDI} + W_j^{imp} \xrightarrow{\max!} s, \tau. \quad (7.1)$$

Hence, the social optimum corresponds to a scenario without any competition for FDI, as countries  $i$  and  $j$  cooperate in both policy areas.

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<sup>5</sup>Remember that the net FDI surplus is defined as the welfare differential between the FDI host- and the importing country. In general, it consists of three elements: First, differently from the importing country, the FDI host can realize an (unambiguously positive) surplus in  $CS$  due to avoided transport costs. Second, the host country realizes a surplus from net environmental-tax revenue. Whether this is positive or negative, depends on the extent of environmental damage. The third element of net FDI surplus is profit-tax revenue, which is, of course, only generated in the host country and can also take on positive or negative values.

Lemma 7.2 characterizes the associated policy equilibrium:

**Lemma 7.2:** *In the social optimum, the cooperative policy choice yields a corporate-profit-tax rate of  $s_i^{opt} = 1$  and a corresponding emissions-tax rate of  $\tau_i^{opt}(s_i^{opt}) = -(1 - c) + \frac{t}{2} + 2(\delta + \mu)$ , with  $\tau_i^{opt}(s_i^{opt}) > \tau_i^N$  for environmental spillovers sufficiently large, i.e. for  $\mu > \tilde{\mu} = \frac{1}{3}(1 - c - \delta - \frac{3}{4}t)$ .<sup>6</sup>*

**Proof:**

- The optimal cooperative profit-tax rate being equal to unity immediately follows from arguments introduced in Chapter 6, and builds on the assumption that the foreign MNE has already decided to invest in the region. Hence, all the countries have to ensure in order to fulfill the MNE's participation constraint, is a foreign net-profit of zero. This allows them to charge the maximum tax-rate of  $s_i = 1$ . Formally:  $(1 - s_i)\Pi_i \stackrel{!}{=} 0 \Rightarrow s_i^{opt} = 1$ .
- The emissions-tax rate is to maximize aggregate regional welfare, which is given by:

$$\begin{aligned}
W_{reg} &= \underbrace{CS_i + \text{net rev}_i + s_i^{opt}\Pi_i}_{W_i^{FDI}} + \underbrace{CS_j + \text{net rev}_j}_{W_j^{imp}} \\
&= \underbrace{\frac{(1 - c - \tau_i)^2}{8}}_{CS_i} + \underbrace{(\tau_i - \delta)(1 - c - \tau_i - \frac{t}{2})}_{\text{net rev}_i} + \underbrace{s_i^{opt}}_{=1} \underbrace{\left( \frac{(1 - c - \tau_i)^2}{4} + \frac{(1 - c - \tau_i - t)^2}{4} \right)}_{\Pi_i} \\
&+ \underbrace{\frac{(1 - c - \tau_i - t)^2}{8}}_{CS_j} - \underbrace{\mu(1 - c - \tau_i - \frac{t}{2})}_{\text{net rev}_j}. \tag{7.2}
\end{aligned}$$

Maximization with respect to  $\tau_i$  yields:

$$\tau_i^{opt} = -(1 - c) + \frac{t}{2} + 2(\delta + \mu). \tag{7.3}$$

The threshold value  $\tilde{\mu}$ , which implies this socially optimal emissions-tax rate to

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<sup>6</sup>Note that this condition on the environmental-spillover parameter corresponds to the threshold value  $\tilde{\mu}$  identified in Proposition 6.3 in Chapter 6. It yields negative profit-tax rate values in the competitive equilibrium:  $\mu > \tilde{\mu} \Leftrightarrow s_i^N < 0$ . Subsidies on foreign profit as equilibrium policy indicate a scenario with relatively fierce FDI competition.

exceed its non-cooperative counterpart, obviously follows from:

$$\begin{aligned}
\tau_i^{opt} &> \tau_i^N \\
\Rightarrow -(1-c) + \frac{t}{2} + 2(\delta + \mu) &> -\frac{1}{3}(1-c) + \frac{4}{3}\delta \\
\Rightarrow \mu &> \frac{1}{3}(1-c - \delta - \frac{3}{4}t).
\end{aligned} \tag{7.4}$$

□

The subsequent analysis assumes that the above-mentioned condition on the environmental-spillover parameter ensuring  $\tau_i^{opt} > \tau_i^N$  is fulfilled. This assumption makes sense, since without transboundary pollution being sufficiently severe, there would be no need to internationally cooperate on environmental-policy making. In order to improve on aggregate welfare, the countries would then have to reduce, rather than intensify their environmental-policy efforts— a situation which is not consistent with “real-life” observations.

A maximum corporate-tax rate as identified in Lemma 7.2 implies that the countries can retain the complete foreign profit generated within the region for themselves. A look at the socially optimal emissions-tax rate reveals that it reflects, differently from its unilaterally chosen counterpart in the Nash equilibrium, environmental damage in *both* countries, as well as intra-regional transport costs. This implies that all externalities from the host- to the importing country are internalized: On the one hand, the environmental spillover  $-\mu(1-c-\tau_i-\frac{t}{2})$  constitutes a negative externality, implying a downward bias in the host country’s non-cooperative emissions-tax rate. On the other hand, the *CS*-spillover  $\frac{(1-c-\tau_i-t)^2}{8}$ , constituting a positive externality, implies an upward bias in the non-cooperative emissions-tax rate. In general, whether the socially optimal tax rate exceeds (as assumed in this paper), or falls short of the non-cooperative one, depends on which of those externalities dominates.

### 7.2.3 Welfare Comparison

As shown above, in the social optimum, the FDI host country is able to appropriate the complete foreign profit by setting the corporate-tax rate equal to one. Differently from the competitive scenario, the host country realizes the net FDI surplus, as this need not serve as investment incentive for the foreign MNE in the course of intra-regional FDI competition. As a consequence, the host country’s exceeds the importing country’s welfare level. Proposition 7.1 summarizes, how aggregate regional-welfare levels in the two policy-regimes differ.

**Proposition 7.1:** *For parameter values that induce non-prohibitive optimal emissions-tax rates (i.e. for  $\tau_i^{opt} < 1 - c - t \Leftrightarrow \delta + \mu < 1 - c - \frac{3}{4}t$ ), aggregate regional welfare*

in the non-cooperative Nash equilibrium falls short of the welfare level attainable under socially optimal policies:  $W_{reg}^N < W_{reg}^{opt}$ .

**Proof:** See Appendix C.1.  $\square$

Proposition 7.1 implies that intra-regional FDI competition is detrimental for aggregate welfare in the region. There is a RtB<sup>7</sup> in both policy instruments, if governments aim at attracting the foreign firm to their own country, rather than acting cooperatively and considering that the MNE has already decided to invest in the region and thus does not require any further incentives. In the Nash equilibrium, potential welfare gains from cooperation are not realized: If the countries jointly decided to tax foreign profit at the maximum possible rate of  $s_i^{opt} = 1$ , rather than each offering a subsidy of  $s_i^N < 0$  to the MNE, they could save the “incentive payments” and so improve on aggregate welfare.

Although this paper does not interpret the social optimum as a “realistic” policy scenario, but rather uses it as a benchmark for welfare comparisons, some additional welfare-related insights, stated in Corollary 7.1a, can be gained:

**Corollary 7.1a:** *On aggregate, the region gains from complete policy cooperation as compared to a scenario with no cooperation at all. This result carries over to the individual perspective of the host- and the importing country. Both achieve higher welfare levels in the social optimum than in the Nash equilibrium:  $W_i^{FDI,opt} > W_i^{FDI,N} \wedge W_j^{imp,opt} > W_j^{imp,N}$ .*

**Proof:** See Appendix C.2.  $\square$

The FDI host country is better-off in the social optimum, because it realizes the complete net surplus from FDI rather than channeling it to the foreign firm in terms of low corporate taxes. The importing country is better-off, because it gains from the internalization of external effects (here expressed in a higher level of the emissions-tax rate).

Furthermore, the welfare relations stated in Corollary 7.1a allow for an insight going beyond the topics analyzed in this chapter: Although both individual countries gain from complete cooperation, such policy pattern is not feasible without additional policy provisions. Because in the social optimum the FDI host country realizes a higher welfare level than its importing neighbor, there is always an incentive to engage in FDI competition—resulting in the Nash-equilibrium outcome. That is, countries face a typical Prisoners’ Dilemma situation. An appropriate scheme of side-payments might help to overcome this dilemma. Such a scheme would have to ensure that in equilibrium, both countries achieved the same level of individual welfare—no matter whether they

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<sup>7</sup>Differently from the positive analysis, the term “RtB” here is interpreted in a normative sense: The reference point for the emissions-tax rate is given by its socially optimal level  $\tau_i^{opt}$  rather than by its “no-competition” level (corresponding to  $\tau_i^N$ ). The reference values of the profit-tax rate coincide, since the socially optimal- and the “no-competition” values are both equal to one.

end up as host- or importing country. The “winner” of the FDI competition must thus pay half of its surplus to the “loser”:

$$W_j^{imp,opt,\nu} = W_j^{imp,opt} + \nu \stackrel{!}{=} W_i^{FDI,opt} - \nu = W_i^{FDI,opt,\nu} \Rightarrow \nu = \frac{1}{2}(W_i^{FDI,opt} - W_j^{imp,opt}),$$

where  $\nu$  represents the side-payments from  $i$  to  $j$ .<sup>8</sup>

## 7.3 Alternative Approaches of Partial Cooperation

### 7.3.1 An International Tax Agreement

An ITA constitutes one potential regime of partial intra-regional cooperation. Such agreement encompasses the direct and complete elimination of FDI competition in corporate taxes (i.e. in the lump-sum policy instrument), whereas environmental taxes (the distortive policy instrument) are still chosen non-cooperatively. This paper assumes that, by concluding an ITA, the countries commit to a common profit-tax rate that maximizes their aggregate welfare, and thus corresponds to the socially optimal rate:  $s_j^{ITA} = s_i^{ITA} = s_i^{opt} = 1 > s_i^N$ .<sup>9</sup>

#### The ITA Policy Equilibrium

Lemma 7.3 states the main characteristics of the ITA policy equilibrium:

**Lemma 7.3:** *Suppose, the countries in the region conclude an ITA by choosing the socially optimal profit-tax rate as common policy level:  $s_i^{ITA} = s_i^{opt} = 1$ . As this tax rate corresponds to its non-strategic value, FDI competition is completely eliminated.*

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<sup>8</sup>It should be annotated that the practical relevance of such (hypothetical) side-payment schemes is highly questionable due to a variety of obstacles of e.g. administrative-, calculatory-, or political nature.

<sup>9</sup>Although such policy choice constitutes the most ambitious pattern of cooperation in an ITA, this assumption is motivated by the fact that the conclusion of an ITA and the implied common corporate-tax rate constitute entirely political decisions (which are exogenous to the model): Which policy level the ITA member countries achieve agreement on, appears, at least from an economic perspective, rather arbitrary. There is thus no reason not to suppose that those countries choose the socially optimal tax rate as their cooperative one. On the contrary: As those countries aim at maximizing aggregate welfare, the social optimum plausibly constitutes a reference scenario for their cooperative policy choices. Hence, in order to keep things simple and comprehensive, the subsequent analysis builds on an ITA profit-tax rate corresponding to its social optimum. The qualitative results, however, do not hinge on this assumption, as long as the relation  $s_i^{ITA} > s_i^N$  is sustained. For ITA profit-tax rates above the non-cooperative value but below one (i.e. for  $s_i^N < s_i^{ITA} < 1$ ), though not completely eliminated, FDI competition is still directly weakened by the agreement. Positive welfare effects from this “competition effect” (see below) still arise, although their extent clearly falls short of that attainable by means of a socially optimal tax rate.

In the resulting ITA policy equilibrium, the emissions-tax rate corresponds to that in the “no-cooperation” Nash equilibrium:  $\tau_i^{ITA} = \tau_i^N = -\frac{1}{3}(1 - c) + \frac{4}{3}\delta$ .

**Proof:** See Appendix C.3.  $\square$

Lemma 7.3 directly implies that the introduction of an ITA has neither an effect on environmental-policy levels, nor on environmental quality in the member countries. This result may appear surprising at first sight: As members of an ITA, the countries in the region are withdrawn the opportunity to engage in corporate-tax competition for FDI. One might thus expect them to apply the second available policy instrument, the distortive one, instead, and so trigger a RtB in environmental policy. The intuition for this not happening is, however, straightforward: If the region cooperatively sets corporate-tax rates equal to one, the MNE’s net-profit option in both countries is zero—no matter, which environmental-tax levels it faces. The ITA regime thus corresponds to the no-competition benchmark scenario introduced in Chapter 6. Hence, why should the countries continue competing for the FDI, if the MNE is indifferent with respect to its location within the region anyway? An agreement on the lump-sum corporate-tax instrument therefore enables the FDI host country to set its distortive environmental-tax instrument in a way that induces the MNE to produce an output volume consistent with maximum domestic welfare.

## Welfare Effects

How does aggregate regional welfare in an ITA regime compare to welfare attainable in case of no cooperation? In other words: Does such tax agreement constitute a “step in the right direction” in what concerns the aim of mitigating the adverse welfare effects of international policy competition? Proposition 7.2 provides the answer to this question:

**Proposition 7.2:** *Aggregate regional welfare in the ITA equilibrium is larger than welfare in the Nash equilibrium with no cooperation, but falls short of the maximum attainable level in the social optimum:  $W_{reg}^N < W_{reg}^{ITA} < W_{reg}^{opt}$ .*

**Proof:** See Appendix C.4.  $\square$

Proposition 7.2 affirms the question posed above: Partial corporate-tax-policy cooperation indeed constitutes an appropriate means to enable the region to approach (though not entirely attain) its socially optimal welfare level.

On the one hand, an ITA regime with common profit-tax rates of one completely eliminates FDI competition (since this is solely exerted in terms of the tax instrument). This *competition effect* ensures that, in contrast to the completely non-cooperative policy scenario, the net FDI surplus can be appropriated by the host country and thus remains within the region. Aggregate regional welfare in the ITA therefore exceeds its respective level in the Nash equilibrium.



On the other hand, aggregate regional welfare in the ITA regime fails to attain the complete-cooperation level: Environmental taxes are not socially optimal, because countries continue to target their *individual* welfare, when choosing the distortive policy instrument. Intra-regional externalities are thus not considered, and the maximum attainable level of regional welfare is missed.

To summarize: An ITA raises aggregate regional welfare. Hence, in terms of corporate-tax policy, “some cooperation is better than no cooperation.”

Corollary 7.2a complements the results with respect to aggregate welfare by an analysis of an ITA’s individual-welfare effects:

**Corollary 7.2a:** *On aggregate, the region gains from partial corporate-tax-policy cooperation as compared to a scenario with no cooperation at all. This result carries over to the individual perspective of the host country:  $W_i^{FDI,ITA} > W_i^{FDI,N}$ . The importing country is at least not worse-off, since it ends up at a welfare level identical to that in the Nash equilibrium:  $W_j^{imp,ITA} = W_j^{imp,N}$ .*

**Proof:** See Appendix C.5.  $\square$

We can infer from Corollary 7.2a that, first, the complete aggregate-welfare gain a region realizes when concluding an ITA is generated in the host country, and, second, originates in the direct elimination of corporate-tax-policy competition. Due to this competition effect, the complete foreign profit (the level of which is not affected by the ITA, since environmental policy is kept constant) is appropriated by the FDI host, rather than by the foreign firm.

Differently from the host country, the importing neighbor’s position does not improve, since environmental taxes remain at a level that disregards intra-regional spillovers. Because country  $j$  does not lose from participating in the ITA neither, such agreement appears to be a feasible option of international policy-cooperation nevertheless.<sup>10</sup>

### 7.3.2 An International Environmental Agreement

An IEA constitutes the second possible regime of “partial cooperation”: Countries determine environmental policy (i.e. the distortive policy instrument) cooperatively, whereas lump-sum corporate taxes are still set in a non-cooperative manner. Analogously to the ITA scenario, the member countries commit to a common emissions-tax rate that maximizes aggregate regional welfare, and thus corresponds to the socially optimal rate:  $\tau_j^{IEA} = \tau_i^{IEA} = \tau_i^{opt} > \tau_i^N$ .<sup>11</sup>

<sup>10</sup>This conclusion holds under the premise that the member countries are committed to the treaty’s corporate-tax-policy provision.

