Green Taxes: Refunding Rules and Lobbying*

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Abstract

Green taxes can internalize environmental externalities *and* raise revenues. We develop a positive theory that treats both of these aspects as endogenous outcomes of special-interest and electoral politics. We consider the choice among three (endogenous) refunding rules: income tax cuts, extra public spending and tax burden compensation to polluters. We show that a polluter lobby group may lobby for the ecotax revenue to be refunded to voters rather than to its members. The reason is that the "price" that the lobby group must pay for a reduction in the green tax can be reduced by supporting a refunding rule that pleases voters. Our analysis provides insights into recent green tax reforms in Europe.

Key words: Green Taxes, Refunding, Lobby Groups, Electoral Competition.

JEL codes: D78, H23.

1 Introduction

In the combat against global warming, acid rain and many other environmental problems, green taxes are, along side with markets for tradable pollution permits, emerging as one of the key regulation instruments. Some Northern European countries (e.g., Sweden, Norway, Denmark, and the Netherlands) implemented far-reaching green tax reforms during the 1990s [24]. Other European countries, such as Germany, Italy, the United Kingdom and France, have more recently introduced environmental taxes to help achieve their reduction targets for greenhouse gas emissions. Table 1 shows some recent examples of CO_2 taxes in selected European countries. These taxes differ in many ways, but the point we want to highlight is the variation in revenue use. In some countries, the tax revenue contributes to the general public budget without being tied to specific purposes (e.g., in Norway and Finland). In others, the revenue is recycled partly or wholly as reductions in social security taxes (e.g., in Germany and the United Kingdom), in personal income taxes (e.g., in Denmark, Sweden and the Netherlands) or employment charges (e.g., in Italy). In yet other cases, some of the revenues are used to compensate polluters (e.g., in Denmark) or to subsidize investments in clean technologies (e.g., in the United Kingdom).

[Table 1: Overview of CO_2 taxes in selected European countries]

Much of the recent academic interest in green taxes centers on efficiency considerations[1] and the possibility of a double dividend.[2] Studies of the political economy of environmental taxation has mostly focussed on explaining why (or why not) green taxes are preferred to other regulation instruments [2, 7, 10], on how and why they deviate from the pigouvian ideal [12, 14, 28, 30], or on loopholes [29]. The equally important

[1] Gersbach and Requate [16], for example, study optimal refunding schemes.

[2] The idea is that the revenue raised by levying correcting environmental taxes can be used to reduce pre-existing distortionary taxes. This can, in principle at least, enhance the efficiency of the overall tax system [4, 5, 6, 15].

question of what happens to the revenue and why has received attention only in a few recent papers. Cremer et al. [9] study how the refund rate can be set by a welfare maximizing constitutional planner to induce the median voter to support higher green taxes. Fredriksson and Sterner [13] and Sterner and Isaksson [32] consider the effect of refunding ecotax revenues to the members of organized industry lobby groups and show how firms with an efficient abatement technology may, for that reason, support higher pollution taxes. Marsiliani and Renstrom [22] show how earmarking of ecotax revenues can serve as a (partial) commitment devise. An important insight from this line of research is that the design of the refunding rule can be used to create political support for green taxes where none or little would otherwise exist. The literature, however, takes the refunding rule either as given (e.g., [13]) or elevates it to the "constitutional" level (e.g., [9]). In reality, all aspects of environmental taxation, including the refunding rule, are determined through the same electoral or regulatory process. As a consequence, the existing literature has little to say about the reasons for the many different types of refunding rules represented by the examples of Table 1.

This paper proposes a positive model of green taxes that treats the refunding rule as well as the green tax rate as endogenous outcomes of a common political process. It is widely recognized that organized industry (polluter) interests have a significant influence on environmental policy (see, e.g., [12]) and that these groups are strongly opposed to tax instruments (see, e.g., [7]). We are, therefore, particularly interested in how the resistance by organized polluter interests to green taxes is affected by the prospect of endogenous revenue recycling. Motivated by the experiences with different refunding rules in Europe and elsewhere, we ask when and why ecotax revenues are recycled as a reduction in distortionary income taxation, as an expansion of public spending, or as tax burden compensation to polluters.

We consider a small open economy in which two electoral-motivated political parties

compete in an election, as in Grossman and Helpman [17]. In the election campaign preceding the election, the parties propose a green tax package consisting of a pollution tax rate and a refunding rule. The two parties are subject to political pressure from a producer lobby group that organizes polluting firms. We prove the surprising result that the polluter lobby group may lobby in favor of a refunding rule that allocates all ecotax revenue to citizen-voters, despite the fact that it could ask for tax burden compensation for its members. This is most likely to happen in societies with many well-informed citizen-voters, a high degree of political competition, and high deadweight costs of (income) taxation. We also show that if tax burden compensation is impossible (or sub-optimal), then the polluter lobby group acts in the best interest of citizen-voters, and to the extent that they like tax cuts better than extra public spending, the lobby group rewards the political parties for cutting income taxes. This is most likely to happen in societies with a large public sector or a highly distortionary income tax system. Both of these results are driven by the same underlying logic. By lobbying for a refunding rule that pleases voters, the lobby group can reduce the "price" of buying a lower green tax. Moreover, compared to a situation with lump-sum refunding of the ecotax revenues (the situation normally considered in the existing literature), the endogenous choice of refunding rule can sometimes, but not always, create support for higher green taxes. Overall, our model can explain why and under what circumstances societies select particular refunding rules, ranging from income tax cuts and extra public spending to tax burden compensation for polluters, as part of their attempt to make the tax system greener. We illustrate the explanatory power of the model in an application to regulation of air pollution in Europe in the 1990s.

2 The model

We consider a small open economy populated by firms and citizen-voters. Its governance structure is representative democracy. Following Grossman and Helpman [17], we model this using a probabilistic voting model with lobbying.

