

Constitutional Choice, Fiscal Federalism, and International Environmental Agreements

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Abstract

In this paper, we analyse how the prospect of international negotiations over transboundary pollution shape the countries' constitutional and political decisions that precede the bargaining process. We show that the countries' dominant strategy at the constitutional stage is to assign the authority over environmental policy and international negotiations to a subsidiary government in that region where the pollution has its origin. Although this decentralization of power is usually accompanied by a federal transfer scheme, there is no 'fair' cost sharing within each country. The negotiating regions' shares of the national damage falls short of the corresponding shares of costs. This depresses the bargaining incentives of the regional negotiators and leads to a suboptimal international environmental agreement from the perspective of the countries as a whole.

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1 Motivation

Most environmental problems are to some extent international or, more precisely, interregional by nature. Economic activities not only pollute the environment in the areas where they take place but also in other regions within the national boundaries and beyond. In other words, they cause externalities on the national level (between regions of the same country) and on the international level (between regions of different countries). Since non-cooperatively acting governments ignore the negative impact on the environment outside their jurisdictions, they usually end up in a prisoners' dilemma. The pollution levels are inefficiently high or, coming to the same, the abatement levels are inefficiently low.

Internalising international externalities is particularly difficult. In the absence of a coercive supranational power, the countries rely on international environmental agreements (IEAs). A federal country can approach the necessary negotiations in two fundamentally different ways: The power to decide on an environmental policy and to negotiate abatement levels can be assigned either to the federal government or to the governments of the polluting regions. This issue is usually already settled at a constitutional stage at which the political structure and the distribution of power are codified. While in the centralised system the negotiating politicians are obliged to their country as a whole, in the decentralised system they only represent the interests of their regions. Since the two alternative negotiating agents substantially differ in their interests, the constitutional design profoundly affects the country's position in the international bargaining process. A country can use this constitutional delegation of decisions to gain an advantage in international negotiations.¹

The constitutional decision to decentralise or centralise the power to negotiate IEAs seems to be a discrete one. However, delegation can become a quasi-continuous decision once federal government applies additional instruments to manipulate the objectives of the regional government. If decentralisation is adopted, the federal government can accompany this institutional arrangement by fiscal transfers. These conventional political instruments can serve as a means to fine tune the bargaining incentives of the polluting regions. Ultimately, rather long-term constitutional designs combined with relatively short-term political measures substantially shape the outcome of IEAs.

We provide answers to the following two questions: First, what constitution-and-policy mix is chosen by a non-cooperatively acting country? And second, how do the resulting strategies affect the efficiency of an IEA? Both issues are analysed in the

¹This insight seems to be common knowledge, as, for instance, the introductory comments of Kockesen and Ok (2004) illustrate.

present paper. To this end, we consider a world with two countries, each of them consisting of two regions. In each country, one of these two regions hosts ‘dirty’ industries that generate transboundary pollution. Each country first decides at the constitutional stage whether the federal or the regional authorities are entitled to determine environmental policy and to negotiate an IEA. Afterwards, each federal government can implement a transfer scheme to cover the abatement costs of its country’s polluting region through matching grants and/or to charge the ‘dirty’ region for the ‘clean’ region’s environmental damage. This mixture of subsidies and taxes provides an incentive for the ‘dirty’ region to act in the best interest of the entire country.² Finally, the governments in charge of international negotiations enter Nash bargaining over binding abatement targets.

The standard theory on fiscal federalism would suggest that assigning power to the federal government is superior, since the benefits of an environmental policy accrues to both regions in each country.³ However, the present paper demonstrates that this conventional justification for centralisation does not prevail in the current context, as the federal governments find it optimal to delegate bargaining power to their regional governments. Such a delegation yields a strategic advantage for the delegating party.

We show that, at the constitutional stage, the two countries delegate the authority to decide on environmental policy and to negotiate an IEA to the regional governments. This decentralisation of power is usually accompanied by a federal transfer scheme. If a federal government implements a combination of matching grants to the ‘dirty’ region and compensation payments to the ‘clean’ region, then these transfers are such that the polluting region’s share of the abatement costs exceeds its share of the country’s abatement benefits. Since such a scheme ensures that a polluting region gains from an IEA relatively less than the country as a whole, it achieves that the interest of the country’s regional negotiators in abatement is lower than that of the federal government. Thereby, the constitutional and accompanying political decisions strengthen the country’s bargaining position. But, since both countries face the same incentives to delegate the bargaining power to the regional

²Kaul et al. (2003) show that matching grants are an adequate measure to enforce international cooperation on financing global public goods. Similarly, Guttman (1978), Danziger and Schnytzer (1991) and, more recently, Boadway et al.(2007) indicate that matching grants can be efficiency enhancing.

³Oates (1972) famous ‘decentralization theorem’ relates the optimal assignment of powers to different government layers to the geographical extent of the externalities that arise from local activities. The theory of fiscal federalism goes back to Musgrave (1959), Olson (1969) and Oates (1972). It makes use of traditional principles, such as the benefit and ability-to-pay principle, and the principle of fiscal equivalence and equivalent taxation, which is based on the philosophy of Thomas Hobbes and John Lock.

government and to implement ‘distortionary’ transfers, their attempts to be at an advantage in the negotiations neutralise each other. Moreover, the resulting IEA sets inefficiently low abatement targets from the perspectives of the countries as a whole exactly because the federal governments strategically depress the bargaining incentives of the negotiators.⁴