<sup>11</sup>This IEA tax rate builds on Proposition 6.2 in Chapter 6, which states for the completely non-cooperative Nash equilibrium: “If the participation constraint is binding, a country’s environmental-policy level is independent of its corporate-tax policy.” This argument carries over to the IEA scenario. Also here, countries lower their profit-tax rate down to a level that reflects their (identical) maximum

In general, uniform (environmental-) policy levels for all member countries of course do not constitute the only conceivable design of an international agreement on the distortive policy instrument (IEA), which is exogenous to the model. The actual policy pattern countries achieve agreement on during the treaty negotiations obviously depends on many factors, e.g. on the number of, and the political-power distribution among the member countries, the specific pattern of externalities (environmental problem) at hand etc. An alternative to the “uniform-policy” solution investigated in the remainder of this paper, a “differentiated-policy” version of an IEA, is discussed in Appendix C.10.

### The IEA Policy Equilibrium

Lemma 7.4 summarizes the main characteristics of the IEA policy equilibrium:

**Lemma 7.4:** *Suppose, the countries in the region conclude an IEA by choosing the socially optimal emissions-tax rate as their common policy:  $\tau_i^{IEA} = \tau_i^{opt} = -(1 - c) + \frac{t}{2} + 2(\delta + \mu)$ . In the resulting IEA policy equilibrium, competition for FDI in terms of corporate taxes persists. The non-cooperative profit-tax rate corresponds to each country’s maximum WTP for the FDI (its minimum necessary tax rate, respectively). This tax rate is larger than that corresponding to the “no cooperation” Nash equilibrium:  $s_i^{IEA} = s_i^{min}(\tau_i^{IEA}) > s_i^N$ .*

**Proof:** See Appendix C.6.  $\square$

Lemma 7.4 implies that the equilibrium profit-tax rate approaches its socially optimal level, if environmental taxes are fixed to their “international” social optimum. This finding implies that the introduction of an IEA indirectly weakens harmful FDI competition in corporate taxes.

The intuition behind this finding is straightforward: The intensity of intra-regional FDI competition is determined by the FDI-option’s relative attractiveness compared to importing (i.e. by the net FDI surplus). If in an IEA, the environmental-tax rate is raised above its optimal non-cooperative level, the host country’s welfare surplus (and thus the incentive to compete for the foreign investment) declines (for a given value of  $s$ ):<sup>12</sup> On the one hand, its own domestic welfare falls short of the initial maximum level associated with an optimal emissions-tax choice in the Nash equilibrium.

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WTP for the FDI (see below). Hence, the generalized participation constraint is binding also in the IEA equilibrium:  $(1 - s_i^{IEA})\Pi_i = (1 - s_j^{IEA})\Pi_j (= k)$ . As a consequence,  $s$  can be eliminated from the aggregate-regional-welfare function analogously:  $W_{reg}^{IEA} = CS_i + CS_j + netrev_i + netrev_j + \underbrace{\Pi_i - k}_{s_i \Pi_i}$ .

Maximization with respect to  $\tau_i$  yields the same value for  $\tau_i^{IEA}$  as in the case of  $s_i = s_i^{opt} = 1$ . Hence:  $\tau_i^{IEA} = \tau_i^{opt}(s_i^{opt})$ .

<sup>12</sup>More specifically, this decline is composed of three potentially counteracting effects. The first is a decrease in the relative  $CS$ -surplus: The tax-induced output detraction causes a decline in  $CS$ , which is more pronounced in the host, than in the importing country (this is due to a larger initial  $CS$ -level in the host, as compared to the importing country). The second effect is a change in net environmental-

On the other hand, the importing country's welfare rises, since the IEA emissions-tax rate internalizes both intra-regional external effects (pollution- and *CS*-spillovers). The host country reacts to the decline in net FDI surplus by reducing the corporate-tax investment incentive offered to the MNE, and raises  $s$ .

### Welfare Effects

How does aggregate regional welfare in an IEA regime compare to welfare in a scenario without any cooperation? In other words: Does such an environmental-policy agreement, like the corporate-tax agreement, mitigate the adverse welfare effects of international policy competition? If so, how does the associated regional-welfare level compare to that associated with the social optimum? Proposition 7.3 provides the answer to these questions:

**Proposition 7.3:** *Aggregate regional welfare in the IEA equilibrium exceeds that in the Nash equilibrium with no cooperation, but falls short of the socially optimal level:*  

$$W_{reg}^N < W_{reg}^{IEA} < W_{reg}^{opt}$$

**Proof:** See Appendix C.7.  $\square$

An environmental-tax agreement, like international cooperation on corporate-tax policy, induces positive aggregate-welfare effects for the involved countries: Not only are environmental taxes raised to their socially optimal level, and thus intra-regional externalities internalized (*internalization effect*). In addition, “harmful” corporate-tax competition for FDI is indirectly weakened, as the equilibrium profit-tax rate rises compared to its non-cooperative level (*competition effect*). As a (unintended, but beneficial) consequence, a larger share of foreign profit is preserved for the region and adds to aggregate welfare. Accordingly, if cooperation on both policy instruments is not a feasible policy option, partial cooperation in terms of an IEA constitutes an appropriate step in direction of approaching the social optimum.

To summarize: An IEA “kills two birds with one stone” and raises aggregate regional welfare. Hence, also in terms of environmental policy, “some cooperation is better than no cooperation.”

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tax-revenue surplus, the direction of which is ambiguous: Whereas a higher tax rate c.p. raises gross environmental-tax revenue and reduces environmental damage (both implying a positive impact on net FDI surplus), the output detraction c.p. lowers the emissions-tax base (implying a negative impact on net FDI surplus). Third, foreign profit shrinks. As in the Nash equilibrium the profit-tax rate is negative, absolute subsidy-payments to the MNE decline. Regarded isolatedly, this effect implies a positive impact on net FDI surplus.

What about the individual-welfare effects of an IEA? Corollary 7.3a summarizes:

**Corollary 7.3a:** *Not only the region as a whole, but also both individual member countries gain from concluding an IEA:  $W_i^{FDI,IEA} > W_i^{FDI,N} \wedge W_j^{imp,IEA} > W_j^{imp,N}$ .*

**Proof:** See Appendix C.8.  $\square$

Both countries gain from partial cooperation in environmental policy. This finding is intuitive from the importing country’s perspective, since environmental- and *CS*-spillovers from its neighbor are now considered in the distortive policy-instrument. This internalization of externalities (expressed by a rise in the emissions-tax rate), however, is per se disadvantageous for the host country. On aggregate, however, its welfare loss due to “excessive” output taxation<sup>13</sup> is overcompensated by the welfare gain induced by the lower intensity of corporate-tax competition.

Consequently, as both countries are made better-off in terms of their individual welfare, also an IEA constitutes a feasible option of partial international policy-cooperation.<sup>14</sup>

### 7.3.3 Comparative Analysis of ITA and IEA

According to the preceding discussion, both international one-policy agreements are, in what concerns the aim of mitigating the adverse welfare effects of “harmful” FDI competition, appropriate instruments of intra-regional cooperation. What remains to be determined, is their *relative* performance in raising aggregate social welfare. In other words: Given the competitive and environmental conditions characterizing the region, which pattern of policy cooperation should the neighboring countries prefer: an environmental- or a corporate-tax agreement? In particular, the question is, whether an ITA or an IEA induces larger aggregate-welfare gains as compared to the completely non-cooperative Nash equilibrium.

Proposition 7.4 provides the answer:

**Proposition 7.4:** *For “moderate” levels of intra-regional pollution spillovers, aggregate regional welfare in the ITA equilibrium exceeds that in the IEA equilibrium:  $W_{reg}^{ITA} > W_{reg}^{IEA}$ .*

**Proof:** See Appendix C.9.  $\square$

What is the intuition behind Proposition 7.4? The ITA’s superiority to the IEA in aggregate-regional-welfare terms hinges on the environmental-externality parameter lying in an “intermediate”, intuitively plausible range. This range is determined by the two crucial assumptions underlying the whole paper:

<sup>13</sup>The term “excessive” is here interpreted from the host country’s perspective, in the sense that the tax exceeds its individual welfare-maximizing rate of  $\tau_i^N$ .

<sup>14</sup>Like the ITA, also the IEA must be binding for this conclusion to hold.

First, intra-regional pollution spillovers (represented by the level of  $\mu$ ) have to be *sufficiently large* to ensure that the socially optimal emissions-tax rate exceeds the non-cooperative Nash-equilibrium rate (i.e.  $\tau_i^{opt} > \tau_i^N$ ).<sup>15</sup> Accordingly, transboundary pollution has to be so severe that the negative environmental externality's impact on the importing country exceeds the positive *CS* externality's impact associated with the FDI. Consequently, their internalization implies the cooperative tax rate to exceed the non-cooperative rate.

Second, intra-regional pollution spillovers have to be *sufficiently small* to ensure a non-prohibitive level of the socially optimal emissions-tax rate (i.e.  $\tau_i^{opt} < \tau_i^{prohib}$ ).<sup>16</sup> According to this condition, for the region as a whole, hosting the MNE must be more attractive than any other option: Despite the pollution associated with the foreign firm's production, the region must benefit from the investment.<sup>17</sup>

Why is the relative performance of the alternative agreements driven by these assumptions? To answer this question, let's recapitulate the mechanisms that determine their respective aggregate-welfare impacts.

As explained in Section 7.3.1, the ITA-induced welfare gain solely originates in the competition effect, i.e. in the direct elimination of intra-regional FDI competition, and, consequently, the region's newly gained ability to appropriate the complete net FDI surplus.

The IEA-induced welfare gain, meanwhile, has two sources (see Section 7.3.2): The internalization of intra-regional externalities by means of a socially optimal emissions-tax rate on the one hand, and the induced indirect weakening of FDI competition, which in turn improves on the region's ability to appropriate foreign profit, on the other hand. Hence, both an internalization- and a competition effect are at work.

If environmental spillovers are "too large", the benefits of the internalization effect in an environmental agreement become so strong that they outweigh the competition effect the corporate-tax agreement's benefit builds on. Hence, in such scenario, the welfare gains attained by an IEA exceed those attained by an ITA.

If, on the contrary, environmental spillovers are "too small", the net FDI surplus for the host country is relatively small, and FDI competition relatively weak. The benefit

<sup>15</sup>This assumption was introduced and motivated in Section 7.2.2.

<sup>16</sup>This assumption was introduced and motivated in Section 7.2.1.

<sup>17</sup>In line with the previously discussed general interpretation of this paper's conclusions, also these two assumptions can be interpreted in a more general sense:

Assumption (1) implies the externality, which is crucial for the respective research question a model is applied to (here: the environmental externality) to be the most relevant. Additional intra-regional spillovers (here: the *CS* externality) may arise, but are dominated by that crucial intra-regional external effect. For FDI/MNE decision variables causing positive externalities (recapitulate the above-mentioned example of R&D-expenditures), assumption (1) would imply the socially optimal tax rate to be smaller than the respective non-cooperative rate.

Assumption (2) generally excludes parameter constellations that imply the region to prefer the foreign firm not to locate within its markets (NIMBY; see above). This assumption is not binding in model frameworks with positive externalities, and sensible in all frameworks dealing with negative externalities, if issues of FDI competition are analyzed.

from the competition effect of an ITA is thus of relatively minor relevance. Therefore, also in a scenario with weak environmental spillovers, an IEA can prove to be superior to an ITA in aggregate-welfare terms, a result that might appear surprising at first sight. Hence, only in a scenario with intermediate (and intuitively plausible) pollution-spillover levels the ITA-induced welfare gain from the competition effect exceeds the respective IEA-induced gain from a combination of competition- and internalization effect.

To summarize: Under plausible assumptions on the patterns of the environmental externality that characterize a region, countries should prefer an ITA to an IEA, if they intend to raise their aggregate social welfare by concluding a partial one-policy agreement.

This conclusion, however, is based on the premise that the region's aim is to raise social welfare on aggregate. This premise ignores that welfare generally consists of different elements, each of which might constitute a target of policy-making in itself. If governments specifically wish to focus on international pollution problems, of course the environmental, and not the corporate-tax agreement would be the suitable pattern of cooperation.

In a more general interpretation, the above conclusion reads as follows: If countries in a region intend to negotiate a partial one-policy agreement in order to improve on their aggregate welfare, they should concentrate on the non-distortive rather than the distortive policy instrument. Such cooperation pattern is superior due to the fact that the benefits from the *direct* elimination of FDI competition (which is initially exerted in terms of the lump-sum instrument only) exceed those attainable from the combination of an internalization benefit (via cooperating on the distortive instrument) and the *indirect* weakening of FDI competition: If the agreement targets the distortive instrument, FDI competition in the lump-sum instrument persists (though less severely). As a consequence, the complete net FDI surplus continues to be channeled to the foreign firm, instead of adding to regional social welfare. Consequently, the potential aggregate-welfare gain, though positive, falls short of the respective gain an agreement on the lump-sum instrument may generate.

## 7.4 Conclusions

In following a normative approach, this chapter complements the preceding positive analysis of the effects strategic FDI competition has on environmental-policy levels: If two countries simultaneously decide on two policy instruments in a non-cooperative manner, they will engage in downward tax competition in a non-distortive corporate tax, whereas a distortive environmental tax is left at its optimal non-strategic reference value.

The current chapter investigates the welfare implications of such international policy competition for FDI by comparing welfare in the resulting non-cooperative equilibrium to the maximum attainable level associated with the social optimum. As such com-

pletely cooperative outcome does not appear to constitute a feasible policy option in the “real world”, two alternative, and apparently more realistic, approaches to mitigate the adverse welfare effects of FDI competition are assessed: partial cooperation in corporate-tax- versus in environmental policy. In particular, the focus is on the question, how such agreements perform in improving on aggregate regional welfare.

The main results are: As compared to the social optimum, where countries cooperatively decide on both policy instruments with the aim of maximizing aggregate regional welfare, FDI competition in emissions- and corporate taxes induces a waste of regional resources and a decline in aggregate welfare. The introduction of an ITA (partial cooperation in corporate-tax policy) has no environmental consequences: Neither equilibrium policy choices, nor environmental quality are affected. The direct elimination of corporate-tax competition for FDI raises aggregate regional welfare compared to the completely non-cooperative setting. The socially optimal welfare level, however, is not attained. The introduction of an IEA (partial cooperation in environmental policy), by indirectly weakening “harmful” corporate-tax competition in addition to committing the member countries to socially optimal emissions-tax rates, also improves on regional welfare. Hence, for both patterns of partial policy-cooperation, this paper suggests that “some cooperation is better than no cooperation”. A comparison of both alternative agreements reveals that an ITA outperforms an IEA in aggregate-welfare terms.

This conclusion can also be read in a more general way: The positive welfare impact of an international agreement on the lump-sum policy instrument, which is initially applied in intra-regional FDI competition, exceeds the positive impact of a respective agreement on the distortive instrument, as the latter is not subject to policy competition in the initial non-cooperative situation anyway.

What can we conclude from these findings? Above all, comparing the welfare effects of the two alternative patterns of partial cooperation highlights the importance of taking interdependencies between different policy instruments into account in the process of policy making. If policy-makers anticipate the repercussions of a change in one policy instrument on another, they can consider (and possibly take advantage of) additional, indirect welfare effects of their policy choice. In particular, governments have to recognize the possibility that the international coordination of one policy instrument will affect their partner countries’ incentive patterns also in other policy areas.

Beyond the scope of this paper and relating to the analysis carried out in Part II of this dissertation, one could think of implications for an investigation of the countries’ national perspective: Governments face different political interests *within* their country when determining policies. If, for instance, policy-makers are aware of an IEA’s “double dividend”, and communicate this to interest groups which are originally opposed to the agreement, the domestic implementation of the IEA could be facilitated by much. Likewise, the awareness of the fact that environmental policy is not affected by international cooperation on corporate taxes, and, thus, no ITA-induced adverse environmental impacts have to be feared, could facilitate the implementation of such agreement by much.