2.1 The production structure

A representative firm produces a private good x.[3] It is sold at a competitive world market at the price p^*. The good is produced using labor, l, raw materials (oil, gas, energy etc.), r, and a specific capital input, K. The domestic prices of labor and raw materials are w and z, respectively. The profit function of the representative firm is $\Pi(p^*, w, z)$. The demand functions for labor and raw materials are $-\frac{\partial \Pi}{\partial w} = l(p^*, w, z)$ and $-\frac{\partial \Pi}{\partial z} = r(p^*, w, z)$. The labor market is competitive. Wages are taxed at the rate $\tau \in (0, 1)$. As discussed in more detail below, we model the deadweight cost thus created as a "leaky bucket", and let the aggregate supply of labor, $\bar{l}$, be fixed. Equilibrium in the labor market requires that $l(p^*, w, z) = \bar{l}$. Solving this condition yields the pre-tax equilibrium wage rate as a function of z and p^*:

$$w^* = w(z, p^*), \text{ where } \frac{\partial w}{\partial z} = -\frac{\frac{\partial l}{\partial z}}{\frac{\partial l}{\partial w}} = \frac{\frac{\partial^2 \Pi}{\partial w \partial z}}{\frac{\partial^2 \Pi}{\partial^2 w}}. \tag{1}$$

By convexity of the profit function, $\frac{\partial^2 \Pi}{\partial^2 w} > 0$. Hence, labor and raw materials are complements if $\frac{\partial^2 \Pi}{\partial w \partial z} > 0$ and substitutes if $\frac{\partial^2 \Pi}{\partial w \partial z} < 0$.

Raw materials are traded at the world market at the price z^*. We assume that the use of raw materials generates pollution (e.g., emissions of CO_2 or SO_2). Pollution is harmful and environmental damage per capita is $G(r)$, where G is an increasing, convex function of the quantity of raw materials used in production. The domestic price of raw

[3] An appendix with a list of all symbols used in the model is available at JEEM's online archive of supplementary material, which can be accessed at http://www.aere.org/journals/.

materials, z, may differ from the world market price z^* if the government levies a green tax, t, i.e., $z = z^* + t$.

2.2 Politics

The endogenous policy variable is a green tax package. A package consists of a tax levied on the use of raw materials (the green tax) and a rule that specifies the use of the revenue (the refunding rule). The revenue can be refunded in (a mixture of) three different ways. Firstly, the revenue can be used to refund polluters directly through tax burden compensation or indirectly through a subsidy to abatement. Secondly, the revenue can be recycled to citizen-voters. In that case, it either enters the general pool of public funds and is used to increase the supply of a public good or it is recycled as cuts in the distortionary tax on labor income. It is convenient to use the following notation to capture these possibilities. Let υ be the share of revenues refunded to polluters. The remaining share, $1 - \upsilon$, is refunded to citizen-voters, where a share ϕ of this is used to cut the income tax and the other share $1 - \phi$ is used to finance extra public goods.[4]

2.2.1 The voters and the political parties

The economy has three types of political agents: two political parties, one polluter lobby group and a continuum of voters (of measure 1) divided into two groups. Voters with index $k \in [0, n_I]$ are informed about the consequences of environmental policy, whereas those with index $k \in (n_I, 1]$ are uninformed. Voters cast their vote for one of the two political parties in an election. The two parties, A and B, endorse a policy platform and collect (and spend) campaign contributions from the lobby group with the aim of maximizing their share of informed and uninformed votes in an upcoming election. The platform contains the party's stance on the green tax package, $(t_j, \phi_j, \upsilon_j)$, $j = A, B$,

[4] By definition, $\upsilon + (1 - \upsilon)(\phi + (1 - \phi)) = 1$.

where t_j is the proposed green tax and (ϕ_j, υ_j) is the proposed refunding rule.

Prior to the introduction of the green tax package, an income tax is levied at the pre-reform rate $\widehat{\tau}$. The associated revenue is used to supply a public good g. The government runs a balanced budget and so the pre-reform supply is $\widehat{g} = \mu\widehat{\tau}w(t_j)\bar{l}$. The parameter $\mu < 1$ represents the leaky bucket. It creates a wedge between the utility cost of the income tax and the moneys raised for public goods. The lower is μ the more distortionary is the income tax. We can interpret μ as an inverse measure of the marginal cost of public funds. The status quo, $(\widehat{g},\widehat{\tau})$, is taken as given. The platform endorsements imply a new income tax rate and a possible expansion of the supply of the public good. In particular, the post-reform government budget constraint is

$$\tau(t_j, \phi_j, \upsilon_j)\mu w\left(t_j\right)\bar{l} + R_j(t_j) = g(t_j, \phi_j, \upsilon_j) + \upsilon_j R_j(t_j), \tag{2}$$

where the left-hand side is the revenue from the income tax levied at the post-reform rate $\tau\left(t_j, \phi_j, \upsilon_j\right)$ plus the ecotax revenue, $R_j(t_j) = t_j r(t_j, w(t_j))$. The right-hand side is total spending on public goods and on tax burden compensation to polluters. The tax package is revenue neutral, i.e., the ecotax revenue must either be spent on reducing the income tax rate, on increasing the supply of public goods or on tax burden compensation to polluters. Accordingly, we can combine the post-reform budget constraint with the platform endorsements of each party to write the post-reform income tax rate as a function of t_j, ϕ_j and υ_j,

$$\tau\left(t_j, \phi_j, \upsilon_j\right) = \frac{\widehat{g} - (1 - \upsilon_j)\,\phi_j R_j(t_j)}{\mu w\left(t_j\right)\bar{l}}. \tag{3}$$

If the revenue is not recycled as income tax cuts ($\upsilon_j = 1$ or $\phi_j = 0$), then $\tau\left(t_j, 0, 1\right) = \widehat{g}/\mu w\left(t_j\right)\bar{l}$.[5] For each unit of ecotax revenue that is recycled as tax cuts, the income tax rate can be reduced by $\left(\mu w\left(t_j\right)\bar{l}\right)^{-1}$ units. This is increasing in the marginal cost of public funds. The corresponding post-reform supply of the public good, as a function

[5] This is not equal to $\widehat{\tau}$ because the tax base (w) is directly affected by the green tax.

of the platform endorsement of party j, is

$$g\left(t_j, \phi_j, \upsilon_j\right) = \widehat{g} + (1 - \upsilon_j)\,(1 - \phi_j) R_j(t_j). \tag{4}$$

The supply of the public good increases one-to-one with each unit of the ecotax revenue devoted to its production. If none of the ecotax revenue is devoted to augmenting the supply of the public good ($\upsilon_j = 1$ or $\phi_j = 1$), then the post- and pre-reform supply is the same.

