The Political Economy of Environmental Regulations and Industry Compensation

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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 stringency of domestic trade 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 tend to increase protection of the industry affected by environmental regulation. This compensation will even be more than complete as long as environmental interests are taken into account. Hence, contrary to what might be expected, a net gain of competitiveness in the polluting sector arises.

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1 Introduction

This paper examines whether and to what degree a government of a small open economy tends to compensate domestic industries for unilaterally introduced environmental regulations by moving to more protectionist trade-policy patterns. Specifically, I analyze 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 me to shed light on the question whether environmental regulations lead to a loss of competitiveness in the domestic polluting sector, as claimed by industry representatives and many economists.[1] In particular, I argue that this may not be the case, if endogenous trade-policy reactions are taken into account.

This issue is relevant for example in connection with the introduction of the European Emissions Trading Scheme (EU-ETS) on CO_2 due to January 1st, 2005, which is targeted at achieving the reductions in Greenhouse Gases (GHGs) agreed on in the Kyoto-protocol. 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.[2,3] For countries that ratified the Kyoto-protocol, the negotiated emissions reductions become binding so that the introduction of a cap on total emissions can be considered as exogenous.[4]

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 repre-

[1]See the literature related to the pollution havens hypothesis, e.g. Copeland/Taylor (2003) or Levinson/Taylor (2004), among many others, or Rauscher (1994). OECD (2006) provides some theoretical and empirical case studies, e.g. for the steel sector, concerning the sectoral competitiveness impacts of different environmental policy measures.

[2]For details see *http://unfccc.int/essential_background/items/2877.php* and Klepper/Peterson (2004).

[3]Although not only the EU countries alone, but altogether 168 countries (up to december 2006) have ratified the protocol, the EU can be seen as the only ratifying region so far which has really 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), pp. 3, Grubb/Neuhoff (2006), pp. 9 or Demailly/Quirion (2006), pp. 93 argue. Hence, environmental policy can 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.

[4]Admittedly, those policies are only exogenous at the moment of their introduction; during the preceding treaty negotiations, each country exercised influence in direction of a favorable outcome from its own point of view. However, as soon as some environmental objective is set by the overall number of treaty-participants, each can be assumed to comply with it. This is reasonable despite of a lacking worldwide "monitoring-institution" for environmental issues. 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 helps to build a good reputation. Hence, in order not to jeopardize current and future international cooperation, countries tend to countervail the potential negative economic effects of their environmental treaty-compliance by means of different policy measures rather than by not complying (this line of reasoning is perfectly consistent with the analysis in this paper).

sentatives 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 example, in November 2005, the Federation of German Industries (BDI) in a position paper claimed that unilateral European climate policy would have only little 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 (BDI (2005), p. 8). 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 (cp. PEW Center (2005), pp. 11 or Smale et al (2006), p. 30).[5]

As governments are not immune against such political pressures from important industries, some policy concession can be expected as a reaction that helps the affected groups accept the environmental restrictions imposed on them. In this paper, I investigate such a governmental reaction with respect to trade policy. In doing so, one has to consider that trade policies are usually restricted within GATT or within the EU. That is why I model trade policy in terms of a production subsidy rather than a tariff. In the EU, for example, subsidies are granted in terms of "State Aid" which is generally prohibited, but many exceptions exist (e.g. Aid for regional development purposes or so-called "horizontal objectives" like support for specific sectors, employment, R&D etc.).[6] Hence, governments may well introduce the ETS, while at the same time compensating the affected sectors by subsidizing their output.[7] A recent example for such behavior is illustrated in section 2.

In the context of this European experience, the aim of this paper is to investigate whether industry concerns with respect to adverse competitiveness-effects of environ-

[5]Other papers dealing with the above-mentioned debate include e.g. Demailly/Quirion (2006) or Grubb/Neuhoff (2006).

[6]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), pp. 110), one can observe the following evolution of State Aid patterns in the EU (15) countries: The overall ratio of Aid to GDP remained rather stable between 2000 and 2004, while Aid granted to the manufacturing sector rose from 24.3 to 33.5 billion Euros within the same period (cp. WTO (2006), p. 159).
In 2005, total Aid payments in the EU-25 countries amounted to 64 billion Euros which is equivalent to 0.6 percent of total GDP. Of this amount, 59 percent went to the manufacturing sector. The EU Commission´s target of reducing Aid-amounts turned out to be hard to meet. (Cp. the European Commission´s Homepage on State Aid, *http://europa.eu.int/comm/competition/state_aid/overview/index_en.html*).

[7]In what concerns a government´s motive for adjusting production subsidies, WTO (2006), pp. 65 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), pp. 42 illustrate how compensation for losses of competitiveness is actually granted to polluting sectors in case of restrictive environmental policies.

mental regulations are generally justified, i.e. to answer the question whether one should really expect an overall loss in international competitiveness in the affected industries if one considers endogenous trade-policy reactions, more specifically, reactions in the choice of the subsidy-rate.

To analyze this issue, a simple small-open-economy model with sector-specific capital in two sectors will be applied. The import-competing sector produces a polluting good by using labor, capital and an environmental factor (i.e. emissions), while the export sector produces a clean numeraire good with only labor and capital. The economy 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 derives disutility from environmental damage. I assume that a binding exogenous cap on total emissions is introduced, lowering productivity in the polluting sector. The endogenous trade-policy reaction to this 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 can be summarized as follows: First, there is indeed a tendency of governments to compensate industries subject to restrictive environmental regulations. Second, as it turns out that compensation is more than complete in the presence of an environmental interest group, polluting industries will experience a net gain in international competitiveness rather than a loss. The environmental interest´s political weight has a positive impact on the degree of industry compensation or, put differently, environmental interests work in the direction of more protectionist trade regimes although they are not directly affected by the trade policy under consideration.[8]

The conceptual basis for the current paper goes back to Hillman (1982) who developed a political-support-function approach to analyze the incentives a government has to protect declining industries. This approach was taken up by Bommer/Schulze (1999), who adapted it to answer the question which impact trade liberalization has on environmental-policy choice. The authors do not model trade policy explicitly; it is rather represented by changes in the relative price of the economy´s export good. The analysis shows that trade liberalization will make domestic environmental policies more restrictive if the polluting sector is the exporting one.

The present paper is closely related to the latter, but it reverses the question posed: Whereas in Bommer/Schulze (1999), trade policy is exogenous due to the country´s membership in the EU and/or GATT/WTO, and the government chooses environmental policies, here, environmental restrictions are exogenous due to membership in

[8]An opposing result was derived by Hillman/Ursprung (1994), though in a different framework (i.e. there is two-party political competition in a partial-equilibrium framework, the foreign industry acts as a lobby group in the domestic country, lobbies pay campaign contributions to parties, markets are subject to imperfect competition): They found that, if environmentalists do not care about the foreign environment (i.e. they are "greens" and not "super-greens") and pollution is caused by production (rather than consumption), assumptions that also hold in this paper, the environmental interest group will favor freer trade over protection. In general, however, environmentalists favor protectionist trade policy regimes like in my paper.

environmental treaties like the Kyoto-protocol and the government chooses trade policy.

Concerning the research question, my approach also relates to Eliste/Fredriksson (2002) and Ederington/Minier (2003). Eliste/Fredriksson (2002) consider the US agricultural sector and analyze both theoretically and empirically whether the imposition of stricter environmental regulations leads to increased government transfers to that sector. Their model builds on the Grossman/Helpman (1994) "protection-for-sale" approach with two interest groups. The policy instruments under consideration are a pollution tax and a production subsidy. Although their model differs from mine in some respects,[9] one basic result is the same: Transfers to the polluting agricultural sector will indeed increase. This result is also supported by the empirical analysis.
In their purely empirical analysis, Ederington/Minier (2003) address the question whether international trade-agreements should be extended to also include environmental-policy coordination. They suspect that, if trade policy is restricted by the commitment to international treaties, environmental policy is used as second-best trade policy to support domestic import-competing industries. The authors run an empirical test of the hypothesis that environmental policy is determined endogenously by international-competitiveness considerations and find that this is indeed the case.
Hence, both Eliste/Fredriksson (2002) and Ederington/Minier (2003) come to qualitatively similar results as the current paper: Import-competing sectors adversely affected by environmental restrictions are supported by endogenous policy-adjustments. However, differently from this paper, no conclusions with respect to the quantitative extent of this compensation, resp. the *net* competitiveness-effect of environmental regulations are derived.