Part IV

Conclusions



What are the common conclusions of the preceding analysis in Part II and III of this dissertation and which implications with respect to the issues of public debate illustrated in Part I do they yield? In particular, are the related concerns about the presumed adverse impacts of globalization justified?

The answer is “yes and no”. Part II comes to the conclusion that the introduction of stricter environmental regulations does not worsen (but even improve on) the international competitiveness of a domestic polluting sector, if the incumbent government aims at being re-elected and for that purpose takes into account different lobby groups’ interests when choosing environmental- and industrial policies. Hence, this paper’s findings suggest that the “international-competitiveness” concern is not justified.

The positive analysis in Part III, Chapter 6 yields an analogous conclusion with respect to the “environmental-RtB” concern: Neither international FDI competition in corporate- and environmental taxes nor continuing trade liberalization induce an erosion of environmental-policy levels.

The findings of the normative analysis in Chapter 7 are slightly less optimistic: They suggest that concerns on adverse aggregate-welfare effects of FDI competition are indeed justified. However, the paper also shows up appropriate and politically feasible ways to overcome the suboptimal non-cooperative policy regime: international cooperation in environmental- or corporate-tax policy-making. In particular, the finding that an international agreement on corporate taxes is suitable to raise the countries’ aggregate welfare provides theoretical validation to the G7 countries’ urgency to coordinate their tax policies referred to in the introduction.

Though the models applied in this dissertation focus on specific environmental- and industrial-policy instruments, the results are more general and carry over to numerous alternative policy scenarios.

In generalized terms, the main conclusion of Part II reads as follows: Interest groups that oppose the introduction of some policy measure because of its presumed adverse impact on their utility level should be aware that they can expect politicians to compensate them by adjusting another policy instrument. This compensation may even yield them a net benefit, if the government trades off the gains and losses of different interest groups in order to sustain maximum overall political support and so ensure its own re-election.

Very broadly speaking, the generalized conclusions of Part III are the following: Countries that face some domestic externality engage in international FDI competition in terms of a lump-sum policy instrument, while leaving a distortive policy instrument at its optimal “no-competition” level. Nevertheless, overall welfare in the non-cooperative policy regime is suboptimally low. However, even if the social optimum associated with international cooperation in both policy instruments is not feasible, countries may overcome such Prisoners’ Dilemma situation by concluding partial one-policy agreements. The associated positive welfare effects are larger if the agreement targets the non-distortive rather than the distortive policy instrument, i.e. the instrument which is subject to the initial FDI competition.

In summary, both parts of the dissertation yield a common general conclusion: Whenever interest groups, politicians or economists assess the consequences of economic developments (like e.g. globalization or trade integration) or newly implemented policy measures (like e.g. emissions restrictions), they should be aware of the political-economic system's complexity. A careful consideration of the various inherent interrelations, the repercussions of one policy measure on another and the associated indirect effects helps avoid drawing premature conclusions. This is particularly important, as those linkages may even induce outcomes (for instance in terms of policy choice or welfare) that oppose public expectations and economic-theory predictions neglecting the associated repercussions and indirect effects.

In analogy to these common general conclusions, also the policy implications derived from both parts of this dissertation relate to one another: Politicians intending to implement some policy measure like e.g. an international environmental agreement should not only take the above-mentioned policy interdependencies and their effects into account, but also communicate them to the public and to the diverse affected interest groups. Both papers have shown that the prevailing public expectations on, and perceptions of, the apparent consequences some policy measure or economic phenomenon might have are too pessimistic and thus provoke widespread (and unjustified) opposition. Hence, policy-making in general, and the introduction of actually beneficial measures in particular, could be facilitated by much, if decision-makers succeeded in explaining these repercussions and indirect effects not immediately obvious to their country's population and to the relevant interest groups.

Let me finish this discussion with one final remark concerning the theoretical modeling of economic issues in general. The purpose of my analysis has been to incorporate additional aspects, most importantly the interdependencies between different policy instruments, into the applied model frameworks and so improve on capturing "real-world" patterns of policy-making. Nevertheless, the introduced models remain highly simplified pictures of the "real" political-economic system. Policy interdependencies, political incentives and economic relations in the "real world" are much too complex to be completely reflected by one analytical model. The aim has thus been to focus on the most relevant features with respect to the research issue and neglect other aspects in order to keep the models tractable and to allow for deriving analytical results. As a consequence, those results have of course to be interpreted cautiously, keeping in mind the underlying simplifications.

To conclude, there remains much scope for future research. As already mentioned in the respective papers' conclusions, the current models neglect aspects like terms-of-trade effects, country asymmetry or firm heterogeneity. In order to take those clearly important characteristics of "real-world" policy-making conditions into account, one could either focus on each of them alternatively, or even try to introduce them in addition to aspects already considered in the current models.

# Appendix A

## Appendix to Part II

## A.1 Auctioning of Emissions Permits

### Percentage of emissions permits allocated via auctioning

Country	2005-07	2008-12
Austria	0	1.3
Belgium-Brussels	0	0
Belgium-Flanders	0	0
Belgium-Wallonia	0	0
Bulgaria	0	0
Czech Republic	0	0
Denmark	5	0
Estonia	0	0
Finland	0	0
France	0	0
Germany	0	9
Greece	0	0
Hungary	2.5	2
Ireland	0.75	0.5
Italy	0	0
Latvia	0	0
Lithuania	1.5	2.7
Luxembourg	0	0
Netherlands	0	3,7
Poland	0	0
Portugal	0	0
Romania	0	0
Slovakia	0	0
Slovenia	0	0
Spain	0	0
Sweden	0	0
UK	0	7

Source: [http://ec.europa.eu/environment/climat/emission/auctioning\\_en.htm](http://ec.europa.eu/environment/climat/emission/auctioning_en.htm)  
(latest access July, 2010)

The numbers are data provided by the member states themselves.

## A.2 Proof of Lemma 3.1

- **Sector I:** The subsidy obviously benefits the polluting industry, since  $s$  raises the remuneration of labor in that sector ( $L$ , according to eq. (2.5), is paid its marginal product). Labor is thus attracted to the subsidized sector ( $L_s^I > 0$ ) and production of good I rises. In addition, due to the small-country assumption, the producer price rises by exactly the amount of the subsidy increase:  $p_s^p = p_s^w + 1 = 1$ . Hence, the return to the specific factor unambiguously rises:

$$\Pi_s^I = \underbrace{p_s^p}_{=1} g(E) \underbrace{(F^I - F_L^I L^I)}_{>0} - \underbrace{p^p g(E) F_{LL}^I L_s^I L^I}_{<0} > 0. \quad (\text{A.1})$$

- **Sector II:** As total labor supply is fixed, the increase in  $L^I$  is accompanied by a proportional decrease in  $L^{II}$ . Production of the numeraire good declines and so does the return to its specific factor:

$$\Pi_s^{II} = -F_{LL}^{II} L_s^{II} L^{II} < 0 \quad \text{with} \quad L_s^{II} = -L_s^I < 0. \quad (\text{A.2})$$

- **Workers:** On the one hand, workers benefit from a positive “wage effect”: As the marginal product of labor increases, also the wage rate  $w$  will rise, though, due to the diminishing marginal product of labor, to a lower extent:<sup>1</sup>

$$w_s = F_{LL}^{II} L_s^{II} > 0. \quad (\text{A.3})$$

On the other hand, the amount each worker has to pay to finance the subsidy,  $\frac{sx^I}{L}$ , increases. The overall change in income is given by:

$$I_s = \underbrace{w_s}_{\text{“wage effect”} > 0} \underbrace{-\frac{x^I}{L}}_{\text{“subsidy effect”} < 0} \underbrace{-\frac{s}{L} x_s^I}_{\text{“scale effect”} < 0} < 0. \quad (\text{A.4})$$

Hence, there are two negative income effects opposing the positive wage effect: The “subsidy effect” arises because the subsidy level per unit of output is increased. The “scale effect” is owed to the rising production scale: For each additional unit of output an additional unit of the subsidy  $s$  has to be paid. Economic-plausibility considerations suggest that the two negative effects outweigh the positive wage effect: The opposite case would imply that workers were able to increase their total income by increasing their tax payments. Consequently, they would prefer

<sup>1</sup>This result also holds for the real wage: Due to the small-country assumption, the consumer price of the import good,  $p^w$ , is constant as well as the numeraire-price of one.

infinite taxation— an economically implausible scenario. Furthermore, industrial policy must yield a decrease in total income of the economy as a whole, as it causes welfare-reducing distortions (here, a distortion in production patterns). If  $I_s$  were positive, the decline in sector-II profits caused by an increase in the subsidy would have to outweigh the rise in both sector-I profits and workers' income in order to be consistent with a decline in total income. As the respective equations show, this is not plausible. Rather,  $|\Pi_s^I| > |\Pi_s^{II}|$  holds (see also the calculations in Appendix A.4). Hence:  $I_s < 0$ .

- **Environmental IG:** The utility of the environmental IG is solely determined by total emissions  $E$ . Those do not depend on output. When the subsidy is increased, the dirty industry raises output *given* a certain level of environmental use:  $D_s = 0$ . That is, output expansions are attained by solely increasing labor employment *without* affecting the level of pollution (within this model framework, this feature may be thought of as pollution depending on the operating time of a factory in hours per day: If more labor is employed, output *per hour* rises whereas operating time and thus pollution remain at their initial levels. Apart from the current model framework, output increases at constant emissions levels can also be attained e.g. by R&D, or by using more advanced and cleaner technology). To summarize, changes in the subsidy do neither affect emissions, nor environmental damage or the environmental IG's utility.<sup>2</sup>

### A.3 Proof of Lemma 3.2

- **Sector I:** Industry I obviously loses from environmental regulations. When total emissions are restricted, contrary to the case of an increase in  $s$ , production in sector I becomes less efficient. The lower wage rate detracts labor and production shrinks. Unlike in the industrial-policy case, however, the producer price is not affected by changes in  $\bar{E}$ :  $p_E^p = p_E^w = 0$ . Hence, although the volume of permitted emissions  $\bar{E}$  and the subsidy rate  $s$  impact on industry-I profits in the same direction, the quantitative effects of equivalent changes in both policy instruments may differ. Overall, the return to the specific factor in sector I unambiguously

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<sup>2</sup>One might annotate that an environmental lobby's utility should nevertheless depend negatively on the subsidy rate: Although industrial policy does not influence environmental damage, it constitutes a means of support for the polluting industry, which environmentalists should generally be opposed to. In addition, it is questionable whether they anticipate the independence of environmental damage from the subsidy. However, including  $s$  into the environmentalists' utility function does not alter the qualitative results of the analysis as long as the utility impact of industrial policy is not stronger than that of environmental policy. This condition is plausible to be fulfilled in the current model, since industrial policy has actually no impact on environmental damage.

declines when emissions are restricted:

$$\Pi_E^I = \underbrace{\left( \underbrace{p_E^p}_{=0} g(E) + p^p g_E \right)}_{>0} \underbrace{(F^I - F_L^I L^I)}_{>0} - \underbrace{p^p g(E) F_{LL}^I L_E^I L^I}_{<0} > 0. \quad (\text{A.5})$$

- **Sector II:** Sector II benefits from the introduction of  $\bar{E}$ :

$$\Pi_E^{II} = -F_{LL}^{II} L_E^{II} L^{II} < 0. \quad (\text{A.6})$$

- **Workers:** A decline in the total emissions allowance has the opposite effect on the wage rate than a rise in the subsidy:

$$w_E = F_{LL}^{II} L_E^{II} > 0. \quad (\text{A.7})$$

Analogously to a change in  $s$ , there is a positive “scale effect” in addition to this negative “wage effect”, since a decline in  $E$  lowers the polluting sector’s output that has to be subsidized. Unlike in the industrial-policy case, however, there is no “subsidy effect”, because the level of  $s$  is unchanged:

$$I_E = \underbrace{w_E}_{\text{“wage effect”} > 0} \underbrace{-\frac{s}{L} x_E^I}_{\text{“scale effect”} < 0} < 0. \quad (\text{A.8})$$

Analogously to the industrial-policy scenario (see Appendix A.2), the subsequent analysis focuses on the case  $I_E < 0$ . This is straightforward because it implies that, as for the two specific factors, both policy instruments affect also a worker’s total income in the same direction.<sup>3</sup>

- **Environmental IG:** Environmental restrictions obviously reduce environmental damage:  $D_E > 0$ . Hence, the environmental IG’s utility unambiguously rises.

## A.4 The Specific Case of a Cobb-Douglas Production Function

The following calculations apply the general expressions derived in this paper to a specific Cobb-Douglas production function and a simple specification of a political-support-function.

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<sup>3</sup>However, both a positive and a negative sign of  $I_E$  may be consistent with economy-wide income to decline due to the inefficiencies associated with the policy intervention. For  $I_E > 0$ , the analytical results concerning the direction of the industrial-policy adjustment (see Section 3.1) are unaffected. Results concerning the “completeness” of industry compensation (see Section 3.2) then depend on the relative size of marginal environmental damage as compared to the marginal income-effects of environmental- and industrial policy.

The production function in each sector is given by:

$$F(\overline{K}^i, L^i) = (\overline{K}^i)^\alpha (L^i)^{1-\alpha} \quad \text{with} \quad \alpha = \frac{1}{2}, \quad i = I, II. \quad (\text{A.9})$$

A political support function with the properties discussed in Section 2.4 is given by:

$$G(\Pi^I, \Pi^{II}, I, D) = \gamma_1(\Pi^I)^{\frac{1}{2}} + \gamma_2(\Pi^{II})^{\frac{1}{2}} + \gamma_3(I)^{\frac{1}{2}} - \gamma_4(D)^{\frac{3}{2}}, \quad (\text{A.10})$$

where  $\gamma_i$ ,  $i = 1, \dots, 4$  are the different interest groups' political weights.