Informed voters have identical quasi-linear preferences and we specify the indirect utility of a representative informed voter as[6]

$$\begin{aligned} V(t_j, \phi_j, \upsilon_j) \;\; = \;\; & w(t_j)(1 - \tau\left(t_j, \phi_j, \upsilon_j\right))\bar{l} + CS\left(p^*\right) \\ & + H\left(g\left(t_j, \phi_j, \upsilon_j\right)\right) - G\left(r\left(t_j, w\left(t_j\right)\right)\right), \end{aligned} \tag{5}$$

where $CS(p^*)$ is consumers' surplus of x and $H(g)$ is an increasing, concave function. The green tax package affects the well-being of informed voters in three ways. First, they are wage earners and are concerned with the effect of the package on the wage rate, $w\left(t_j\right)$.[7] Second, the refunding rule affects their well-being if it allows for higher after-tax income or for extra public goods. Third, they are concerned with the environmental impact of the package.

Informed voter k evaluates and compares the utility generated by the green tax package endorsed by each of the two parties and votes in favor of party A only if

$$V(t_A, \phi_A, \upsilon_A) - V(t_B, \phi_B, \upsilon_B) \geq \beta^k. \tag{6}$$

The parameter β^k captures voter k's assessment of the superiority ($\beta^k > 0$) or inferiority ($\beta^k < 0$) of party B's fixed characteristics relative to those of party A. These may be related to fixed personal characteristics of the leaders of the parties (such as competence

[6] We assume that the numeraire good is imported and normalize its price to 1.

[7] The total supply of labour is $\int_0^1 \bar{l} dk = \bar{l}$.

or charisma) or may derive simply from a historical attachment to a particular party. We shall refer to β^k as the *ex ante bias* of voter k. A voter with a large ex ante bias in favor of, say, party B will only vote for party A if the platform endorsed by party A is sufficiently more appealing than that endorsed by party B. We assume that β^k is drawn from a uniform distribution defined on $\left[-\frac{1}{2\lambda}-\frac{b}{\lambda},\frac{1}{2\lambda}-\frac{b}{\lambda}\right]$ with distribution function Λ. The realization is only observed by voter k. The parameter $\lambda>0$ controls the diversity of the ex ante bias and it is common to interpret it as an index of political competition. If, on the one hand, λ is large, then most voters are primarily concerned with the platforms endorsed by the parties and political competition is intense. If, on the other hand, λ is small, then many voters put a lot of weight on the fixed characteristics of the parties and political competition is less intense. The parameter b can be interpreted as the average popularity of party A ($b>0$) or of party B ($b<0$). When $b=0$, the parties are equally popular ex ante. The parties know the distribution of the bias but not the realizations. Accordingly, from their point of view, the vote decision is probabilistic with the probability that voter k votes in favor of party A being $\Lambda(V(t_A,\phi_A,\upsilon_A)-V(t_B,\phi_B,\upsilon_B))$. The law of large numbers implies that the fraction, s_I, of informed voters voting for party A is $\frac{1}{n_I}\int_0^{n_I}\Lambda(.)dk$ or

$$s_I=\frac{1}{2}+b+\lambda\left(V(t_A,\phi_A,\upsilon_A)-V(t_B,\phi_B,\upsilon_B)\right). \tag{7}$$

The uninformed voters are unable to evaluate the platforms and may be swayed by the information they receive during the election campaign. As in Grossman and Helpman [17], we assume that the fraction of uninformed voters that vote for party A, s_U, is a linear function of the difference between the campaign spending of the two parties. That is, $s_U=\frac{1}{2}+\theta(C_A-C_B)$, where C_j is the campaign spending of party j. The parameter $\theta>0$ reflects the productivity of campaign spending and can be linked to legal restrictions on campaign finance. The more restrictions, the lower the productivity of each dollar of campaign spending. Adding up the votes of informed and

uninformed voters, the total share of votes for party A is $s = (1 - n_U)\, s_I + n_U s_U$. The share of votes in favor of party B is $1 - s$.

After the election, the parliament convenes to decide which of the two endorsements to implement. The two parties are committed to their platform endorsements, but if they propose different platforms only one of them can be implemented. We do not model the details of the legislative process that determines which one is actually chosen. Instead, we assume that the parties are successful in getting their platform implemented with a certain probability which we, for simplicity, assume is equal to their vote share. This is consistent with several interpretations. If, for example, the seats in parliament are allocated in proportion to the vote shares, then it is natural to suppose that a party's influence on policy is positively related to its share of the seats but also that the majority sometime fails to implement its policy program. However, as shown by Grossman and Helpman [17, appendix], the analysis can be adopted very easily to situations in which the parliament operates a strict majority rule so that the party with the most votes (seats) decides on policy.

2.2.2 The polluter lobby group

A single lobby group, representing the interests of polluters (firms), provides campaign finance to the two political parties.[8] The lobby group's objective is to maximize expected industry profit net of campaign contributions:

$$\begin{aligned} E\left(\pi, C_A, C_B\right) &= s\pi\left(t_A, w\left(t_A\right), \upsilon_A\right) + (1-s)\,\pi\left(t_B, w\left(t_B\right), \upsilon_B\right) \\ &\quad -C_A(t_A, \phi_A, \upsilon_A) - C_B(t_B, \phi_B, \upsilon_B), \end{aligned} \tag{8}$$

where $C_j\left(t_j, \phi_j, \upsilon_j\right)$ is the campaign contribution from the lobby group to party j as a function of that party's platform endorsement and $\pi\left(t_j, w\left(t_j\right), \upsilon_j\right) = \Pi\left(w\left(t_j\right), t_j\right) +$

[8] An appendix showing that the main insights emerging from the model are not affected by the assumption of a single lobby group is available at JEEM's online archive of supplementary material.

$v_j t_j r(t_j, w(t_j))$. In contrast to an individual firm, which takes the wage rate as given, the polluter lobby group internalizes the effect of the green tax package on the wage bill of its members. Likewise, the lobby group takes the prospect of refunding into account, while individual firms ignore this when they make their input choices. Finally, polluters are represented in the political process through the lobby group only. In principle, the lobby group can pursue two different lobbying strategies. Firstly, it can seek influence on the two parties' choice of platform (the influence motive). Secondly, it can seek influence on the vote shares of the two parties (the electoral motive). As we shall see below, only the first motive operates at equilibrium when b is (numerically) small and neither party enjoys a particular advantage with the electorate.