Our conclusions are in contrast to the results in Eckert (2003). She also considers how the distribution of power in a state affects the outcome of an IEA. But she concludes that the delegation of bargaining power to the regional level might or might not be an optimal strategy for a country, while we argue that this kind of delegation is always an equilibrium choice. The ambiguity of her results are basically caused by a lack of instruments. In her framework, the federal governments have no matching grants nor other taxes and transfers at their disposal. Without accompanying taxes and transfers, a country is left only with a discrete delegation choice between the federal and the regional government. In this case, it might abstain from delegating the decision to regional negotiators if their interests differ too much from those of the federal authorities. By contrast, if the federal government can fine tune the incentives it gives to the regional government by means of a suitable transfer scheme as in our model, a decentralised constitution is always optimal from the perspective of a non-cooperatively acting country. So one major difference between our approach and that of Eckert (2003) is that our framework fiscal federalism enriches the set of instruments. We will come back to this issue below. A further, technical difference is that we construct a model that enables us to derive all results analytically, while Eckert (2003) partly relies on simulations.

The present analysis is also particularly related to the literature on delegation in bargaining processes. Segendorff (1998) and Buchholz et al. (2005) analyse negotiations between two countries over the provision of a pure international public good and over cuts in transboundary pollution, respectively. These papers stress the incentives to strategically delegate bargaining power to agents who differ from the delegating ‘authority’.⁵ However, they ignore the role of constitutional choices

⁴Note that the reason for the ineffectiveness of an IEA in the present context is very different from that in non-cooperative approaches to international negotiations. Barrett (1994), for instance, shows that IEAs fail to be efficient in most instances because self-enforcing agreements do often not support a large number of signatory countries. By contrast, in the current framework negotiations lead to suboptimal abatement levels because the bargaining authority is delegated to regional governments whose interests differ from those of the country as a whole.

⁵The basic idea—that in misrepresenting the own preferences, an individual can raise her payoff in a bargaining solution—was developed in the seminal contributions by Crawford and Varian (1979), Sobel (1981), and Burtraw (1992). In an environmental context, Hoel (1991) argues that a country which acts as if it were eco-friendlier than it really is reduces the payoff it receives in the bargaining solution. He does, however, not relate this finding to delegation or other mechanisms

in federal systems as an indirect delegation device.

The paper is organised as follows: In section 2 we describe the basic constitution of a federation, its fiscal instruments and the relationship between abatement costs and environmental damages. A short description of sequential decisions on the constitutional design, the political choices and the bargaining agreement completes this section. The outcome of an international environmental agreement is provided in section 3. We analyse the federal constitution and its fiscal instruments in section 4. In this section, we also explore the entire equilibrium. In section 5, we further examine the role of constitutional and political choices as devices to strategically delegate the authority to negotiate an IEA. We summarise our results and discuss some political implications in the concluding section.

2 Regions, Constitutions, and the Environment

In this section, we present our stylised model that enables us to outline the interplay between the constitutional and political choices on the one hand and the ensuing international environmental negotiations on the other hand. We consider a two-country world where environmental externalities between the regions within a country and between the countries coexist. While the federal government can in principle adopt suitable measures so that the environmental spillovers between the domestic regions are internalised, there exists no authority that could do the same on the international stage. The spillovers between regions of different countries can only be tackled by means of an IEA. The decision process outlined below models not only the international negotiations, but also the preceding constitutional and political choices in the two countries that substantially affect the succeeding IEA. These preceding decisions encompass constitutional and political choices. In the constitutional stage, the power to decide on abatement levels and to negotiate on an IEA is assigned to the federal governments or to the governments of the polluting regions. For brevity, we refer to these two alternatives as centralised and decentralised system, respectively. In the political stage, the federal government of each country decides on an intracountry transfer scheme. Afterward, Nash bargaining between the governments in charge of negotiations over abatement levels takes place.

2.1 Pollution, Abatement, and Transfers

Consider two neighbouring countries 1 and 2, which are symmetric in every respect. Each of them consists of two regions. To take into account the fact that ‘dirty’

that enable a country to commit itself to a strategy which is in conflict with its true objectives.

industries are unevenly distributed, in each country the pollution is assumed to be generated only in one of the two regions. It, however, damages the environment in all areas of the same country and abroad. Consequently, the benefits of abatement activities that reduce this transboundary pollution are spread over all four regions. By contrast, the costs of abatement only occur in the polluting regions.

For instance, think of a fishing industry which is located in the countries' coastal areas. While these regions bear the costs of tougher regulations, the whole population in the two countries benefits from the protection of species and the resulting maintenance of biodiversity. Further examples are the carbon mining industry and the nuclear power stations along the upper course of a river. Acid waste water and the waste heat can be only avoided in the upstream areas where the mines and cold-storage plants are located. The benefits of abatement, however, also arise in the regions downstream.

Denote by $a_i \geq 0$ the abatement costs of country i 's the polluting region. The abatement activities diminish pollution and thus environmental damage. An environmental damage function $D_i = D(a_i + sa_j)$, with $D'(\cdot) < 0$ and $D(\cdot) > 0$, captures the negative relationship between country i 's environmental damage on the one hand and the abatement costs of country i 's and j 's polluting regions on the other hand. This damage function is twice-continuously differentiable and strictly convex. It reaches its maximum $D^{max} = D(0)$ if neither region abates. The damage function also fulfils the Inada-type conditions $\lim_{a_i+sa_j \rightarrow 0} D'(\cdot) = -\infty$ and $\lim_{a_i+sa_j \rightarrow \infty} D'(\cdot) = 0$. The parameter s denotes the international spillover. We assume that $s \in (0, 1)$ holds, i.e., that abatement in country i 's polluting region contributes more to a cleaner environment in country i than in country j .⁶

Environmental damage D_i is measured in monetary terms, and so is thus abatement benefit $D^{max} - D(a_i + sa_j)$. As the abatement benefit varies only with environmental damage, maximising the overall net benefit of country i is equivalent to minimising the total costs, consisting of environmental damage and abatement costs:

$$TC_i^F = D(a_i + sa_j) + a_i. \quad (1)$$

The superscript ' F ' stands for federal government, which represents the country as a whole.

