University of Connecticut

Department of Economics Working Paper Series

Environmental Policy in Majoritarian Systems

Per G. Fredriksson
University of Louisville

Xenia Matschke
University of Connecticut

Jenny Minier
University of Kentucky

Working Paper 2008-01R

January 2008, revised September 2009

341 Mansfield Road, Unit 1063
Storrs, CT 06269–1063
Phone: (860) 486–3022
Fax: (860) 486–4463
http://www.econ.uconn.edu/

Abstract

This paper sheds new light on the determination of environmental policies in majoritarian federal electoral systems such as the U.S., and derives implications for the environmental federalism debate on whether the national or local government should have authority over environmental policies. In the absence of majority bias, the socially preferred policy would be federal district-level taxation which accounts both for cross-boundary pollution and differences in industry concentration across districts. In majoritarian systems, however, where the legislature consists of geographically distinct electoral districts, the majority party (at either the national or the state level) favors its own home districts; depending on the location of polluting industries and the associated pollution damages, the majority party may therefore impose sub-optimally high or low pollution taxes due to a majority bias. We show that majority bias can influence the social-welfare ranking of alternative government policies. In some cases, the existence of majority bias may actually make decentralized or federal uniform taxation the preferred solution.

Journal of Economic Literature Classification: Q48, D72, D78, H20, R50

Keywords: Institutions, environmental policy, environmental federalism, geography, majority bias, political economy.

We thank Josh Ederington and the participants at a presentation at the 54th Annual North American Meetings of the Regional Science Association International in Savannah for helpful comments.

Environmental Policy in Majoritarian Systems

Abstract. This paper sheds new light on the determination of environmental tax policies in majoritarian federal electoral systems such as the U.S., and derives implications for the environmental federalism debate on whether the national or local government should have authority over environmental taxes. In the absence of majority bias, the socially preferred policy would be federal district-level taxation which accounts both for cross-boundary pollution and differences in industry concentration across districts. In majoritarian systems, however, where the legislature consists of geographically distinct electoral districts, the majority party (at either the national or the state level) favors its own home districts; depending on the location of polluting industries and the associated pollution damages, the majority party may therefore impose sub-optimally high or low pollution taxes due to a *majority bias*. We show that majority bias can influence the social-welfare ranking of alternative government environmental tax policies. In some cases, the existence of majority bias may actually make decentralized or federal uniform taxation the preferred solution.

Keywords: Institutions, environmental policy, environmental federalism, geography, majority bias, political economy.
JEL Classification: Q48, D72, D78, H20, R50.

1. Introduction

There is a long-standing debate in the economics literature about whether environmental policies should be set by local or national policy-makers,[1] but this "environmental federalism debate" has mainly ignored the effects of political institutions.[2] In a majoritarian system such as the U.S., with geographically distinct electoral districts, the majority political party (whether in Congress or state-level legislatures) tends to favor the social welfare of its home districts over other districts (see Pashigian (1986) and Persson et al. (2000)). This gives rise to a "majority bias" (Grossman and Helpman, 2005) at both levels of government.[3] The purpose of this paper is, firstly, to show that the majority bias that arises within a majoritarian electoral system has important implications for environmental taxation in a federation, and, secondly, that the presence of this bias can provide a new rationale for or against centralization of environmental policy and for uniformity of environmental tax rates across jurisdictions.

The role of geographic location has rarely been discussed in connection with political institutions and environmental policy determination. This appears to be a serious deficiency. The political location of the polluting source and the political location of exposure to the associated pollution damage are important for understanding the design of environmental policy. For example, the U.S. steel industry is heavily concentrated in Pennsylvania, Ohio, and West Virginia. With the switch in U.S. Congressional majority party in 1994, the (Democratic) legislators from these states were no longer in the majority party; on an index of majority representation, the steel industry (SIC 3312) went from 51st out of 415 industries in 1993 to 208th in 1997.[4] Over that same time period, the steel industry saw its pollution abatement operating

[1]Oates (1972) established that in a federal system, policies addressing spillover effects should be centralized, whereas they should be decentralized when there is a high degree of heterogeneity in preferences. Also see Oates and Portney (2003) for a recent survey.

[2]Recent exceptions that discuss the role of political institutions (such as parliamentary versus presidential-congressional systems) for cross-country variations in environmental and fiscal policies include Fredriksson and Millimet (2004) and Persson, Roland, and Tabellini (2000).

[3]Majoritarian systems such as the U.S. system are particularly grounded in local interests (Milesi-Ferretti, Perotti, and Rostagno, 2002). Under majoritarian electoral rule with single-member districts, political parties may focus on a subset of the population rather than on maximizing social welfare (Persson and Tabellini, 1999, 2003).

[4]The majority representation index measures the extent to which an industry is over-represented in majority-party states relative to the population of those states; for more details on this variable and the pollution abatement cost comparison, see Appendix A.

costs increase by 11%, relative to an overall decrease of 27% in manufacturing industries overall. In our view, the change from majority to minority representation may help explain this increase.

We argue in this paper that the legislative majority tends to favor industries that are disproportionately located in majority-party districts (by granting those industries less stringent environmental policies). This is particularly true if they emit transboundary pollution that primarily affects minority districts.[5] The majority bias occurs at both the federal and state level, and has important implications for the design of government policy. It follows that cross-district uniform policies have the advantage of limiting the majority party legislators' ability to favor their home districts at the expense of other districts.

We also show that majority bias influences the social-welfare ranking of alternative policies. Although district-specific environmental taxes set by the federal government are optimal when governments maximize social welfare (accounting for both transboundary pollution and heterogeneity in pollution damage across districts), uniform federal policies across districts (states) or decentralized policies may be socially optimal when governments exhibit majority bias. Indeed, tax uniformity and decentralization of tax policy both limit the negative effects of majority bias, and may thus be Pareto superior to federal district-level taxation in the presence of majority bias. Moreover, if districts face uncertainty about whether they will be part of a majority coalition, or about their future characteristics, the existence of majority bias will influence their preferred constitutional choice for the environmental tax system.

There is indeed some empirical evidence that geographical concerns have played a role for federal environmental policies, although no theoretical underpinnings have been provided. Pashigian (1986) argues that federal air quality standards (the prevention of significant deterioration) set by the 1970 Clean Air Act and its later amendments were designed to impose high costs (and thus slow factor mobility) on the fast-growing South and West. These regions had superior air quality relative to the northern urban areas of the U.S., many of which were not directly affected by the policies. In this case, a legislative coalition was able to impose strict standards mostly at the expense of legislative minority states.

[5] The greater is the share of the sector's capital stock located in majority districts, the greater the marginal cost of raising the pollution tax from the majority legislative delegation's point of view, while the marginal benefits in terms of improved environmental quality and tax revenues remain constant.

The policy instrument modelled in this paper is a pollution tax. Not only have pollution taxes received a considerable amount of recent attention due to the "double-dividend" hypothesis debate (see, e.g., Bovenberg and Goulder (2002) for a survey, and Bento and Jacobsen (2007) for a recent study), many countries with majoritarian systems (or some blend of a majoritarian and another system, see Reynolds, Reilly, and Ellis (2005), Annex A) have such taxes in place. For example, France introduced charges on polluting atmospheric emissions in 1985 (SO_2, NO_x, HCl, H_2S, VOCs) (Ekins, 1999); in the U.S., federal and state taxes are levied on kerosene, diesel, gasohol, aviation fuel, gasoline, petroleum products and chemicals, underground storage of petroleum, gas guzzling cars, as well as on hazardous waste generation, transportation, treatment, storage, disposal, and on solid waste disposal (Richards, 2007).[6]

Our paper also relates to the literature on the political economy of fiscal federalism. Common in this literature is that externalities are not (sufficiently) internalized. Besley and Coate (2003) study two alternative forms of legislative behavior under a centralized system (see also Inman and Rubinfeld (1997)), using a model with heterogenous populations in two regions where citizen-candidates may seek election. First, when a minimum winning coalition of legislators determines the allocation and level of spending on local public goods, spending is skewed towards coalition districts. This gives rise to both misallocation and uncertainty regarding the amount of public good each district will receive. This is reminiscent of our result regarding the distortion of taxes, especially under a system of district-specific federal taxation. Second, when a cooperative legislature maximizes members' surplus (utilitarian bargaining solution), voters are found to strategically delegate policy choices by electing representatives with an intense taste for public good spending, yielding over-provision of public goods in centralized systems.[7]

[6]The 1980-85 and 1986-95 U.S. Superfund programs (which, for example, generated $2 billion dollars in tax revenue in 1992–94) imposed taxes on petroleum, hazardous waste, and 42 chemicals (Richards, 2007).

[7]Lockwood (2002) also compares decentralization and centralization of public good provision from a political economy perspective. He uses a model with discrete local public goods, homogeneous citizens, and a legislative bargaining game where spillovers influence the legislative outcome. He finds that weaker externalities and greater heterogeneity among regions may not raise the relative efficiency of decentralization of public good provision. Cheikbossian (2000) shows that with political decentralization the median voter strategically elects a representative with a preference for local public good spending. This occurs in order to mitigate cooperation aimed at reducing spending. Seabright (1996) finds that centralization enhances policy coordination but reduces the accountability of government.

The theoretical political economy literature on environmental federalism itself is rather slim. Oates and Schwab (1988) include a median-voter model with decentralized policy-making, multiple jurisdictions, mobile capital, a capital tax, and a population of both workers and non-wage-earners. Median-voter rule implies that the median voter will impose his preferred policy in each jurisdiction and that the resulting policy outcome will be inefficient. Fredriksson and Gaston (2000) analyze a similar model with multiple jurisdictions and mobile capital, but where the government's policy decision is taken under the influence of worker and capital-owner lobby groups. They argue that centralized and decentralized environmental policy outcomes are equivalent, because the aggregate effects of environmental regulations on income are identical under either regulatory design. While workers carry the whole burden in the decentralized case (with capital competition), capital owners share this burden in the centralized case (without capital competition).[8] Roelfsema (2007) builds on the model of strategic delegation by Besley and Coate (2003), and shows that if the median voter cares sufficiently for the environment she may have an incentive to delegate policy making to a politician with an even stronger preference for environmental quality. This leads to an increased pollution tax, i.e. stricter environmental policy.