My paper differs from Bommer/Schulze (1999) with respect to some specific features: Here, for example, the polluting sector is the import-competing one instead of the export sector. This is due to industry characteristics in the EU: 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 (cp. Klepper/Peterson (2004)). Within those sectors, the EU typically is a net importer. For example in 2004, the EC-15 countries covered their own energy needs (i.e. oil, coal and natural gas) by only 50%, the remainder was imported from third countries (cp. WTO (2004), p. 107). As data from EUROSTAT[10] show, in 2004, the EU has also been a net importer of

[9] As the most important differences, the following are to be mentioned: First of all, Eliste/Fredriksson (2002) use a partial-equilibrium model ignoring policy repercussions on the clean numeraire sector and workers. Hence, those sectors are not organized as lobbies. Second, the political-economy framework is a different one: Instead of maximizing political support, governments in their model maximize a weighted sum of contribution payments by the environmental- and agricultural (i.e. "dirty") lobbies and social welfare. A third difference concerns environmental policy: This is represented by a pollution tax instead of a total emissions limit. As a consequence, environmental policy via agricultural output impacts on total emissions unlike in my model.

[10] Cp. the information on http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=Yearlies_new_environment_energy&depth=4 .

mineral fuels, lubricants and related materials. In the future, the enlarged EU´s need for energy imports will still rise to up to 70% of total energy use, as a press release by the EU Commission from July 24th, 2006, points out.

However, within the political-support-function framework chosen here, which assumes that a government seeks to maximize a weighted aggregate of individual voter groups´ welfare, this distinction does not alter the results: As long as the compensating subsidy is directly targeted at the polluting sector subject to environmental regulation, 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 incentive for more protectionist behavior in form of increasing subsidy payments.[11]

Other papers using a political-support-function approach to analyze the trade/environment relationship are for example Bommer (1996) or Rauscher (1997).[12]

However, most of the existing literature on the issue considers the trade regime or a trade policy change as exogenous and concentrates on the endogenous determination of environmental policies:[13] Bommer (1996) analyzes the impact of changes in the tariff rate (which is used to represent all possible trade policy measures to be abolished in the process of European integration) on the determination of production and process standards in an imperfectly competitive market. He finds that under certain conditions concerning the relative power of environmental interest groups in member countries it is possible that environmental standards will be increased in the course of market integration.
Rauscher (1997) does not model trade policy explicitly: He assumes completely free trade to be already prevalent and analyzes how different measures of environmental policy are determined in the presence of interest group influence. In his approach, environmental policy serves as implicit trade policy. There are situations in which

[11] This is different in Bommer/Schulze (1999) as they analyze the impact of trade liberalization (generally inducing 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, i.e. whether it loses or benefits from freer trade.

[12] Besides those examples, the majority of analyses on the trade/environment relationship apply the "protection-for-sale" approach by Grossman/Helpman (1994): Examples include Fredriksson (1997a, b), Aidt (1998), Schleich (1999), Conconi (2000, 2003), Schleich/Orden (2000). Those papers are in general concerned with the impacts different lobby groups have on the determination of environmental- and trade policies, and thus on environmental quality. Depending on the model assumptions e.g. with respect to country size, policy availability or type of lobby, it turns out that neither the presence of environmental lobbies unambiguously implies stricter environmental policies nor that of industry lobbies weaker policies. What can be stated, however, is that lobbies in general induce socially suboptimal policy decisions.
Only Fredriksson (1997a), however, explicitly asks which effects trade liberalization has on pollution taxes and -levels. It turns out that declining tariffs may induce lower pollution taxes and thus higher environmental damage. Hence, trade liberalization in a small country can no longer be considered to be unambiguously welfare-increasing.

[13] One exception is the work by Hillman/Ursprung (1992, 1994), who analyze the determination of trade policies when there are environmental concerns (i.e. interest groups). There is, however, no environmental policies explicitly considered in their papers.

both lobby groups, environmentalists *and* the specific production factor, favor stringent environmental policies, but opposing interests may also arise.

The rest of the paper is organized as follows: The next section provides an illustrative example of how governments might compensate domestic polluting industries for environmental regulations. Section 3 presents the basic model by introducing all relevant interest groups and the political framework under which government decisions are taken. Section 4 derives the political equilibrium with respect to the trade policy variable first in general and then as a reaction to exogenous environmental policy. Both the direction and the magnitude of the policy adjustment as well as the latter´s determining factors are discussed. Finally, section 5 concludes.

2 Example: costless emissions permits

As mentioned in the introduction, governments can be expected to make certain policy concessions to groups (here: industries) adversely affected by environmental restrictions. With respect to the introduction of the EU-ETS, an immediate example for such behavior is the costless allocation of emissions permits through the member countries´ NAPs. Such free allocation comprises two elements of a subsidy (cp. Johnston (2006), pp. 188): The first is the value of the allowances themselves. Those have a positive market price as soon as emissions are traded, but industries receive them for free. 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.[14]
Whether the costless receipt of emissions allowances represents more 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 modeling a production subsidy seems to be an appropriate approach.

The view that costless permit allocation constitutes an implicit subsidy, or, more specifically, in the EU case, an element of State Aid, is commonly held in the literature. For example, Grubb/Neuhoff (2006), pp. 14 characterize the phenomenon, analogously to this paper, as "compensation for forgone profits due to the environmental regulation". Smale et al. (2006), pp. 29, argue in a similar way. Johnston (2006), pp. 132, by taking a legal perspective to approach the issue, comes to the same conclusion: He finds strong

[14] 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 like JI or CDM, 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 subsidy, cp. e.g. Betz et al. (2004), for the second trading period 2008-12 Rogge et al. (2006).

arguments supporting the view that free allowances involve elements of State Aid. He also points out that even the EU Commission adopts this view which became obvious in its assessment of the French NAP (although no formal decision with respect to State Aid was taken, cp. pp. 118).

In the first emissions trading period 2005-07, the EU Commission allowed for 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, up to 10 percent allocation via auctioning are allowed. But, again, only 10 out of 25 Member countries plan to choose this allocation method (for an overview table see appendix 6). None of these countries, however, fully uses up its permission of 10 percent auctioning.
A look at European NAPs also provides some evidence for 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 (and could thus sell on the market). The level of this over-allocation (measured as share of allocated emissions permits that were not used up in total allocation) ranges from 5 percent in Germany to 26 percent in Finland.[15]

These observations strongly support the notion that EU countries tend to compensate their polluting industries by allocating costless emissions permits among them and that they often do so in an excessive manner. To get an impression of the monetary value of the subsidization, one can have a look at the permit prices as they represent the value of the subsidy: The average price for an allowance in 2005 was 19.9 Euros (although subject to high volatility with prices ranging between 9 and 30 Euros, cp. CRS (2006), pp. 8). By the end of 2006, however, permit prices have dropped to around 7 Euros and even further in January, 2007, to around 4 Euros (cp. e.g. the webpage of the European Climate Exchange, ECX).
The number of (costlessly) allocated allowances in a country corresponds to its cap on total CO_2 emissions according to the NAP. In Germany, for example, 499 Mt of emissions are allowed between 2005 and 2007, compared to expected 465 Mt from 2008-12 (data from the webpage of the German Environmental Ministry, BMU). In the UK, for the first ETS-phase 245 Mt emissions allowances were allocated compared to 238 Mt in the second phase (data from the UK Department for Environment, Food and Rural Affairs, defra). Hence, the value of these allowances in the first phase can be roughly estimated as 9.98/4.9 billion Euros on average in Germany/the UK.

[15] For data see $http : assets.panda.orgdownloads/wwf\_can\_table.pdf$.

3 The model

3.1 Production

There are two sectors, I and II. Both exhibit constant returns to scale and there is perfect competition on goods- and on factor markets. Supply of specific capital is fixed as well as total labor supply, i.e. $L^I + L^{II} = \overline{L}$. Thus, an increase in labor in one sector must be accompanied by a respective decrease in the other sector: $\triangle L^I = -\triangle L^{II}$.

The import-competing "dirty" sector produces a good x^I, a substitute to the foreign good x^{imp}, by using sector-specific capital $\overline{K}^I$, mobile labor L^I and an environmental factor E. Specifically, use of the environment (i.e. pollution) makes production more efficient (subscripts denote partial derivatives):

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

Producers in sector I receive a subsidy s per unit of output. As a consequence, producer- and consumer prices do not coincide:[16] While consumers face the world market price p^w, producers receive the additional amount s: $p^p = p^w + s$.

The return to the specific factor in sector I is given by

$$\Pi^I = p^p x^I - wL^I = p^p g(E)F(\overline{K}^I, L^I) - wL^I, \quad (2)$$

where w is the wage rate. Profit maximization yields the common result that labor is paid its marginal product: $w = p^p g(E)F_L^I$.

The other sector, a "clean" one, produces a numeraire good by using sector-specific capital $\overline{K}^{II}$ and mobile labor L^{II}:

$$x^{II} = F(\overline{K}^{II}, L^{II}) \qquad \text{with} \qquad F_L^{II} > 0, F_{LL}^{II} < 0. \quad (3)$$

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

$$\Pi^{II} = x^{II} - wL^{II} = F(\overline{K}^{II}, L^{II}) - wL^{II}. \quad (4)$$

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

$$w = p^p g(E)F_L^I = F_L^{II} \quad (5)$$

and equal across sectors due to labor mobility.