2.3 The efficient supply of public goods

Although there is no particular reason to believe that the initial supply of public goods is chosen to maximize the welfare of informed voters, it is useful, as a benchmark, to entertain the idea. Combining the government's budget constraint with equation (5), we see that the level of the public good that maximizes the integral of the utilities of informed voters, g^*, balances the marginal benefit of public goods with the marginal cost of public funds:

$$\frac{\partial H}{\partial g}(g^*) = \frac{1}{\mu}. \tag{9}$$

For simplicity, we shall refer to g^* as the efficient supply of public goods.[9]

[9] Strictly speaking, the efficient supply of public goods must also take the welfare of uniformed voters into account. However, if we assume that uniformed voters have the same utility function as informed voters, the supply of public goods that maximizes the integral of the utilities of *all* voters continues to be given by the expression in equation (9).

3 The political equilibrium

[Figure 1: The time line]

The timing of events is summarized by the time line shown in Figure 1. The political process operates in five stages. In the first stage, the lobby group offers campaign contributions to the two parties simultaneously. Each contribution schedule is contingent on the platform endorsed by the party to which it is offered. In the second stage, each party $j = A, B$ endorses a platform (t_j,ϕ_j,υ_j) taking as given the contribution schedules offered by the lobby group. These endorsements are made simultaneously. The parties collect the associated campaign funds which are then spent on the election campaign. In the third stage, an election takes place. Informed voters observe the platform endorsements of the two parties. This along with their ex ante bias determines how they cast their vote. Uninformed voters are swayed by the campaign spending of the two parties and vote accordingly. In the fourth stage, after the election, the parliament convenes to decide which of the two green tax packages to implement. As noted above, the two parties are committed to their platform endorsement and try to get it implemented. The ex ante probability that a party is successful in pushing its platform through parliament is equal to its share of the votes. In the fifth stage, firms and citizens make their economic decisions knowing the nature of the green tax package actually implemented. We look for a subgame perfect equilibrium, and solve the model backwards. The outcome of stages three to five follows immediately from the preceding analysis and, consequently, we can focus our attention on the two first stages.

In stage two, each party is confronted with a contribution schedule, $C_j(t_j,\phi_j,\upsilon_j)$, and

endorses the platform, (t_j,ϕ_j,υ_j), that maximizes its expected share of votes, i.e.,

$$\begin{aligned}(t_j^o, \phi_j^o, \upsilon_j^o) &= \arg \max_{(t_j,\phi_j,\upsilon_j)} (1-n_U)\left[\frac{1}{2} + I_j b + \lambda\left(V(t_j,\phi_j,\upsilon_j) - V(t_{-j},\phi_{-j},\upsilon_{-j})\right)\right] + \\ & \quad n_U\left[\frac{1}{2} + \theta\left(C_j(t_j,\phi_j,\upsilon_j) - C_{-j}(t_{-j},\phi_{-j},\upsilon_{-j})\right)\right], \qquad (10)\end{aligned}$$

where superscript "o" indicates equilibrium value, I_j is an indicator function equal to 1 for $j = A$ and equal to -1 for $j = B$, and the notation "$-j$" means "not j".

In stage one, the lobby group is effectively involved in bilateral bargaining with each of the two parties. This takes place simultaneously. Each party can decline the contribution offered by the lobby group. If it does, it cannot sway any uninformed voters to vote for it and, as a consequence, the optimal platform endorsement, irrespective of what the other party endorses, is the platform that attracts the greatest share of informed voters, i.e.,

$$(t_j^*, \phi_j^*, \upsilon_j^*) = \arg \max_{(t_j,\phi_j,\upsilon_j)} \frac{1}{2} + I_j b + \lambda\left(V(t_j,\phi_j,\upsilon_j) - V(t_{-j},\phi_{-j},\upsilon_{-j})\right). \qquad (11)$$

This defines the outside option for each of the parties in the bargaining with the lobby group. We notice that the platform endorsement associated with the outside option is the same for the two parties and we simply denote it by $(t^*, \phi^*, \upsilon^*)$. If a party deviates from $(t^*, \phi^*, \upsilon^*)$, its share of informed votes goes down. The lobby group must, therefore, offer the party a contribution that allows it to increase its share of the uninformed votes to compensate for this loss and in that way keep the total share of votes at least as large as that associated with the outside option. The participation constraint for party j can, therefore, be written as:

$$\begin{aligned}& (1-n_U)\left[\frac{1}{2} + I_j b + \lambda\left(V(t_j,\phi_j,\upsilon_j) - V(t_{-j},\phi_{-j},\upsilon_{-j})\right)\right] \qquad (12)\\ & +n_U\left[\frac{1}{2} + \theta\left(C_j(t_j,\phi_j,\upsilon_j) - C_{-j}(t_{-j},\phi_{-j},\upsilon_{-j})\right)\right] \\ \geq\ & (1-n_U)\left[\frac{1}{2} + I_j b + \lambda\left(V(t^*,\phi^*,\upsilon^*) - V(t_{-j},\phi_{-j},\upsilon_{-j})\right)\right] \\ & +n_U\left[\frac{1}{2} - \theta\left(C_{-j}(t_{-j},\phi_{-j},\upsilon_{-j})\right)\right].\end{aligned}$$

The left-hand side represents the vote share of party j if it endorses the platform $(t_j, \phi_j, \upsilon_j) \neq (t^*, \phi^*, \upsilon^*)$ and takes money from the lobby group, $C_j(t_j, \phi_j, \upsilon_j)$. The right-hand represents the vote share of party j if it rejects the contribution offer from the lobby group and endorses the platform that appeals the most to the informed voters, $(t^*, \phi^*, \upsilon^*)$. In both cases, it takes the platform endorsed by the other party $(t_{-j}, \phi_{-j}, \upsilon_{-j})$ as given. Rewriting this constraint, we find

$$C_j(t_j, \phi_j, \upsilon_j) \geq u \left(V(t^*, \phi^*, \upsilon^*) - V(t_j, \phi_j, \upsilon_j) \right), \tag{13}$$

where $u = \frac{(1-n_U)\lambda}{\theta n_U}$. The right-hand side of this equation defines the "minimum" contribution that the lobby group must make to party j to induce it to deviate from $(t^*, \phi^*, \upsilon^*)$. We see that this is proportional to the difference between the welfare of informed voters under the platform proposed by party j when the party does and does not accept finance from the lobby group. Importantly, the "minimum" contribution does not depend on the policy platform endorsed by the other party.