Since only a part of the population resides in the polluting region, this region bears only a part of the country's environmental damage D_i . Denoting this share by $\alpha \in (0, 1)$, the damage within the polluting region is equal to αD_i . Moreover,

⁶Note that the upper bound of the interval $(0, 1)$ covers the case of the environment as a pure international public good, while for the lower bound means that pollution causes environmental damage only domestically.

a region might receive, or pay for, interregional and intracountry transfers, which are a means of the federal government to shape the bargaining incentives of the polluting region under decentralisation. The federal government has two instruments at its disposal. Firstly, the ‘dirty’ region can be compensated for its abatement costs through a matching grant $m_i a_i$. Secondly, the ‘dirty’ region can be forced to compensate the ‘clean’ region for its environmental damage through a transfer $\beta_i D_i$. Then, $\beta < 1 - \alpha$, $\beta_i = 1 - \alpha$, and $\beta > 1 - \alpha$ represents partial compensation, full compensation, and overcompensation. Both instruments impose some degree of burden sharing between the regions. However, while the former leaves the property right with the ‘dirty’ region, the latter is more in the spirit of a polluter-pays principle.

To sum up, the polluting region might receive a matching grant $m_i a_i$, which covers part of the regional abatement costs, and it might be forced to make a compensation payment $\beta_i D_i$. In any case, $(m_i, \beta_i) \geq 0$ is assumed to hold. Taking these transfers into account, the total cost of the polluting region is given by

$$TC_i^R = (\alpha + \beta_i) D(a_i + s a_j) + (1 - m_i) a_i, \quad (2)$$

where ‘ R ’ stands for that region’s government, which represents the local population.

2.2 Constitutional Design, Political Choices, Bargaining

A three-stage decision process models not only the international negotiations, but also the preceding constitutional and political choices that shape the outcome of the IEA. In the first stage (*constitutional stage*), the federal governments of the two countries non-cooperatively decide whether the power to determine the abatement levels in the polluting regions and the power to negotiate over an IEA stay with them or lie with the governments of the polluting regions. We refer to these two distinct arrangements as centralised and decentralised systems, respectively.⁷ Making this constitutional decision, each federal government takes the strategy of its opponent as given and chooses the solution that maximizes its payoff.

If the decentralised system is adopted in a country, the government of the polluting region irrevocably decides on the abatement activities. In this case, only the regional government can sign a binding IEA. The federal government, however, can still influence the bargaining incentives of the regional authority by implementing a transfer scheme. As described above, the federal government has a matching grant

⁷These constitutional choices cannot be revoked, at least not within the relevant time horizon. So they imply a perfect commitment of the country. In this respect, our approach differs from models in which principles can revoke their partial commitments at some costs later on. See, for instance, Muthoo (1996).

m_i and compensation rate β_i at its disposal. Thus, in the second stage (*political stage*) it decides on the rates m_i and β_i .

After the decision on the constitutional and political bargaining framework have been made in the two countries, the international negotiations can start. In the third stage (*bargaining stage*), the two governments in charge of environmental negotiations bargain over the abatement levels and potential side payments between them. The outcome of these negotiations is described by the Nash bargaining solution. This solution crucially depends on the threat point, i.e., the outcome that would be realized if negotiations failed. In that case, the governments which are responsible for environmental policy set the abatement levels simultaneously and non-cooperatively. The resulting solution of this Nash game serves as a threat point for the negotiations.

The following table summarises the sequence of decisions:

Stages	Decisions
1. Constitutional stage	Governments in charge of negotiations, F or R
2. Political stage	Transfer scheme m_i and β_i
3. Bargaining stage	IEA: abatement levels a_1 and a_2 (and side payments)

2.3 Centralization versus Decentralization

A closer look at the total costs (1) and (2) shows that for a compensation rate $\beta_i = 1 - \alpha$ which is not accompanied by a matching grant, i.e. $m_i = 0$, the objective functions of the federal and the regional governments coincide. In this case, the regional government has the same bargaining incentive as the federal government. In fact, the regional government would act as if it were the federal government. Consequently, the Nash bargaining solution for the decentralized system in the case of the transfer scheme $(m_i, \beta_i) = (0, 1 - \alpha)$ replicates the centralised system. In this sense, the centralised solution can be considered as a special case of the decentralised one.

This relationship between the two constitutional designs simplifies the following analysis considerably. Conducting the usual backward induction, we do not need to distinguish between the centralised and decentralised system explicitly. Instead, we can simply analyse the second and third stage of the game for the case of a decentralised solution. If *either* $m_i \neq 0$ *or* $\beta_i \neq 1 - \alpha$ results in the second stage, the decentralised system is indeed the equilibrium choice. Then, the optimal negotiator should have bargaining incentives that differ from those of the federal government. This can only be achieved by means of decentralisation. By contrast, if the outcome is $m_i = 0$ *and* $\beta_i = 1 - \alpha$ in the political stage, then the federal government

would be the optimal negotiator for the country. In this case, there is no need for decentralisation.