Profits in the two sectors then are:[17]

$$\Pi^I = p^p g(E)[F(\overline{K}^I, L^I) - F_L^I L^I] \quad (6)$$
$$\Pi^{II} = F(\overline{K}^{II}, L^{II}) - F_L^{II} L^{II}. \quad (7)$$

[16] Let p denote the relative price of good I, i.e. the price of good I in terms of the numeraire good II.

[17] In the following, the terms "profit" and "return to the specific factor" will be used as synonyms.

3.2 Workers

The individual utility of a worker is determined by his level of income.[18] It is assumed that each worker supplies one unit of labor and that there is no unemployment. Thus, labor income is w. The subsidy to the polluting sector is financed via a lump-sum tax on workers which implies that each of them bears an equal share of the total transfer $S = sx^I$. Hence, individual income of a worker is given by:

$$I = w - \frac{sx^I}{\overline{L}}. \tag{8}$$

3.3 The environment

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

$$D(E) \quad \text{with} \quad D_E > 0 \quad \text{and} \quad D_{EE} > 0, \tag{9}$$

i.e. marginal damage is increasing in E. This kind of damage function abstracts from transboundary pollution, i.e. negative effects domestic (foreign) emissions have on the foreign (domestic) environment are not considered.[19]

[18] One might annotate that a worker´s utility should also be influenced by environmental damage as each consumer will exhibit some kind of preference for a clean environment. In the political-support-function approach applied here, however, a government is assumed to maximize political support over different interest groups (i.e. lobbies) which in turn represent their members´ common interests *with respect to a certain issue.* Workers here are organized as a labor union which usually focuses on issues directly related to labor, mainly income. Environmental concerns of workers, in this model, are expressed via the environmental interest group (alternatively interpreted as "general environmental interest", see below): The more expressed environmental concerns in a country are, the higher will be the political weight of the environmental group. However, including environmental damage into a worker´s utility function would not alter the qualitative results and influence the quantitative results in the same way a higher political weight of the environmental interest group would do (cp. section 4.2.2).

[19] 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 (cp. section 4 and Appendix 1b) if the induced external effects and thus reactions of the foreign country (ROW) are taken into account:

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

Depending on sign and size of the term $\frac{\partial E^{ROW}}{\partial E^d}$, positive effects of domestic environmental policy may be strengthened, weakened, leveled out or even reversed.

3.4 The government

In representative democracies like e.g. in European countries, governments are elected by voters. It can be considered as the main goal of an incumbent government to be re-elected. The probability of being re-elected is influenced by the support a government receives from different interest groups. This support can be interpreted as implicit or explicit (re-)election recommendations to voters expressed by those lobbies.[20,21] A common public appearance at events organized by the governing party resp. the lobby group could for example constitute an implicit recommendation to vote for the government (example: labor unions invite the president/chancellor). More explicit recommendations could be given in form of position papers or positive public statements concerning a government position on some policy in the media (example: an industry representative supports the government´s tax policies in a newspaper article).

Hence, a government maximizes a political support function G over different interest groups, where G is a weighted aggregate of those groups´ utilities. In doing so, tradeoffs between opposing interests of different groups have to be considered: A policy measure which is beneficial for one group and thus raises that group´s political support may be harmful for another group and so decrease the latter group´s support in turn.

Interest groups which are considered by the government are first of all the group of workers, or labor ($\overline{L}$), organized in a labor union. They enter G via income I according to eq. 8: The higher this income (and thus utility), the more labor representatives support the government.

In addition, sectors I and II (i.e. the owners of the specific factors) are organized as interest groups. As their goal can be seen to achieve maximum profits, those groups are represented by Π^I and Π^{II} (cp. eqs. 6 and 7) in G with political support depending positively on the respective profits.

However, interdependencies between different countries are not in the scope of this model as it 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 reaction of foreign emissions. This, however, would not add further insights to the analysis as it could equivalently be expressed by simply modifying the damage function D which is not specified anyway. An economically plausible example would be to assume $-1 < \frac{\partial E^{ROW}}{\partial E^d} < 0 \Rightarrow \frac{\partial D}{\partial E^d} < \frac{\partial D}{\partial E^w}$, i.e. positive effects of domestic environmental policy are weakened by the foreign reaction. The implications of varying levels of marginal environmental damage for the model results are discussed in section 4.

[20]It should be mentioned here 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 policies, general party preferences/sympathies, etc. However, the probability that c.p. a government is re-elected can be increased by interest groups´ political support.

[21]Campaign contribution payments are intendedly not mentioned here as the analysis focuses on Europe, where such payments are not a common practice like for example in the US. In the EU, direct lobbying of the government is a rather complicated process, in which money payments are officially not prevalent. For details see *http://www.europarl.eu.int/workingpapers/pana/pdf/w5en_en.pdf*

Finally, there is an environmental lobby, i.e. a group that cares only about domestic environmental quality.[22] Its goal is to minimize environmental damage which is caused by industry-I emissions. Thus, damage D enters the support function negatively, i.e. a rise in environmental damage decreases political support by the environmental interest group.[23]

A general political support function including all the above-mentioned groups is thus given by: $G = G(I, \Pi^I, \Pi^{II}, D)$.

Within G, the government attaches different weights to those groups´ utilities, depending on their ability to influence the government itself on the one hand and, on the other hand, voter decisions (or "public opinion"). Because the government´s ultimate goal is its own re-election, the former type of a lobby´s political influence is determined by the latter type. Hence, the influence on public opinion is decisive for the political weight of a lobby. 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 example, in countries where people are environmentally aware, the environmental interest group can be expected to have a strong influence on public opinion, which should translate into a high political weight in the support function.

4 The political equilibrium

Due to the small-country assumption and the analysis of a trade policy instrument not distorting consumer prices, the impacts of policy measures on the different interest groups´ utilities (except for the environmental IG) can be measured solely by changes in their income.

Trade policy is represented by a subsidy s per unit of output to the polluting sector I, which is financed by a lump-sum tax on workers.[24] The impacts of this policy measure on the different IG´s utilities are summarized in Lemma 1:

Lemma 1 *When 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 1a. □

[22]This assumption implies that environmentalists do not care about foreign, or world-wide pollution. Hence, "greens" rather than "supergreens" are considered here.

[23]The term D in the support function (see below) may also be interpreted as some kind of general environmental concern among the population which is considered by the government.

[24]If instead of a production subsidy, a trade policy instrument was analyzed which distorts not only producer- but also consumer prices, the model applied here would not be appropriate anymore as no explicit assumptions on consumer choices are taken.

The intuition behind Lemma 1 is that the subsidized sector I raises output as reaction to the increased producer price of its good. This improves its own profits but detracts labor from sector II and so 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 which they have to pay for. Hence, workers´ total income declines. The environmentalists´ utility is solely determined by the national emissions level E which does not change when the subsidy is raised.

Environmental policy is exerted via a (binding) quantitative cap on total emissions in the polluting sector, $\overline{E}$.[25] The impacts of this policy measure on the different IG´s utilities are summarized in Lemma 2:

Lemma 2 *When environmental restrictions are strengthened, the return to the specific factor in the polluting sector declines ($\Pi^I_E > 0$), the return to the clean sector´s specific factor rises ($\Pi^{II}_E < 0$), 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 1b. □

The intuition behind Lemma 2 is similar to what was explained with respect to Lemma 1: A stricter emissions cap decreases labor productivity (and thus wages) in the polluting sector so that 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 decline in subsidy-payments as output in the subsidized sector shrinks. Concerning environmentalists, it is obvious that they benefit from an improved environment.

4.1 Policy choice in general

As described in section 3.4, the government maximizes a political support function G over all interest groups. This function G is twice continuously differentiable. Political support is assumed to increase 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 $(-)V_i$ stands for the level of (dis)utility of any group i, as illustrated in Figure 1:

The policy instrument available here is the subsidy to the polluting sector I. The first-

[25] Though it is not arguable that output-based instruments of emissions-control like taxes are more efficient than quantitative restrictions, such standards are more often observable in practice for different reasons already elaborated on by e.g. Buchanan/Tullock (1975). Hence, many papers dealing with environmental-policy choice follow these findings and consider standards rather than taxes (cp. e.g. Oates/Schwab (1988) or Bommer/Schulze (1999)). Recent examples include, as described in the introduction, the Kyoto protocol or the US Clean Air Act (last amendment in 1990, cp. *http : www.epa.govoaroaqpspeg_caapegcaa02.html*).