The lobby group designs the two contribution schedules to maximize its expected payoff given in equation (8) subject to the participation constraints in equation (13). Letting ρ_j denote the Lagrangian multiplier on the participation constraint for party j, we can write the associated first-order conditions with respect to C_j as

$$n_U \theta \left(\pi \left(t_j, w\left(t_j\right), \upsilon_j \right) - \pi \left(t_{-j}, w\left(t_{-j}\right), \upsilon_{-j} \right) \right) + \rho_j \geq 1. \tag{14}$$

The left-hand side represents the benefit of a marginal contribution to party j. This marginal benefit consists of two terms. The first term is the (expected) value of a small increase in the share of uninformed voters voting for party j. This is increasing in the profit differential between the two platform endorsements and is absent if the two parties endorse the same platform. The second term (ρ_j) is the marginal value of shifting the platform endorsed by party j a little. The right-hand side is the marginal cost of the contribution which is always equal to one. The participation constraint must be binding

($\rho_j > 0$) for at least one of the two parties. This is because the lobby group will at most pay one of the parties more than the "minimum" contribution needed to induce a change in its platform. After all, the only reason to pay a party extra is to increase its vote share among uninformed voters and it cannot be an equilibrium outcome for both parties to attempt to do so. On the other hand, any extra contribution must go to the party that offers the best platform and only if $n_U\theta\left(\pi\left(t_j, w\left(t_j\right), \upsilon_j\right) - \pi\left(t_{-j}, w\left(t_{-j}\right), \upsilon_{-j}\right)\right) > 1$ for that party. In this case, the (expected) marginal benefit of increasing the vote share of the party a little is greater than the marginal cost of the extra contribution. This requires that the difference between the platform endorsements be large. In the rest of the paper, we rule this out and focus on the case in which the participation constraints bind for both parties. Since, as we shall see below, the parties will only endorse different platforms if one of them is intrinsically more popular than the other ($b \neq 0$) and this differential is increasing in b, this is equivalent to assuming that b is numerically small.[10] In our context, it, moreover, seems reasonable to suppose that the polluter lobby group, which must be considered "small" relative to the entire economy, concentrates on the influence motive and does not attempt to affect the outcome of the election as such.

Under the assumption that the two participation constraints bind, the lobby group can, by an appropriate choice of its contribution schedules, control the platform endorsements. To see this, substitute the participation constraints into the expression for the vote shares ($s = (1 - n_U)\, s_I + n_U s_U$) to get that the vote share of party A is $s = \frac{1}{2} + b$ while the vote share of party B is $1 - s = \frac{1}{2} - b$ for *any* choice of platform. That is, at equilibrium, the vote shares are independent of the parties' platforms: the polluter lobby group *completely* captures the two parties. We can then substitute equation (13), which holds with equality, into equation (8) to see that the equilibrium platform endorsements

[10] If $b = 0$, the electoral motive is totally absent because the two parties endorse the same platforms. For $b \neq 0$, but numerically small, $n_U\theta\left(\pi\left(t_j, w\left(t_j\right), \upsilon_j\right) - \pi\left(t_{-j}, w\left(t_{-j}\right), \upsilon_{-j}\right)\right) < 1$ for all j and, again, only the influence motive for lobbying is operating and both participation constraints bind.

are characterized by:[11]

$$\begin{aligned} & \{(t_A^o, \phi_A^o, \upsilon_A^o), (t_B^o, \phi_B^o, \upsilon_B^o)\} \\ = \quad & \arg\max \sum_j \left(\left(\frac{1}{2} + I_j b \right) \pi(t_j, w(t_j), \upsilon_j) + uV(t_j, \phi_j, \upsilon_j) \right) \end{aligned} \tag{15}$$

subject to equations (3) and (4). As pointed out by Grossman and Helpman [17], the lobby group induces the political parties to behave *as if* they were maximizing a weighed sum of the welfare of the lobby group and the group of informed voters. The weight given to the group of informed voters is $u = \frac{(1-n_U)\lambda}{\theta n_U}$. It is increasing in the size of the group $(1 - n_U)$. The weight is also increasing in λ – the parameter that controls the degree of political competition – and we note that informed voters get a higher weight in the political calculus when competition is intense. Finally, the weight is decreasing in θ. The more productive campaign spending is (a large θ), the cheaper it is to disregard the group of informed voters.

Calculating the three first-order conditions associated with maximization of equation

[11] We have omitted the constant terms.

(15), we get[12]

$$\phi_j^o \quad : \quad (1-\upsilon_j)\, uR_j \left[\frac{1}{\mu} - \frac{\partial H}{\partial g}\left(g_j'\right)\right] \begin{cases} < 0 \text{ if } & \phi_j^o = 0 \\ = 0 \text{ if } & \phi_j^o \in (0,1) \\ > 0 \text{ if } & \phi_j^o = 1 \end{cases} \tag{16}$$

$$\upsilon_j^o \quad : \quad R_j \left[\frac{1}{2} + I_j b - u\left(\frac{\phi_j^o}{\mu} + \left(1-\phi_j^o\right)\frac{\partial H}{\partial g}\left(g_j'\right)\right)\right] \begin{cases} < 0 \text{ if } & \upsilon_j^o = 0 \\ = 0 \text{ if } & \upsilon_j^o \in (0,1) \\ > 0 \text{ if } & \upsilon_j^o = 1 \end{cases} \tag{17}$$

$$\begin{aligned} t_j^o \quad : \quad & \left(\frac{1}{2} + I_j b\right)\left\{\frac{d\Pi}{dt_j} + \upsilon_j^o \frac{dR_j}{dt_j}\right\} \\ & + u\left\{\frac{\partial w}{\partial t_j}\bar{l} + \left(1-\upsilon_j^o\right)\left(\frac{\phi_j^o}{\mu} + \left(1-\phi_j^o\right)\frac{\partial H}{\partial g}\left(g_j'\right)\right)\frac{dR_j}{dt_j} - \frac{\partial G}{\partial r}\frac{dr}{dt_j}\right\} \\ = \quad & 0, \end{aligned} \tag{18}$$