3 International Environmental Agreements

Applying backward induction, we first turn to the bargaining solution in the third stage. Since the non-cooperative abatement levels, which are implemented if the negotiations fail, determine the threat point, they have to be solved for first. Afterwards, we provide the Nash-bargaining solution and show how this outcome is related to countries' transfer schemes. These results are the prerequisites for our analysis of the constitutional and political decisions in section 4.

3.1 Threat Point

Let us explore the strategies of the governments in charge of environmental policy when abatement levels are determined non-cooperatively. In this case, the two governments carry out their optimal policy, taking the strategy of the rival as given and ignoring the externalities of their policies. Country i 's responsible government chooses the level a_{in} that minimises its total costs

$$TC_{in}^R = (\alpha + \beta_i) D(a_{in} + sa_{jn}) + (1 - m_i) a_{in}, \quad (3)$$

where the additional subscript n indicates that the decisions are made non-cooperatively. We obtain the first-order condition⁸

$$-(\alpha + \beta_i) D'_{in} = 1 - m_i \quad \text{for } i = 1, 2. \quad (4)$$

It says that *from the perspective of country i 's government in charge of environmental policy*, the marginal decline in damage (including compensation payments) equals marginal abatement costs. If the responsibility for the abatement levels lies with the federal government (i.e. if $m_i = 0$ and $\beta_i = 1 - \alpha$), these figures coincide with the marginal benefits and costs of the country as a whole. By contrast, if the government of the polluting region is in charge, condition (4) only captures the marginal benefits and costs that accrue to this region.

The first-order condition (4) implicitly determines the reaction curves and the unique Nash equilibrium, which is characterised by an active abatement policy in both countries if the transfer schemes in the two countries are not too different.⁹ The

⁸ D'_{in} denotes the value of the derivative of region i 's damage function with respect to $a_{in} + sa_{jn}$ in case of non-cooperatively acting governments.

⁹In any case, the equilibrium is unique (cf. Buchholz et al., 2005). Moreover, in section 4 we argue why focusing on an interior solution makes indeed sense.

threat point (a_{1n}, a_{2n}) and thus the bargaining solution obviously depend on the two countries' matching grants $m = (m_1, m_2)$ and the compensation rates $\beta = (\beta_1, \beta_2)$. Since these connections offer an opportunity for the federal governments to influence the outcome of an IEA, we are interested in the comparative statics of these variables.

Lemma 1 *Threat Point and Transfer Scheme.*

If the federal government of country i raises the matching grant to, or the compensation payments of, the 'dirty' region, then domestic abatement activities increase. This increase is at least partially offset by lower abatement activities abroad. Overall, environmental damage is diminished in country i and remains unchanged in country j .

Proof. Using first-order condition (4), we obtain

$$\frac{\partial(a_{in} + sa_{jn})}{\partial m_i} > \frac{\partial(a_{jn} + sa_{in})}{\partial m_i} = 0 \text{ and } \frac{\partial(a_{in} + sa_{jn})}{\partial \beta_i} > \frac{\partial(a_{jn} + sa_{in})}{\partial \beta_i} = 0. \quad (5)$$

This outcome can only result if $\partial a_{jn}/\partial m_i = -s(\partial a_{in}/\partial m_i) < 0$ and $\partial a_{jn}/\partial \beta_i = -s(\partial a_{in}/\partial \beta_i) < 0$. It directly implies $\partial D_{in}/\partial m_i < 0$, $\partial D_{in}/\partial \beta_i < 0$, and $\partial D_{jn}/\partial m_i = \partial D_{jn}/\partial \beta_i = 0$. ■

The intuition for Proposition 1 is straightforward. A higher matching grant or compensation rate raises the marginal damage (including compensation payments) of i 's responsible government relative to its abatement costs. Abatement activities become more attractive, and the abatement level a_{in} increases. As a consequence, country j 's marginal damage declines, and thus its incentive to abate. The decrease in abatement a_{jn} partially offset the increase in a_{in} . In other words, the countries' choice variables are strategic substitutes like in the standard models of non-cooperative private provision of public goods. Still, environmental damage diminishes in country i because the reduction in domestic pollution more than compensates for the rise of pollution abroad. By contrast, damage is unchanged in country j .¹⁰

3.2 Bargaining over Abatement and Side payments

The equilibrium of the previous section provides the countries' abatement levels if environmental policies are decided non-cooperatively. This solution determines the threat point of the negotiations over an IEA. To give the outcome of these negotiations, we apply the Nash-bargaining concept. We also take account of the fact that agreements on environmental issues are frequently accompanied by (implicit) side

¹⁰This conclusion follows from a quasi-linear objective function.

payments between countries.¹¹ Thus, any negotiations contain two issues, abatement levels and potential side payments.

The calculation of the Nash-bargaining solution with side payments is straightforward. The negotiating governments first choose the abatement levels that minimise their aggregate costs. (Recall that abatement costs as well as the environmental damages are measured in monetary units.) Afterwards, a side payment from one government to the other is determined such that the two negotiating parties share the gains from cooperation evenly.¹²

The resulting abatement levels a_{1c} and a_{2c} are efficient from the perspective of the negotiating governments. They minimise their aggregate costs

$$AC = \sum_{i=1}^2 [(\alpha + \beta_i) D(a_{ic} + sa_{jc}) + (1 - m_i) a_{ic}], \quad (6)$$

where the subscript c indicates the cooperative case.

Since this aggregate payoff is strictly convex, a unique solution to the allocation problem (6) exists. The optimal abatement levels are implicitly given by the first-order conditions

$$-(\alpha + \beta_i) D'_{ic} - s(\alpha + \beta_j) D'_{jc} = 1 - m_i \quad \text{for } i, j = 1, 2 \quad (7)$$

The left-hand side of condition (7) captures the *aggregate* marginal decline in damage (including compensation payments) caused by abatement in either country i or j . The right-hand side gives the corresponding marginal abatement costs. Trivially, marginal abatement costs are equal to the generated aggregate marginal cut in damage (including compensation payments) of the two negotiating parties.