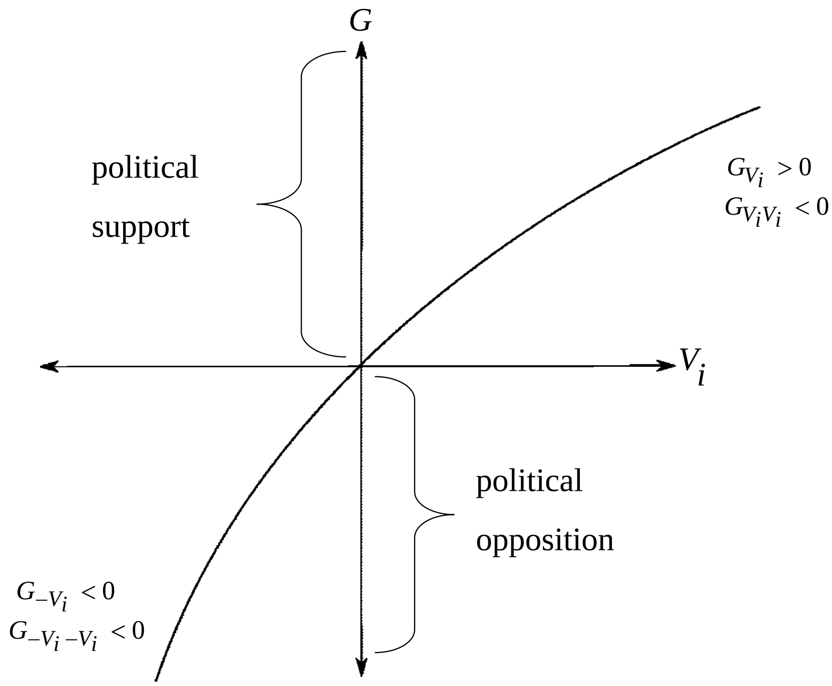

fig. 1: properties of the political support function G

order condition is given by:

$$G_s = G_I I_s + G_{\Pi^I} \Pi_s^I + G_{\Pi^{II}} \Pi_s^{II} + G_D \underbrace{D_s}_{=0} \overset{!}{=} 0. \tag{10}$$

Condition (10) implies that marginal political support from the winners of a subsidy is equated to marginal political opposition from the respective losers and leads to the choice of a unique subsidy s* which maximizes political support over all relevant groups. The environmental interest group does not directly influence this choice because their utility does not depend on s, as was shown above and in appendix 1b.

4.2 Policy choice as a reaction to environmental restrictions

In order to analyze a government´s incentive to compensate an industry for the introduction of restrictive environmental policies, it is assumed that, departing from an initial situation with no restrictions on environmental use at all, a binding cap on total emissions in industry I, $\overline{E}$, is introduced. This policy is considered to be exogenously determined. Here, it should be mentioned that for the EU example which is used to motivate this paper, the cap on total emissions necessary for achieving the Kyoto-target is attempted to be achieved by an emissions trading scheme. The model, however, is more general in that it does not consider *how* emissions reductions are achieved by the government. Hence, efficiency considerations with respect to different instruments of environmental policy or the governmental decision problem as to how achieve a given emissions reduction are not subject of this analysis.

4.2.1 The direction of the trade-policy adjustment

As discussed above, the "new" policy $\overline{E}$ will lead to losses in utility and thus political support by some groups and to respective rises by other groups.

The question to be answered now is how trade policy, represented by the subsidy s, has to be adjusted in order to keep political support at its maximum level. Formally, sign and magnitude of $\frac{ds}{dE}$ have to be determined. Total differentiation of eq. 10 yields:

$$\begin{aligned} G_{ss}ds + G_{sE}dE &= 0 \\ \Rightarrow \quad \frac{ds}{dE} &= -\frac{G_{sE}}{G_{ss}}. \end{aligned} \tag{11}$$

The interpretation of eq. 11 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 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 1 states this paper´s first result:

Proposition 1: *In an economy where the government aims at sustaining a maximum level of total political support, there is a negative relationship between the policy variables E and s, i.e. stricter environmental regulations induce increased protection of the domestic polluting industry.*

Proposition 1 follows from considerations on the signs of denominator and numerator in eq. 11 that suggest both terms be negative:
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:[26]

$$G_{ss} = G_{II}(I_s)^2 + G_I I_{ss} + G_{\Pi^I\Pi^I}(\Pi^I_s)^2 + G_{\Pi^I}\Pi^I_{ss} + G_{\Pi^{II}\Pi^{II}}(\Pi^{II}_s)^2 + G_{\Pi^{II}}\Pi^{II}_{ss}. \tag{12}$$

As pointed out in section 4.1, marginal political support is positive but diminishing by assumption so that the first, third and fifth element of eq. 12 are negative. In order to ensure the whole term to be negative, what remains to be determined are the signs of I_{ss}, Π^I_{ss} and Π^{II}_{ss}, i.e. of the second, fourth and sixth elements of the equation. The common assumption of declining marginal utility/rising marginal disutility would imply all three terms be negative.

[26] Following Bommer/Schulze (1999), p. 646, no so-called envy effects are assumed to exist: $G_{V_iV_j} = 0 \quad \forall \quad i \neq j$, i.e. marginal utility of one group is not affected by utility-changes of another group.

The numerator of eq. 11 is given by:

$$G_{sE} = G_{II} I_s I_E + G_I I_{sE} + G_{\Pi^I \Pi^I} \Pi_s^I \Pi_E^I + G_{\Pi^I} \Pi_{sE}^I + G_{\Pi^{II} \Pi^{II}} \Pi_s^{II} \Pi_E^{II} + G_{\Pi^{II}} \Pi_{sE}^{II}. \quad (13)$$

What can be said about its overall sign? Similarly to the case of G_{ss}, no unambiguous statements valid for all functional forms can be made. However, economic-plausibility considerations suggest G_{sE} to be negative as well as the term consists of very similar elements as G_{ss}. The latter must be negative for s^* to meet the second-order condition for maximum political support. In case the sufficient conditions for this, i.e. non-convexity of profit- and income functions, are fulfilled, it is economically plausible that also the respective conditions for $G_{sE} < 0$ are met, as the policy variables s and E impact on profits and income in the same direction (calculations in appendix 2 use the specific example of a Cobb-Douglas production function to show that both G_{ss} and G_{sE} being negative is reasonable in a standard analytical framework).

Proposition 1 leads to the conclusion that the government indeed has an incentive to compensate the industry subject to environmental policies $\overline{E}$ by a rise in the subsidy-rate s, which is not a surprising result. Hence, part of the gain from environmental restrictions which is accrued by the clean sector, workers and the environmental interest group is redistributed to the losers from environmental policy, the polluting sector.

4.2.2 Magnitude and determining factors of the trade-policy adjustment

While the qualitative effect of an increase in environmental regulations (i.e. a reduction of emissions allowances) is now clear, the quantitative extent of this effect remains to be discussed. This extent determines whether the combination of environmental- and trade policies leads to overall losses or benefits concerning the utilities of the different interest groups compared to their initial situation. For this purpose, the concept of "completeness" is introduced. It is interpreted in terms of the initial income-distribution: Compensation of the losers from environmental policy is complete if the induced change in trade policy retains the initial income-distribution among industry I, 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, however, is the overall impact of the policy mix on profits (and thus competitiveness) of the polluting sector.[27] What turns out in the analysis is a rather unexpected result stated in proposition 2:

Proposition 2: *Compensation of sector I for losses caused by environmental policies will be more than complete as long as the environmental interest (group) is attached some political weight. In other words, the increase in the losers´ welfare achieved by a higher subsidy is higher than their original loss due to a reduced emissions allowance, i.e. they benefit from a net welfare gain.*

Proof: See Appendix 3. □

[27]The case of complete compensation also implies that the initial level of total (economy-wide) income is retained, i.e. that the overall income-loss from the distortion of production patterns induced by environmental policy is completely offset by trade policy.

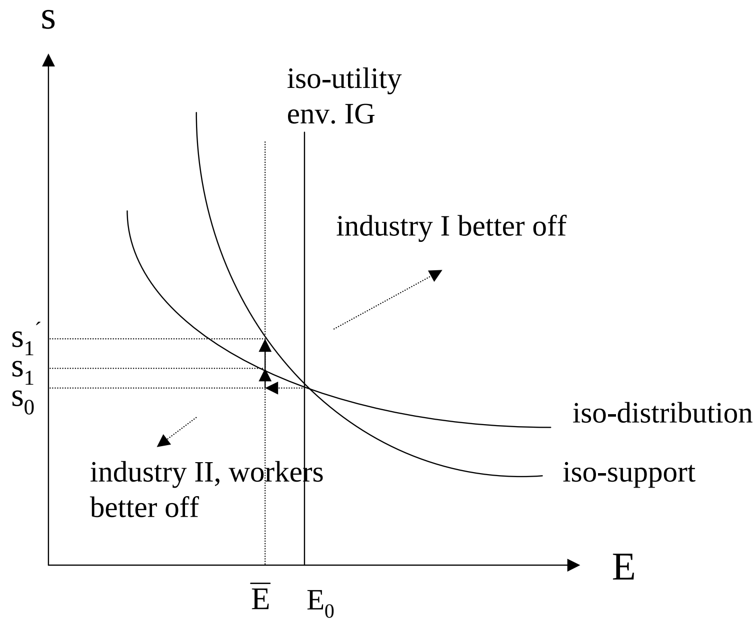

fig. 2: iso-support- versus iso-distribution curves

Proposition 2 is illustrated by figure 2: The iso-distribution curve shows all combinations of policies s and $\overline{E}$ that lead to the same distribution of income among industries I and II and workers. This curve is convex because of the assumption of diminishing marginal utilities and rising marginal disutilities.[28] Respectively, the iso-support locus depicts all combinations of s and $\overline{E}$ that induce the same level of overall political support. In contrast to the former curve, the latter considers the utility level of the environmental IG. This alone is depicted as a vertical line through the emissions level, as the subsidy does not influence the environmentalists´ utility. Hence, a graphical combination of the iso-distribution- and the environmental-utility curve yields an iso-support curve somewhere in-between, i.e. steeper than the iso-distribution locus.