- **Specific expressions for sector I:**

Profits in the polluting industry are:

$$\Pi^I = \frac{(p^p)^2 g(E)^2}{4w} K^I. \quad (\text{A.11})$$

In analogy to the general expressions derived in Appendices A.2 and A.3, derivatives of the specific profit function with respect to  $s$  and  $E$  are unambiguously positive:

$$\Pi_s^I = \frac{p^p g(E)^2}{2w} K^I > 0. \quad (\text{A.12})$$

$$\Pi_E^I = \frac{(p^p)^2 g(E)}{2w} g_E K^I > 0. \quad (\text{A.13})$$

The second derivative with respect to  $s$  is ambiguous in general:

$$\Pi_{ss}^I = -2g(E)F_{LL}^I L_s^I L^I - p^p g(E)(L_s^I)^2 (F_{LLL}^I L^I + F_{LL}^I) - p^p g(E)F_{LL}^I L_{ss}^I L^I \gtrless 0 \quad (\text{A.14})$$

For our specific production function, this expression indicates rising marginal profits:

$$\Pi_{ss}^I = \frac{g(E)^2}{2w} K^I > 0. \quad (\text{A.15})$$

The same holds for the second derivative with respect to  $E$ :

$$\begin{aligned} \Pi_{sE}^I &= g_E (F^I - F_L^I L^I) - g(E) F_{LL}^I L_E^I L^I \\ &\quad - p^p g_E F_{LL}^I L_s^I L^I - p^p g(E) L_E^I L_s^I (F_{LLL}^I L^I + F_{LL}^I) \\ &\quad - p^p g(E) F_{LL}^I L_s^I L_E^I L^I \gtrless 0. \end{aligned} \quad (\text{A.16})$$



For our example, this expression becomes:

$$\Pi_{sE}^I = \frac{p^p g(E)}{w} g_E K^I > 0. \quad (\text{A.17})$$

In consistence with the general analysis in Section 2.4, marginal political support from industry I is positive and decreasing:

$$G_{\Pi_I} = \frac{1}{2} \gamma_1 (\Pi^I)^{-\frac{1}{2}} > 0; \quad G_{\Pi_I \Pi_I} = -\frac{1}{4} \gamma_1 (\Pi^I)^{-\frac{3}{2}} < 0. \quad (\text{A.18})$$

• **Specific expressions for sector II:**

Profits in the clean industry are:

$$\Pi^{II} = \frac{1}{4w} K^{II}. \quad (\text{A.19})$$

In analogy to the general expressions derived in Appendices A.2 and A.3, derivatives of the specific profit function with respect to  $s$  and  $E$  are unambiguously negative:

$$\Pi_s^{II} = -\frac{p^p g(E)^2}{4w} K^I < 0. \quad (\text{A.20})$$

$$\Pi_E^{II} = -\frac{(p^p)^2 g(E)}{4w} g_E K^I < 0. \quad (\text{A.21})$$

The second derivative with respect to  $s$  is, similar to sector-I profits, ambiguous in general:

$$\Pi_{ss}^{II} = -[(L_s^{II})^2 (F_{LLL}^{II} L^{II} + F_{LL}^{II}) + F_{LL}^{II} L_{ss}^{II} L^{II}] \gtrless 0 \quad (\text{A.22})$$

Contrary to sector I, this expression is negative for our specific production function:

$$\Pi_{ss}^{II} = -\frac{g(E)^2}{4w} K^I < 0. \quad (\text{A.23})$$

The same holds for the second derivative with respect to  $E$ :

$$\Pi_{sE}^{II} = -[L_s^{II} L_E^{II} (F_{LLL}^{II} L^{II} + F_{LL}^{II}) + F_{LL}^{II} L_{sE}^{II} L^{II}] \gtrless 0. \quad (\text{A.24})$$

For our example, this expression becomes:

$$\Pi_{sE}^{II} = -\frac{p^p g(E)}{2w} g_E K^I < 0. \quad (\text{A.25})$$

As for sector I, political support from sector II is increasing in profit at decreasing rates:

$$G_{\Pi_{II}} = \frac{1}{2} \gamma_2 (\Pi^{II})^{-\frac{1}{2}} > 0; \quad G_{\Pi_{II} \Pi_{II}} = -\frac{1}{4} \gamma_2 (\Pi^{II})^{-\frac{3}{2}} < 0. \quad (\text{A.26})$$

- **Specific expressions for workers:**

A worker's total income equals wage minus subsidy payments:

$$I = w - \frac{sp^p g(E)^2 K^I}{2w \bar{L}}. \quad (\text{A.27})$$

The three effects determining the derivative with respect to  $s$  are subsumed in the following term:

$$I_s = p^p g(E)^2 w \frac{K^I}{K^{II}} - \frac{p^w g(E)^2 K^I}{2w \bar{L}}. \quad (\text{A.28})$$

The two effects determining the derivative with respect to  $E$  are subsumed in the following term:

$$I_E = (p^p)^2 g(E) w g_E \frac{K^I}{K^{II}} - \frac{sp^p g(E)}{w} g_E \frac{K^I}{\bar{L}}. \quad (\text{A.29})$$

The second derivative with respect to  $s$  is ambiguous in general as well as for our specific function:

$$I_{ss} = w_{ss} - \frac{2}{\bar{L}} x_s^I - \frac{s}{\bar{L}} x_{ss}^I = g(E)^2 w \frac{K^I}{K^{II}} - \frac{g(E)^2 K^I}{w \bar{L}} \geq 0. \quad (\text{A.30})$$

$I_{ss} < 0$  holds for  $w < \frac{\sqrt{K^{II}}}{\sqrt{\bar{L}}}$ .

Also the second derivative with respect to  $E$  has an ambiguous sign in general as well as for the specific production function:

$$I_{sE} = w_{sE} - \frac{x_E^I}{\bar{L}} - \frac{s}{\bar{L}} x_{sE}^I = 2p^p g(E) g_E w \frac{K^I}{K^{II}} - \frac{p^w g(E)}{w} g_E \frac{K^I}{\bar{L}} \geq 0. \quad (\text{A.31})$$

$I_{sE} < 0$  requires  $\frac{2p^p w^2}{p^w} < \frac{\sqrt{K^{II}}}{\sqrt{\bar{L}}}$ .

Political-support patterns are characterized by:

$$G_I = \frac{1}{2} \gamma_3 I^{-\frac{1}{2}} > 0; \quad G_{II} = -\frac{1}{4} \gamma_4 I^{-\frac{3}{2}} < 0. \quad (\text{A.32})$$

- **Policy outcomes for the specific functional forms:**

What do the preceding calculations imply for the general results derived in Section 3.1 with respect to the direction of an industrial-policy adjustment to stricter environmental regulations? More specifically, what are the signs of  $G_{ss}$  (eq. (3.3)) and  $G_{sE}$  (eq. (3.4))?

Concerning  $G_{ss}$ , terms 1, 3 and 5 are always negative due to the properties of the political support function (see the discussion in Section 3.1).

Term 2 remains ambiguous even if our specific functional forms are used:  $G_I I_{ss} < 0$  for  $w < \frac{\sqrt{K^{II}}}{\sqrt{\bar{L}}}$ .

Term 4 turned out to be positive for our specific function:  $G_{\Pi I} \Pi_{ss}^I > 0$ .

Term 6 is negative here:  $G_{\Pi II} \Pi_{ss}^{II} < 0$ .

Comparing the two elements of  $G_{ss}$  that represent industry I (terms 3 and 4) shows that they are equal in absolute values. Hence, the only unambiguously positive term in  $G_{ss}$  completely cancels out. What remains, are three definitively negative terms and one which is negative under a certain condition. This additional assumption of  $w$  and  $\bar{L}$  being sufficiently small relative to  $K^{II}$ , however, is not necessary for the whole expression  $G_{ss}$  to be negative.

These conclusions carry over to  $G_{sE}$ : Also there, terms 3 and 4 cancel out.  $w$  and  $\bar{L}$  being sufficiently small relative to  $K^{II}$  is a sufficient but not necessary condition also for  $G_{sE} < 0$  to be ensured.

To conclude, the calculations in this Appendix have demonstrated that standard functional forms of the production- and political-support function are consistent with the general results derived in the paper.

## A.5 Proof of Proposition 3.2

$G_{sE} < 0$  implies that marginal political support  $G_s$  increases when  $\bar{E}$  is introduced (i.e.  $E$  reduced). Due to the support function's concavity, increased marginal support in turn implies a decrease in absolute support:  $dE < 0 \Rightarrow dG_s > 0 \leftrightarrow dG < 0$ . Thus, restrictive environmental policies  $\bar{E}$  lead to an overall decline in political support, aggregated over all groups: Losses in support from sector I exceed the sum of gains in support from sector II, workers and the environmental IG:

$$\begin{aligned}
 G_{\bar{E}} &= \underbrace{G_I I_{\bar{E}}}_{>0} + \underbrace{G_{\Pi I} \Pi_{\bar{E}}^I}_{<0} + \underbrace{G_{\Pi II} \Pi_{\bar{E}}^{II}}_{>0} + \underbrace{G_D D_{\bar{E}}}_{>0} < 0 \\
 \Rightarrow \quad |G_{\Pi I} \Pi_{\bar{E}}^I| &> |G_I I_{\bar{E}} + G_{\Pi II} \Pi_{\bar{E}}^{II} + G_D D_{\bar{E}}|. \tag{A.33}
 \end{aligned}$$

After an increase in  $G_s$ , however, the first-order condition for maximum political support ( $G_s = 0$ ) is violated. In order to re-establish the initial level of maximum political support, the government reacts by increasing  $s$ . Due to  $G_{ss} < 0$ , this induces a decline in  $G_s$ , or, equivalently, a rise in  $G$ :  $ds > 0 \Rightarrow dG_s < 0 \leftrightarrow dG > 0$ . Specifically, increased subsidization of industry I causes support from sector I to rise and support from sector

II and workers to decline, whereas support from the environmental group is unaffected:

$$\begin{aligned}
 G_s &= \underbrace{G_I I_s}_{<0} + \underbrace{G_{\Pi I} \Pi_s^I}_{>0} + \underbrace{G_{\Pi II} \Pi_s^{II}}_{<0} + \underbrace{G_D D_s}_{=0} > 0 \\
 \Rightarrow |G_{\Pi I} \Pi_s^I| &> |G_I I_s + G_{\Pi II} \Pi_s^{II} + 0|. \tag{A.34}
 \end{aligned}$$

Comparing the respective equations shows that for the industrial-policy case, the increase in political support from sector I (inducing the intended reduction in  $G_s$ ) has to compensate for only two countervailing effects (i.e. decreased support from sector II and workers inducing “undesirable” increases in  $G_s$ ) for eq. (A.34) to hold. When environmental policy is applied (eq. (A.33)), three countervailing effects have to be outweighed because the environmental interest and its political support are affected in addition. Hence, the difference between the LHS and the RHS will be larger for the lower part of eq. (A.34) than for eq. (A.33) for proportional policy changes.

Consequently, in order to attain a rise in political support  $G$  (respectively, a decline in marginal support  $G_s$ ), which exactly cancels out the initial decline in  $G$  (rise in  $G_s$ ) and hence retain the optimum  $G_s = 0$ , the subsidy has to be raised *more* than proportionally to the initial decrease in  $E$ , that is, by more than necessary to retain the initial income-distribution.

This result is attributable to the properties of the political-support function: In order to “close the gap” between the LHS-/RHS-differentials of eqs. (A.34) and (A.33) which arises due to the missing environmental-IG effect in eq. (A.34), the LHS of eq. (A.34) has to “decline” relative to its RHS. Industry I gains from the increased subsidy and thus raises support, but at a *declining rate*. Hence, the term  $|G_{\Pi I} \Pi_s^I|$  is the smaller, the larger the increase in  $s$ . On the other hand, industry II and workers lose from the increased subsidy and thus raise their opposition, but at an *increasing rate*, so that the term  $|G_I I_s + G_{\Pi II} \Pi_s^{II}|$  is the larger, the higher the increase in  $s$ . Taken together, both effects imply that only an adjustment of  $s$  which is *more than proportional* can retrieve the initial level of political support.<sup>4</sup>

## A.6 The Slope of the Iso-Distribution Curve

The iso-distribution curve’s slope is characterized by two equations: It is, on the one hand, given by  $\frac{ds}{dE} \Big|_{\frac{dw}{dE}=0}$ . That is, equal income distribution is given where wages and thus labor allocation and profits are constant. When  $E$  is decreased from  $E_0$  to  $\bar{E}$ ,

---

<sup>4</sup>Note that the increase in the subsidy cannot be arbitrarily large as it has to be financed by workers. At some threshold value of  $s$ , their labor income will be completely “eaten up” by the lump-sum subsidy they have to pay for, yielding a total income of zero. From this point on, further subsidy increases are no longer feasible. The analysis in this paper thus implicitly assumes  $s$  to be sufficiently small for not reaching its upper bound.

labor productivity and wages decline. In order to retain the initial level of  $w$ ,  $s$  has to be raised from  $s_0$  to  $s_1$  in turn.

This “direct” productivity effect is weakened by an opposing “indirect” one. This is due to the fact that the decrease in productivity detracts labor from the affected sector, thus making the remaining labor more productive. In order to keep  $w$  constant,  $s$  has to be decreased (according to this isolated indirect effect).

Formally:

$$\frac{ds}{dE} = \underbrace{-\frac{(p^w + s)g_E}{g(E)}}_{\text{direct effect } <0} - \underbrace{\frac{(p^w + s)F_{LL}^I L_E^I}{F_L^I}}_{\text{indirect effect } >0} < 0. \quad (\text{A.35})$$

On the other hand,  $\frac{dI}{dE}|_{\frac{dw}{dE}=0} = 0$  has to hold in order to maintain an equal income-distribution, since workers not only receive wage income but also have to finance the subsidy ( $I = w - \frac{sx^I}{L}$ ). On the iso-distribution locus, the introduction of  $\bar{E}$  reduces the output of the polluting good for constant labor allocation. This leads to a decline in total subsidy payments  $S$ . An appropriate increase in the subsidy rate  $s$  then serves to exactly offset the initial rise in total income:

$$\begin{aligned} \frac{dI}{dE} &\stackrel{!}{=} 0 \\ \Rightarrow \underbrace{\frac{dw}{dE}}_{=0} - \frac{x^I}{L} \frac{ds}{dE} &= -\frac{s}{L} \underbrace{\frac{dx^I}{dE}}_{=g_E F^I(L^I, \bar{K}^I)} \\ \Rightarrow \frac{ds}{dE} &= -g_E F^I(L^I, \bar{K}^I) \frac{s}{x^I} \\ \Rightarrow \frac{ds}{dE} &= -\frac{g_E s}{g(E)} < 0. \end{aligned} \quad (\text{A.36})$$

## A.7 Proof of Proposition 3.3

The following line of argument is based on the proof of Proposition 3.2 in Appendix A.5.

- **The impact of environmental factors on the extent of industry compensation:**

According to the reasoning in Appendix A.5, marginal environmental damage  $D_E$  is an important determinant of industry-I compensation, since it is responsible for the environmental IG's change in political support  $G_D D_E$ . This in turn is crucial for the difference in the levels of the "countervailing effects" the change in support from sector I has to outweigh to fulfill eq. (A.34) compared to eq. (A.33). As argued in Appendix A.5, the extent of excess compensation is positively related to this differential (the "gap"). Hence, the larger is  $D_E$ , the more environmental damage is reduced by the introduction of  $\bar{E}$ , the more the environmental IG raises its political support, and the larger is the industrial-policy adjustment necessary to re-establish the political optimum.

This line of argument carries over to the political weight of the environmental interest, as this, via  $G_D$ , constitutes the second determinant of the environmental IG's change in political support  $G_D D_E$ .

- **The impact of industry II and workers:**

Both the increase in support (or, equivalently, decrease in marginal support) from industry II and workers after the introduction of  $\bar{E}$  and the respective decrease in support (or increase in marginal support) after the increase in  $s$  will be stronger for higher political weights of these groups (see eqs. (A.33) and (A.34)). However, the reinforcement of the industrial-policy effect outweighs the preceding reinforcement of the environmental-policy effect (and does so by more, the larger these groups' political weights are) for two reasons following from the properties of the political support function: First, environmental-policy effects are weaker than the respective industrial-policy effects because they originate from a higher level of overall political support (corresponding to a lower level of marginal support). Second, also due to concavity, declines in support outweigh rises in support. Hence, the necessity of increasing  $s$  more than proportionally in order to induce a net reduction of political support from the income-receiving groups and so re-establish the political optimum weakens as the political weights of the clean industry and workers increase.

- **The impact of the polluting industry's own political weight:**

Results are not as clear-cut for the political weight of the environmental-policy loser, respectively the industrial-policy winner (industry I): If this group is attached a higher weight, also both environmental- and industrial-policy effects

become stronger- the former effect inducing a more pronounced rise in marginal political support, the latter a more pronounced decrease in marginal support. Following the line of argument applied for industry II and workers, it is ambiguous here, which effect is stronger, as environmental policy induces a decline, and industrial policy a rise in support. Hence, the influence of the polluting sector's own political weight on the extent of compensation depends on which effect dominates. This rather paradoxical result can be explained by the fact that both the negative impact of environmental policy on total political support (c.p. weakening the necessity of increasing  $s$ ) and the respective positive impact of a subsidy (c.p. strengthening the necessity of increasing  $s$ ) increase in the political weight of the affected group.

# Appendix B

## Appendix to Part III, Chapter 6

### B.1 Proof of Proposition 6.3

The proof proceeds in a stepwise manner, as the results stated in Proposition 6.3 build on the premise of a binding participation constraint in the non-cooperative equilibrium. A first step thus shows this condition to be fulfilled.