As condition (7) holds for both $i = 1$ and $i = 2$, the optimal solution is alternatively characterised by

$$-(\alpha + \beta_i) D'_{ic} = \frac{1 - m_i - s(1 - m_j)}{1 - s^2} \quad \text{for } i, j = 1, 2. \quad (8)$$

¹¹The Kyoto Protocol on the emission of substances that cause global warming provides an example for the incorporation of international transfers into an IEA. We think it is fair to say that implicit side payments are granted through ‘generous’ grandfathering of certificates to Russia and other countries. Selling these certificates on the world market generates transfer-like revenues for these regions. The role of such side payments is already discussed in Chichilnisky and Heal (1994) and Eyckmans, Prost and Schokkaert (1993).

¹²Using Nash bargaining with appropriate side payments simplifies the analysis significantly. Similar results as in the current framework can be obtained when the modelling approach to negotiations applies the outside option principle. Then, threat points do not play any role in case of symmetric countries. Such a kind of modelling reduces the complexity of the economic structure in a similar way as side payments do.

In contrast to its counterpart in the non-cooperative case (4), the spillover parameter s explicitly appears in condition (8), since the impact of a country's abatement activities on the other negotiating party is now taken into account.

If at least one regional government is involved in the negotiations, the resulting abatement levels depend on the transfers. As a prerequisite of exploring the optimal schemes from the perspective of a federal government and the question of whether a federal government decentralises power at all, we analyse the impact of these schemes on the IEA in more detail.

Lemma 2 *Bargaining Outcome and Transfer Scheme.*

In the cooperative solution, both a higher compensation rate and a higher matching grant in country i shift the abatement activities from country j to country i . Thus, the total abatement costs of country i increase. The environmental damage in country i declines in either case. However, matching grants increase the environmental damage in country j , while a change in β will leave it unchanged.

Proof. Using first-order condition (8), we obtain

$$\frac{\partial(a_{ic} + sa_{jc})}{\partial m_i} > 0 > \frac{\partial(a_{jc} + sa_{ic})}{\partial m_i} \text{ and} \quad (9 \text{ a})$$

$$\frac{\partial(a_{ic} + sa_{jc})}{\partial \beta_i} = (1 - s^2) \frac{\partial a_{ic}}{\partial \beta_i} > \frac{\partial(a_{jc} + sa_{ic})}{\partial \beta_i} = 0, \text{ respectively.} \quad (9 \text{ b})$$

This outcome can only result if the abatement level a_{ic} is raised and the level a_{jc} is lowered. It directly implies $\partial D_{ic}/\partial m_i < 0$, $\partial D_{ic}/\partial \beta_i < 0$, $\partial D_{jc}/\partial m_i > 0$, and $\partial D_{jc}/\partial \beta_i = 0$. ■

As Propositions 1 and 2 show, the impacts of higher matching grants and compensation payments in the cooperative case are very similar to those in the non-cooperative case. In both cases, such policy changes shift the costs of abatement from country j to country i .

This broad picture remains valid if side payments are included, as a closer look on them shows. Since the gains from cooperation are split equally between the two negotiating parties, side payments S_i from i 's government to its opponent in the negotiations are given by

$$S_i = \frac{1}{2} \left\{ \underbrace{[(\alpha + \beta_i) \cdot (D_{in} - D_{ic}) + (1 - m_i) \cdot (a_{in} - a_{ic})]}_{\text{gains of } i\text{'s negotiating government from cooperation}} - \underbrace{[(\alpha + \beta_j) \cdot (D_{jn} - D_{jc}) + (1 - m_j) \cdot (a_{jn} - a_{jc})]}_{\text{gains of } j\text{'s negotiating government from cooperation}} \right\} \quad (10)$$

where D_{ic} and D_{in} denote country i 's damages in the cooperative solution and in the non-cooperative threat point, respectively. In the current model, the transfer paid by one of the negotiating governments equals the payments received by the other, i.e. $S_i = -S_j$.

In the cooperative solution, both a higher compensation rate and a higher matching grant in country i increases the abatement costs including side payments in country i . As stated above, a rise in country i 's compensation rate or matching grant increases its abatement costs. However, country i might be rewarded for its intensified abatement activities by lower side payments S_i . In any case, abatement costs including side payments, i.e. $a_i + S_i$, will go up, too.¹³

4 Constitutional Choice and Transfer Schemes

If the federal government chooses the decentralised solution in the first stage, it still can implement a matching grant and a compensation rate in the second stage. The transfer schemes are used to fine tune the bargaining incentive for the country's regional government so that the regional negotiators optimally pursue the goal of the country as a whole. Making its choice on the rates m_i and β_i , i 's non-cooperatively acting federal government takes the other country's negotiating party and, if this is the regional government too, the transfer scheme abroad as given.

No matter whether the other side's negotiating party is the federal or the regional government of that country, its representatives are completely described by the rates β_j and m_j . As already explored above, centralisation can only be optimal if $\beta_i = 1 - \alpha$ and $m_i = 0$ result. Otherwise, decentralisation is country i 's best strategy.

When choosing the optimal transfer scheme for region i , the federal government considers environmental damage and abatement costs for the country as a whole including potential side payments in connection with an IEA. Thus, it minimises

$$P_i^F = TC_i^F + S_i = D(a_{ic}(\beta, m) + sa_{jc}(\beta, m)) + a_{ic}(\beta, m) + S_i(\beta, m), \quad (11)$$

where $\beta = (\beta_i, \beta_j)$ and $m = (m_i, m_j)$.