In case the environmental group had no influence at all, the iso-distribution- and iso-support curves would coincide, and compensation would be complete (i.e. s would be increased so that the initial income-distribution is retained). However, in the presence of some 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 in order to simply retain income distribution (i.e. from s_0 to s_1). The figure also illustrates that industry I is better off in the presence of an environmental interest group than it would be without

[28]For details on the slope of the iso-distribution curve see appendix 4.

it, while industry II and workers are worse off.

What is the intuition behind these results? In addition to their impacts on income distribution and in contrast to trade policy, environmental policies (resp. the induced environmental improvements) have a value in themselves. As a consequence, a given level of overall political support can be achieved by lower support from IGs other than the environmental one if a country´s environmental performance is improved. That is, the initial income-redistribution caused by $\overline{E}$ does not have to be reversed completely by an adjustment in s. Hence, the new political equilibrium yields a net reduction in aggregated political support from industries I and II and workers because declines in support from the trade policy losers (industry II and workers) outweigh the rise in support from the polluting industry I. 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 of an environmental IG, however, is it possible to do so without losing overall political support.[29]

So far, the analysis has shown that compensation will be more than complete. What remains to be discussed are the factors responsible for the extent of this excess compensation. The results are summarized in the following proposition:

Proposition 3: *The extent of the polluting industry´s excess compensation is positively affected by the level of marginal environmental damage D_E (equivalent to the absolute pollution-level) and the political weight of the environmental interest. In addition, there is some negative influence from the political weight of the clean industry and workers, that is, of the loser group from protection. The impact of the polluting industry´s own political weight is indeterminate.*

Proof: See Appendix 5. □

The first part of proposition 3 implies that, as a high level of marginal damage is associated with a high pollution level, the political necessity to compensate an industry for environmental restrictions is the higher, the "dirtier" this industry is. Furthermore, environmental concerns (i.e. an environmental interest group) have a positive impact on policies favoring the polluting industry (i.e. the subsidy) although environmental damage is not affected by those policies. The intuition is that in situations with severe pollution also the environmental IG´s utility and -political support are very sensitive to environmental policies so that the potential for decreases in support from other groups is large from the government´s point of view.

[29]Also other papers belonging to the political-economy literature find that governments have a preference for supporting domestic industries exposed to international competition (i.e. the import-competing sector like in this paper), cp. Ederington/Minier (2003). The empirical observation that trade protection is positively related to the degree of import-penetration (cp. the theory of endogenous protection, e.g. in Trefler (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 made up by the relevant interest groups).

In terms of Figure 2, the degree of excess compensation, or, respectively, the extent to which industry I is better off in the new equilibrium, can be measured by the difference in the absolute values of the slopes of the iso-support- and iso-distribution curves in the initial situation (E_0, s_0):

$$\underbrace{\left|\frac{s_0 - s_1'}{E_0 - \overline{E}}\right| \approx \left|\frac{ds}{dE}\right|_{\overline{G},E_0}}_{\text{slope of iso-support curve at } E_0} > \underbrace{\left|\frac{ds}{dE}\right|_{\overline{dist.},E_0} \approx \left|\frac{s_0 - s_1}{E_0 - \overline{E}}\right|}_{\text{slope of iso-distribution curve at } E_0} . \tag{14}$$

The more those slopes deviate from one another, the more will sector I be over-compensated. The difference in the curves´ slopes in turn is mainly determined by the value of the change in political support from the environmental IG induced by the environmental restrictions:[30]

$$\underbrace{\frac{ds}{dE}\Big|_{\overline{G}}}_{<0} = \underbrace{\frac{ds}{dE}\Big|_{\overline{dist.}}}_{<0} - \underbrace{\frac{dG}{dD}\frac{dD}{dE}}_{<0} < \underbrace{\frac{ds}{dE}\Big|_{\overline{dist.}}}_{<0} . \tag{15}$$

The second result concerning the clean industry and workers is immediately apparent as these groups benefit from environmental- and lose from trade policy: If they are attached a higher political weight, compensation of the polluting industry and thus losses of these groups will be lower.

Part three of proposition 3 implies that it is well possible that a high political weight of the polluting industry has a detrimental effect on the compensation it can expect for restrictive environmental regulations. A negative impact of its own political weight arises in a setting where environmental-policy impacts on profits are relatively weak compared to trade-policy impacts. Hence, if industry I was aware of this interrelation, it should prefer not to demonstrate too much political influence in order to avoid being attached a too large weight by the government and so be worse off in the political equilibrium.

Expressed graphically, the iso-support curve becomes flatter when industry II and/or workers are weighted more and either steeper, flatter or unchanged when industry I is weighted more. The iso-distribution locus, however, is unaffected. Hence, the degree to which groups are worse/better off in the presence of an environmental interest group than without it may vary with the political weights.

5 Conclusion

This paper examined the impacts of exogenous environmental regulation on the choice of trade policy and on the international competitiveness of the polluting sector in a small open economy.

[30]This holds for equal political weights of all interest groups. How differences between those weights affect the outcome is discussed below.

It turned out that there is an incentive for a political-support maximizing government to compensate the polluting sector for restrictive environmental policies by increasing that sector´s output subsidization: The country becomes more protectionist when environmental restrictions are imposed exogenously.
In contrast to what might be expected and to what is claimed by industry representatives in the public debate, a net *gain* in international competitiveness for the polluting sector arises. In other words, industry compensation will be more than complete. The reason for this outcome is an environmental interest group whose political support is positively affected by increased environmental regulations and not affected at all by trade policy. Hence, their gain from the initial decrease in the emissions allowance is not touched by the following increase in the subsidy. Maximum political support can thus be retained even if support from other groups than the environmental interest declines; an outcome which is achieved by increasing the polluting industry´s profits by more than their initial loss (or, by more than in case the environmental interest group did not exist).

Due to rising marginal environmental damage and a positive impact of marginal damage on the degree of industry compensation as shown in this paper, this feature is especially relevant in countries at a high level of development. It is known from the literature on the environmental Kuznets-curve (EKC),[31] that the level of environmental protection positively depends on a country´s GDP (after a certain threshold is passed, i.e. the curve has a U-shape). The reason is that preferences for a clean environment rise with increasing wealth of the population.

What does this imply for the public debate e.g. on the economic consequences of the Kyoto-protocol resp. the EU-ETS? Industry concerns about losses in competitiveness in terms of profit declines are, according to this paper´s analysis, completely unjustified. On the contrary, the polluting sector can even expect to be better-off if exogenous environmental restrictions are implemented. Two conclusions can be drawn from this finding: First, interest groups adversely affected by some policy measure should consider that there is more than one policy instrument available to politicians. As in the model discussed here, compensation for potential income-losses can be expected in terms of a different policy instrument if the instrument directly under discussion is restricted exogenously, e.g. by international agreements. Second, lobbies should also be aware that the government aims at maximizing *overall* political support from all relevant interest groups, thus trading off gains and losses from different groups against each other. This creates the chance of being more than compensated for potential losses. Taken together and re-considering the example of the EU dirty-industry´s arguments in the run-up to the ETS introduction, those findings suggest that expectations of interest groups concerning adverse policy-impacts are potentially biased towards being too pessimistic.

At this point, alternative approaches to analyze the issue under consideration in this

[31]Cp. e.g. the theoretical work by Selden/Song (1994) or empirical studies by Grossman/Krueger (1995) or Hettige et al. (1999).

paper should be mentioned as well as some propositions for future research.