where $g_j' = \widehat{g} + \left(1-\upsilon_j^o\right)\left(1-\phi_j^o\right) R_j(.)$, $\frac{d\Pi}{dt_j} = \frac{\partial \Pi}{\partial t_j} + \frac{\partial \Pi}{\partial w}\frac{\partial w}{\partial t_j}$, $\frac{dr}{dt_j} = \frac{\partial r}{\partial t_j} + \frac{\partial r}{dw}\frac{\partial w}{\partial t_j}$ and $\frac{dR_j}{dt_j} = \frac{dr}{dt_j}t_j + r\left(t_j, w(t_j)\right)$. In what follows, we assume that $\frac{dr}{dt_j} < 0$ and $\frac{d\Pi}{dt_j} < 0$.[13] These three first-order conditions characterize the equilibrium platform endorsement (the green tax rate and the refunding rule) of party j, while the implied income tax rate and post-reform supply of public goods are implied by equations (3) and (4), respectively. If $b = 0$ such that the parties are equally popular ex ante, the two parties endorse the same platform, i.e., $t_j^o = t^o$, $\phi_j^o = \phi^o$ and $\upsilon_j^o = \upsilon^o$ for $j = A, B$. This, in turns, implies that the two parties give the same weight to the lobby group ($\frac{1}{2}$). If, on the other hand, one of the parties is more popular ex ante than the other ($b \neq 0$), then the platform endorsement of the popular party is more favorable to the lobby group. The reason is that this party can afford to cater more to special interests without losing the support of too many informed voters.

[12] We assume that the second-order conditions for a maximum are satisfied. This among other things require that the sum of $H(g_j'(t_j))$, $w(t_j)$ and $R_j(t_j)$ are concave or that $G(r(t_j, w(t_j)))$ is sufficiently convex in t_j.

[13] This requires that the direct effect on the demand for raw materials or on profits of a change in the green tax rate dominates the indirect effect operating through the wage rate.

To present the main insight of our analysis, it is useful to discuss two special cases. The first special case does not impose any restrictions on the refunding rule, but assumes that the initial supply of public goods ($\widehat{g}$) is equal to g^*, i.e., efficient. This case is designed to demonstrate why and when the ecotax revenue is refunded to voters rather than to polluters. The second special case assumes that all the revenue is recycled to voters, i.e., $\upsilon_j = 0$, but makes no assumption about the pre-reform supply of public goods. This is designed to highlight the choice between recycling through income tax cuts and through extra public spending.

3.1 Refunding to voters or polluters?

Suppose that the pre-reform supply of public goods matches the level informed voters want ($\widehat{g} = g^*$). From equation (16), it is immediately clear that any ecotax revenue refunded to voters will be spent entirely on tax cuts, i.e., $\phi_j^o = 1$ for $j = A, B$. Given that, we can write the first-order condition for υ_j as

$$\upsilon_j^o : R_j(t_j)\left[\frac{1}{2} + I_j b - \frac{u}{\mu}\right] \begin{cases} < 0 \text{ if } & \upsilon_j^o = 0 \\ = 0 \text{ if } & \upsilon_j^o \in (0,1) \\ > 0 \text{ if } & \upsilon_j^o = 1 \end{cases} . \tag{19}$$

This equation reveals that a party may propose to refund all revenue to voters despite being completely captured by the polluter lobby group. In other words, although the polluter lobby group could ask for tax burden compensation for its members, it may not do so!

Proposition 1 *Suppose that $\widehat{g} = g^*$ and $b = 0$. If $\frac{u}{\mu} > \frac{1}{2}$, then all ecotax revenue is refunded to voters (as income tax cuts).*

To see the intuition behind this surprising result, recall that the minimum contribution needed to "buy" a given reduction in the green tax is decreasing in the well-being

of informed voters (see equation (13)). Hence, by lobbying in favor of the refunding rule that maximizes the welfare of informed voters, the lobby group implicitly minimizes the cost of "buying" a given reduction in the green tax. Thus, the lobby group is willing to forego tax burden compensation if, by lobbying for the revenue to be refunded to voters, it can reduce the "price" of buying a reduction in the green tax sufficiently. The marginal cost of foregoing tax burden compensation is $\frac{1}{2}$ – the equilibrium weight of the lobby group in the political calculus (with $b = 0$). The marginal benefit is that the cost of buying a reduction in the green tax falls by $\frac{u}{\mu}$ for each unit of revenue refunded to voters. Accordingly, the marginal benefit is greater than the cost when $\frac{u}{\mu} > \frac{1}{2}$. This is more likely to be the case when income taxation is highly distortionary and the marginal cost of public funds is high (μ is low) or when the weight given to informed voters in the political calculus, u, is large. This weight is, as we noted above, large when the fraction of informed voters is large, when campaign spending is unproductive in swaying uninformed voters, and/or when political competition is intense. Conversely, the theory suggests that tax burden compensation to polluters, which is the equilibrium choice for $\frac{u}{\mu} \leq \frac{1}{2}$, is most likely when most voters are uninformed, when campaign spending is productive and it is easy to persuade uninformed voters, when political competition is lax, and/or when the deadweight cost of (income) taxation is relatively low.

If $b \neq 0$, the two parties do not endorse the same refunding rule. For concreteness, suppose that party A is the favorite to win the election ($b > 0$). Then it follows from equation (19) that party A is more likely to endorse full tax compensation to polluters than party B. The reason is that the lobby group finds it cheaper to buy influence on the platform endorsement of the party with the highest ex ante popularity.

3.2 Income tax cuts or extra public goods?

Now, suppose that all ecotax revenue is refunded to citizen-voters (i.e., $\upsilon_j \equiv 0$ for all j). The question then is whether the ecotax revenue will be refunded as income tax cuts or as extra spending on public goods. The equilibrium platform endorsements are characterized by the following conditions:

$$\phi_j^o : uR_j\left(t_j\right)\left[\frac{1}{\mu} - \frac{\partial H}{\partial g}\left(\widehat{g} - \left(1-\phi_j^o\right)R_j\left(t_j\right)\right)\right] \begin{cases} < 0 \text{ if } & \phi_j^o = 0 \\ = 0 \text{ if } & \phi_j^o \in (0,1) \\ > 0 \text{ if } & \phi_j^o = 1 \end{cases}. \tag{20}$$

Equation (20) shows that the lobby group acts in the best interest of (informed) voters: it lobbies for an allocation of the revenue that fits their preferences perfectly. The intuition for this alignment of interest is similar to that behind proposition 1. Since the contribution needed to "buy" a given reduction in the green tax is decreasing in the well-being of informed voters, the lobby group implicitly minimizes the cost of "buying" a given reduction in the green tax by lobbying in favor of the refunding rule that maximizes the welfare of informed voters. More specifically, we can state the following result.