Neither of these papers incorporate the political institution of a majoritarian electoral system, nor do they analyze the majority bias discussed by Grossman and Helpman (2005). Thus, they do not model the role of districts represented by different political parties in a legislature (i.e., majority and minority districts), nor do they include multiple sectors with specific factors, heterogeneous industries across different geographic and political regions, or district-specific transboundary pollution exposure.[9] Admittedly, we do abstract from some interesting features brought up in the previous literature. Our model has immobile sector-specific capital and each state (jurisdiction) is a small open economy, which enables us to better focus on the effects of majoritarian systems without the extra complications of capital competition and general equilibrium effects, which already have been extensively investigated in the literature.[10] The assumption of immobile capital does not drive our main results.

[8]Helland (1998) finds evidence that local special interests are able to influence enforcement effort when national policy is delegated to the state level.

[9]Grossman and Helpman (2005) study the role of majority bias in trade policy, and do not discuss positive or normative issues related to federal uniform- or district-specific environmental policies in federal systems with transboundary pollution problems.

[10]For theoretical models studying strategic interaction in the presence of capital competition and transboundary pollution, see, for example, Rauscher (1994), Levinson (1997), Markusen, Morey, and Olewiler (1993, 1995), Glazer (1999), Ulph (2000), McAusland (2002), Dijkstra (2003) and Kunce and Shogren (2002, 2005). Fredriksson and Millimet (2002), Levinson (2003), Helland and Whitford

Instead, including mobile capital would serve to further accentuate our results, as the majority party would have an additional incentive to favor majority districts. Since our paper is not focused on the election of representatives, we assume that the majority party's goal is to maximize majority districts' aggregate welfare; this allows us to concentrate on the role played by majority bias.[11] We also do not include lobby influence;[12] although we could easily introduce industry lobbying in a way similar to, e.g., Fredriksson (1997), this would obscure the main focus of the paper: the effects of majoritarian bias on environmental tax policy.[13]

To summarize, our paper discusses the role of majority bias in a model where federal environmental tax policy (as opposed to decentralized district-level tax policy) is decided by a majority of districts acting as joint welfare-maximizers. The resulting majority bias influences the social welfare ranking of alternative government policies and also affects the type of environmental taxation (decentralized, federal district-level, or federal uniform) that a country would prefer to adopt.

The paper is organized as follows: Section 2 outlines the model and section 3 solves for social-welfare maximizing policies, section 4 discusses majoritarian policy, and section 5 investigates some implications for the environmental federalism debate. Section 6 concludes.

(2003), Gray and Shadbegian (2004), and Sigman (2005) find empirical evidence that U.S. states engage in regulatory competition or free-ride on other states. List and Gerking (2000) and Millimet (2003) detect no effect on air pollution due to President Reagan's decentralization efforts in the 1980s, but Millimet establishes a positive effect on abatement spending.

[11]Evidence from North America includes Ansolabehere and Snyder (2006), who find that areas providing the largest vote share to the incumbent party receive the highest shares of state transfers to local government, and that the distribution of funds is redirected towards the new governing party's core supporters as a result of a change in the state government. Levitt and Snyder (1995) report that when the Democrats had a majority in the U.S. Congress, federal spending in a congressional district increased with its Democratic vote. Joanis (2007) shows that in Quebec, the geographic allocation of spending is highly dependent on districts' party loyalties.

[12]Cheikbossian (2008) provides a model where in a centralized system, public spending in member regions depends on the regions' lobbying expenditures. Cheikbossian (2008) shows that centralization yields a higher level of surplus only if spillovers are large and lobbying has a relatively minor effect on spending allocation.

[13]Also, note that the assumption that the majority maximizes the welfare of its districts is equivalent to assuming that only a subset of districts is allowed to (or is able to) lobby the federal government (or state government, where applicable). Using a lobby group model such as in Fredriksson (1997), but with geographically-based lobby groups and some unorganized jurisdictions, is likely to generate results similar to the present paper (the authors are grateful to a referee for pointing this out). See Persson and Tabellini (1994) for a model with districts lobbying a federal government.

2. Model

The following model builds on Grossman and Helpman (2005), but focuses on environmental taxation in a federation. A small open economy has individuals living in an odd number K of geographically and politically separate districts which make up states indexed by s. The economy has a total population normalized to unity. Each individual i living in geographic district j, $j \in \{1, ..., K\}$, consumes $G+1$ goods and has quasi-linear preferences given by

$$U_j^i = x_0^i + \sum_{g=1}^{G} u(x_g^i) - \sum_{k=1}^{K}\sum_{g=1}^{G} X_{kg}\theta_g\gamma_{kgj} \tag{1}$$

where x_0^i represents i's consumption of the clean numeraire good 0, $u(.)$ is a differentiable and strictly concave function of consumption x_g^i of polluting good g, $g \in \{1, ..., G\}$, and X_{kg} is sector g output produced in district k, $k \in \{1, ..., K\}$. θ_g is the pollution coefficient (pollution intensity) of sector g production, and γ_{kgj} is the pollution exposure intensity coefficient, which reflects the extent to which residents of district j suffer from sector g pollution emitted in district k; i.e., when $k \neq j$ it represents the degree of transboundary pollution between districts. The numeraire good has world and domestic consumer and producer prices equal to unity, while good g has world and domestic consumer price p_g^*. The legislature sets a pollution tax t_{kg} in district k for sector g, and thus district k producers receive a net price in sector g equal to $p_{kg} = p_g^* - t_{kg}\theta_g$.

Individual i located in geographic district j spends $\sum_{g=1}^{G} p_g^* d_g(p_g^*)$ on non-numeraire goods, where demand for good g is given by $d_g(p_g^*) = [u'(x_g)]^{-1}$ and where individual-specific superscripts are dropped since the consumption quantities of all non-numeraire goods and the associated consumer surplus are equal for all individuals, provided they have sufficient income. The remaining part of the income is spent on numeraire good 0; this is assumed to be positive.

The numeraire good is produced from labor only with constant returns to scale and an input-output coefficient equal to unity. Assuming positive production of the numeraire good yields a wage rate equal to one. Good $g \in \{1, ..., G\}$ production requires labor and a sector-specific input. With a fixed wage rate, the aggregate factor reward for district k producers in sector g, $\pi(p_{kg})$, depends on the producer price of good g in district k only. Each individual receives wage income. The consumer surplus derived from consumption of good g equals $s_g(p_g^*) = u[d_g(p_g^*)] - p_g^* d_g(p_g^*)$ and is independent of the producer price (and thus independent of the environmental tax). Since consumer surplus s_g and wage income do not depend on environmental taxes, we omit them in the following welfare formulae. The government collects pollution tax revenue in district k's sector g given by $r_{kg}(t_{kg}) = X_{kg}(p_{kg})\theta_g t_{kg}$, where, by Hotelling's Lemma, $X_{kg} = \pi'_{kg}(p_{kg})$ is the domestic supply of good g by district k producers. We assume $X'_{kg} > 0$ and $X''_{kg} = 0$. To keep things simple, we assume that capital of any sector g located in district k is exclusively owned by district k residents; i.e., if industry g earns profit π_{kg} in district k, this profit is received by residents of k.[14]

Let λ_j be the exogenous share of total tax revenue that district j residents receive. The determination of λ_j is not a focus of this paper, and, for simplicity, we do not endogenize this variable, following Grossman and Helpman (2005). Our general approach allows the majority districts to receive up to 100 percent of revenues. If revenue is distributed across districts according to population share, λ_j is equal to district j's population share.[15] If majority legislators are able to channel all tax revenue to majority districts, the sum of λ_j over majority districts equals 1. As shown below, revenue redistribution influences the size of the majority bias and thus the equilibrium tax rates set under the various institutional designs discussed in this paper. For the SOCs to hold, the revenue share going to the majority must be equal to or greater than its population share. On the other hand, if tax revenue is completely ignored in our model, or if the majority receives a lower than proportional share of revenue, the SOCs do not hold.[16]

Adding disutility from pollution and income of district j residents gives the aggregate social welfare level of residents in district j as a function of environmental taxes t_{kg}, equal to

$$W_j = \sum_{g=1}^{G} \pi_{jg}(p_{jg}) + \lambda_j \sum_{k=1}^{K}\sum_{g=1}^{G} r_{kg}(t_{kg}) - \sum_{k=1}^{K}\sum_{g=1}^{G} X_{kg}(p_{kg})\theta_g \gamma_{kgj}. \tag{2}$$

[14]With absentee capital owners, the incentive to tax pollution in majority and minority districts may increase or decrease depending on whether the factor owners and their factors are located in minority or majority districts, respectively. See Lee (2005) for an analysis of absentee ownership and environmental policies in federations.

[15]Weingast (1979) argues that legislators in Congress set up legislative "rules of the game" that lead to a fairly even distribution of funds, in effect insuring themselves against being left outside minimum-winning coalitions. As discussed in Ansolabehere and Snyder (2006), long-lived programs and budget lags reduce the ability of the majority to capture all funds.

[16]Ethier (2007) argues that tariff revenue is relatively unimportant for trade policy and therefore allows for a lower weight of such revenue in the government's objective function. While our approach also implicitly allows for a similar weighting scheme via λ_j (subject to fulfilling the SOC condition), the "double dividend" debate, for example, suggests that pollution tax revenue considerations play a significant role in environmental policymaking and public policy discussions.