One remark concerns the application of a sector-specific-capital model of international trade. This implies a short-run perspective as in the long run, capital will be mobile between sectors. A more farsighted perspective was e.g. taken by Copeland/Taylor (2003) who developed a Heckscher-Ohlin-type model of trade between two countries differently endowed with labor, capital and an environmental factor (the latter´s availability determined by environmental policy). Their analysis, however, does not contain political-economy aspects.
Inter-sectoral capital mobility in the political-economy framework applied here leads to a plausibility problem. The government is assumed to maximize support over different interest groups. With mobile capital, factors (i.e. "capital" and "labor") rather than sectors would have to form lobbies. While this is not much of a problem to be thought of for the case of labor (and has already been done in the present paper), the formation of a lobby representing the whole factor "capital" is hard to imagine as interests are likely to differ a lot between different sectors of production. If, despite this problem, a Heckscher-Ohlin framework is applied to analyze the distributional- and political-support effects of environmental- and trade policy and the induced consequences for policy determination, the basic results should not differ from those in the sector-specific-capital case: According to the Stolper Samuelson Theorem, capital loses real income when environmental restrictions are introduced if the polluting (i.e. environmental factor-intensive) sector is assumed to be also capital-intensive. On the other hand, labor benefits. Like before, in order to retain maximum political support, the government partly compensates capital by raising the subsidy. The reason for the incompleteness of compensation is the same as in the sector-specific-capital model: The presence of the environmental interest group.
Overall, the additional benefit from considering inter-sectoral capital mobility is at most small, especially when compared to the additional plausibility problem that arises with respect to the political-economy framework. The sector-specific-capital model thus seems to be the more appropriate framework here.

Building on the analysis carried out in this paper, some questions for future research arise. First of all, especially as the model is tailored to the example of the European Union, a model of a large open economy should be considered alternatively. Does this change the results due to terms-of-trade effects of environmental- and/or trade policies? Here, it has to be considered that in the large-country case, also consumer prices are affected by domestic policy measures. Hence, a different setup of the model explicitly containing consumer preferences would become necessary.
A second issue that could be added to the present framework is international mobility of capital: Which results could be derived if the location decision of firms was explicitly modeled? To answer that question, a framework of policy interactions between different countries competing for capital/FDI appears to make sense.
Furthermore, this paper´s assumption of unilaterally introduced environmental restrictions (motivated by the example of the EU-ETS vs. "rest of the world") ignores that

other countries might react to domestic policies or, put differently, that countries might interact strategically with each other. It would be interesting to see how the feature that the domestic country introduces certain policy measures by anticipating a foreign country´s reaction and taking this into account changes the results of the analysis (cp. also the remark on global environmental problems in section 3.3).

Another interesting point to consider could be firm heterogeneity. In particular, one could analyze how the results change due to the assumption that firms in the polluting sector differ with respect to their efficiency. In that case, more efficient firms possibly exhibit opposing interests to the less efficient ones, i.e. favor rather than oppose strict environmental policies. This is due to their ability to increase market share in case the less efficient firms are driven out of the market by the environmental policy measure. Another possible implication of firm heterogeneity could be that sectoral competitiveness is not necessarily declining due to the introduced environmental/trade policy mix because less efficient production is (partly) replaced by more efficient production.

A Appendix 1a

The following calculations and arguments are to show how trade policy, represented by a production subsidy to sector I, impacts on the different IG´s incomes resp. utilities.

Sector I:

Clearly, the subsidy is favorable for profits in the polluting industry: When production in sector I is subsidized, the remuneration of labor in that sector rises (as L is paid its marginal product; see eq. 5). Thus, labor is 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 the amount of the subsidy-increase: $p_s^p = p_s^w + 1 = 1$. Hence, the return to the specific factor unambiguously rises:

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

Sector II:

Because of the fixed total labor supply, an increase in L^I, caused by the increased subsidization, is accompanied by a proportional decrease in L^{II}. Production of the numeraire good declines and so does the return to its specific factor:

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

Workers:

Workers will be affected by trade policy in the following way: When the government raises the subsidy, the marginal product of labor will rise; hence, the wage rate w will increase, though, due to the diminishing marginal product of labor, to a lower extent than the increase in s:

$$w_s = F_{LL}^{II} L_s^{II} > 0. \tag{A.3}$$

Remark: This is also true for the real wage as the consumer price of the import good I, p^w, is constant due to the small-country assumption as well as the numeraire-price (=1).

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

$$I_s = \underbrace{w_s}_{\text{"wage effect"}>0} \underbrace{-\frac{x^I}{\overline{L}}}_{\text{"subsidy effect"}<0} \underbrace{-\frac{s}{\overline{L}} x_s^I}_{\text{"scale effect"}<0} < 0. \tag{A.4}$$

Besides the positive "wage effect", there are two negative effects on income: The "subsidy effect" arises because the subsidy level per unit of output is increased, and the "scale effect" mirrors the rising production scale where for each additional unit of output an additional unit of the subsidy s has to be paid. Economic-plausibility considerations suggest that the positive wage effect be outweighed by the two negative effects so that $I_s < 0$ holds.

The opposite case would imply that workers were able to increase their income by paying an increased amount of tax. Hence, from their point of view, infinite taxation would be preferred which is not consistent with economic intuition. In addition, if the economy as a whole is considered, total income must, in general, decrease due to trade policy measures as those cause 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 yield a decline in total income. This, simply by looking at the respective equations, is not plausible. Rather, $|\Pi_s^I| > |\Pi_s^{II}|$ will hold which implies $I_s < 0$ (see also the calculation in appendix 2).

Environmental IG:

The utility of the environmental interest group only depends on total emissions E. Those are not determined endogenously in the model via output. When the subsidy is increased, the dirty industry raises output, *given* a certain level of environmental use. That is, output expansions can be achieved solely by increased labor employment *without* affecting the level of pollution (within this model framework, this feature may e.g. be thought of as pollution depending on the operating time of a factory in hours per day. When more labor is employed, output *per hour* rises so that the operating time of the factory and thus pollution remain at their initial levels. Apart from the model framework applied here, output-increases at constant emissions levels can also be achieved e.g. by R&D, resp. by using more advanced and cleaner technology).
Consequently, changes in the subsidy do not affect emissions, environmental damage and the environmental interest group´s utility.

Remark: One might annotate here, that an environmental lobby´s utility should also depend negatively on the subsidy s. Although trade policy does not influence environmental damage, it constitutes a support for the polluting industry which environmentalists are generally opposed to. In addition, it is questionable whether they completely anticipate the independence of environmental damage and 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 trade policy is not stronger than that of environmental policy, which seems to be plausible in case the former does not impact on environmental damage.

B Appendix 1b

The following calculations and arguments are to show how environmental policy, represented by a quantitative cap on total emissions $\overline{E}$, impacts on the different IG´s incomes resp. utilities.

Sector I:

As opposed to trade policy, environmental restrictions have a negative impact on industry-I profits. Put differently, a change in $\overline{E}$ has the same qualitative effects as an equivalent change in s as both policies work in the same direction. However, quantitative effects may differ: When total emissions are allowed to increase, similarly as in case of an increase in s, production in sector I becomes more efficient so that labor is attracted as the wage rate increases. Production rises. There is, however, no reaction of the producer price to changes in $\overline{E}$: $p^p_E = p^w_E = 0$. Hence, the return to the specific factor in sector I unambiguously declines when E is restricted:

$$\Pi^I_E = \underbrace{(\underbrace{p^p_E}_{=0} g(E) + p^p g_E)}_{>0} \underbrace{(F^I - F^I_L L^I)}_{>0} - \underbrace{p^p g(E) F^I_{LL} L^I_E L^I}_{<0} > 0. \tag{B.1}$$

Sector II:

Sector II gains from environmental restrictions $\overline{E}$:

$$\Pi^{II}_E = -F^{II}_{LL} L^{II}_E L^{II} < 0. \tag{B.2}$$

Workers:

A decline in the total emissions allowance has the opposite effect on the wage rate from a rise in the subsidy:

$$w_E = F^{II}_{LL} L^{II}_E > 0. \tag{B.3}$$

As in case of a change in s, there is an additional "scale effect" on total income of a worker as a decline in E will lower output of the polluting good. Unlike the former case, however, there is no "subsidy effect" because the level of s is unchanged. Thus we have:

$$I_E = \underbrace{w_E}_{\text{“wage effect”}>0} \underbrace{-\frac{s}{\overline{L}} x^I_E}_{\text{“scale effect”}<0} < 0. \tag{B.4}$$

With respect to I_E, like in the analysis in the preceding section, the case $I_E < 0$ is considered. This seems straightforward because it implies that, as for the two specific factors, both policy instruments affect income in the same direction.

Remark: However, both a positive and a negative sign are consistent with economy-wide income to decline due to inefficiencies caused by the policy intervention. For the case $I_E > 0$ the results of the model concerning the direction of trade-policy adjustment are unaffected. Results concerning the "completeness" of industry compensation (see section 4.2.2), however, then depend on the relative size of marginal environmental damage as compared to marginal income-effects from environmental- and trade policy. Theoretically, results opposing those derived in section 4.2.2 become possible, though only under certain conditions. Hence, as this would unnecessarily complicate the analysis and, as argued above, assuming $I_E < 0$ seems plausible, the case $I_E > 0$ it not further investigated here.