Proposition 2 *Suppose that* $\upsilon \equiv 0$ *and* $b = 0$.[14] *The two parties endorse the same refunding rule as follows:*

1. *If* $\widehat{g} > g^*(\mu)$, *then* $\phi^o = 1$ *and all the ecotax revenue is spent on cutting income taxes.*

2. *If* $\widehat{g} \in [g^*(\mu) - R\left(t^o\right), g^*(\mu)]$, *then* $\phi^o = 1 - \frac{g^*(\mu)-\widehat{g}}{R(t^o)}$ *and the ecotax revenue is split between income tax cuts and spending on public goods.*

[14] We can see from equation (20) that the average popularity of the parties (b) does not affect the choice of ϕ_j directly. The parameter b does, however, have an indirect effect on the choice of ϕ_j through the choice of t_j and the associated ecotax revenue (see equation (18)). Thus, for $b \neq 0$, the two parties will endorse different green taxes and, therefore, different recycling rules. These differences are not important for the main point that we want to make here and, for simplicity, we state the proposition for the case with $b = 0$.

3. *If* $\widehat{g} < g^*(\mu) - R(t^o)$*, then* $\phi^o = 0$ *and all the ecotax revenue is spent on additional public goods.*

Proof. Fix t^o. Consider the first-order condition in equation (20). If $\widehat{g} > g^*$, then clearly $\frac{\partial H}{\partial g}\left(\widehat{g} + (1-\phi) R(t^o)\right) < \frac{1}{\mu}$ for all $\phi \in [0,1]$. Consequently, $\phi^o = 1$. If $\widehat{g} \in [g^* - R(t^o), g^*]$, then the lobby group induces each party to decrease ϕ until $\frac{\partial H}{\partial g}\left(\widehat{g} + (1-\phi^o) R(t^o)\right) = \frac{1}{\mu}$. Finally, if $\widehat{g} < g^* - R(t^o)$, then $\frac{\partial H}{\partial g}\left(\widehat{g} + (1-\phi) R(t^o)\right) > \frac{1}{\mu}$ for all $\phi \in [0,1]$ and so $\phi^o = 0$ ■

The choice of equilibrium refunding rule is a function of the pre-reform supply of public goods ($\widehat{g}$) relative to the efficient supply (g^*). In a nutshell, the ecotax revenue is fully recycled as income tax cuts if the pre-reform supply is higher than the efficient supply (case 1 of the proposition). If not, it will be used, at least partly, to increase the supply of public goods. If, as in the case 2 of the proposition, the ecotax revenue collected is more than enough to close the gap between the pre-reform and efficient supply of public goods, i.e., $R(t^o) \geq g^*(\mu) - \widehat{g}$, then the revenue is split between income tax cuts and extra public spending. At equilibrium, enough ecotax revenue is devoted to the task of supply public goods to equalize the marginal utility of public goods to the marginal cost of public funds $\frac{1}{\mu}$ and the equilibrium supply is $g^o = g^*$. The remaining revenue is used to cut the income tax. If, on the other hand, as in case 3 of the proposition, the ecotax revenue is insufficient to close the gap, i.e., $R(t^o) < g^*(\mu) - \widehat{g}$, then all available ecotax revenue is spent on public goods, i.e., $\phi^o = 0$. That is what voters want.

The efficient supply of public goods, g^*, is smaller when the deadweight cost of taxation is higher (see equation (9)). An increase in the deadweight cost, therefore, makes it more likely, for a given pre-reform supply of public goods, that the ecotax revenue is refunded through income tax cuts. Our analysis, therefore, suggests that refunding through tax cuts are most likely in countries with a large public sector and/or

with a high marginal cost of public funds. In contrast, societies with poor public services and/or with a relatively efficient income tax system are more likely to allocate any ecotax revenue to the task of providing public goods.

3.3 Political acceptability of green taxes

The green tax endorsed by each of the two parties is given by equation (18). It reflects a trade-off between the interests of the polluter lobby group and informed voters. The polluter lobby group wants the tax to be low in order to keep profits high, but this preference may be tempered if it gets the ecotax revenue reimbursed *and* a higher green tax at the margin means more revenue. Informed voters want the tax to be high insofar as that yields more ecotax revenue and internalizes the externality but this preference may be tempered if raw materials and labor inputs are substitutes in the production process. If one of the parties is more popular than the other ($b \neq 0$), then the more popular party will endorse the lowest green tax as it is willing to cater more to polluter interests.

More importantly, since the green tax is part of a package, the endogenous choice of refunding rule affects the size of the green tax and vice versa. This raises the interesting possibility that the choice of the refunding rule could help creating support for higher green taxes and more environmental protection. To address this issue, we need a counter-factual so that we can isolate the impact of endogenizing the revenue refunding rule. The natural choice is a situation with lump-sum replacement of the ecotax revenue[15] and no lobbying. Under the counter-factual, the tax rates endorsed by the two parties

[15] This is the standard assumption in the literature on the political economy of environmental taxation, see, e.g., [1].

satisfy[16]

$$(1-n_U)\left(\frac{\partial w}{\partial t_j}\bar{l}+\frac{dR_j}{dt_j}-\frac{\partial G}{\partial r}\frac{dr}{dt_j}\right)=0 \text{ for } j=A,B. \tag{21}$$

It is clear that the two parties endorse the same green tax, $t_j = t^{**}$. It is useful to consider two cases separately. In the first case, the ecotax revenue is recycled to voters, i.e., $v^o = 0$, and in the other case, the revenue is recycled to polluters, i.e., $v^o = 1$.