3. Benchmarks: Welfare Maximization in Centralized and Decentralized Systems

In this section, we derive four basic welfare-maximizing policies. Although these have been previously shown in the literature, they serve as useful benchmarks for comparisons with the political equilibrium tax rates (discussed in Section 4 below) that usually deviate from the welfare-maximizing policies. The central government may set either (i) district-specific pollution tax rates for each sector, or (ii) a uniform sector-specific tax that applies to all states and districts. The district-specific central policy has two clear advantages over the other policies (which, we believe, have not been sufficiently recognized in the environmental policy literature): namely, it can tailor taxation to the situation in a particular district and at the same time, it takes into consideration any spillover effects that production in a district can have on other districts. In a world without political distortions, this policy is clearly the first-best solution; yet, in the real world, the federal uniform policy usually prevails, based on the uniformity of standards principle. (As we discuss later, the presence of majority bias may provide an additional rationale against centralized district-specific policy.) If local differences in policies are desired, the central government can transfer the right to set policies to subnational entities (such as districts or states) that then have the right to set jurisdiction-specific environmental taxes. We now derive the two centralized (federal district-specific and federal uniform) welfare-maximizing tax policies and the two decentralized (district and state uniform) welfare-maximizing tax policies, respectively.

3.1. Welfare-Maximizing Federal Tax Policies.

We start by deriving the welfare-maximizing tax policy when the federal government sets district-specific pollution tax rates for each sector g.

Lemma 1. *The "federal welfare-maximizing district-specific tax policy" in sector g for district k equals*

$$t_{kg}^0 = \sum_{j=1}^{K} \gamma_{kgj}, \quad \forall g, k. \tag{3}$$

Proof. Calculating the first-order condition of maximizing $\sum_{j=1}^{K} W_j$ from (2) by choice of t_{kg}, noting that $dp_{kg}/dt_{kg} = -\theta_g$, and solving yields (3). □

If the federal government can set different environmental tax rates for different districts, then the first-best optimal tax rate t_{kg}^0 for good g production in district k

equals the sum of the pollution coefficients of district k production, including both local and transboundary pollution.

A federal government may alternatively (and much more commonly) set a tax rate which applies to all districts.

Lemma 2. *The "federal welfare-maximizing uniform tax policy", t_g^f, equals*

$$t_g^f = \frac{1}{\frac{\partial X_g}{\partial p_g}} \sum_{k=1}^{K} \left[\frac{\partial X_{kg}}{\partial p_g} \sum_{j=1}^{K} \gamma_{kgj} \right], \quad \forall g, \tag{4}$$

where $\frac{\partial X_g}{\partial p_g} = \sum_{k=1}^{K} \frac{\partial X_{kg}}{\partial p_g}$.

Proof. Maximizing the sum of (2) over all districts j and restricting district tax rates to a uniform policy value t_g, we find (4). □

The centralized optimal tax t_g^f depends on the aggregated marginal exposure to damage per unit of pollution, and cannot vary by district. Instead, the centralized optimal tax in (4) is a weighted average of the optimal rates t_{kg}^0 in (3), using as weights the relative district-level output adjustment $\frac{\partial X_{kg}}{\partial p_g} / \frac{\partial X_g}{\partial p_g}$ to net price changes. Eqn. (4) suggests that while a uniform policy takes transboundary pollution damage fully into account, it introduces distortions compared to the district-specific policy in (3). A uniform policy cannot tailor the industry tax rate by district according to district-specific variations in transboundary pollution. Thus, in sum:

Corollary 1. *A federal district-specific pollution tax yields weakly greater social welfare than a federal uniform pollution tax.*

When environmental damage differs depending on the pollution-emitting district, federal district-specific pollution taxes are strictly preferred to federal uniform pollution taxes; the former policies are efficient since they allow a federal government to control for both transboundary pollution and differences in environmental damage across districts. However, if environmental damage has the same effect on any district j, regardless of the district k from which the pollution originates (i.e. $\gamma_{kgj} = \gamma_{gj}$ for all k, g, j), then federal district-specific and federal uniform policy are equivalent.

3.2. **Welfare-Maximizing Decentralized Tax Policies.** We now contrast the centralized (federal) welfare-maximizing environmental policy with its fully decentralized (district) welfare-maximizing counterpart. The local government of district j maximizes

$$W_j^d = \sum_{g=1}^{G} \pi_{jg}(p_{jg}) + \sum_{g=1}^{G} r_{jg}(t_{jg}) - \sum_{k=1}^{K} \sum_{g=1}^{G} X_{kg}(p_{kg}) \theta_g \gamma_{kgj}. \tag{5}$$

Eqn. (5) differs slightly from (2) because with decentralized decision-making, the district itself has tax authority and thus collects its own tax revenue (whereas in (2), it is assumed that the district population receives a part λ_j of the centrally collected tax revenue).

Lemma 3. *District j's "locally optimal pollution tax policy", t^d_{jg}, equals*

$$t^d_{jg} = \gamma_{jgj}, \quad \forall g, j. \tag{6}$$

Proof. Maximizing (5) by choice of t_{jg} yields (6). □

Corollary 2. *A federal district-specific pollution tax yields weakly greater social welfare than a decentralized district-specific pollution tax.*

Eqn. (6) reveals that when policy-making is carried out at the district level, only the pollution damage affecting the district itself is addressed, and transboundary pollution is completely ignored, which usually lowers national welfare. But if no transboundary pollution exists, the federal district-specific tax given in (3) and the decentralized district-specific tax given in (6) coincide and lead to the same welfare level.

Finally, we can derive the state-level welfare-maximizing policy. State s sets an industry-specific environmental tax that applies to all districts located in the state. Denote the set of these districts by S.

Lemma 4. *The "optimal uniform pollution tax policy" for state s, t^s_g, equals*

$$t^s_g = \frac{1}{\frac{\partial X^s_g}{\partial p^s_g}} \sum_{k \in S} \left[\frac{\partial X^s_{kg}}{\partial p^s_g} \sum_{j \in S} \gamma_{kgj} \right], \quad \forall g, s. \tag{7}$$

Proof. Maximizing $\sum_{j \in S} W^d_j$ from (5) by choice of a uniform tax rate t_g yields (7). □

Corollary 3. *A federal district-specific pollution tax yields weakly greater social welfare than a decentralized state-specific pollution tax.*

4. Majoritarian Politics in Centralized and Decentralized Systems

We now drop the assumption that policy makers maximize the aggregate welfare of all districts. Instead, we assume that in a majoritarian system, the majority party in both national and state legislatures maximizes the welfare of the legislators' home districts only, consistent with Grossman and Helpman (2005). This assumption rules out any type of strategic delegation by citizens to a representative who maximizes his own preferences that differ from those of his district, as for example in Besley and Coate (2003); i.e., we simplify the federal model in order to focus on the effect of policymaking by the majority party. We do not lose much insight from this simplification; we could easily incorporate the existence of strategic delegation by replacing the welfare of district j with the welfare of district j's representative. In our setting, effects of the majoritarian political system are present both in federal- and state-level policy making, but absent in district-level policy making.

Each district j is represented by one single legislator who is affiliated with one of two parties (e.g. in the U.S., the Democratic and Republican Party). The number of parliamentary seats assigned to each party has been determined in a previous election. The majority party is represented by at least $(K+1)/2$ legislators in the federal (or state) legislative body, and we denote the set of majority districts by M. We assume that members of the same party are able to provide each other with compensation in the form of political side payments or inter-temporal trades, and hence the majority delegation maximizes its party representatives' joint welfare. In particular, we postulate that members of the same party always work together and maximize their joint welfare rather than forming majority coalitions on a case-by-case basis, i.e., we do not allow delegates to form minimum-winning coalitions.[17] Thus, all majority delegates maximize the overall welfare of citizens in their home districts. Their joint welfare is given by

$$\begin{aligned} W^M &= \sum_{j \in M} W_j \\ &= \sum_{g=1}^{G} \sum_{k \in M} \pi_{kg}(p_{kg}) + \Lambda_M \sum_{g=1}^{G} \sum_{k=1}^{K} r_{kg}(t_{kg}) - \sum_{k=1}^{K} \sum_{g=1}^{G} X_{kg}(p_{kg}) \theta_g \sum_{j \in M} \gamma_{kgj} \qquad (8) \end{aligned}$$

where W_j is defined as in (2) and $\Lambda_M = \sum_{j \in M} \lambda_j$. The equilibrium environmental tax policy is determined as the policy that maximizes the majority party legislators' joint welfare, given by (8).

4.1. **Majority Bias: Federally Set District-Specific Taxes.** To obtain a clear understanding of the effects of a majoritarian system on environmental tax policy, we start with the scenario that the federal government sets district-specific tax rates. Note that the optimal tax rate is then given by Lemma 1, i.e. (3). Let δ_k^M be an indicator variable equal to one if district k is a majority district and equal to zero otherwise.

[17]Essentially, we assume perfect party discipline, where each legislator from the majority party cooperates (see McGillivray (1997), Snyder and Groseclose (2000), McCarty, Poole, and Rosenthal (2001)).

Proposition 1. *The "federal district-specific equilibrium tax policy" in sector g in district k equals*

$$t_{kg} = \overbrace{\sum_{j=1}^{K} \gamma_{kgj}}^{A} + \overbrace{\frac{\Lambda_M - \delta_k^M}{\Lambda_M \theta_g} \frac{X_{kg}}{\frac{\partial X_{kg}}{\partial p_{kg}}}}^{B} + \overbrace{\frac{1}{\Lambda_M} \sum_{j \in M} \gamma_{kgj} - \sum_{j \in M} \gamma_{kgj}}^{C}$$
$$= \frac{1}{\Lambda_M} \sum_{j \in M} \gamma_{kgj} + \frac{\Lambda_M - \delta_k^M}{\Lambda_M \theta_g} \frac{X_{kg}}{\frac{\partial X_{kg}}{\partial p_{kg}}} \quad \forall k, g. \quad (9)$$

Proof. The federal government maximizes (8) by choice of t_{kg}. Rearranging the first-order condition

$$(\Lambda_M - \delta_k^M)\theta_g X_{kg} - \Lambda_M \theta_g^2 \frac{\partial X_{kg}}{\partial p_{kg}} t_{kg} + \theta_g^2 \frac{\partial X_{kg}}{\partial p_{kg}} \sum_{j \in M} \gamma_{kgj} = 0 \quad (10)$$

gives (9). The SOC equals $(\delta_k^M - 2\Lambda_M)\theta_g \frac{\partial X_{kg}}{\partial p_{kg}} \leq 0$. Since by definition δ_k^M takes a value of either zero or one, the SOC holds provided $2\Lambda_M > 1$, i.e., if majority districts receive more than half of the tax revenue. □

Term A in (9) equals the optimal tax rate t_{kg}^0, given by Lemma 1. Terms B and C in (9) are majority bias terms and are ambiguous in sign. Term B appears when the majority party has won only a subset of districts; when the majority party has won all districts, the profit-decreasing effect and the tax-revenue-increasing effect of a tax increase offset each other.[18] If district k is a majority district ($\delta_k^M = 1$), term B is negative (provided that minority districts receive some tax revenue) because the profit reduction of an increased tax rate would occur in a majority district, whereas only part of the tax revenue increase would go to majority districts. Term B is positive if district k is a minority district ($\delta_k^M = 0$) because in this case the government does not value district k profits. The sign of term C depends on both the share of the majority districts in tax revenue and the damage caused by pollution by industry g of district k in majority districts. Term C increases with (i) a declining majority tax share and (ii) increasing concentration of pollution in majority districts, holding total pollution constant. If both the tax revenue and pollution are concentrated in majority districts, term C disappears. Finally, the right-hand side of (9) makes clear what matters to the majority party when the federal government can set district-specific taxes. When sector g pollution damage does not affect majority districts, pollution

[18] If all districts are majority districts, maximization of majority welfare is the same as social welfare maximization, and majority bias is not an issue.

will be subsidized in majority districts ($\delta_k^M = 1$), i.e., a pronounced majority bias is observed (as long as $\Lambda_M < 1$).