The federal government indirectly affects the final abatement outcome (a_{ic}, a_{jc}) and the side payments S_i via its choice of the transfer rates m_i and β_i . Analysing the optimal scheme, we first focus on interior solutions, but discuss the possibility of boundary solutions later. Moreover, we concentrate on symmetric equilibria, since the two countries are identical in every respect.

¹³An earlier version of this paper discusses this issue in detail and can be obtained upon request.

In the case of an interior solution, the optimal transfer scheme is characterized by the first-order conditions

$$-D'_{ic} \frac{\partial (a_{ic} + sa_{jc})}{\partial \beta_i} = \frac{\partial (S_i + a_{ic})}{\partial \beta_i} \quad (12 \text{ a})$$

$$-D'_{ic} \frac{\partial (a_{ic} + sa_{jc})}{\partial m_i} = \frac{\partial (S_i + a_{ic})}{\partial m_i}. \quad (12 \text{ b})$$

In optimum, the transfer scheme balances two opposing effects already indicated by the comparative statics in the previous section. On the one hand, both a higher matching grant and a higher compensation rate indeed increase the global abatement level $a_{ic} + sa_{jc}$ and, therefore, decreases country i 's environmental damage (LHSs), since they provide additional incentives for domestic pollution cuts. On the other hand, the sum of side payments and abatement costs $S_i + a_{ic}$ increase (RHSs), since the grants weaken the country's bargaining power.

Using the definition of the side payments (10), the first-order condition (8), and the results of the comparative statics (5) and (9 b), condition (12 a) yields

$$\begin{aligned} \frac{\partial a_{ic}}{\partial \beta_i} \left[\frac{1 - m_i - s(1 - m_j)}{\alpha + \beta_i} - [1 - s(1 - m_j)] \right] = \\ \frac{1}{2} \left\{ D_{in} - D_{ic} + s[1 - m_i + s(1 - m_j)] \frac{\partial a_{in}}{\partial \beta_i} \right\} > 0. \end{aligned} \quad (13)$$

As the environmental is indeed larger in the non-cooperative solution than in the cooperative outcome, i.e., $D_{in} - D_{ic} > 0$, the RHS of (13) is positive.¹⁴ Then, the LHS is also positive in equilibrium. This implies that the inequalities $\alpha + \beta_i < \frac{[1 - m_i - s(1 - m_j)]}{[1 - s(1 - m_j)]} \leq 1$ are satisfied. Since $\beta_i < 1 - \alpha$ results, the compensation rate only partially internalises the externalities between the domestic regions. To put it differently, the federal government prefers a negotiator that never bears the full domestic damage. As an immediate consequence of this conclusion, choosing a decentralised system is a dominant strategy in the constitutional stage. It can never be optimal that the power to negotiate an IEA lies with the federal government.

To fully assess the implications of this result, we establish the relationship between the compensation rate and the matching grant in equilibrium. Using (10), the first-order condition (8), and the comparative statics (5) and (9 a), we can rearrange

¹⁴To see this, note that the following relationships are implied by the convexity of the damage function and the conditions (4) and (8): $D_{ic} < D_{in} \Leftrightarrow D'_{ic} > D'_{in} \Leftrightarrow [1 - m_i + s(1 - m_j)] / (1 - s^2) < 1 - m_i \Leftrightarrow [1 - m_j + s(1 - m_i)] > 0$. The last inequality is fulfilled as long as an interior solution exists and thus the RHS of (8) is positive.

the first-order condition (12 b):

$$\frac{\partial a_{ic}}{\partial m_i} \left[\frac{1 - m_i - s(1 - m_j)}{(1 - s^2)(\alpha + \beta_i)} + \frac{s[1 - m_i - s(1 - m_j)]}{1 - s^2} - 1 \right] = \tag{14}$$

$$\frac{1}{2} \left\{ a_{ic} - a_{in} + s[1 - m_i + s(1 - m_j)] \frac{\partial a_{in}}{\partial m_i} \right\} + s \frac{\partial a_{jc}}{\partial m_i} [1 - \alpha - \beta_i] D'_{ic} > 0.$$

Since $\alpha + \beta_i < 1$ follows from (13), the RHS of (14) is positive in a symmetric equilibrium.¹⁵ Thus, the first-order condition can be only fulfilled if the LHS is also positive, which means that the inequality $1 - m_i > \alpha + \beta_i$ has to hold. Although the matching grant covers a part of the abatement costs, the polluting region's share of the domestic abatement costs $1 - m_i$ is larger than its share of the domestic damage $\alpha + \beta_i$. In this sense, there is no 'fair' cost sharing, i.e., the financial burdens associated with the pollution cuts are more than proportionally born by the polluting region.

In this way, each country delegates bargaining power to a negotiator whose net gains from a cleaner environment are lower than that of the federal government. This strategy depresses the willingness of the negotiating regional government to accept financially painful domestic abatement levels. Since it strengthens the country's bargaining power, the costs of an environmental improvement upon the non-cooperative solution are shifted to the other country.

This cost-shifting effect explains why countries have an incentive to put regional governments in charge of environmental policy and negotiations. But why should, from a country's perspective, this constitutional choice be accompanied by a transfer scheme? The answer to this question is straightforward. Regional governments might care 'too little' for the environment. Note that the bargaining solution optimises, by definition, the aggregate payoff of the two negotiating regional governments. Since they underestimate the 'true' payoff gains from abatement, the pollution cuts agreed on in the IEA are suboptimally low from the perspective of the country as a whole. This negative lack-of-effectiveness dominates the positive cost-shifting effect if the payoff function of the polluting region differs too much from that of the federal government. To balance these two opposing effects, the regional interests have to be sufficiently aligned with the federal ones. This goal can be achieved by means of a transfer scheme, which fine tunes the bargaining incentives of the regional government.