Environmental IG:

Environmental damage is obviously reduced by environmental restrictions, i.e. the utility of the environmental interest group is positively affected.

C Appendix 2

The following calculations apply the general expressions derived in this paper to a specific Cobb-Douglas production function and a simple example of a political support function. The aim is to show that standard functional forms can satisfy the conditions under which the results of this paper hold.

The specific production function is given by:

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

A political support function with the properties mentioned in section 4.1 is given by:

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

where γ_i, i=1,2,3,4 are the political weights.

Sector I:

- Profits in the polluting industry are:

$$\Pi^I = \frac{(p^p)^2 g(E)^2}{4w} K^I. \tag{C.3}$$

- Marginal profits with respect to s and E are always positive as derived in Appendices 1a and 1b:

$$\Pi^I_s = \frac{p^p g(E)^2}{2w} K^I > 0. \tag{C.4}$$

$$\Pi^I_E = \frac{(p^p)^2 g(E)}{2w} g_E K^I > 0. \tag{C.5}$$

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

$$\Pi^I_{ss} = -2g(E)F^I_{LL}L^I_sL^I - p^p g(E)(L^I_s)^2(F^I_{LLL}L^I + F^I_{LL}) - p^p g(E)F^I_{LL}L^I_{ss}L^I >< 0 \quad (C.6)$$

For our specific production function, this expression is not negative as proposed in the text, but exhibits rising marginal profits:

$$\Pi^I_{ss} = \frac{g(E)^2}{2w}K^I > 0. \quad (C.7)$$

- The same holds for the second derivative of sector-I profits with respect to E:

$$\begin{aligned}\Pi^I_{sE} = g_E\left(F^I - F^I_L L^I\right) - g(E)F^I_{LL}L^I_E L^I \\ -p^p g_E F^I_{LL}L^I_s L^I - p^p g(E)L^I_E L^I_s(F^I_{LLL}L^I + F^I_{LL}) \\ -p^p g(E)F^I_{LL}L^I_s L^I_E >< 0.\end{aligned} \quad (C.8)$$

In our example, this expression becomes:

$$\Pi^I_{sE} = \frac{p^p g(E)}{w}g_E K^I > 0. \quad (C.9)$$

- As argued in section 4.1, marginal political support from industry I with respect to s is positive and decreasing:

$$G_{\Pi_I} = \frac{1}{2}\gamma_1(\Pi^I)^{-\frac{1}{2}} > 0; \quad G_{\Pi_I\Pi_I} = -\frac{1}{4}\gamma_1(\Pi^I)^{-\frac{3}{2}} < 0. \quad (C.10)$$

Sector II:

- Profits in the clean industry are:

$$\Pi^{II} = \frac{1}{4w}K^{II}. \quad (C.11)$$

- Marginal profits with respect to s and E are always negative as derived in Appendices 1a and 1b:

$$\Pi^{II}_s = -\frac{p^p g(E)^2}{4w}K^I < 0. \quad (C.12)$$

$$\Pi^{II}_E = -\frac{(p^p)^2 g(E)}{4w}g_E K^I < 0. \quad (C.13)$$

- The second derivative of sector-II profits with respect to s is, similarly to sector-I profits, ambiguous in general:

$$\Pi^{II}_{ss} = -[(L^{II}_s)^2(F^{II}_{LLL}L^{II} + F^{II}_{LL}) + F^{II}_{LL}L^{II}_{ss}L^{II}] >< 0 \tag{C.14}$$

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

$$\Pi^{II}_{ss} = -\frac{g(E)^2}{4w}K^I < 0. \tag{C.15}$$

- The same holds for the second derivative of sector-II profits with respect to E:

$$\Pi^{II}_{sE} = -\left[L^{II}_s L^{II}_E \left(F^{II}_{LLL}L^{II} + F^{II}_{LL}\right) + F^{II}_{LL}L^{II}_{sE}L^{II}\right] >< 0. \tag{C.16}$$

In our example, this expression becomes:

$$\Pi^{II}_{sE} = -\frac{p^p g(E)}{2w} g_E K^I < 0. \tag{C.17}$$

- Political support from sector II is characterized by analogous functional patterns to sector I:

$$G_{\Pi_{II}} = \frac{1}{2}\gamma_2(\Pi^{II})^{-\frac{1}{2}} > 0; \quad G_{\Pi_{II}\Pi_{II}} = -\frac{1}{4}\gamma_2(\Pi^{II})^{-\frac{3}{2}} < 0. \tag{C.18}$$

Workers:

- The total income of a workers equals the wage minus subsidy payments:

$$I = w - \frac{sp^p g(E)^2}{2w}\frac{K^I}{\overline{L}}. \tag{C.19}$$

- As shown in Appendix 1a, marginal income with respect to s is determined by three effects which, for our specific function, are summarized by the following term:

$$I_s = p^p g(E)^2 w \frac{K^I}{K^{II}} - \frac{p^w g(E)^2}{2w}\frac{K^I}{\overline{L}}. \tag{C.20}$$

Marginal income with respect to E consists of two elements as shown in Appendix 1b and the specific expressions yield:

$$I_E = (p^p)^2 g(E) w g_E \frac{K^I}{K^{II}} - \frac{sp^p g(E)}{w} g_E \frac{K^I}{\overline{L}}. \tag{C.21}$$

- The second derivative of I with respect to s is again ambiguous in general:

$$I_{ss} = w_{ss} - \frac{2}{\overline{L}}x^I_s - \frac{s}{\overline{L}}x^I_{ss} >< 0. \tag{C.22}$$

Even if applied to our specific function, the sign of I_{ss} is indeterminate:

$$I_{ss} = g(E)^2 w \frac{K^I}{K^{II}} - \frac{g(E)^2}{w}\frac{K^I}{\overline{L}} >< 0. \tag{C.23}$$

For $I_{ss} < 0$ to hold, the condition $w < \frac{\sqrt{K^{II}}}{\sqrt{\overline{L}}}$ has to be fulfilled.

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

$$I_{sE} = w_{sE} - \frac{x_E^I}{\overline{L}} - \frac{s}{\overline{L}} x_{sE}^I >< 0. \tag{C.24}$$

The example used here yields:

$$I_{sE} = 2p^p g(E) g_E w \frac{K^I}{K^{II}} - \frac{p^w g(E)}{w} g_E \frac{K^I}{\overline{L}} >< 0. \tag{C.25}$$

In this case, $I_{sE} < 0$ requires $\frac{2p^p w^2}{p^w} < \frac{\sqrt{K^{II}}}{\sqrt{\overline{L}}}$.

- Concerning political-support patterns, we have:

$$G_I = \frac{1}{2}\gamma_3 I^{-\frac{1}{2}} > 0; \quad G_{II} = -\frac{1}{4}\gamma_4 I^{-\frac{3}{2}} < 0. \tag{C.26}$$

Total political support:

Using the preceding calculations, what can be concluded with respect to the properties of marginal political support from all IGs (i.e. the sign of G_{ss}, see eq. 12)?

- As already mentioned in the text, terms 1, 3 and 5 are always negative solely due to the properties of the political support function.
- Term 2 remains ambiguous even if our specific functional forms are used: $G_I I_{ss} < 0$ for $w < \frac{\sqrt{K^{II}}}{\sqrt{\overline{L}}}$.
- Term 4 turned out to be positive in our case: $G_{\Pi^I} \Pi_{ss}^I > 0$.
- Term 6 is negative here: $G_{\Pi^{II}} \Pi_{ss}^{II} < 0$.

Comparing both elements of G_{ss} representing industry I (terms 3 and 4) leads to the result that they are equal in absolute values here. Hence, the only unambiguously positive term in G_{ss} completely cancels out. What remains, are three definitively negative terms and one which can be negative under a certain condition. This condition however, is not necessary for G_{ss} to be negative.

To conclude, the additional assumption of w and $\overline{L}$ being sufficiently small relative to K^{II} can ensure $G_{ss} < 0$ in our specific example, but even without this additional assumption, marginal political support is very likely to be decreasing in s.

Concerning G_{sE} (eq.13), the above calculations yield an analogous conclusion as also there, terms 3 and 4 cancel out. Also for $G_{sE} < 0$ to be ensured, w and $\overline{L}$ have to be sufficiently small relative to K^{II}, but this does not constitute a necessary condition.

D Appendix 3

The following reasoning is supposed to explain the finding of excess compensation granted to the polluting industry, as stated in proposition 2.