4.2. **Majority Bias: Federal Uniform Taxes.** In the following, let A_g^M denote the share of sector g production located in majority districts.

Proposition 2. *The equilibrium "federal uniform tax policy" in sector g equals*

$$t_g^{fM} = \overbrace{\frac{1}{\frac{\partial X_g}{\partial p_g}} \sum_{k=1}^{K} \frac{\partial X_{kg}}{\partial p_g} \sum_{j=1}^{K} \gamma_{kgj}}^{A} + \overbrace{\frac{\Lambda_M - A_g^M}{\Lambda_M} \frac{X_g}{\theta_g \frac{\partial X_g}{\partial p_g}}}^{B}$$
$$+ \overbrace{\frac{1}{\frac{\partial X_g}{\partial p_g}} \left[\frac{1}{\Lambda_M} \sum_{k=1}^{K} \frac{\partial X_{kg}}{\partial p_g} \sum_{j \in M} \gamma_{kgj} - \sum_{k=1}^{K} \frac{\partial X_{kg}}{\partial p_g} \sum_{j=1}^{K} \gamma_{kgj} \right]}^{C}$$
$$= \frac{1}{\frac{\partial X_g}{\partial p_g}} \frac{1}{\Lambda_M} \sum_{k=1}^{K} \frac{\partial X_{kg}}{\partial p_g} \sum_{j \in M} \gamma_{kgj} + \frac{\Lambda_M - A_g^M}{\Lambda_M} \frac{X_g}{\theta_g \frac{\partial X_g}{\partial p_g}}, \quad \forall g. \quad (11)$$

Proof. The federal government maximizes (8) by choice of $t_{kg} = t_g$. Rearranging the first-order condition

$$(\Lambda_M - A_g^M)\theta_g X_g - \Lambda_M \theta_g^2 \frac{\partial X_g}{\partial p_g} t_g + \theta_g^2 \sum_{k=1}^{K} \frac{\partial X_{kg}}{\partial p_g} \sum_{j \in M} \gamma_{kgj} = 0 \quad (12)$$

gives (11). The SOC of (12) equals $(A_g^M - 2\Lambda_M)\theta_g \frac{\partial X_g}{\partial p_g} \leq 0$. Since $2\Lambda_M > 1$ provided that majority districts receive more than half of the tax revenue and $A_g^M \leq 1$ by definition, the SOC is fulfilled. □

Term A in (11) equals t_g^f, the optimal uniform tax given in (4), whereas terms B and C reflect forms of majority bias. In term B, the profit decrease of industry g capital owners located in majority districts is compared to the tax revenue increase accruing to the population of these districts; term B equals zero only in the knife-edge case when the profit share A_g^M of industry g capital owners in majority districts equals the tax revenue share Λ_M of majority districts. Term C shows that the effect of pollution on the pollution tax also depends on the majority districts' revenue share and the distribution of the pollution. As in (9), this part of the majority bias disappears when tax revenue and pollution damage are concentrated in majority districts.

The right-hand side of (11) focuses on the net political bias components of interest. If the majority districts are unaffected by pollution damage, the federal uniform equilibrium tax policy in sector g is positive (negative) when the majority districts own a disproportionally small (large) share of the sector g capital stock.

The following propositions discuss the comparative statics of the federal uniform equilibrium tax when majority bias is present.

Proposition 3. *The equilibrium federal uniform pollution tax in sector g is decreasing in the share of sector g capital stock owned by majority districts.*

Proof. Differentiation of (11) with respect to A_g^M yields

$$\frac{dt_g^{fM}}{dA_g^M} = \frac{X_g}{(A_g^M - 2\Lambda_M)\theta_g \frac{\partial X_g}{\partial p_g}}, \quad \forall g, \tag{13}$$

where the denominator must be negative in order for the welfare function (8) to be strictly concave in t_g. Since $2\Lambda_M > 1$ provided that majority districts receive more than half of the tax revenue and $A_g^M \leq 1$ by definition, this condition is indeed fulfilled. Hence, (13) is negative. □

The intuition is that, ceteris paribus, the greater is the share of sector g capital stock owned by majority districts, the greater is the marginal cost of raising the pollution tax to the majority legislative delegation (while the marginal benefits — improved environmental quality and tax revenues — remain constant). This helps explain the intuition behind the anecdotal evidence from the steel industry related in the introduction: an industry that is primarily located in minority districts will face more stringent regulations than other industries.[19]

Next, we investigate the effect of greater exposure to pollution (less absorption of pollutants).

Proposition 4. *Whereas increased exposure to pollution in a majority district yields a positive pollution tax policy response, increased exposure to pollution in a minority district yields no pollution tax policy response.*

Proof. Differentiation of (11) with respect to the pollution exposure coefficient, γ_{kgj}, assuming district j is a majority district, yields

$$\frac{dt_g^{fM}}{d\gamma_{kgj}} = \frac{-\theta_g \frac{\partial X_{kg}}{\partial p_g}}{(A_g^M - 2\Lambda_M)\frac{\partial X_g}{\partial p_g}} \quad \forall j, g, k, \tag{14}$$

[19]However, if capital shares and population are distributed proportionally across majority and minority regions, then governments will be unable to discriminate against minority districts given the constraint of federal uniformity. In that case, majority bias is not a factor affecting policy, provided there is no heterogeneity in pollution damage.

where the denominator is negative (as in (13)), and thus (14) is positive. Differentiation of (11) with respect to γ_{kgj}, assuming district j is a minority district, yields no effect. □

When majority bias is present, the government has a political incentive to react to an increase in pollution damage only to the extent that it affects the majority district population.

Proposition 5. *The equilibrium federal uniform pollution tax in sector g is increasing in the tax revenue share Λ_M that goes to majority districts if and only if tax revenue is increasing in the tax rate t_g.*

Proof. Differentiation of (11) with respect to Λ^M yields

$$\frac{dt_g^{fM}}{d\Lambda_M} = \frac{-\theta_g \left(X_g - \theta_g t_g^{fM} \frac{\partial X_g}{\partial p_g}\right)}{(A_g^M - 2\Lambda_M)\theta_g \frac{\partial X_g}{\partial p_g}}, \quad \forall g, \tag{15}$$

where the denominator is negative (as in (13)) and the numerator equals the negative of the derivative of tax revenue with respect to the tax rate. Hence, (15) is positive if and only if the tax revenue is increasing in t_g. □

Usually, we expect tax revenue to be increasing in the tax rate; that is, we operate on the left side of the Laffer curve. In this case, the equilibrium tax rate will be higher when majority legislators are able to direct more tax revenue to their districts.

4.3. **Majority Bias: The State Level.** We now calculate the tax rates in the political equilibrium when states set pollution taxes. If the majority party in the state legislature sets a uniform tax rate, this leads to a mix of both decentralized and centralized policy features. The resemblance to federal centralized policy arises because tax rates are uniform across districts and majority bias is potentially present. But the policy also has decentralized features, namely better tax tailoring with regard to industry characteristics within the state, and the disregard for transboundary pollution beyond state lines.

In state s, the state majority legislature maximizes

$$\sum_{g=1}^{G} \sum_{k \in M^s} \pi_{kg}^s(p_g^s) + \Lambda_M^s \sum_{g=1}^{G} \sum_{k \in S} r_{kg}^s(t_g^s) - \sum_{g=1}^{G} \sum_{k \in S} X_{kg}(p_g^s)\theta_g \sum_{j \in M^s} \gamma_{kgj}, \tag{16}$$

where production-related terms in districts outside state s are omitted because the state government cannot influence them via taxation.[20] The set M^s consists of all majority districts of state s, and Λ_M^s denotes the revenue share of state s majority districts as percentage of the state tax revenue. Let A_g^{Ms} denote the share of sector g production in a majority district of state s. We find the following result:

Proposition 6. *In a majoritarian system with state-level environmental policy making, the uniform equilibrium pollution tax for sector g in state s is given by*

$$t_g^{Ms} = \overbrace{\frac{1}{\frac{\partial X_g^s}{\partial p_g^s}} \sum_{k \in S} \left[\frac{\partial X_{kg}^s}{\partial p_g^s} \sum_{j \in S} \gamma_{kgj} \right]}^{A} + \overbrace{\frac{\Lambda_M^s - A_g^{Ms}}{\Lambda_M^s} \frac{X_g^s}{\theta_g \frac{\partial X_g^s}{\partial p_g^s}}}^{B}$$
$$+ \overbrace{\frac{1}{\frac{\partial X_g^s}{\partial p_g^s}} \sum_{k \in S} \left[\frac{\partial X_{kg}^s}{\partial p_g^s} \left(\frac{1}{\Lambda_M^s} \sum_{j \in M^s} \gamma_{kgj} - \sum_{j \in S} \gamma_{kgj} \right) \right]}^{C} \quad \forall s, g. \quad (17)$$