Figure 1 a) and b) illustrate this result. The graphs show the relationship between the federal government's total costs P_i^F and polluting region's effective damage

¹⁵Note that, in the symmetric case, $D'_{ic} > D'_{in}$ directly implies that $g_{ic} > g_{in}$ for $i = 1, 2$. Thus, the terms in the first bracket of RHS of (14) are positive.

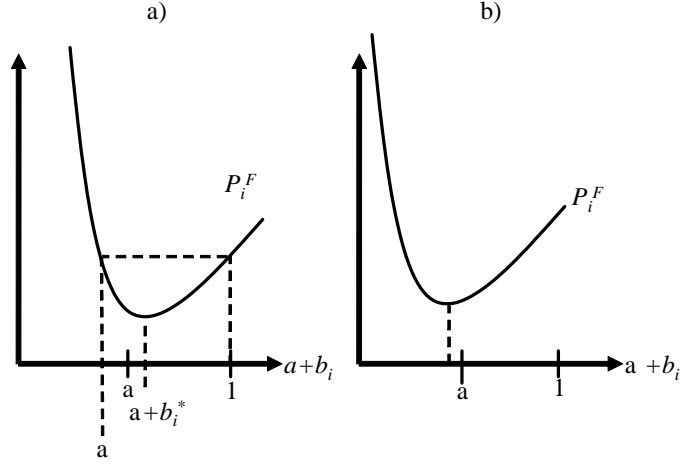


Figure 1: Optimal Compensation Rate

share $\alpha + \beta_i$ for a given policy abroad. (For simplicity, assume that the rate m_i is fixed at zero.) In figure 1 a), the minimum will be reached if rate β_i^* is implemented. By contrast, a ‘pure’ decentralisation, i.e., decentralisation without an accompanying transfer scheme, is optimal from the country’s perspective in the case drawn in figure 1 b). In this situation, a boundary solution results, since the payoff function of the regional government is already too similar to that of the federal government. If a negative compensation rate is excluded, the best the federal government can do is to set the rate β_i equal to zero.¹⁶ A similar line of reasoning holds for the matching grant.¹⁷ Thus, an interior solution requires a sufficiently small parameter α . To sum up:

Proposition 1 *Constitutional Choices and Transfer Schemes.*

i) In the constitutional stage, each federal government’s dominant strategy is to put the government of its polluting region in charge of environmental policy and

¹⁶Formally, this means that the objective function P_i^F is already decreasing with β_i at $\beta_i = 0$.

¹⁷While we cannot exclude a ‘lower boundary solution’ $m_i = 0$ or $\beta_i = 0$, we can neglect ‘upper boundary solutions’. Our preceding analysis already indicates that the outcome $m_i = 1$ cannot be an equilibrium. In this case, the regional government would not bear any abatement costs, and it would thus abate as much as possible (see first-order conditions (7)). Then, environmental damage becomes zero at infinite abatement costs. Such a strategy cannot be optimal even if parts of these costs were offset by side payments. For similar reasons, ‘too’ large rates β_i can be also ignored. Since the solution has to contain rather ‘moderate’ schemes, the relevant intervals of the rates are reasonably assumed to generate interior solutions $(a_{ic}, a_{jc}) > 0$ and $(a_{in}, a_{jn}) > 0$ in the third stage so that we can apply the usual comparative statics.

negotiations.

ii) If strictly positive transfers are implemented, the scheme has two properties. Firstly, the compensation rate internalises the domestic abatement externalities only partially, i.e., $\alpha + \beta_i^* < 1$. Secondly, in a symmetric equilibrium the polluting region's share of abatement costs exceeds its share of the environmental damage, i.e., $1 - m^* > \alpha + \beta^*$ results.

Both countries delegate the power to negotiate an IEA to regional governments without providing sufficient incentives for them to internalise the international externalities. Thereby, the federal governments also relinquish the internalisation of the domestic externalities in order to gain a strategic advantage in the international negotiations. But the attempts of both countries to shift the costs of an IEA to the other side neutralise each other. The federal governments end up in a prisoners' dilemma. In a symmetric equilibrium, the only lasting effect is that the abatement levels agreed on are suboptimally low from the perspective of the two countries as a whole. The IEA is inefficient, although it minimises the aggregate costs of the negotiators, since the countries' free-riding behaviour is simply shifted from the level of the negotiations to that of the preceding constitutional and political decisions.

Proposition 2 *Inefficiency of the IEA.*

In a symmetric equilibrium, the abatement activities are too low from the perspective of the countries as a whole. The countries' aggregate payoff would be higher if the two federal governments were in charge of environmental policy and negotiations.

Proof. In a symmetric equilibrium, the two countries make identical choices. Hence,

$$-D'(a_c^*(1+s)) = \frac{(1-m^*)}{(\alpha+\beta^*)(1+s)} > \frac{1}{(1+s)} = -D'(a_F(1+s)), \quad (15)$$

where a_F denotes each country's abatement level in case in which the federal governments negotiate with each other and a_c^* refers to the abatement level in the subgame-perfect equilibrium. Note that a_F is also the symmetric abatement level that minimises each country's total costs $D(a_F(1+s)) + a_F$. (Side payments do not appear in the payoff because they are zero in a symmetric solution.) Since the damage function $D(\cdot)$ is strictly convex, $D'(a_c^*(1+s)) < D'(a_F(1+s)) < 0$ directly implies the inequality $a_c^* < a_F$ and thus $P^F(a_F) < P^F(a_c^*)$. ■

5 Constitution and Strategic Delegation

The conclusion of the previous section is obvious. Decentralisation is a dominant but ultimately harmful strategy for both countries. This outcome deviates from Eckert's

(2003) findings. In her setting, decentralisation might, but need not necessarily be the best strategy of a country.