As laid out in appendix 2, under reasonable assumptions, $G_{sE} < 0$ will hold. This implies that marginal political support, G_s, increases when $\overline{E}$ is introduced (i.e. E reduced). Increased marginal support in turn implies a decrease in total support because of the assumption of diminishing marginal support:
$dE < 0 \Rightarrow dG_s > 0 \leftrightarrow dG < 0$. Thus, restrictive environmental policies $\overline{E}$ lead to an overall decline in political support, aggregated over all groups, i.e. losses in sector-I profits exceed gains in sector-II profits, workers´ income and environmental interests:

$$\begin{aligned} G_{\overline{E}} &= \underbrace{G_I I_{\overline{E}}}_{>0} + \underbrace{G_{\Pi^I} \Pi^I_{\overline{E}}}_{<0} + \underbrace{G_{\Pi^{II}} \Pi^{II}_{\overline{E}}}_{>0} + \underbrace{G_D D_{\overline{E}}}_{>0} < 0 \\ \Rightarrow \quad & |G_{\Pi^I} \Pi^I_{\overline{E}}| > |G_I I_{\overline{E}} + G_{\Pi^{II}} \Pi^{II}_{\overline{E}} + G_D D_{\overline{E}}|. \end{aligned} \tag{D.1}$$

An increase in G_s, however is not optimal, as from the first-order condition of support maximization we know that $G_s = 0$ has to hold. In order to re-establish the initial level of maximum political support, politicians react by increasing s. As $G_{ss} < 0$, a higher s leads to a decline in G_s, or, equivalently, to 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. Support from the environmental group, however, is unaffected:

$$\begin{aligned} G_s &= \underbrace{G_I I_s}_{<0} + \underbrace{G_{\Pi^I} \Pi^I_s}_{>0} + \underbrace{G_{\Pi^{II}} \Pi^{II}_s}_{<0} + \underbrace{G_D D_s}_{=0} > 0 \\ \Rightarrow \quad & |G_{\Pi^I} \Pi^I_s| > |G_I I_s + G_{\Pi^{II}} \Pi^{II}_s + 0|. \end{aligned} \tag{D.2}$$

Comparing eqs. D.1 and D.2 shows that for the trade-policy case (eq. D.2), 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). In contrast, when environmental policy is applied (eq. D.1), 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 of the lower part of eq. D.2 will be larger than the respective difference in eq. D.1 for proportional policy changes.

Consequently, in order to achieve 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 can be explained by the properties of the political support function. In order to "close the gap" between the deviations of the LHSs from the RHSs of eqs. D.2 and D.1, which arises due to the missing environmental-IG effect in eq. D.2, the LHS of eq. D.2 has to decline relative to the RHS. As industry I gains from the increased subsidy and thus raises support at a declining rate, the term $|G_{\Pi^I}\Pi^I_s|$ 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 at an increasing rate, so that the term $|G_I I_s + G_{\Pi^{II}}\Pi^{II}_s|$ is the larger, the higher the increase in s. Hence, only an adjustment of s which is more than proportional can retrieve the initial level of political support.

Remark: The increase in the subsidy, however, 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, yielding a total income of zero. From this point on, further subsidy increases are not attainable anymore. Hence, the analysis in this paper assumes that s is sufficiently small for not reaching its upper bound.

E Appendix 4

The slope of the iso-distribution curve is, on the one hand, given by $\frac{ds}{dE}|_{\frac{dw}{dE}=0}$, that is, equal income distribution is ensured where wages and thus labor allocation and profits are constant. When E is decreased from E_0 to $\overline{E}$, labor productivity and wages decline. In order to keep w constant, s has to be raised from s_0 to s_1' in turn.

In addition to this "direct" productivity effect, there is also an opposing "indirect" one. This is due to the fact that decreased productivity after a decrease in E detracts labor from the affected sector thus making the remaining labor more productive. In order to keep w constant, s has to be decreased.

Formally: $\frac{ds}{dE} = \underbrace{-\frac{(p^w+s)g_E}{g(E)}}_{\text{direct effect} <0} \underbrace{-\frac{(p^w+s)F^I_{LL}L^I_E}{F^I_L}}_{\text{indirect effect} >0}.$

However, the direct effect will outweigh the indirect one so that the overall relation between s and E is a negative one.

In addition, as workers not only receive wages as income but also have to finance the subsidy (i.e. $I = w - \frac{sx^I}{\overline{L}}$), $\frac{dI}{dE}|_{\frac{dw}{dE}=0} = 0$ has to hold. The introduction of $\overline{E}$ reduces the output of the polluting good although labor allocation is constant (cp. eq. 1), which leads to a decline in total subsidy payments S. When the subsidy is then increased properly, the rise in income I is counteracted exactly by a rise in s so that workers´ income is held constant.

That is: $\frac{dI}{dE} \stackrel{!}{=} 0 = \underbrace{\frac{dw}{dE}}_{=0} - \frac{x^I}{\overline{L}}\frac{ds}{dE} - \frac{s}{\overline{L}} \underbrace{\frac{dx^I}{dE}}_{=g_E F^I(L^I,\overline{K^I})} \Rightarrow \frac{ds}{dE} = -g_E F^I(L^I,\overline{K^I})\frac{s}{x^I} = -\frac{g_E s}{g(E)}.$

Hence, the slope of the iso-distribution curve is negative. Convexity follows from a positive second derivative $\frac{d^2s}{dE^2}$ which can be shown to hold under reasonable assumptions.

F Appendix 5

The following reasoning is supposed to explain the results with respect to the determinants of excess compensation as summarized by proposition 3:

(1) Positive impact of environmental factors:

The reasoning in appendix 3 implies that marginal environmental damage D_E is an important determinant of excess compensation as it is responsible for the change in political support from the environmental interest group ($G_D D_E$). 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. D.2 compared to eq. D.1. As argued above, the extent of excess compensation follows from this difference (the "gap"). Hence, the more environmental damage is reduced by the introduction of $\overline{E}$, the more the environmental group increases political support and the more trade policy has to be adjusted to retain the political optimum.

An analogous argument holds with respect to the political weight of environmental interests as this, via G_D, also determines the change in political support from the environmental IG.

(2) Negative impact of other income-receivers:

Both the increase in support (or, equivalently, decrease in marginal support) from industry II and workers after the introduction of $\overline{E}$ and the respective decrease in support (or increase in marginal support) after the increase in s will be stronger for higher political weights (cp. eqs. D.1 and D.2). However, the reinforcement of the initial environmental-policy effect will be outweighed by the following reinforcement of the trade-policy effect for two reasons following from the properties of the political support function: Firstly, environmental-policy effects are weaker than the respective trade-policy effects because they originate from a higher level of overall political support (lower level of marginal support) and secondly, declines in support outweigh rises in support, also due to declining marginal 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 retain the political optimum weakens as the political weights of the clean industry and workers increase.

(3) Ambiguous impact of own political weight:

Results are not as clear-cut when the political weight of the loser of environmental policy, respectively the winner of trade policy (industry I), is considered: If this group is attached a higher weight, also both environmental- and trade-policy effects become stronger, the former inducing a more pronounced rise in marginal political support, the latter a more pronounced decrease in marginal support. Unlike the industry II- and workers´ case, it is not clear which effect will be stronger as environmental policy induces a decline- and trade policy a rise in support. Hence, the influence of 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 (c.p. weakening the necessity of increasing s) and the positive impact of a subsidy (c.p. strengthening the necessity of increasing s) on total political support increase with rising weight of the affected group. Which impact dominates the other is ambiguous.

G Appendix 6

Percentage of emissions permits allocated via auctioning per country

Country	2005-07[1]	2008-12[2,3]
Austria	0	1.2
Belgium-Brussels	0	0
Belgium-Flanders	0	0.5
Belgium-Wallonia	0	0
Bulgaria	0	0
Czech Republic	0	0
Denmark	5	no information available
Estonia	0	0
Finland	0	0
France	0	0
Germany	0	0
Greece	0	0
Hungary	2.5	5
Ireland	0.75	0.5
Italy	0	3
Latvia	0	0
Lithuania	1.5	2.7
Luxembourg	0	5
Netherlands	0	4
Poland	0	1
Portugal	0	no information available
Romania	0	0
Slovakia	0	0
Slovenia	0	0
Spain	0	0
Sweden	0	0
UK	0	7

1: Data for 2005-07 are from the EU-webpage http://ec.europa.eu/environment/climat/emission/pdf/ets_co2_emission_auctioning.pdf. (latest data from 10/06)

2: Data for 2008-12 are from Rogge et al. (2006) and WWF (2006) on http://assets.panda.org/downloads/wwf_can_table.pdf (latest data from 11/06)

3: Most of this information is preliminary as not all countries have submitted their NAPs to the EU Commission yet (for Austria, however, a draft NAP can be downloaded from the country´s "Lebensministeriums" homepage), submitted NAPs have not been
competely assessed by the Commission yet and those already assessed still have to be modified by the member states (cp. e.g. the webpage http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1650&format=HTML&aged=0&language=EN&guiLanguage=en)

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