- (1) As in the non-cooperative policy equilibrium, both countries offer a profit-tax rate  $s_i^{min}$  which corresponds to their maximum WTP for the FDI to the MNE, the participation constraint is binding in both countries. To prove this by contradiction involves to consider the two alternative outcomes, in which the participation constraint would *not* be fulfilled with equality:

Suppose  $s_j^N = s_j^{min} = s_i^{min}$ ,  $k = (1 - s_j^N)\Pi_j$  and

- (i)  $(1 - s_i)\Pi_i > k$ . Such an outcome would imply country  $i$ 's profit-tax rate to fall short of its maximum-WTP equivalent  $s_i^{min}$ . FDI would be attracted, but yield a negative net FDI surplus for country  $i$ , since, by definition,  $s_i^{min}$  corresponds to a net surplus of zero. On the other hand, the MNE's net profit exceeds its outside option. Hence, there is a potential to raise the tax rate until the participation constraint is exactly met at  $s_i = s_i^{min} = s_j^N$ , so that net FDI surplus becomes non-negative for country  $i$  and the investment is just sustained.
- (ii)  $(1 - s_i)\Pi_i < k$ . Such an outcome in turn implies country  $i$ 's tax rate to exceed its minimum necessary value and, in addition, yield a potential positive net FDI surplus. The MNE, however, would locate in the neighboring country  $j$ . Hence, there is an incentive for  $i$  to lower its tax rate at least until the participation constraint is exactly met at  $s_i = s_i^{min} = s_j^N$  and the FDI attracted to the domestic market.



Consequently, the only stable equilibrium yields profit-tax rates corresponding to both countries' maximum WTP for the FDI. Due to the countries' symmetry, those tax rates are identical:  $s_j^N = s_i^N = s_i^{min}$ . The same holds for the MNE's gross profit:  $\Pi_i = \Pi_j$ .

Hence:  $(1 - s_i^N)\Pi_i = (1 - s_j^N)\Pi_j$ , i.e. the generalized participation constraint is fulfilled with equality (binding).

According to Proposition 6.2, this first part of the proof implies, that in the non-cooperative equilibrium, environmental-policy levels are independent of corporate-tax policies (and thus independent of the FDI competition's intensity). This result allows to use the environmental-tax rate's non-strategic value  $\bar{\tau}_i^*$  in the second step of this proof concerning the equilibrium corporate-tax-rate levels.

- (2) For a given value of  $\bar{\tau}_i^*$ , the corresponding optimal profit-tax rate  $s_i^N(\bar{\tau}_i^*)$  can be easily calculated by equating welfare levels of the FDI host- and the importing country and solving for  $s$ :

$$\begin{aligned}
 W_i^{FDI}(\bar{\tau}_i^*, s_i) &\stackrel{!}{=} W_j^{imp}(\bar{\tau}_i^*, s_i) \\
 \Rightarrow \frac{(1 - c - \bar{\tau}_i^*)^2}{8} + (\bar{\tau}_i^* - \delta)(1 - c - \bar{\tau}_i^* - \frac{t}{2}) + s_i \frac{(1 - c - \bar{\tau}_i^*)^2 + (1 - c - \bar{\tau}_i^* - t)^2}{4} \\
 &= \frac{(1 - c - \bar{\tau}_i^* - t)^2}{8} - \mu(1 - c - \bar{\tau}_i^* - \frac{t}{2}) \\
 &\Rightarrow s_i^N(\bar{\tau}_i^*) = \\
 &\left( \underbrace{-\frac{(1 - c - \bar{\tau}_i^*)^2 - (1 - c - \bar{\tau}_i^* - t)^2}{8}}_{\text{surplus in CS}} - \underbrace{(\bar{\tau}_i^* - \delta + \mu)(1 - c - \bar{\tau}_i^* - \frac{t}{2})}_{\text{surplus/loss in net rev}} \right) \underbrace{\frac{4}{(1 - c - \bar{\tau}_i^*)^2 + (1 - c - \bar{\tau}_i^* - t)^2}}_{\Pi_i^{-1}} \\
 \Rightarrow s_i^N(\bar{\tau}_i^*) &= \frac{16(1 - c - \delta - \frac{3}{8}t)(1 - c - \delta - \frac{3}{4}t - 3\mu)}{(32c^2 + 12ct + 9t^2) + 32(1 - \delta)(1 - c - \delta - \frac{3}{4}t)}. \quad (\text{B.1})
 \end{aligned}$$

Rather than analyzing the specific and rather complex value of  $s_i^N (=s_i^{min})$  as given by eq. (B.1), the remaining steps of this proof will focus on deriving the general characteristics of the optimal tax rate:

- (3) An equilibrium profit-tax rate below unity  $s_i^N = s_i^{min} < 1$  implies a country's welfare with FDI and complete foreign-profit extraction (i.e.  $s_i = 1$ ) to exceed

the importing country's welfare (a regime that corresponds to the no-competition benchmark scenario):

$$\begin{aligned}
& W_i^{FDI}(\bar{\tau}_i^*, s_i = 1) > W_j^{imp}(\bar{\tau}_i^*, s_i = 1) \quad (\text{B.2}) \\
\Rightarrow & \frac{(1 - c - \bar{\tau}_i^*)^2}{8} + (\bar{\tau}_i^* - \delta)(1 - c - \bar{\tau}_i^* - \frac{t}{2}) + \frac{(1 - c - \bar{\tau}_i^*)^2 + (1 - c - \bar{\tau}_i^* - t)^2}{4} \\
& > \frac{(1 - c - \bar{\tau}_i^* - t)^2}{8} - \mu(1 - c - \bar{\tau}_i^* - \frac{t}{2}).
\end{aligned}$$

Plugging in  $\bar{\tau}_i^* = -\frac{1}{3}(1 - c) + \frac{4}{3}\delta$  shows that the inequality (B.2) holds for  $\bar{\tau}_i^*$  non-prohibitive.

- (4) The threshold value for  $\mu$  at which the optimal profit-tax rate turns from a “real” tax into a subsidy, implying that the net FDI surplus for the host country in the absence of any profit-tax revenue equals zero, can be calculated by setting eq. (B.1) equal to zero and solving for  $\mu$ :<sup>1</sup>

$$\begin{aligned}
& s_i^N \stackrel{!}{=} 0 \\
\Rightarrow & \frac{(1 - c - \bar{\tau}_i^* - t)^2 - (1 - c - \bar{\tau}_i^*)^2}{8} = (\bar{\tau}_i^* - \delta + \mu)(1 - c - \bar{\tau}_i^* - \frac{t}{2}). \quad (\text{B.3})
\end{aligned}$$

Plugging in  $\bar{\tau}_i^* = -\frac{1}{3}(1 - c) + \frac{4}{3}\delta$  and re-arranging yields:  $\tilde{\mu} = \frac{1}{3}(1 - c - \delta - \frac{3t}{4})$ .  $\square$

## B.2 Proof of Proposition 6.4

- An increase in  $\delta$  raises country  $i$ 's optimal non-strategic emissions-tax rate  $\tau_i^*$  – a reaction, which aims at correcting for the (aggravated) pollution distortion caused by the MNE's investment:  $\frac{\partial \tau_i^*}{\partial \delta} = \frac{4}{3} > 0$ . As a consequence, the MNE's profit attainable in country  $i$  will decrease:

$$\frac{\partial \Pi_i}{\partial \tau_i^*} = -\frac{(1 - c - \tau_i^*)}{2} - \frac{(1 - c - \tau_i^* - t)}{2} < 0. \quad (\text{B.4})$$

Given country  $j$ 's Nash-equilibrium policy  $(\bar{\tau}_j^*; s_j^N)$ , this detraction in gross profit induces a situation, in which the participation constraint is no longer fulfilled in country  $i$ :  $(1 - s_i^N)\Pi_i < (1 - s_j^N)\Pi_j$ . In order to sustain the investment, country  $i$

<sup>1</sup>The following reasoning uses the fact that  $\Pi_i^{-1} > 0$ .

must therefore lower its profit-tax rate to a level  $s_i' < s_i^N$ , which just ensures the participation constraint to hold with equality again. Hence:  $\frac{\partial s_i^N}{\partial \delta} < 0$ .<sup>2</sup>

- The result that in the no-pollution scenario, the equilibrium profit-tax rate is unambiguously positive (i.e.  $s_i^N(\bar{\tau}_i^*, \delta = \mu = 0) > 0$ ), becomes obvious by plugging in  $\delta = \mu = 0$  in eq. (B.1):

$$s_i^*(\bar{\tau}_i^*, \delta = \mu = 0) = \frac{16(1-c-\frac{3}{8}t)(1-c-\frac{3}{4}t)}{(32c^2+12ct+9t^2)+32(1-c-\frac{3}{4}t)} > 0. \quad (\text{B.5})$$

- A no-pollution equilibrium profit-tax rate below unity  $s_i^N(\bar{\tau}_i^*, \delta = \mu = 0) < 1$  implies welfare with FDI and complete foreign-profit extraction (i.e.  $s_i = 1$ ) to exceed the importing country's welfare:

$$W_i^{FDI}(\bar{\tau}_i^*, s_i = 1) > W_j^{imp}(\bar{\tau}_i^*, s_i = 1) \quad (\text{B.6})$$

$$\Rightarrow \frac{(1-c-\bar{\tau}_i^*)^2}{8} + \bar{\tau}_i^*(1-c-\bar{\tau}_i^*-\frac{t}{2}) + \frac{(1-c-\bar{\tau}_i^*)^2}{4} + \frac{(1-c-\bar{\tau}_i^*-t)^2}{4} > \frac{(1-c-t-\bar{\tau}_i^*)^2}{8}.$$

Plugging in  $\bar{\tau}_i^*(\delta = 0) = -\frac{1}{3}(1-c)$  shows that the inequality (B.6) holds for any value of  $t$ . Hence,  $s_i^N(\bar{\tau}_i^*, \delta = \mu = 0) < 1$ .  $\square$

### B.3 Proof of Proposition 6.5

- The optimal profit-tax rate  $s_i^N$  is given by eq. (B.1). Differentiation with respect to  $\mu$  yields:  $\frac{\partial s_i^N}{\partial \mu} = -(1-c-\bar{\tau}_i^*-\frac{t}{2}) < 0$ . This follows from the term in brackets representing total MNE output, which is positive under the assumption of non-prohibitive  $\bar{\tau}_i^*$ -values.
- For the local-pollution scenario, a positive equilibrium profit-tax rate  $s_i^N(\bar{\tau}_i^*, 0 = \mu \leq \delta) > 0$  immediately follows from Proposition 6.3:  $0 = \mu < \tilde{\mu} = \frac{1}{3}(1-c-\delta-\frac{3t}{4}) \Leftrightarrow s_i^N > 0$ .<sup>3</sup>
- In analogy to the proof of Proposition 6.3 for the general pollution-scenario, also a local-pollution equilibrium profit-tax rate below unity  $s_i^N(\bar{\tau}_i^*, 0 = \mu \leq \delta) < 1$

<sup>2</sup>The negative relationship between  $s_i^N$  and  $\delta$  can also be mathematically established unambiguously. The specific term of the derivative is  $\frac{\partial s_i^N}{\partial \delta} = -\frac{6(-9t^3+256(-1+c+\delta)^2\mu+32t(-1+c+\delta)(-1+c+\delta+6\mu))}{(32c^2+9t^2+24t(-1+\delta)+32(-1+\delta)^2+8c(-8+3t+8\delta))^2} < 0$ .

<sup>3</sup>Alternatively, plugging in  $\mu = 0$  in eq. (B.1) yields a term which, under the non-prohibitiveness assumption with respect to  $\bar{\tau}_i^*$ , is unambiguously positive:  $s_i^N(\bar{\tau}_i^*, 0 = \mu < \delta) = \frac{16(1-c-\delta-\frac{3}{8}t)(1-c-\delta-\frac{3}{4}t)}{(32c^2+12ct+9t^2)+32(1-\delta)(1-c-\delta-\frac{3}{4}t)} > 0$ .

implies welfare with FDI and complete foreign-profit extraction (i.e.  $s_i = 1$ ) to exceed the importing country's welfare:

$$W_i^{FDI}(\bar{\tau}_i^*, s_i = 1, 0 = \mu \leq \delta) > W_j^{imp}(\bar{\tau}_i^*, s_i = 1, 0 = \mu \leq \delta) \quad (\text{B.7})$$

$$\Rightarrow \frac{(1-c-\bar{\tau}_i^*)^2}{8} + (\bar{\tau}_i^* - \delta)(1-c-\bar{\tau}_i^* - \frac{t}{2}) + \frac{(1-c-\bar{\tau}_i^*)^2 + (1-c-\bar{\tau}_i^* - t)^2}{4} > \frac{(1-c-\bar{\tau}_i^* - t)^2}{8}.$$

Plugging in  $\bar{\tau}_i^* = -\frac{1}{3}(1-c) + \frac{4}{3}\delta$  shows that the inequality (B.7) holds for  $\bar{\tau}_i^*$  non-prohibitive. Hence,  $s_i^N(\bar{\tau}_i^*, 0 = \mu \leq \delta) < 1$ .  $\square$

## B.4 Proof of Proposition 6.6

- A decline in intra-regional trade costs  $t$  raises the MNE's gross profit in the host country  $i$  by making exports to the neighboring country  $j$  more profitable:

$$\frac{\partial \Pi_i}{\partial t} = -\frac{(1-c-\bar{\tau}_i^* - t)}{2} < 0. \quad (\text{B.8})$$

Given the importing country  $j$ 's equilibrium policy pair  $(\bar{\tau}_j^*; \bar{s}_j^N)$ , the MNE's participation constraint is no longer fulfilled:  $(1-s_i^N)\Pi_i > (1-s_j^N)\Pi_j$ . Country  $i$ 's best response to country  $j$ 's policy therefore is to increase its profit-tax rate to a level of  $s_i' > s_i^N$ , which just ensures the participation constraint to hold with equality again. Hence:  $\frac{\partial s_i^N}{\partial t} < 0$ .<sup>4</sup>

- The specific value of the profit-tax rate under free trade is  $s_i^N(\bar{\tau}_i^*, t = 0) = \frac{1}{2} + \frac{3\mu}{2(-1+c+\delta)} \geq 0$ . According to Proposition 6.3, the condition the environmental-spillover parameter has to fulfill in order to yield a negative equilibrium-value is:  $s_i^N(\bar{\tau}_i^*, t = 0) < 0 \Leftrightarrow \mu > \frac{1}{3}(1-c-\delta)$ .

The respective tax rate's specific value in autarky is:

$$s_i^N(\bar{\tau}_i^*, t = 1-c) = \frac{(-5+5c+8\delta)(-1+c+4\delta+12\mu)}{34(-1+c)^2+80(-1+c)\delta+64\delta^2} \geq 0. \text{ Here, the condition for a negative equilibrium-value becomes: } s_i^N(\bar{\tau}_i^*, t = 1-c) < 0 \Leftrightarrow \mu > \frac{1}{3}(\frac{1}{4}(1-c) - \delta).$$

<sup>4</sup>The negative relationship between  $s_i^N$  and  $t$  can also be mathematically established unambiguously for  $t = 0$  and  $t = 1-c$ : The specific term of the general derivative is

$$\frac{\partial s_i^N}{\partial t} = \frac{(6(32c^2-9t^2+64c(-1+\delta)+32(-1+\delta)^2)(-1+c+\delta)-18(32c^2+9t^2+48t(-1+\delta)+32(-1+\delta)^2+16c(-4+3t+4\delta))\mu)}{(32c^2+9t^2+24t(-1+\delta)+32(-1+\delta)^2+8c(-8+3t+8\delta))^2}. \text{ For}$$

$t = 0$ , this expression becomes  $\frac{\partial s_i^N}{\partial t} \Big|_{t=0} = \frac{3(-1+c+\delta-3\mu)}{16(-1+c+\delta)^2} < 0$ . For  $t = 1-c$ , we get

$$\frac{\partial s_i^N}{\partial t} \Big|_{t=1-c} = \frac{(6(-23+23c^3+32\delta^3+21\mu-96\delta^2(1+\mu))+3c^2(-23+29\delta+7\mu)+\delta(87+48\mu)+3c(23+32\delta^2-14\mu-2\delta(29+8\mu)))}{(17+17c^2-40\delta+32\delta^2+c(-34+40\delta))^2} < 0.$$

The rather intuitive line of argument in this proof, however, is not restricted to those special cases. We can thus consider the negative relationship to be a general one, holding for the whole range of values  $t \in (0, 1-c)$ .