Proof. The first-order condition characterizing state-level policy making equals

$$(\Lambda_M^s - A_g^{Ms}) \theta_g X_g^s - \Lambda_M^s \theta_g^2 \frac{\partial X_g^s}{\partial p_g^s} t_g^{sM} + \theta_g^2 \sum_{k \in S} \frac{\partial X_{kg}^s}{\partial p_g^s} \sum_{j \in M^s} \gamma_{kgj} = 0 \quad \forall s, g. \quad (18)$$

The SOC of (18) equals $(A_g^{Ms} - 2\Lambda_M^s)\theta_g^2 \frac{\partial X_g^s}{\partial p_g^s} \leq 0$, and is fulfilled since $2\Lambda_M^s > 1$ (provided that state majority districts receive more than half of the state tax revenue) and $A_g^{Ms} \leq 1$ by definition. Simply solve (18) for t_g^{Ms}. □

Clearly, the federal tax rate (11) and the state tax rate (17) are structurally similar. Both consist of the welfare-maximizing unified tax given in term A and two majority bias terms B and C. However, whereas these terms depend on the distribution of production and pollution in the federation when the tax policy is chosen at the federal level, they only depend on the distribution of production and pollution within the state when the environmental tax is decided at the state level. Moreover, (17) only captures pollution in majority districts in the state. Thus, ceteris paribus, the influence of transboundary pollution on the tax in (17) will be smaller than in (11), since the latter reflects all transboundary pollution affecting majority districts across the nation. Thus, free-riding problems are likely to be accentuated with decentralized majoritarian policy making.

[20] Note that the possibility of strategic interaction between local governments is ruled out by the formulation of the model. Thus, the tax rates are strategically independent in the game played between the state governments (see, e.g., Kessler, Lülfesmann, and Myers (2003) and Eggert and Sørensen (2008) for recent studies of the political economy of tax competition).

Finally, note that if industry location is non-uniform across states and districts, sector g pollution taxes will vary (perhaps sharply) across states; this depends on the degree to which the sector g capital stock is located in majority districts. State policy making may therefore exhibit great dispersion in pollution tax rates.[21]

5. Majoritarian Politics and the Environmental Federalism Debate

5.1. **Social Welfare Considerations.** In this section, we discuss which policies maximize overall social welfare when policies are subject to majority bias. An implication of the analysis in Section 4 is that the existence of majority bias always introduces a wedge between the federal district-specific policy and the social welfare-maximizing policy. Moreover, when majority bias is present, federal district-level policy making may lead to lower social welfare than alternative policies. In other words, a benevolent social planner who creates a fiscal constitution may prefer either federal uniform policy making or decentralized policy making over federal district-level policy-making.

5.1.1. *Federal Uniform vs. Federal District-Level Policy Making.* Here, we show that federal uniform policy making may actually lead to higher social welfare than federal

[21]Alternatively, we may assume that a minimum winning coalition of majority party districts determines policy (a case of imperfect party discipline). This is the benchmark model in Besley and Coate (2003). Only the minimum number of majority representatives for a (50 + x)% legislative majority is included. From (4), we can infer that under the federal uniform tax policy the majority coalition will have a tendency to include districts with a capital stock concentrated in the same set of industry sectors. These sectors will have a low tax rate (A_g^M is high), and other sectors will have a high tax rate. The coalition will also tend to include districts that suffer from pollution from sectors primarily in non-coalition districts, particularly from transboundary pollution emitted in minority districts. This raises the pollution tax imposed on sectors primarily located outside the coalition districts, and thus revenues. Moreover, the coalition will tend to include districts emitting pollution primarily affecting minority districts. This lowers taxes on industries in the coalition. This approach to legislative behavior yields uncertainty regarding the identity of districts included, as discussed by Besley and Coate (2003). Coalition members favor districts that help the remaining coalition members raise the coalition's aggregate welfare (including via compensating transfers). In the case of a federal district-specific approach, (3) suggests that the majority coalition has similar incentives as under the federal uniform policy. However, belonging to the majority now becomes (even) more important, as this designation drives down the tax rate in industry g more sharply than previously, ceteris paribus. On the other hand, if party discipline is non-existent, a majority coalition of any districts may create a minimum winning coalition. In sum, the formation of a minimum winning coalition has policy effects. The emergence of minimum winning coalitions is likely to yield greater policy differences between industries located primarily in majority districts and those located primarily in minority districts.

district-level policy making. In the following, we study the case when there are both minority and majority districts; i.e., we do not consider here the case where all legislators are members of the majority party.

Proposition 7. *In the presence of majority bias, a federal uniform pollution tax policy may yield strictly higher social welfare than a federal district-specific pollution tax policy.*

Proof. Assume pollution damage is uniform across districts; i.e., we have $\gamma_{kgj} = \gamma_g$, $\forall k, g, j$. Assume further that $\Lambda_M = A_g^M = M/K$, where M and K are the number of majority districts and total number of districts, respectively. Thus, sector-specific capital and revenue are distributed proportionally across majority and minority districts.[22] Then, the federal uniform tax policy, given by (11), equals $t_g^{fM} = \sum_{j=1}^{K} \gamma_{kgj} = K\gamma_g = t_{kg}^0$, i.e., the federal uniform tax policy is equivalent to the optimal federal district-specific tax policy given in (3) in Lemma 1. On the other hand, the federal district-specific tax policy, given by (9), equals

$$t_{kg} = \frac{1}{\Lambda_M} \sum_{j \in M} \gamma_{kgj} + \frac{\Lambda_M - \delta_k^M}{\Lambda_M \theta_g} \frac{X_{kg}}{\frac{\partial X_{kg}}{\partial p_{kg}}} = K\gamma_g + \frac{1 - \frac{K}{M}\delta_k^M}{\theta_g} \frac{X_{kg}}{\frac{\partial X_{kg}}{\partial p_{kg}}} \neq t_{kg}^0, \tag{19}$$

i.e. the federal district-specific tax policy is *not* equivalent to the optimal federal district-specific tax policy. This is due to majority bias. □

For example, assume that a fiscal constitution could restrict federal tax policy to be uniform. Then, Proposition 7 presents a case where a benevolent social planner would want to restrict federal environmental policy to be uniform when a majority coalition sets policy. Intuitively, requiring environmental taxes to be uniform across districts places a constraint on the ability of governments to favor majority districts at the expense of minority districts.[23]

5.1.2. *State-Level vs. Federal Policy Making.* Oates (1972) showed that federal uniform policies are socially preferred when transboundary pollution problems are present, whereas decentralized policies lead to higher social welfare when pollution varies widely across districts. Decentralized policies ignore transboundary externalities, whereas federal uniform policies ignore differences in pollution creation across districts. Without majority bias, federal district-level taxation combines the advantages

[22]Note that this need only be true in the aggregate; i.e. if majority districts receive 54% of the tax revenue, they also harbor 54% of the capital stock in sector g.

[23]Federal uniform policies may also avoid sharp policy reversals when the majority party (with different constituency districts) changes after an election loss by the incumbent party.

of decentralized and centralized policy making and is thus first-best. If majoritarian bias is present, however, state-level policy making may be preferred to federal district-level policy making as the following Proposition 8 shows.

Proposition 8. *State-level environmental taxes may lead to strictly higher social welfare than federal taxes provided that at the federal level, both minority and majority districts exist.*

Proof. Assume that the state legislature is homogeneous in the sense that all districts within the state are represented by legislators of the same party.[24] Also, assume that there is no transboundary pollution across state lines and that environmental damage affects each district $j \in S$ equally regardless of the pollution-origin district $k \in S$ (i.e. $\gamma_{kgj} = \gamma_{gj}$). Since by assumption, there are no minority districts at the state level, there is no majority bias. Pollution does not cross state boundaries, so no transboundary pollution problem exists. Moreover, since pollution damage is the same regardless of the exact pollution-source district within the state, the uniformity of the state tax does not result in welfare loss. As a consequence, the state-level policy maximizes the welfare of each state and thus also national welfare. In contrast, federal majority policy-making ignores the welfare of federal minority districts and thus does not maximize national welfare. □

5.2. **System Policy Choice: An Example.** In the previous section, we argued that a social planner who drafts a fiscal constitution may find either federal uniform or decentralized policy superior to district-level federal policy in the presence of majority bias. In this section, we investigate whether this result still holds if the fiscal constitution is drafted by a collection of districts, rather than by a benevolent social welfare-maximizing planner. It turns out that also for this case, depending on the circumstances, either the federal uniform or the decentralized policy may be preferred.

To show this, consider the following simple example. Suppose there are only two industries, the numeraire industry 0 and industry 1, and two districts, A and B, in a federation. If policy choice is centralized, either district can be the one that sets federal tax rates, thus affecting all firms within industry 1. If policy choice is decentralized, each district sets a tax for its own industry 1 firms only. Industry 1's production function in district $j \in \{A, B\}$ is given as $X_{j1} = K_{j1}^{\frac{1}{2}} L_{j1}^{\frac{1}{2}}$, implying a profit

[24]In the U.S., many state legislatures are much more dominated by one party than is the federal legislature. Even after the 2008 "landslide" elections, Democrats do not exceed 60% in either the U.S. Senate or House, but of the 49 states with partisan legislatures, one party exceeds a 60% majority in both state legislative bodies in 18 states (13 Democrat, 5 Republican), a 70% majority in eight states (6 Democrat, 2 Republican), and an 80% majority in three states (all Democrat).

function for industry 1 in district j of $\pi_{j1} = \frac{1}{4}p_{j1}^2 K_{j1}$. For this particular example, we can calculate closed-form solutions for the optimal tax rates.