The difference between her and our framework is that she only considers the constitutional choice and ignores accompanying political instruments of fiscal federalism. If the set of possible instruments is constrained in that way, the constitutional decision is not a priori clear. As explored above, the lack-of-effectiveness can outweigh the cost-shifting effect in the case of ‘pure’ decentralisation. This situation is illustrated in figure 1a). As long as the share α falls short of the threshold $\underline{\alpha}$, the total costs are lower in the centralised solution than the ‘purely’ decentralised solution, i.e. $P_i^F(1) < P_i^F(\alpha)$. Left with the two extreme solutions as the only choices, the federal government prefers to centralise political power, and in the case of a symmetric equilibrium the IEA establishes the countries’ first-best solution. By contrast, if the government has sufficient instruments at its disposal, decentralisation emerges as dominant strategy, and environmental agreements are suboptimal from the perspective of the federal governments. In this sense, our conclusion is much stronger and more worrying than that in Eckert (2003).

It is, however, in line with two other contributions on negotiations over the provision of public goods in general or environmental quality in particular. Segendorff (1998) and Buchholz et al. (2005) show that a country’s ‘authority’ gains from delegating the bargaining power to an ‘agent’ who pays less attention to the environment than the ‘authority’ itself.¹⁸ In the public-choice approach in Buchholz et al. (2005), the electorate as a country’s ultimate authority even supports politicians that attach no weight at all to the environment in the case of a global pollutant. As a consequence, even international cooperation does not yield any effective improvement upon the non-cooperative outcome. The implications are less gloomy in the present paper. Since negative grants are excluded, the delegation race to the bottom is bounded from below. Nevertheless, the fundamental tendencies are the same.

A basic difference between Segendorff (1998) and Buchholz et al. (2005) on the one hand and Eckert (2003) and the present paper on the other hand is that in

¹⁸In contrast to these two papers, Siqueira (2003) argues that the preferences of the delegated agents are consistent with that of the principals if countries cooperatively determine their policy in the context of international externalities. This difference partly arises because Siqueira (2003) uses a very different notion of cooperation. He focuses on an economic and political integration, i.e., the two governments become a single decision unit. By contrast, Segendorff’s, Eckert’s and our solutions are based on Nash bargaining, which encompasses more than maximizing aggregate payoff. (See Muthoo, 1999, for an excellent treatment of this approach.) This concept pays, for instance, particular attention to the threat point. This point, to which the countries fall back if negotiations fail, does not play a role in the cooperative solution of Siqueira (2003).

the former papers there is a continuous delegation choice while in the latter there is only a discrete one - either the federal government or the government of the polluting region is entitled to negotiate over an IEA. We show, however, that if the constitutional decision is accompanied by proper transfers to fine tune the regional bargaining incentives, the discrete delegation choice is de facto transformed into a continuous choice. In this sense, the current paper bridges the gap between the two strands of literature.

6 Concluding Remarks

In the present paper, we analyse how the prospect of international negotiations over transboundary pollution shapes the countries' constitutional and political decisions. We show that, at the constitutional stage, countries have an incentive to assign the authority over environmental policy and international negotiations to regional governments. Even if this decentralisation of power is accompanied by a federal transfer scheme, the negotiating regions' share of the abatement costs exceed their share of the environmental damage. The resulting unfair cost sharing within a country means that the regional negotiators gain less from an IEA than the federal governments. Depressing the bargaining incentives of the domestic negotiators in this way, the federal governments intend to shift the abatement costs to the neighbouring country. Since both countries pursue the same strategy, they neutralise each other, at least in the symmetric case. While no side can gain an advantage in the negotiations, the drawback of the non-cooperative constitutional and political decisions becomes apparent. The abatement levels are suboptimally low from the perspective of the countries' as a whole, although an IEA is reached. Both countries are worse off than in the case in which the federal governments enter negotiations.

Our analysis demonstrates that international environmental negotiations by itself are not sufficient to overcome the deficiencies of non-cooperative behaviour, since these talks simply shift the problems from the level of the abatement decisions to the level of the preceding political and constitutional choices. Obviously, the bargaining framework matters, and a truly cooperative solution has to encompass the constitutional and political conditions under which negotiations take place.

Unfortunately, not only decisions on intergovernmental transfers and the distribution of power affect the outcome of IEAs.¹⁹ So even if the countries agree on negotiating at the federal level, this does not guarantee a more effective IEA. Rather

¹⁹As shown in Copeland (1990), Buchholz and Konrad (1994) and Buchholz and Haslbeck (1997), investment decisions and the choice of environmental technologies can be also used to gain an advantage in ensuing negotiations.

it might shift the efforts to strategically manipulate the bargaining framework to other areas. Since complete contracts that precisely regulate all the potentially important circumstances are not possible, there always remains a refuge for strategic behaviour prior to negotiations. Therefore, it arises the question of whether limiting this strategic behaviour partially, even if it is possible, really improves the overall outcome of IEAs. In any case, since the institutional environment in which international negotiations are embedded is of fundamental importance for the resulting agreement, it deserves more attention in future research.

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