A comparison of both conditions reveals that the threshold value the parameter  $\mu$  must exceed to induce a negative tax rate on foreign profit is lower (and thus “easier to fulfill”) in the autarky scenario. Accordingly, a subsidy on foreign profit is c.p. more likely, if trade costs are prohibitively high.  $\square$

# Appendix C

## Appendix to Part III, Chapter 7

### C.1 Proof of Proposition 7.1

- According to eq. (7.2), aggregate regional welfare in the social optimum is given by:  $W_{reg}^{opt} = W_i^{FDI,opt} + W_j^{imp,opt}$ . Simple computation shows that  $W_i^{FDI,opt} > W_j^{imp,opt}$  holds under the assumption of a non-prohibitive socially optimal emissions-tax rate, respectively for aggregate environmental damage not too severe (i.e. for  $\tau_i^{opt} < 1 - c - t \Rightarrow \delta + \mu < 1 - c - \frac{3}{4}t$ ).
- In the Nash equilibrium, welfare in both countries equals the importing country's level:  $W_i^{FDI,N} = W_j^{imp,N}$ . Aggregate regional welfare is thus given by:  $W_{reg}^N = 2W_j^{imp,N}$ .
- In order to show that  $W_{reg}^N < W_{reg}^{opt}$ , the impact of changes in the emissions-tax rate on the importing country's welfare has to be investigated in detail. This is due to the following line of argument:  
Because of the relation  $W_i^{FDI,opt} > W_j^{imp,opt}$ , a sufficient (though not necessary) condition for  $W_{reg}^{opt} = W_i^{FDI,opt} + W_j^{imp,opt} > 2W_j^{imp,opt} > 2W_j^{imp,N} = W_{reg}^N$  to hold is given by  $W_j^{imp,opt} > W_j^{imp,N}$ .
- In what concerns the two policy instruments, the importing country's welfare is solely determined by the level of  $\tau_i$ , since the host country's profit-tax rate  $s_i$  is non-distortive with respect to output (and export volume) and thus not affecting  $CS$ - or emissions spillovers to the neighboring country. The preceding analysis (see Section 7.2.2) has established  $\tau_i^N < \tau_i^{opt}$ . This implies:  $W_j^{imp,opt} > W_j^{imp,N} \Leftrightarrow \frac{\partial W_j^{imp}}{\partial \tau_i} \Big|_{\tau_i^{opt}} > 0$ .
- Differentiating the importing country's welfare as given by eq. (7.2) with respect to  $\tau_i$  yields:  $\frac{\partial W_j^{imp}}{\partial \tau_i} = -\frac{(1-c-\tau_i-t)^2}{4} + \mu$ . This derivative is positive for

$\tau_i > 1 - c - t - 4\mu$ . Plugging in  $\tau_i^{opt} = -(1 - c) + \frac{t}{2} + 2(\delta + \mu)$  yields:  $\tau_i^{opt} > 1 - c - t - 4\mu \Leftrightarrow \mu > \frac{1}{3}(1 - c - \delta - \frac{3}{4}t)$ . This condition holds due to the assumption  $\tau_i^N < \tau_i^{opt}$  (see Section 7.2.2). Accordingly, the sufficient condition for  $W_j^{imp,opt} > W_j^{imp,N}$  and thus  $W_{reg}^{opt} > W_{reg}^N$  is fulfilled.  $\square$

## C.2 Proof of Corollary 7.1a

- For the importing country, the relationship  $W_j^{imp,opt} > W_j^{imp,N}$  is readily established in the proof of Proposition 7.1 in Appendix C.1.
- For the host country, we can deduce from the same proof:  $W_i^{FDI,opt} > W_j^{imp,opt} > W_j^{imp,N} = W_i^{FDI,N}$ .  $\square$

## C.3 Proof of Lemma 7.3

This proof refers to the analysis in Section 6.4: If in an ITA, the profit-tax rate in both countries is fixed to a level of  $s = 1$ , the MNE's participation constraint is binding in the ITA equilibrium:  $(1 - s_i)\Pi_i = (1 - s_j)\Pi_j = 0$ . Hence, the host country's optimal emissions-tax choice is independent of  $s$  (see Proposition 6.2 and the respective proof), and thus corresponds to its competitive level, which in turn coincides with the non-strategic value:  $\tau_i^{ITA} = \tau_i^N = \bar{\tau}_i^*$ .  $\square$

## C.4 Proof of Proposition 7.2

- The first part of Proposition 7.2 ( $W_{reg}^{ITA} > W_{reg}^N$ ) first follows from the fact that in the ITA equilibrium, the FDI host country attains a higher level of individual welfare than its importing neighbor:  $W_i^{FDI,ITA}(s_i^{ITA} = 1, \tau_i^N) > W_j^{imp,ITA}(\tau_i^N)$ . This condition coincides with the condition for profit-tax rates in the Nash equilibrium to be lower than one ( $s_i^N < 1$ ). This condition is established in Appendix B.2.

Second, the importing country attains identical individual-welfare levels in both regimes:  $W_j^{imp,ITA}(\tau_i^N) = W_j^{imp,N}(\tau_i^N)$ . As the formula indicates, this equality is owed to the fact that country  $j$ 's welfare is solely determined by country  $i$ 's emissions-tax rate (i.e. independent of  $s$ ; see Appendix C.1). This tax rate is identical in both regimes ( $\tau_i^{ITA} = \tau_i^N$ ).

Hence:  $W_{reg}^{ITA} = W_i^{FDI,ITA} + W_j^{imp,ITA} > 2W_j^{imp,ITA} = 2W_j^{imp,N} = W_{reg}^N$ .

- The second part of Proposition 7.2 ( $W_{reg}^{ITA} < W_{reg}^{opt}$ ) is straightforward, and follows from the general definition of a social optimum:

In both regimes, ITA and social optimum, the lump-sum profit-tax rate equals one. The only policy difference consists in the environmental tax: Whereas the distortive emissions-tax rate in the social optimum ( $\tau_i^{opt}$ ) amounts to a level that maximizes aggregate regional welfare, the respective tax in an ITA regime falls short of the optimal rate:  $\tau_i^{ITA} < \tau_i^{opt}$ . By definition, any tax rate different from the socially optimal one (i.e. each  $\tau_i \neq \tau_i^{opt}$ ) must induce suboptimal regional-welfare levels.

Hence:  $W_{reg}^{ITA}(s = 1, \tau_i^{ITA}) < W_{reg}^{opt}(s = 1, \tau_i^{opt})$ .  $\square$

## C.5 Proof of Corollary 7.2a

- For the importing country, the relationship  $W_j^{imp,ITA} = W_j^{imp,N}$  is readily established in the proof of Proposition 7.2 in Appendix C.4.
- For the host country, the proof is intuitive: In both regimes N and ITA, country  $i$  maximizes its individual welfare by an optimal choice of the distortive emissions-tax rate:  $\tau_i^{ITA} = \tau_i^N$ . The domestic-welfare differential is thus driven by the other, lump-sum policy instrument: Given  $\tau_i$ , a corporate-tax rate of  $s_i = 1$  allows to redirect the maximum possible share of foreign profit to the domestic market. Hence, any value of  $s_i < 1$  must induce a sub-optimal amount of profit-tax revenue. Country  $i$ 's welfare in the Nash equilibrium with  $s_i^N < 1$  must thus fall short of welfare in the ITA equilibrium, where  $s_i^{ITA} = 1$ .  $\square$

## C.6 Proof of Lemma 7.4

- The level of  $s_i^{min}$ , which reflects the intensity of FDI competition, is determined by the net FDI surplus, i.e. the welfare differential between the host- and the importing country given by  $W_i^{FDI}(\tau_i, s_i) - W_j^{imp}(\tau_i)$ .<sup>1</sup>
- For the Nash equilibrium, i.e. the initial policy pattern countries face when concluding an IEA, the optimal profit-tax choice is based on the welfare differential

$$W_i^{FDI}(\tau_i^N, s_i) - W_j^{imp}(\tau_i^N). \quad (C.1)$$

Remember that the Nash equilibrium emissions-tax rate corresponds to the host country's optimal non-strategic tax rate:  $\tau_i^N = \bar{\tau}_i^*$  (see the analysis in Chapter 6).

<sup>1</sup>Accordingly, Appendix B.1 derived the countries' optimal profit-tax rate in the Nash equilibrium by setting this welfare differential equal to zero. Given the IEA equilibrium emissions-tax rate  $\tau_i^{IEA} = \tau_i^{opt} = -(1-c) + \frac{t}{2} + 2(\delta + \mu)$ , the specific value of the profit-tax rate corresponding to the IEA equilibrium becomes:  $s_i^{IEA} = s_i^{min}(\tau_i^{opt}) = \frac{2(2c+t+2(-1+\delta+\mu))(4c+3t+4(-1+\delta+3\mu))}{16c^2+5t^2+16t(-1+\delta+\mu)+16(-1+\delta+\mu)^2+16c(t+2(-1+\delta+\mu))}$ .



- For the IEA scenario, the relevant welfare differential is given by:

$$W_i^{FDI}(\tau_i^{IEA} = \tau_i^{opt} > \tau_i^N, s_i) - W_j^{imp}(\tau_i^{IEA} = \tau_i^{opt} > \tau_i^N). \quad (C.2)$$

- It is straightforward to show that the welfare differential inducing the Nash equilibrium profit-tax rate  $s_i^N$  in eq. (C.1), given  $s_i^N$ , exceeds the respective differential in eq. (C.2) yielding the IEA-induced optimal profit-tax rate  $s_i^{IEA}$ :

– When, starting from the Nash equilibrium, the emissions-tax rate is exogenously raised to a level of  $\tau_i^{IEA} > \tau_i^N = \bar{\tau}_i^*$ , the host country's domestic welfare will decline, as the IEA detains it from charging its optimal environmental-tax rate. By definition of an optimal policy-choice, any value of  $\tau_i$  with  $\tau_i \neq \bar{\tau}_i^*$  induces sub-optimal individual-welfare levels.

Hence:  $W_i^{FDI}(\tau_i^{IEA}, s_i^N) < W_i^{FDI}(\tau_i^N, s_i^N)$ .

– The importing country, on the contrary, gains from the rise in  $\tau_i$ , as, differently from the non-cooperative tax, the IEA emissions-tax rate considers all externalities from the neighboring FDI host.

Hence:  $W_j^{imp}(\tau_i^{IEA}) > W_j^{imp}(\tau_i^N)$ .<sup>2</sup>

– Taken together, the preceding steps show:

$$W_i^{FDI}(\tau_i^{IEA}, s_i) - W_j^{imp}(\tau_i^{IEA}) < W_i^{FDI}(\tau_i^N, s_i) - W_j^{imp}(\tau_i^N).$$

Hence, the introduction of an IEA reduces the welfare differential between the host- and the importing country, corresponding to the net FDI surplus.

- To conclude, the introduction of an IEA, by exogenously raising the emissions-tax rate above its initial domestic-welfare maximizing level, reduces the relative attractiveness of hosting the FDI and thus the countries' maximum WTP for the investment. As a consequence, the minimum necessary tax rate ensuring a net FDI surplus of at least zero, corresponding to the profit-tax rate offered to the MNE in the IEA equilibrium, will exceed that in the initial Nash equilibrium:  $s_i^{IEA} = s_i^{min}(\tau_i^{IEA}) > s_i^{min}(\tau_i^N) = s_i^N$ .  $\square$

## C.7 Proof of Proposition 7.3

- The first part of Proposition 7.3 ( $W_{reg}^{IEA} > W_{reg}^N$ ) is proved by the following line of argument:

– In both scenarios (IEA- and Nash equilibrium), countries compete for FDI in corporate-tax policy until their maximum WTP for the FDI, conditional on the respective equilibrium-level of  $\tau_i$ , is reached:  $s_i^{IEA} = s_i^{min}(\tau_i^{opt})$ ,  $s_i^N = s_i^{min}(\tau_i^N)$ . As a consequence, both IEA members attain the same level of individual welfare:  $W_i^{FDI,IEA} = W_j^{imp,IEA}$ .

<sup>2</sup>For further details see the welfare analysis in Section 7.3.2 and Appendices C.7 and C.8.

- Hence:  $W_{reg}^{IEA} = 2W_j^{imp,IEA} > 2W_j^{imp,N} = W_{reg}^N \Leftrightarrow \frac{\partial W_j^{imp}}{\partial \tau} \Big|_{\tau_i^N} > 0$ , i.e. an IEA raises aggregate regional welfare (relative to the completely non-cooperative scenario), if the relation between the importing country's welfare and the emissions-tax rate is positive.
- As argued in Section 7.2.3, the importing country's welfare is solely determined by the level of  $\tau_i$ . Furthermore, the preceding analysis has established that  $\tau_i^{IEA} > \tau_i^N$ , and  $\frac{\partial W_j^{imp}}{\partial \tau_i} > 0 \Leftrightarrow \tau_i > 1 - c - t - 4\mu$ .  
The value of the non-cooperative emissions-tax rate  $\tau_i^N = -\frac{1}{3}(1 - c) + \frac{4}{3}\delta$  meets this condition for environmental-spillover parameters sufficiently large, i.e. for  $\mu > \frac{1}{3}(1 - c - \delta - \frac{3}{4}t)$ . The latter condition in turn is fulfilled by assumption (a feature that has already been used in the proof of Proposition 7.1 in Appendix C.1).
- Hence, starting from the Nash-equilibrium level of  $\tau_i^N$ , increases in the emissions-tax rate raise the importing country's welfare:  $\frac{\partial W_j^{imp}}{\partial \tau} \Big|_{\tau_i^N} > 0$ .  
This implies:  $W_j^{imp,IEA} > W_j^{imp,N} \Leftrightarrow W_{reg}^{IEA} > W_{reg}^N$ .
- The second part of Proposition 7.3 ( $W_{reg}^{IEA} < W_{reg}^{opt}$ ) is proved by a similar line of argument as followed in the proof of Proposition 7.1, supplemented by a consideration of the welfare effects for the host country:

- Due to  $\tau_i^{IEA} = \tau_i^{opt} \Rightarrow W_j^{imp,IEA} = W_j^{imp,opt}$ , the following relationship is easily established:  

$$W_{reg}^{opt} = W_i^{FDI,opt} + W_j^{imp,opt} > 2W_j^{imp,opt} = 2W_j^{imp,IEA} = W_{reg}^{IEA}$$

$$\Leftrightarrow W_i^{FDI,opt} > W_j^{imp,opt}.$$
- The latter relationship has been established in Section 7.2.3. Hence:  
 $W_{reg}^{opt} > W_{reg}^{IEA}$ .  $\square$

## C.8 Proof of Corollary 7.3a

- For the importing country, the relationship  $W_j^{imp,IEA} > W_j^{imp,N}$  is readily established in the proof of Proposition 7.3 in Appendix C.7.
- For the host country, the proof combines elements of the preceding proofs as follows:
  - The first part of the proof of Proposition 7.3 shows:  $W_i^{FDI,IEA} = W_j^{imp,IEA}$ .
  - The proof of Proposition 7.3 has also established:  $W_j^{imp,IEA} > W_j^{imp,N}$ .
  - The proof of Proposition 7.1 shows:  $W_j^{imp,N} = W_i^{FDI,N}$ .
  - Combining those three findings yields:  $W_i^{FDI,IEA} = W_j^{imp,IEA} > W_j^{imp,N} = W_i^{FDI,N}$ .  $\square$

## C.9 Proof of Proposition 7.4

As the result  $W_{reg}^{ITA} > W_{reg}^{IEA}$  does not hold in general, the following proof will show this to be the case under the two crucial assumptions the complete analysis in this paper is based on. To repeat, those assumptions are:

$$(1) \tau_i^{opt} > \tau_i^N \Leftrightarrow \mu > \frac{1}{3}(1 - c - \delta - \frac{3}{4}t).$$

$$(2) \tau_i^{opt} < \tau_i^{prohib} \Leftrightarrow \mu < 1 - c - \delta - \frac{3}{4}t.$$

In addition, the proof uses the following definition:  $\Delta W(\mu) \doteq W_{reg}^{ITA} - W_{reg}^{IEA}$ . This proof thus establishes the relation  $\Delta W(\mu) > 0$ .