The decentralized approach. Consider the case when districts A and B set decentralized environmental taxes. In this case, region A maximizes

$$W_A^d = \frac{1}{4}p_{A1}^2 K_{A1} + \frac{1}{2}t_{A1}\theta_1 p_{A1}K_{A1} - \frac{1}{2}p_{A1}K_{A1}\theta_1\gamma_{A1A} - \frac{1}{2}p_{B1}K_{B1}\theta_1\gamma_{B1A} \tag{20}$$

to which the solution is

$$t_{A1}^d = \gamma_{A1A}. \tag{21}$$

Similarly, district B maximizes

$$W_B^d = \frac{1}{4}p_{B1}^2 K_{B1} + \frac{1}{2}t_{B1}\theta_1 p_{B1}K_{B1} - \frac{1}{2}p_{B1}K_{B1}\theta_1\gamma_{B1B} - \frac{1}{2}p_{A1}K_{A1}\theta_1\gamma_{A1B} \tag{22}$$

by choosing

$$t_{B1}^d = \gamma_{B1B}. \tag{23}$$

The federal district-specific approach. Now suppose instead that district A sets federal district-specific taxes to maximize

$$W_A = \frac{1}{4}p_{A1}^2 K_{A1} + \frac{1}{2}\theta_1\lambda_M[t_{A1}p_{A1}K_{A1} + t_{B1}p_{B1}K_{B1}] - \frac{1}{2}\theta_1[p_{A1}K_{A1}\gamma_{A1A} + p_{B1}K_{B1}\gamma_{B1A}]. \tag{24}$$

The optimal tax rates are

$$t_{A1}^{fA} = \frac{(1-\lambda_M)p_1^* - \theta_1\gamma_{A1A}}{\theta_1(1-2\lambda_M)} \tag{25}$$

and

$$t_{B1}^{fA} = \frac{\lambda_M p_1^* + \theta_1\gamma_{B1A}}{2\lambda_M\theta_1}, \tag{26}$$

where the superscript A indicates that the tax rates were chosen by A.[25] Similarly, if district B can choose the federal district-specific taxes, it will maximize

$$W_B = \frac{1}{4}p_{B1}^2 K_{B1} + \frac{1}{2}\theta_1\lambda_M[t_{A1}p_{A1}K_{A1} + t_{B1}p_{B1}K_{B1}] - \frac{1}{2}\theta_1[p_{A1}K_{A1}\gamma_{A1B} + p_{B1}K_{B1}\gamma_{B1B}], \tag{27}$$

to which the solution is

$$t_{B1}^{fB} = \frac{(1-\lambda_M)p_1^* - \theta_1\gamma_{B1B}}{\theta_1(1-2\lambda_M)} \tag{28}$$

and

$$t_{A1}^{fB} = \frac{\lambda_M p_1^* + \theta_1\gamma_{A1B}}{2\lambda_M\theta_1}. \tag{29}$$

[25] It is assumed that a district's tax revenue share λ_M depends on the district being the one who sets federal tax rates, rather than on any other district characteristic, such as employment or capital share.

The federal uniform approach. Finally, consider the case when a district sets a federal uniform tax rate. If district A chooses the policy, it chooses t_{A1} and t_{B1} to maximize (24) subject to the constraint that $t_{A1} = t_{B1} = t_1$. The solution is

$$t_1^{fA} = \frac{p_1^*[\lambda_M K_1 - K_{A1}] + \theta_1[\gamma_{A1A} K_{A1} + \gamma_{B1A} K_{B1}]}{\theta_1[2\lambda_M K_1 - K_{A1}]}. \tag{30}$$

If district B chooses the policy to maximize (27), we similarly obtain

$$t_1^{fB} = \frac{p_1^*[\lambda_M K_1 - K_{B1}] + \theta_1[\gamma_{B1B} K_{B1} + \gamma_{A1B} K_{A1}]}{\theta_1[2\lambda_M K_1 - K_{B1}]}. \tag{31}$$

Since the tax rate is uniform, the difference between the welfare of the district setting the tax and the welfare of the other district is not as high as under federal district-level taxation; more generally, uniformity limits the negative welfare effects of discrimination against minority districts.

5.2.1. *System Policy Choice Under Uncertainty about Majority.* Suppose district A has been chosen to draft a fiscal constitution. At this stage, district A cannot be certain whether it will be the district setting the actual federal tax rates later on (i.e., for the more general case, whether it will be a majority district), if centralized taxation is written into the constitution. Rather, the probability that A will get to choose the actual tax rate is given by $\phi \in (0, 1)$. The tradeoff then looks as follows: If taxation is decentralized, A's welfare does not depend on ϕ, i.e., it equals $W_A^d(t_{A1}^d, t_{B1}^d)$. If A chooses federal district-specific taxation, its expected welfare is $\phi W_A^{fA}(t_{A1}^{fA}, t_{B1}^{fA}) + (1-\phi) W_A^{fB}(t_{A1}^{fB}, t_{B1}^{fB})$, whereas under federal uniform taxation the expected welfare is $\phi W_A^{fA}(t_1^{fA}) + (1-\phi) W_A^{fB}(t_1^{fB})$. When drafting the fiscal constitution, district A will choose the taxation option that maximizes its expected welfare.

To illustrate the tradeoff in more detail, we provide the following numerical example, setting parameter values as follows: $p_1^* = 20$, $K_1 = 20$, pollution intensity $\theta_1 = 2.1$, majority share of tax revenue $\lambda_M = 0.7$, and pollution exposure coefficients $\gamma_{A1A} = \gamma_{B1B} = 5$. Table 1 shows which tax system (decentralized D, federal uniform FU, or federal district-specific FD) is preferred by district A as K_{A1} varies from zero to 20, and the extent of (symmetric) transboundary pollution $\gamma_{k1j} = \gamma_{B1A} = \gamma_{A1B}$ ranges from 0 to 5. These values cover the range of district A owning none to all of sector 1 capital, and from transboundary pollution being non-existent ($\gamma_{k1j} = 0$ for $j \neq k$) to complete ($\gamma_{k1j} = 5$ for $j \neq k$). Finally, in Table 1 we set the probability of A being the district to set the actual tax rate at $\phi = 0.5$. (More generally, of course, this is the probability that A is a majority district.)

From Table 1, we infer that a major determinant of district A's constitutional choice is its share in industry 1 capital, K_{A1}. If this share is sufficiently low, then centralized taxation is optimal, but if K_{A1} lies above a certain threshold, decentralized taxation will be chosen. When district A's ownership of the capital stock in sector 1 rises, it increasingly wants to avoid the risk of being in the minority under a federal system. The advantage of centralized taxation lies in the fact that the district that sets federal tax rates receives a higher share of the overall tax revenue, in the example $\lambda_M = 0.7$. Decentralized taxation gives each district the tax revenue from taxing its own industry only, which is favorable when the district's capital stock is relatively large.

TABLE 1. Optimal Constitutional Choice, Uncertainty About Who Will Set Tax Rate, $\phi = 0.5$

	$\gamma_{k1j} = 0$	$\gamma_{k1j} = 1$	$\gamma_{k1j} = 2$	$\gamma_{k1j} = 3$	$\gamma_{k1j} = 4$	$\gamma_{k1j} = 5$
$K_{A1} = 0$	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU
$K_{A1} = 1$	FU	FU	FU	FU	FU	FU
$K_{A1} = 5$	FU	FU	FU	FU	FU	FU
$K_{A1} = 8$	FU	FU	FU	FU	FU	FU
$K_{1A} = 10$	D	FU	FU	FU	FU	FU
$K_{A1} = 12$	D	D	D	D	FU	FU
$K_{A1} = 14$	D	D	D	D	D	D
$K_{A1} = 15$	D	D	D	D	D	D
$K_{A1} = 18$	D	D	D	D	D	D
$K_{A1} = 20$	D	D	D	D	D	D

Notes: Cell entries are the preferred constitutional choice for the given set of parameters: FD=federal district-specific; FU=federal uniform; D=decentralized. See text for more details.

The degree of cross-boundary pollution also matters for the constitutional choice; i.e., higher cross-boundary pollution coefficients may lead to an increased preference for a centralized tax system. In the example, this effect leads to a switch in the preferred policy system for intermediate levels of K_{A1}, in Table 1 for $K_{A1} = 10$ and $K_{A1} = 12$. Also notice that in the example, the federal district-level system is never strictly preferred. Since $\phi = 0.5$, region A always at least weakly prefers the uniform federal policy (FU) over the district-level federal policy (FD), which would lead to lower overall social welfare. When district A has no capital in industry 1, FD and FU become equivalent. This is because the district that sets policy always sets (only) the tax rate in the other district, in this case.

Proposition 9. *When there is uncertainty about which districts will be in the majority, districts with greater industry capital concentration facing lower cross-boundary pollution are more likely to opt for a decentralized taxation system.*

The intuition is that under a centralized (federal) system, being in the minority is detrimental for welfare, in particular when the minority has a relatively large share of the capital stock. At lower levels of the capital stock a district would agree to the restrictions imposed by a federal uniform (FU) approach but not to a federal district-specific (FD) approach, due to concerns about majority bias.

Table 2. Optimal Constitutional Choice, Uncertainty About Who Will Set Tax Rate, $\phi = 0.9$

	$\gamma_{k1j} = 0$	$\gamma_{k1j} = 1$	$\gamma_{k1j} = 2$	$\gamma_{k1j} = 3$	$\gamma_{k1j} = 4$	$\gamma_{k1j} = 5$
$K_{A1} = 0$	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU
$K_{A1} = 1$	FU	FU	FU	FU	FU	FU
$K_{A1} = 5$	**FD**	FU	FU	FU	FU	FU
$K_{A1} = 8$	**FD**	FU	FU	**FD**	**FD**	**FD**
$K_{A1} = 10$	**FD**	FU	**FD**	**FD**	**FD**	**FD**
$K_{A1} = 12$	**FD**	FU	**FD**	**FD**	**FD**	**FD**
$K_{A1} = 14$	D	D	D	D	**FD**	**FD**
$K_{A1} = 15$	D	D	D	D	D	**FD**
$K_{A1} = 18$	D	D	D	D	D	D
$K_{A1} = 20$	D	D	D	D	D	D

Notes: Cell entries are the preferred constitutional choice for the given set of parameters: FD=federal district-specific; FU=federal uniform; D=decentralized. See text for more details.