- In general, whether  $\Delta W(\mu) \gtrless 0$ , depends on the level of  $\mu$ , since  $\tau_i^{opt}$  depends on  $\mu$ :

$$\Delta W(\mu) = W_i^{FDI,ITA}(s_i = 1, \tau_i^N) + W_j^{imp,ITA}(\tau_i^N) - 2W_j^{imp,IEA}(\tau_i^{opt}).$$

Plugging in the values of  $\tau_i^N$  and  $\tau_i^{opt}$  yields the following expression:

$$\Delta W(\mu) = \frac{1}{144}(-16c^2 - 27t^2 - 48t(-2 + 2\delta + 9\mu) - 32c(-1 + 3t + \delta + 21\mu) - 16((-1 + \delta)^2 + 42(-1 + \delta)\mu + 45\mu^2)) \gtrless 0.$$

- This expression has two roots:  $\Delta W(\mu) \stackrel{!}{=} 0 \Rightarrow$

$$\tilde{\mu}_1 = \frac{1}{60}(28 - 28c - 18t - 28\delta -$$

$$\sqrt{704 - 1408c + 704c^2 - 528t + 528ct + 189t^2 - 1408\delta + 1408c\delta + 528t\delta + 704\delta^2});$$

$$\tilde{\mu}_2 = \frac{1}{60}(28 - 28c - 18t - 28\delta +$$

$$\sqrt{704 - 1408c + 704c^2 - 528t + 528ct + 189t^2 - 1408\delta + 1408c\delta + 528t\delta + 704\delta^2}).$$

- The next step is to determine the size of a value for  $\mu$  satisfying assumptions (1) and (2), i.e.  $\frac{1}{3}(1 - c - \delta - \frac{3}{4}t) < \mu < 1 - c - \delta - \frac{3}{4}t$ , in relation to those roots:

- In what concerns the first root, calculations reveal that  $\tilde{\mu}_1 \leq \frac{1}{3}(1 - c - \delta - \frac{3}{4}t)$ .

Hence,  $\tilde{\mu}_1$  violates assumption (1). Evidently, assumption (2) is met:  $\tilde{\mu}_1 < 1 - c - \delta - \frac{3}{4}t$ . Hence, an environmental-spillover parameter consistent with this paper's assumptions must exceed  $\tilde{\mu}_1$ :  $\mu > \tilde{\mu}_1$ .

- In what concerns the second root, analogous calculations reveal that  $\tilde{\mu}_2 \gtrless 1 - c - \delta - \frac{3}{4}t$ . It is thus possible that  $\tilde{\mu}_2$  violates assumption (2), whereas it can be shown to meet assumption (1):  $\tilde{\mu}_2 > \frac{1}{3}(1 - c - \delta - \frac{3}{4}t)$ . Hence, an environmental-spillover parameter consistent with this paper's assumptions must be smaller than or equal to  $\tilde{\mu}_2$ :  $\mu \leq \tilde{\mu}_2$ .

In summary, the findings of the preceding root analysis yield:  $\tilde{\mu}_1 < \mu \leq \tilde{\mu}_2$ . A value of  $\mu$  which is consistent with this paper's assumptions thus lies in-between the two roots of the function  $\Delta W(\mu)$ .

- What remains to be determined, is, whether  $\tilde{\mu}_1$  and  $\tilde{\mu}_2$  enclose a minimum or a maximum of  $\Delta W(\mu)$  (and, thus, whether this function takes on positive or negative values for relevant levels of  $\mu$ ):

Setting the derivative of  $\Delta W(\mu)$  with respect to  $\mu$  equal to zero and solving for  $\mu$ , yields the following extremum:  $\frac{\partial \Delta W(\mu)}{\partial \mu} = \frac{1}{3}(14 - 14c - 9t - 14\delta - 30\mu) \stackrel{!}{=} 0 \Rightarrow \tilde{\mu}_0 = \frac{1}{30}(14 - 14c - 9t - 14\delta)$ .

This value constitutes a maximum, since the second derivative is negative:  $\frac{\partial^2 \Delta W(\mu)}{\partial \mu^2} = -10$ .

- Hence:  $\tilde{\mu}_1 < \mu \leq \tilde{\mu}_2 \Leftrightarrow \Delta W(\mu) > 0$ . Figure C.1 illustrates this conclusion:

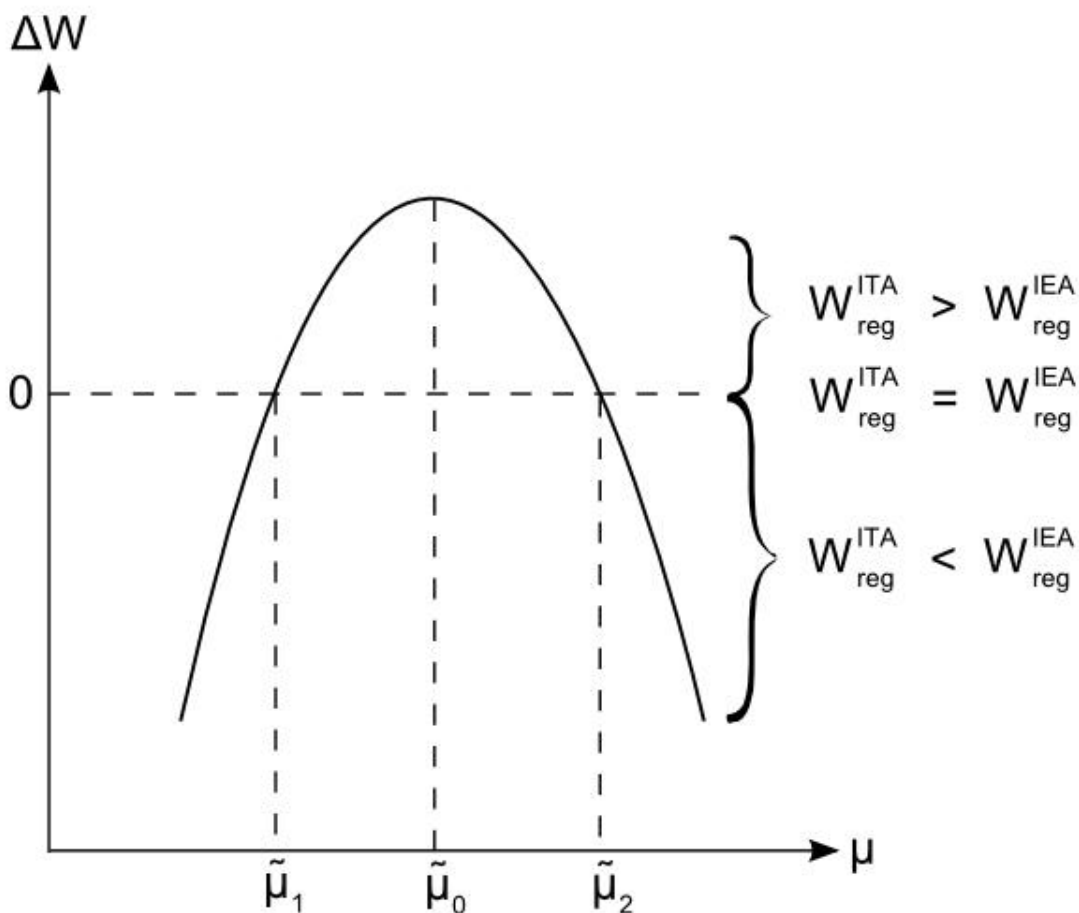


Figure C.1: ITA-IEA Welfare Differential

The figure shows: Values of  $\mu$  that satisfy the assumptions underlying this paper's analysis lie in-between the two roots of the function  $\Delta W(\mu)$ . Since those roots enclose a maximum,  $\Delta W(\mu)$  must be positive for relevant values of  $\mu$ :  $\Delta W(\mu) > 0$  for  $\tilde{\mu}_1 < \mu \leq \tilde{\mu}_2$ . Hence:  $W_{reg}^{ITA} > W_{reg}^{IEA}$ .  $\square$

## C.10 An IEA with Differentiated Environmental Taxes

This Appendix introduces an alternative pattern of how countries may cooperate in environmental-policy making and draws comparisons to the IEA version in the main text.<sup>3</sup> The IEA there is referred to as “uniform-policy” agreement (regime U), the alternative version here as “differentiated-policy” agreement (regime D).<sup>4</sup>

The differentiated-policy IEA discussed below constitutes the most efficient form of international environmental-policy cooperation, since in the associated policy equilibrium, aggregate regional welfare amounts to the maximum level associated with the social optimum.

The IEA member countries commit to the following environmental-policy patterns:<sup>5</sup>

- In analogy to regime U, country  $i$  charges the socially optimal emissions-tax rate derived in Section 7.2.2:  $\tau_i^{IEA,D} = \tau_i^{opt} = -(1 - c) + \frac{t}{2} + 2(\delta + \mu)$ .
- In contrast to regime U, the neighboring country  $j$  sets its tax rate at a prohibitively high level:  $\tau_j^{IEA,D} = \tau_j^{prohib} = 1 - c - t$ . As a consequence, the MNE's gross-profit option in country  $j$  equals zero, and investment is definitely deterred from there (whereas in regime U, the MNE is indifferent between the two locations within the region).

What is the rationale behind the differentiated-IEA policy-pattern?

- As shown in Section 7.2.2, for a given profit-tax rate, charging the socially optimal emissions-tax rate in the FDI host country implies internalizing all prevalent intra-regional externalities and thus yields the maximum welfare level for the region as a whole.
- Due to the prohibitively high emissions-tax rate in country  $j$ , it is certain that the FDI goes to country  $i$ , where the MNE's gross-profit option is positive (by assumption:  $\tau_i^{opt} = \tau_i^{IEA,D} < \tau_j^{IEA,D} = \tau_j^{prohib}$ ).

<sup>3</sup>Though all policy patterns described here are tailored to this paper's model framework, they are analogously applicable to a broad range of alternative settings. Hence, as repeatedly discussed in the text, also the findings and conclusions in this Appendix are interpretable in a much more general way.

<sup>4</sup>The general idea for regime D goes back to Davies/Ellis (2007).

<sup>5</sup>In this Appendix, the superscripts D and U identify variables referring to regime D and U, respectively.

- Hence, under such environmental-policy patterns, country  $j$  can choose any (arbitrarily low) profit-tax rate  $s_j \in [-\infty, 1]$  without inducing the foreign firm to invest in its domestic market. Such a situation is equivalent to a scenario in which country  $j$  does not have any incentive to engage in FDI competition. As a consequence, country  $i$  need not compete for the FDI neither. It can thus appropriate the complete foreign profit by charging the MNE with a maximum profit-tax rate of one. This equilibrium tax rate also corresponds to the socially optimal one derived in Section 7.2.2:  $s_i^{IEA,D} = 1 = s_i^{opt}$ .
- To summarize, the IEA equilibrium in regime D yields the following policy patterns:
 
$$\{\tau_i^{IEA,D} = \tau_i^{opt}; \tau_j^{IEA,D} = \tau_j^{prohib}; s_i^{IEA,D} = s_i^{opt}; s_j^{IEA,D} \in [-\infty, 1]\}.$$

What are the welfare effects of an IEA with differentiated policies?

- From a *regional-welfare perspective*, the surplus from FDI, which is completely realized by country  $i$  (and thus benefits the region), corresponds to the maximum amount in the social optimum. Such IEA therefore raises aggregate regional welfare above its level in the non-cooperative Nash equilibrium to the maximum possible extent.  
Furthermore, the IEA-induced regional-welfare gain exceeds the respective gain from a uniform-policy IEA (see the proof of Proposition 7.3 in Appendix C.7):  $W_{reg}^{opt} = W_{reg}^{IEA,D} > W_{reg}^{IEA,U} > W_{reg}^N$ .
- Both *individual countries* gain from environmental-policy cooperation, since their welfare in the social optimum exceeds the level attainable in the Nash equilibrium (see the proof of Corollary 7.1a in Appendix C.2):  $W_i^{opt} = W_i^{IEA,D} > W_i^N \wedge W_j^{opt} = W_j^{IEA,D} > W_j^N$ .
- A comparison of the alternative IEA versions shows that the *FDI host country*  $i$  benefits by more in regime D than in regime U:  $W_i^{IEA,D} > W_i^{IEA,U} > W_i^N$ . This result is attributable to the fact that regime D completely eliminates FDI competition in profit taxes and thus enables country  $i$  to extract the complete foreign profit. This is different in regime U, which also mitigates corporate-tax-policy competition to a certain extent, but does not completely eliminate it. In the associated policy equilibrium, the countries offer the complete net FDI surplus to the foreign firm as investment incentive in terms of a low profit-tax burden (see Section 7.3.2).
- For the *importing country*  $j$ , on the contrary, it makes no difference, which IEA regime it faces:  $W_j^{IEA,D} = W_j^{IEA,U} > W_j^N$ . This equality is due to the fact that country  $j$ 's individual-welfare level is solely determined by the host country's emissions-tax rate (see the proof of Proposition 7.1 in Appendix C.1), which is the same in both IEA scenarios.

- Finally, an *inter-country comparison* of individual-welfare levels in both IEA scenarios yields interesting insights: It is straightforward to show that in the regime-D policy equilibrium, the FDI host country is better off than the importing country:  $W_i^{IEA,D} > W_j^{IEA,D}$ . This is due to the complete elimination of profit-tax competition, which enables country  $i$  to realize the complete net FDI surplus, since this need not be “competed away” to the foreign firm. Its welfare will thus exceed the level attainable in the importing country by exactly this amount. In regime U, on the contrary, FDI competition persists, leaving both countries with identical welfare levels:  $W_i^{IEA,U} = W_j^{IEA,U}$  (see Section 7.3.2).

This finding has general implications concerning the political feasibility of such an IEA in the “real world”: The individual-welfare differential between the FDI host and its neighbor casts some doubt on the assumption that countries succeed in concluding an IEA with differentiated policy levels, though such agreement is superior to the uniform alternative in welfare-terms. When thinking of this issue, one has to consider that an IEA is not imposed by some federal authority with the aim of maximizing aggregate welfare (as supposed in Davies/Ellis (2007)). Rather, an IEA involves negotiations between sovereign national states, each focussing on its individual domestic-welfare maximization (though to a certain extent recognizing the need to cooperate internationally). Since countries in the model framework applied here are symmetric, there is no political justification for differentiated policy levels: Which of the two countries would voluntarily commit to setting prohibitively high taxes and so deter the investment, if its neighbor is enabled to definitely become the FDI host?

These plausibility considerations suggest to introduce the IEA, in the given model framework, as a uniform, rather than a differentiated-policy agreement. Consequently, this chapter treats the latter IEA version, just like the social optimum, as an ideal, rather hypothetical version of international policy-cooperation.

# Appendix D

## Eidesstattliche Erklärung

Ich erkläre hiermit an Eides Statt, dass ich meine Doktorarbeit “Environmental Policy in Open Economies” selbständig und ohne fremde Hilfe angefertigt habe und dass ich alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehenden Ausführungen meiner Arbeit, besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert habe. Ich versichere weiterhin, dass ich keine weiteren als die in der Dissertationsschrift angegebenen Hilfsmittel verwendet habe.

Kiel, im Juli 2010

Barbara Stoschek



# Appendix E

## Hilfsmittel

Dieses Dokument ist mit der Software “MiKTeX” und der Software “WinEdt 5.4” erstellt worden.

Sämtliche Berechnungen wurden mit Hilfe der Software “Mathematica for Students Version 4.1” durchgeführt.

Die Graphiken wurden mit Hilfe der Software “Microsoft Powerpoint” erstellt; die Tabelle im Anhang mit der Software “Microsoft Excel”.