The higher probability of district A setting the tax rate may not only lead to the federal district-level policy being preferred over the federal uniform policy in most cases. In addition, the range of situations in which a centralized system is chosen increases, once again because of the redistributional possibilities that centralized systems offer. This is particularly the case for high levels of transboundary pollution damage. As in Table 1, higher capital in district A and lower cross-boundary pollution coefficients make the decentralized system relatively more advantageous.

District-level federal policy can be the preferred tax system, however, if a district expects to be setting the tax rate itself (displayed in bold in Table 2). Consider the optimal tax system choice for the above example, with the only change that now

$\phi = 0.9$. In this case, it is likely that A will set the tax rates, and A is thus less interested in limiting majority bias, but wants to take advantage of deciding discriminatory tax rates. Therefore, the federal district-level policy may be the preferred centralized choice for intermediate values of K_{A1} and zero or high values of γ_{k1j}, as Table 2 shows. When district A's share of the capital stock is sufficiently low, it prefers FU due to the risk that B may end up deciding tax rates, and at the same time the cost of FU is low in terms of the tax levied on its own capital stock. District A selects FU again when the level of transboundary pollution damage γ_{k1j} is low but positive (and K_{A1} is not excessively high). This is because here transboundary pollution is not a major consideration for district B, and an FD regime would lead to a severely penalizing tax rate for district A. In the absence of transboundary pollution ($\gamma_{k1j} = 0$), however, the choice pivots back again to FD for several levels of the capital stock, as the opportunity to take advantage of majority bias is the only concern.

Proposition 10. *If districts have an a priori higher expectation that they will be part of a majority coalition and thus will be able to choose the centralized tax rates, they are more likely to back a federal tax system in general, and a federal district-level tax system in particular.*

5.2.2. *System Policy Choice Under Uncertainty about Majority and Identity.* In addition to uncertainty about who will set the actual federal tax rates, it is also conceivable that a district is uncertain about its own characteristics, for example because these characteristics, such as capital concentration, may change over time. To show the effects of such uncertainty about district characteristics, consider our simple example from the previous section and suppose that a district is not only uncertain about whether it will set the federal tax rates, but also about whether it will have the characteristics of district A or district B, which, assuming that the cross-boundary pollution coefficients are symmetric, is really an uncertainty about capital concentration in a district. Denote the probability that a district will have the characteristics of district A by η, and the characteristics of district B by $(1-\eta)$. When choosing the fiscal constitution, the district compares its expected welfare if taxes are decentralized $(\eta W_A^d(t_{A1}^d, t_{B1}^d) + (1-\eta)W_B^d(t_{A1}^d, t_{B1}^d))$, federal district-specific $(\eta\phi W_A^{fA}(t_{A1}^{fA}, t_{B1}^{fA}) + (1-\eta)\phi W_B^{fA}(t_{A1}^{fA}, t_{B1}^{fA}) + \eta(1-\phi)W_A^{fB}(t_{A1}^{fB}, t_{B1}^{fB}) + (1-\eta)(1-\phi)W_B^{fB}(t_{A1}^{fB}, t_{B1}^{fB}))$, or federal uniform $(\eta\phi W_A^{fA}(t_1^{fA}) + (1-\eta)\phi W_B^{fA}(t_1^{fA}) + \eta(1-\phi)W_A^{fB}(t_1^{fB}) + (1-\eta)(1-\phi)W_B^{fB}(t_1^{fB}))$, and chooses the tax system that leads to maximum expected welfare.

Consider the numerical example with $p_1^* = 20$, $K_1 = 20$, $\theta_1 = 2.1$, $\lambda_M = 0.7$, $\gamma_{A1A} = \gamma_{B1B} = 5$, $\gamma_{B1A} = \gamma_{A1B}$, $\phi = 0.5$, $\eta = 0.6$, given in Table 3. The numbers are the same as in Table 1, with the additional parameter η (the probability that the district has A characteristics) set equal to 0.6.

TABLE 3. Optimal Constitutional Choice, Uncertainty About Tax Rate Setter and District Characteristics, $\phi = 0.5$, $\eta = 0.6$

	$\gamma_{k1j} = 0$	$\gamma_{k1j} = 1$	$\gamma_{k1j} = 2$	$\gamma_{k1j} = 3$	$\gamma_{k1j} = 4$	$\gamma_{k1j} = 5$
$K_{A1} = 0$	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU
$K_{A1} = 1$	FU	FU	FU	FU	FU	FU
$K_{A1} = 5$	FU	FU	FU	FU	FU	FU
$K_{A1} = 8$	FU	FU	FU	FU	FU	FU
$K_{A1} = 10$	D	FU	FU	FU	FU	FU
$K_{A1} = 12$	D	D	FU	FU	FU	FU
$K_{A1} = 14$	D	D	D	FU	FU	FU
$K_{A1} = 15$	D	D	D	FU	FU	FU
$K_{A1} = 18$	D	D	D	D	FU	FU
$K_{A1} = 20$	D	D	D	D	D	FD,FU

Notes: Cell entries are the preferred constitutional choice for the given set of parameters: FD=federal district-specific; FU=federal uniform; D=decentralized. See text for more details.

Compared to Table 1, this additional uncertainty about the characteristics of the district causes the federal uniform taxes to be preferred over more sets of parameter values (strictly preferred in 35 of the 60 cases, instead of 25). What causes the change in preferred policies? Basically, the uncertainty about district characteristics means that a weighted welfare of district A and district B for different tax rate setters is maximized. District B holds capital $K_{B1} = K_1 - K_{A1}$ in industry 1, and the probability that B is the majority district equals $1 - \phi$. If there is no uncertainty about district characteristics, B's tax system choices would be opposite to A's choices: If A prefers decentralized policy, B prefers centralized policy and vice versa. Moreover, if A prefers federal district-level policy for some parameter values K_{A1} and γ_{j1k}, B does not. Hence, $\eta < 1$ may affect the policy choice: The closer η is to 1, the more closely Table 3 resembles Table 1. The closer η is to 0, the more different from Table 1 will Table 3 be. Moreover, as η approaches 0.5, increasingly often the federal uniform tax system becomes the tax system of choice: In fact, in the example, if instead $\eta = \phi = 0.5$, FU is the best choice except for the case of no transboundary pollution ($\gamma_{j1k} = 0$).

What happens if district A has a higher probability of being the district to set the taxes? To investigate, consider the numerical example with $p_1^* = 20$, $K_1 = 20$, $\theta_1 = 2.1$, $\lambda_M = 0.7$, $\gamma_{A1A} = \gamma_{B1B} = 5$, $\gamma_{B1A} = \gamma_{A1B}$, $\phi = 0.9$, $\eta = 0.6$. The numbers are the same as in Table 2, with the additional parameter $\eta = 0.6$.

In Table 4, the extent to which uncertainty about district characteristics increases the preference for federal uniform policy is striking: federal uniform taxes are strictly preferred for 40 of the 60 parameter combinations presented in the table, compared to only 15 in Table 2, when the district was certain to have A characteristics. Unlike Table 2, federal district-specific policies are no longer strictly preferred in any scenario considered. Note that here, the probability that the district is a majority district is 0.58 (it is a majority district with A characteristics with probability $0.9 \times 0.6 = 0.54$ and a majority district with B characteristics with probability $0.1 \times 0.4 = 0.04$).

Table 4. Optimal Constitutional Choice, Uncertainty About Tax Rate Setter and District Characteristics, $\phi = 0.9$ and $\eta = 0.6$

	$\gamma_{k1j} = 0$	$\gamma_{k1j} = 1$	$\gamma_{k1j} = 2$	$\gamma_{k1j} = 3$	$\gamma_{k1j} = 4$	$\gamma_{k1j} = 5$
$K_{A1} = 0$	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU	FD,FU
$K_{A1} = 1$	FU	FU	FU	FU	FU	FU
$K_{A1} = 5$	FU	FU	FU	FU	FU	FU
$K_{A1} = 8$	FU	FU	FU	FU	FU	FU
$K_{A1} = 10$	FU	FU	FU	FU	FU	FU
$K_{A1} = 12$	FU	FU	FU	FU	FU	FU
$K_{A1} = 14$	D	D	FU	FU	FU	FU
$K_{A1} = 15$	D	D	FU	FU	FU	FU
$K_{A1} = 18$	D	D	D	D	FU	FU
$K_{A1} = 20$	D	D	D	D	D	D

Notes: Cell entries are the preferred constitutional choice for the given set of parameters: FD=federal district-specific; FU=federal uniform; D=decentralized. See text for more details.

We thus conclude:

Proposition 11. *A higher degree of uncertainty (i.e. the closer ϕ and η are to 0.5) leads to an increased preference for the federal uniform tax system.*

6. CONCLUSION

Our results yield new insights about environmental policy outcomes in federal systems, which are applicable to the environmental federalism debate. Majority bias, in the form of policies that favor the majority party's home districts, affects federal and state-level policy making. The degree to which majority bias drives a wedge between optimal and actual policy outcomes depends on whether factors of production and pollution damage are located in majority or minority party districts. In particular, we find a novel argument for uniform (across districts) federal policy making: these policies reduce the majority legislators' ability to favor their home districts at the expense of districts represented by the minority party. Majority bias also affects the optimal choice between state-level and federal policy. We show that the presence of majority bias can change the ranking of government policies and, in some cases, may bring distortionary policies closer to the optimal policy. These theoretical results may provide guidance for future empirical work on the determinants of environmental taxation in majoritarian political systems, since they suggest that empirical studies should be on the lookout for majority bias as an environmental policy determinant.

Appendix A. Majority Representation Variable

We constructed a variable measuring the extent of each industry's majority representation as follows. For each state, the difference between the percentage of industry employment located in that state and the population share of that state is computed. For industry employment, we used County Business Patterns, which gives employment by 4-digit SIC for each state. Since many observations are censored, it also gives the number of establishments in various size classes. These data are also available at the national level (with far fewer censored observations). Following Busch and Reinhardt (2000), we compute the mean establishment size at the national level for each size class. We then estimate total employment in the industry for each state using the national industry average for each size class, and the number of firms in each size class by state. Note that, like Busch and Reinhardt (2000), we use the imputed data even when the actual data are not censored. The percentage of industry employment in each state is estimated using the sum across states as the denominator (so that the percentages sum to one for each industry).

To construct the index, we then sum this measure over only those states in which more than 50% of the House delegation is in the majority party. Although the pollution abatement costs (see Appendix B below) are available for 1994 and 1999, we use majority representation for 1993 and 1997 due to lags in the setting of policy.

Appendix B. Environmental Stringency Variable

The pollution abatement costs for the steel industry are from Becker and Shadbegian (2005), page 85. Note that the standard measure of environmental policy stringency at the industry level (the Pollution Abatement Costs and Expenditures Survey) was discontinued in 1994, and reintroduced in a significantly revised form in 1999. The steel industry is one of the few industries that maps easily from 1994 to 1999. The estimate of a 27% decline in pollution abatement operating costs across all manufacturing industries is from Becker and Shadbegian (2005).

References

Ansolabehere, S. and J. M. Snyder, Jr. (2006): "Party Control of State Government and the Distribution of Public Expenditures," *Scandinavian Journal of Economics*, 108, 547–569.

Becker, R. A. and R. J. Shadbegian (2005): "A change of PACE: Comparing the 1994 and 1999 Pollution Abatement Costs and Expenditures surveys," *Journal of Economic and Social Measurement*, 30, 63–95.

Bento, A. M. and M. Jacobsen (2007): "Ricardian Rents, Environmental policy and the 'Double-dividend' Hypothesis," *Journal of Environmental Economics and Management*, 53, 17–31.

Besley, T. and S. Coate (2003): "Central versus Local Provision of Public Goods: A Political Economy Analysis," *Journal of Public Economics*, 87, 2611–2637.

Bovenberg, A. L. and L. H. Goulder (2002): "The Political Economy of Environmental Policy," in *Handbook of Public Economics*, ed. by A. Auerbach and M. Feldstein, Elsevier, 1471–1547.

Busch, M. L. and E. Reinhardt (2000): "Geography, International Trade, and Political Mobilization in U.S. Industries," *American Journal of Political Science*, 44, 703–719.

Cheikbossian, G. (2000): "Federalism, Distributive Politics and Representative Democracy," *Economics of Governance*, 1, 105–122.

——— (2008): "Rent-seeking, Spillovers and the Benefits of Decentralization," *Journal of Urban Economics*, 63, 217–228.

Dijkstra, B. R. (2003): "Direct Regulation of a Mobile Pollution Firm," *Journal of Environmental Economics and Management*, 45, 265–277.

Eggert, W. and P. B. Sørensen (2008): "The Effects of Tax Competition When Politicians Create Rents to Buy Political Support," *Journal of Public Economics*, 92, 1142–1163.

Ekins, P. (1999): "European Environmental Taxes and Charges: Recent Experience, Issues and Trends," *Ecological Economics*, 31, 39–62.

Ethier, W. J. (2007): "The Theory of Trade Policy and Trade Agreements: A Critique," *European Journal of Political Economy*, 23, 605–23.

Fredriksson, P. G. (1997): "The Political Economy of Pollution Taxes in a Small Open Economy," *Journal of Environmental Economics and Management*, 33, 44–58.

Fredriksson, P. G. and N. Gaston (2000): "Environmental Governance in Federal Systems: The Effects of Capital Competition and Lobby Groups," *Economic Inquiry*, 38, 501–514.

Fredriksson, P. G. and D. L. Millimet (2002): "Strategic Interaction and the Determination of Environmental Policy Across U.S. States," *Journal of Urban Economics*, 51, 101–122.

——— (2004): "Comparative Politics and Environmental Taxation," *Journal of Environmental Economics and Management*, 48, 705–722.

Glazer, A. (1999): "Local Regulation May Be Excessively Stringent," *Regional Science and Urban Economics*, 29, 553–558.

Gray, W. and R. J. Shadbegian (2004): "Optimal Pollution Abatement: Whose Benefits Matter and How Much?" *Journal of Environmental Economics and Management*, 47, 510–534.

Grossman, G. M. and E. Helpman (2005): "A Protectionist Bias in Majoritarian Politics," *Quarterly Journal of Economics*, 120, 1239–1282.

Helland, E. (1998): "Environmental Protection in the Federalist System: The Political Economy of NPDES Inspections," *Economic Inquiry*, 36, 305–319.

Helland, E. and A. B. Whitford (2003): "Pollution Incidence and Political Jurisdiction: Evidence from the TRI," *Journal of Environmental Economics and Management*, 46, 403–424.

Inman and Rubinfeld (1997): "Rethinking Federalism," *Journal of Economic Perspectives*, 11, 43–64.

Joanis, M. (2007): "The Road to Power: Partisan Loyalty and the Centralized Provision of Local Infrastructure," Working paper, University of Toronto.

Kessler, A. S., C. Lülfesmann, and G. M. Myers (2003): "Economic Versus Political Symmetry and the Welfare Concern With market Integration and Tax Competition," *Journal of Public Economics*, 87, 847–865.

Kunce, M. and J. F. Shogren (2002): "On Environmental Federalism and Direct Emission Control," *Journal of Urban Economics*, 51, 238–245.

——— (2005): "On Interjurisdictional Competition and Environmental Federalism," *Journal of Environmental Economics and Management*, 50, 212–224.

Lee, K. (2005): "Absentee Ownership of Immobile Factors and Environmental Policies in a Federation," *Environmental and Resource Economics*, 32, 407–417.

Levinson, A. (1997): "A Note on Environmental Federalism: Interpreting Some Contradictory Results," *Journal of Environmental Economics and Management*, 33, 359–366.

——— (2003): "Environmental Regulatory Competition: A Status Report and Some New Evidece," *National Tax Journal*, 56, 91–106.

Levitt, S. D. and J. M. Snyder, Jr. (1995): "Political Parties and the Distribution of Federal Outlays," *American Journal of Political Science*, 39, 958–980.

List, J. A. and S. Gerking (2000): "Regulatory Federalism and Environmental Protection in the United States," *Journal of Regional Science*, 40, 453–471.

Lockwood, B. (2002): "Distributive Politics and the Costs of Centralization," *Review of Economic Studies*, 69, 313–337.

Markusen, J. R., E. R. Morey, and N. D. Olewiler (1993): "Environmental Policy when Market Structure and Plant Locations Are Endogenous," *Journal of Environmental Economics and Management*, 24, 69–86.

——— (1995): "Competition in Regional Environmental Policies When Plant Locations are Endogenous," *Journal of Public Economics 56:*, 56, 55–77.

McAusland, C. (2002): "Cross-Hauling of Polluting Factors," *Journal of Environmental Economics and Management*, 44, 448–470.

McCarty, N., K. Poole, and H. Rosenthal (2001): "The Hunt for Party Discipline in Congress," *American Political Science Review*, 95, 673–687.

McGillivray, F. (1997): "Party Discipline as a Determinant of the Endogenous Formation of Tariffs," *American Journal of Political Science*, 41, 584–607.

Milesi-Ferretti, G. M., R. Perotti, and M. Rostagno (2002): "Electoral Systems and Public Spending," *Quarterly Journal of Economics*, 117, 609–657.

Millimet, D. L. (2003): "Assessing the Empirical Impact of Environmental Federalism," *Journal of Regional Science*, 43, 711–733.

Oates, W. E. (1972): *Fiscal Federalism*, New York: Harcourt, Brace, Jovanovich.

Oates, W. E. and P. R. Portney (2003): "The Political Economy of Environmental Policy," in *Handbook of Environmental Economics*, ed. by K.-G. Mäler and J. Vincent, Elsevier, 325–354.

Oates, W. E. and R. M. Schwab (1988): "Economic Competition Among Jurisdictions: Efficiency Enhancing or Distortion Inducing?" *Journal of Public Economics*, 35, 333–354.

Pashigian, B. P. (1986): "Environmental Regulation: Whose Self-Interests Are Being Protected?" *Economic Inquiry*, 23, 551–584.

Persson, T., G. Roland, and G. Tabellini (2000): "Comparative Politics and Public Finance," *Journal of Political Economy*, 108, 1121–1161.

Persson, T. and G. Tabellini (1994): "A European State: Lessons from Existing Federations. Does Centralization Increase the Size of Government?" *European Economic Review*, 38, 765–773.

——— (1999): "The Size and Scope of Government: Comparative Politics with Rational Politicians," *European Economic Review*, 43, 699–735.

——— (2003): *The Economic Effects of Constitutions*, Cambridge, Mass.: MIT Press.

Rauscher, M. (1994): "On Ecological Dumping," *Oxford Economic Papers (Suppl.)*, 46, 822–840.

Reynolds, A., B. Reilly, and A. Ellis (2005): *Electoral System Design: The New International IDEA Handbook*, Stockholm: International Institute for Democracy and Electoral Assistance.

Richards, K. R. (2007): "Environmental Taxes in the United States," in *Critical Issues in Environmental Taxation: International and Comparative Perspectives, Vol. IV*, ed. by K. Deketelaere, J. E. Milne, L. A. Kreiser, and H. Ashiabor, Oxford University Press, 189–216.

Roelfsema, H. (2007): "Strategic Delegation of Environmental Policy Making," *Journal of Environmental Economics and Management*, 53, 270–275.

Seabright, P. (1996): "Accountability and Decentralisation in Government: An Incomplete Contracts Model," *European Economic Review*, 40, 61–89.

Sigman, H. A. (2005): "Transboundary Spillovers and Decentralization of Environmental Policies," *Journal of Environmental Economics and Management*, 50, 82–101.

Snyder, Jr., J. M. and T. Groseclose (2000): "Estimating Party Influence in Congressional Roll-Call Voting," *American Journal of Political Science*, 44, 193–211.

Ulph, A. (2000): "Harmonization and Optimal Environmental Policy in a Federal System with Asymmetric Information," *Journal of Environmental Economics and Management*, 39, 224–241.

Weingast, B. R. (1979): "A Rational Choice Perspective on Congressional Norms," *American Journal of Political Science*, 23, 245–262.