Kiel, im Juli 2010

Barbara Stoschek

# Bibliography

- [1] *Aidt, T.S.* (1998): Political Internalization of Economic Externalities and Environmental Policy. *Journal of Public Economics* 69, pp. 1-16.
- [2] *Amerighi, O./de Feo, G.* (2009): Is Competition for FDI Bad for Regional Welfare? Working Paper, Department of Economics, University of Bologna.
- [3] *Barros, P.P./Cabral, L.* (2000): Competing for Foreign Direct Investment. *Review of International Economics* 8 (2), pp. 360-371.
- [4] *Bayindir-Upmann, T.* (1995): Interjurisdictional Tax Competition, Provision of Two Local Public Goods, and Environmental Policy. *Finanzarchiv* 52 (3), pp. 379-400.
- [5] *Betz, R./Eichhammer, W./Schleich, J.* (2004): Designing National Allocation Plans for EU Emissions Trading- A First Analysis of the Outcome. *Energy and Environment* 15 (3), pp. 375-425.
- [6] *Bjorvatn, K./Eckel, C.* (2006): Policy Competition for Foreign Direct Investment between Asymmetric Countries. *European Economic Review* 50 (7), pp. 1891-1907.
- [7] *Bjorvatn, K./Schjelderup, G.* (2002): Tax Competition and International Public Goods. *International Tax and Public Finance* 9, pp. 111-120.
- [8] *Bommer, R.* (1996): Environmental Regulation of Production Processes in the European Union: A Political-Economy Approach. *Aussenwirtschaft (IV)*, pp. 559-582.
- [9] *Bommer, R./Schulze, G.G.* (1999): Environmental Improvements With Trade Liberalization. *European Journal of Political Economy* 15, pp. 639-661.
- [10] *Buchanan, J.M./Tullock, G.* (1975): Polluters' Profits and Political Response: Direct Control versus Taxes. *The American Economic Review* 65 (1), pp. 139-147.
- [11] *Chao, C.-C./Yu, S.H.* (1997): International Capital Competition and Environmental Standards. *Southern Economic Journal* 64 (2), pp. 531-541.

- [12] *Charlton, A.* (2003): Incentive Bidding for Mobile Investment: Economic Consequences and Political Responses. OECD Development Centre Working Paper No. 203, OECD, Paris.
- [13] *Conconi, P.* (2000): Can Green Lobbies Replace a World Environmental Organization? Nota di Lavarò 56.2000, Department of Economics, University of Warwick.
- [14] *Conconi, P.* (2003): Green Lobbies and Transboundary Pollution in Large Open Economies. *Journal of International Economics* 59, pp. 399-422.
- [15] *Copeland, B.R./Taylor, M.S.* (2003): Trade and the Environment: Theory and Evidence. Princeton Series in International Economics, Princeton University Press, Princeton.
- [16] *Davies, R.B./Eckel, C.* (2010): Tax Competition for Heterogenous Firms with Endogenous Entry: The Case of Heterogenous Fixed Costs. *American Economic Journal: Economic Policy* 2 (1), pp. 77-102.
- [17] *Davies, R.B./Ellis, Ch.J.* (2007): Competition in taxes and performance requirements for foreign direct investment. *European Economic Review* 51, pp. 1423-1442.
- [18] *Demailly, D./Quirion, P.* (2006): CO<sub>2</sub> Abatement, Competitiveness and Leakage in the European Cement Industry Under the EU ETS: Grandfathering Versus Output-Based Allocation. *Climate Policy* 6, pp. 93-113.
- [19] *Devereux, M.P./Griffith, R.* (2002): The Impact of Corporate Taxation on the Location of Capital: A Review. *Swedish Economic Policy Review* 9, pp. 79-102.
- [20] *Devereux, M.P./Lockwood, B./Redoano, M.* (2008): Do Countries Compete over Corporate Tax Rates? *Journal of Public Economics* 91, pp. 1210-1235.
- [21] *Dijkstra, B./Mathew, A./Mukherjee, A.* (2006): Environmental Regulation: An Incentive for FDI. University of Nottingham Research Paper No. 2006/38, Nottingham.
- [22] *Ederington, J./Minier, J.* (2003): Is Environmental Policy a Secondary Trade Barrier? An Empirical Analysis. *The Canadian Journal of Economics* 36 (1), pp. 137-154.
- [23] *Egger, P./Raff, H.* (2009): Tax Rate and Tax Base Competition for Foreign Direct Investment. Manuscript, University of Kiel and University of Munich.
- [24] *Eliste, P./Fredriksson, P.G.* (2002): Environmental Regulations, Transfers, and Trade: Theory and Evidence. *Journal of Environmental Economics and Management* 43, pp. 234-250.

- [25] *Ferrett, B./Wooton, I.* (2005): Competing for a Duopoly: International Trade and Tax Competition. Discussion Paper No. 5379, Centre for Economic policy Research, London, UK.
- [26] *Ferrett, B./Wooton, I.* (2009): Tax Competition and the International Distribution of Firm Ownership: An Invariance Result. International Tax and Public Finance, Online Publication DOI 10.1007/s10797-009-9126-z, 26 August 2009.
- [27] *Fredriksson, P.G.* (1997): The Political Economy of Pollution Taxes in a Small Open Economy. *Journal of Environmental Economics and Management* 33, pp. 44-58.
- [28] *Fredriksson, P.G.* (1999): The Political Economy of Trade Liberalization and Environmental Policy. *Southern Economic Journal* 65 (3), pp. 513-525.
- [29] *Fredriksson, P.G./Millimet, D.L.* (2002): Strategic Interaction and the Determination of Environmental Policy across U.S. States. *Journal of Urban Economics* 51, pp. 101-122.
- [30] *Fredriksson, P.G./List, J.A./Millimet, D.L.* (2004): Chasing the Smokestack: Strategic Policymaking with Multiple Instruments. *Regional Science and Urban Economics* 34, pp. 387-410.
- [31] *Fumagalli, C.* (2003): On the Welfare Effects of Competition for Foreign Direct Investments. *European Economic Review* 47, pp. 963-983.
- [32] *Gordon, R.H./Hines, J.R.* (2002): International Taxation. NBER Working Paper 8854, National Bureau of Economic Research, Cambridge.
- [33] *Grossman, G.M./Helpman, E.* (1994): Protection for Sale. *American Economic Review* 84 (4), pp. 833-850.
- [34] *Grubb, M./Neuhoff, K.* (2006): Allocation and Competitiveness in the EU Emissions Trading Scheme: Policy Overview. *Climate Policy* 6, pp. 7-30.
- [35] *Haaland, J.I./Wooton, I.* (1999): International Competition for Multinational Investment. *Scandinavian Journal of Economics* 101 (4), pp. 631-649.
- [36] *Haufler, A.* (2001): Taxation in a Global Economy. Cambridge University Press, Cambridge.
- [37] *Haufler, A./Wooton, I.* (1999): Country Size and Tax Competition for Foreign Direct Investment. *Journal of Public Economics* 71, pp. 121-139.
- [38] *Haufler, A./Wooton, I.* (2003): Regional Tax Coordination and Foreign Direct Investment. Munich Discussion Paper No. 2003-17, Department of Economics, University of Munich, München.

- [39] *Hillman, A.L.* (1982): Declining Industries and Political-Support Protectionist Motives. *American Economic Review* 72 (5), pp. 1180-1187.
- [40] *Hillman, A.L./Ursprung, H.W.* (1994): Greens, Supergreens, and International Trade Policy: Environmental Concerns and Protectionism. In: Carraro, C. (Ed.): *Trade, Innovation, Environment*, Kluwer Academic Publishers, Dordrecht, pp. 75-108.
- [41] *Hoel, M.* (1994): Environmental Policy as a Game between Governments when Plant Locations are Endogenous. Memorandum from Department of Economics, University of Oslo.
- [42] *Hoel, M.* (1997): Environmental Policy with Endogenous Plant Locations. *Scandinavian Journal of Economics* 99 (2), pp. 241-259.
- [43] *Johnston, A.* (2006): Free Allocation of Allowances Under the EU Emissions Trading Scheme: Legal Issues. *Climate Policy* 6, pp. 115-136.
- [44] *Kim, J./Wilson, J.D.* (1997): Capital Mobility and Environmental Standards: Racing to the Bottom with Multiple Tax Instruments. *Japan and the World Economy* 9, pp. 537-551.
- [45] *Klepper, G./Peterson, S.* (2004): The EU Emissions Trading Scheme: Allowance Prices, Trade Flows, Competitiveness Effects. Kiel Working Paper No. 1195, Kiel Institute for World Economics, Kiel.
- [46] *Levinson, A.* (1999): An Industry-Adjusted Index of State Environmental Compliance Costs. NBER Working Paper 7297, National Bureau of Economic Research, Cambridge.
- [47] *Levinson, A.* (2002): Environmental Regulatory Competition: A Status Report and Some New Evidence. Working Paper No. 02-02-07, Georgetown University, Washington, D.C.
- [48] *List, J.A./Gerking, S.* (2000): Regulatory Federalism and Environmental Protection in the United States. *Journal of Regional Science* 40 (3), pp. 453-471.
- [49] *Markusen, J.R./Morey, E.R./Olewiler, N.* (1993): Environmental Policy when Market Structure and Plant Locations Are Endogenous. *Journal of Environmental Economics and Management* 24, pp. 69-86.
- [50] *Markusen, J.R./Morey, E.R./Olewiler, N.* (1995): Competition in Regional Environmental Policies when Plant Locations are Endogenous. *Journal of Public Economics* 56, pp. 55-77.
- [51] *Millimet, D.L.* (2003): Assessing the Empirical Impact of Environmental Federalism. *Journal of Regional Science* 43 (4), pp. 711-733.

- [52] *Motta, M./Thisse, J.-F.* (1994): Does environmental dumping lead to delocation? *European Economic Review* 38, pp. 563-576.
- [53] *Mulatu, A.* (2004): Relative Stringency of Environmental Regulation and International Competitiveness. Tinbergen Institute Research Series 332, Amsterdam.
- [54] *Oates, W.E.* (2001): A Reconsideration of Environmental Federalism. Discussion Paper 01-54, Resources for the Future, Washington.
- [55] *Oates, W.E./Schwab, R.M.* (1988): Economic Competition among Jurisdictions: Efficiency Enhancing or Distortion Inducing? *Journal of Public Economics* 35, pp. 333-354.
- [56] *OECD* (1998): Harmful Tax Competition. An Emerging Global Issue. OECD, Paris.
- [57] *OECD* (2006): The Political Economy of Environmentally Related Taxes. OECD, Paris.
- [58] *OECD* (2007a): Fundamental Reform of Corporate Income Tax. OECD Tax Policy Studies No. 16, OECD, Paris.
- [59] *OECD* (2007b): Tax Effects on Foreign Direct Investment. Recent Evidence and Policy Analysis. OECD Tax Policy Studies No. 17, OECD, Paris.
- [60] *OECD* (2009): Linkages Between Environmental Policy and Competitiveness. OECD, Paris.
- [61] *Oman, C.* (2000): Policy Competition for Foreign Direct Investment. A Study of Competition among Governments to Attract FDI. Development Center Studies, OECD, Paris.
- [62] *PEW Center* (2005): The European Union Emissions Trading Scheme (EU-ETS). Insights and Opportunities. Online-Source: <http://www.pewclimate.org/>.
- [63] *Rauscher, M.* (1995): Environmental Regulation and the Location of Polluting Industries. *International Tax and Public Finance* 2, pp. 229-244.
- [64] *Rauscher, M.* (1997): The Political Process and Environmental Policy in Open Economies. In: Rauscher, M. (Ed.): *International Trade, Factor Movements, and the Environment*, Clarendon Press, Oxford, pp. 217-246.
- [65] *Rauscher, M.* (2001): Interjurisdictional Competition and Environmental Policy. In: Rauscher, M. (Ed.): *The International Yearbook of Environmental and Resource Economics: A Survey of Current Issues*, Elgar, Cheltenham, pp. 197-230.

- [66] *Rogge, K./Schleich, J./Betz, R.* (2006): An Early Assessment of National Allocation Plans for Phase 2 of EU Emission Trading. Working Paper Sustainability and Innovation No. S1/2006, Fraunhofer ISI and CEEM, Karlsruhe, Germany and Sydney, Australia.
- [67] *de Santis, R.A./Stähler, F.* (2009): Foreign Direct Investment and Environmental Taxes. *German Economic Review* 10 (1), pp. 115-135.
- [68] *Schleich, J.* (1999): Environmental Quality with Endogenous Domestic and Trade Policies. *European Journal of Political Economy* 15, pp. 53-71.
- [69] *Schleich, J./Orden, D.* (2000): Environmental Quality and Industry Protection with Noncooperative Versus Cooperative Domestic and Trade Policies. *Review of International Economics* 8 (4), pp. 681-697.
- [70] *Smale, R./Hartley, M./Hepburn, C.J./Ward, J./Grubb, M.* (2006): The Impact of CO<sub>2</sub> Emissions Trading on Firm Profits and Market Prices. *Climate Policy* 6, pp. 29-46.
- [71] *Trefler, D.* (1993): Trade Liberalization and the Theory of Endogenous Protection: An Econometric Study of U.S. Import Policy. *The Journal of Political Economy* 101 (1), pp. 138-160.
- [72] *Triebswetter, U.* (2004): The Impact of Environmental Regulation on Competitiveness in the German Manufacturing Industry: A Comparison with Other Countries of the European Union. Peter Lang, Frankfurt am Main.
- [73] *Ulph, A.* (1994): Environmental Policy, Plant Location and Government Protection. In: Carraro, C. (Ed.): *Trade, Innovation, Environment*. Kluwer Academic Publishers, Dordrecht, pp. 123-163.
- [74] *Ulph, A./Valentini, L.* (2001): Is Environmental Dumping Greater when Plants are Footloose? *Scandinavian Journal of Economics* 103 (4), pp. 673-688.
- [75] *UNCTAD* (1996): Incentives and Foreign Direct Investment. *Current Studies, Series A, No. 30*, United Nations, New York, Geneva.
- [76] *Wilson, J.D.* (1996): Capital Mobility and Environmental Standards: Is There a Theoretical Basis for a Race to the Bottom? In: Bhagwati, J./Hudec, R.E. (Eds.): *Fair Trade and Harmonization. Prerequisites for Free Trade? Volume 1, Economic Analysis*. MIT Press, Cambridge, London, pp. 393-427.
- [77] *Wilson, J.D.* (1999): Theories of Tax Competition. *National Tax Journal* 52, pp. 269-304.
- [78] *WTO* (2006): World Trade Report 2006: Exploring the Links Between Subsidies, Trade and the WTO. Online-source: [http://www.wto.org/english/res\\_e/booksp\\_e/anrep\\_e/world\\_trade\\_report06\\_e.pdf](http://www.wto.org/english/res_e/booksp_e/anrep_e/world_trade_report06_e.pdf)

- [79] *Zodrow, G.R./Mieszkowski, P.* (1986): Pigou, Tiebout, Property Taxation, and the Underprovision of Local Public Goods. *Journal of Urban Economics* 19, pp. 356-370.



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### Academic Education

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05/2004-01/2011	Participant in the Ph.D.-Programme “Quantitative Economics” at the University of Kiel
05/2004	Diploma in Economics, University of Kiel
10/2001-05/2004	Graduate Studies in Economics with Emphasis on International Economics
08/2000-08/2001	Studies in Economics and Political Science as Erasmus Exchange Student at the University of Stockholm, Sweden
10/1998-07/2000	Undergraduate Studies in Economics at the University of Kiel

### Working Experience

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05/2004-05/2010	Teaching and Research Assistant at the Chair of Microeconomics of Prof. Raff, PhD, University of Kiel
03/2002	Internship at the Chamber of Industry and Commerce, Kiel
10/1999-07/2000 and 09/2001-04/2004	Student Assistant at the Chair of International and Regional Economic Relations of Prof. Dr. Bröcker, University of Kiel
01/1998-06/1998	Travel Agent at the Hapag-Lloyd Travel Agency, Lübeck
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### Other Activities

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07/2005-08/2005	Summer School in China: Study Programme in Chinese Language and Culture, Zhejiang University, Hangzhou
10/1998-04/2004	Active Member of the Student Representatives’ Association (“Fachschaft”) at the Department of Economics

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