Begin by supposing that $v^o = 0$. Subtracting first-order condition (21) from the first-order condition that determines the green tax with lobbying and endogenous refunding (given by equation (18) with $v^o = 0$) and evaluating the result at t^{**}, we get

$$\frac{n_U\theta}{2\lambda}\frac{d\Pi}{dt}+(1-n_U)\left\{\phi^o\left(\frac{1}{\mu}-\frac{\partial H}{\partial g}\right)+\frac{\partial H}{\partial g}-1\right\}\frac{dR}{dt}. \tag{22}$$

The differential reduces to

$$\frac{n_U\theta}{2\lambda}\frac{d\Pi}{dt}+(1-n_U)\left\{\frac{\partial H}{\partial g}-1\right\}\frac{dR}{dt} \tag{23}$$

if the equilibrium refunding rule is interior ($\phi^o \in (0,1)$). Not surprisingly, since the term $\frac{n_U\theta}{2\lambda}\frac{d\Pi}{dt}$ is negative, lobbying biases the green tax downwards. Importantly, however, since $\frac{\partial H}{\partial g} > 1$ by equation (16), the lobbying bias is moderated by the fact that the refunding rule is chosen endogenously as long as the economy, at equilibrium, is operating on the upwards sloping part of the Laffer curve ($\frac{dR}{dt} > 0$). The intuition is that informed voters are more keen on increasing the green tax yield when the resulting revenue can be (partly) used to reduce distortionary income taxes than when the revenue comes back lump sum. This increases their stake in green taxes. As a consequence, the bargaining positions of the two political parties relative to the lobby group are improved because their outside options are better. In turn, to the benefit of the environment, it becomes more expensive for the lobby group to "buy" a given reduction in the green tax and the

[16] These platform choices can be found by applying what Hettich and Winer [18] refer to as the "representation theorem". This theorem says that the equilibrium policy platforms in a probabilistic voting model without lobbying maximize a weighted sum of the indirect utility functions of (informed) voters. We assume in this section that $b = 0$.

equilibrium tax is, ceteris paribus, higher. If, in contrast, the economy is pushed beyond the Laffer point ($\frac{dR}{dt} < 0$), then the same logic implies that the green tax is lower than in the economy with lump-sum replacement.[17]

Secondly, suppose the ecotax revenue is used to compensate polluters ($v^o = 1$). Using the same procedure as above, we find that tax burden compensation leads to a higher green tax than lump-sum replacement if

$$\frac{n_U \theta}{2\lambda} \frac{d\Pi}{dt} + (1 - n_U) \left\{ \frac{1}{2u} - 1 \right\} \frac{dR}{dt} > 0. \tag{24}$$

The first term is, as before, negative, but $\frac{1}{2u} - 1 > 0$ since $v^o = 1$ and $\mu < 1$. This implies that tax burden compensation, ceteris paribus, results in a higher green tax if the economy is to the left of the Laffer point. This time, however, the reason is that the polluter lobby group reduces its opposition to a high green tax if doing so increases the revenue recycled to its members.

Overall, we conclude that the endogenous choice of refunding rule may buy political acceptability but only if a higher tax at the margin yields more revenue. This can either happen by mobilizing informed voters to take a greater interest in environmental taxation and thereby create a constituency of voters in favor of higher green taxes. Alternatively, it can happen by buying off organized polluter interests by offering them tax burden compensation and thereby making it in the their interest to generate ecotax revenue.

4 Applications

The model identifies a number of economic and political factors that are likely to influence the politically optimal use of the ecotax revenue. In this section, we provide

[17] In theory, the economy could be pushed beyond the Laffer point if, for example, the marginal damage of pollution is sufficiently large. In practise, it is, however, unlikely that this is the case as most green taxes are levied at relatively modest rates. An appendix with a detailed analysis of this is available at JEEM's online archive of supplementary material.

quantitative and qualitative evidence that some of these factors played a role in the design of the refunding rules that accompanied the green taxes that have been introduced primarily in Europe to regulation air pollution problems (acid rain and green house gas emissions) since the early 1990s.

4.1 Taxation of air pollution

Using information from the OECD Economic Instruments Database [25], from Cansier and Krumm [8] and from Ekins and Speck [11] on refund mechanisms in environmentally related taxes – more specifically taxes related to air pollution and energy – we have constructed a (small) data set of 26 green tax packages adopted in 18 European countries[18] and Japan.[19,20] Most of the packages were introduced in the 1990s. We classify each of the packages according to the refunding rule used to recycle the ecotax revenue:

- Rule Ia: the revenue is recycled to citizen-voters as additional spending on public services.
- Rule Ib: the revenue is recycled to citizen-voters as tax cuts.
- Rule II: the revenue is used to refund polluters directly through tax burden compensation or indirectly through a subsidy to abatement.

There are 10 green tax packages that use rule Ia, 7 that use rule Ib, and 9 that use rule II in the data set.

We begin the analysis by asking under what circumstances the ecotax revenue is recycled to polluters rather than to citizen-voters (either through tax cuts or extra

[18] The European countries are Austria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, the Netherlands, Norway, Poland, the Slovak Republic, Spain, Sweden, Switzerland, and the United Kingdom.

[19] Norway, Sweden, Denmark and the Slovak Republic introduced several green tax packages to combat SO_2, CO_2 or NO_x emissions. These are treated as separate packages.

[20] The data set is available at JEEM's online archive of supplementary material.

spending). To this end, we divide the 26 tax packages into two groups. The first group consists of the packages that employ either rule Ia or Ib, i.e., where the ecotax revenue is recycled in one way or the other to citizen-voters. The second group consists of the packages that employ rule II and recycle the revenue to polluters.

The model predicts that this choice is governed by five main factors: the marginal cost of public funds (μ), the productivity of campaign spending (θ), the degree of political competition (λ), the fraction of informed voters (n_I) and the political influence of organized polluter interests ($\frac{1}{2}+b$). For each of the 26 packages, we have collected proxies for these factors. Firstly, Kleven and Kreiner [21] provide estimates of the marginal cost of public funds for most of the countries covered by the sample. For those which are missing, we have used their method to calculate the cost using data on marginal and average tax rates from the OECD Economic Instruments Database [25]. The model predicts that polluters are more likely to get refunded (rule II) in countries in which the marginal cost of public funds is low. Secondly, to approximate the productivity of campaign spending, we have, based on the information about legal restrictions on campaign spending from the Political Finance Database [19], constructed an index of the leniency of campaign contribution legislation for each of the 19 countries. This index ranges from 0 (total ban on campaign contributions) to 15 (no restrictions at all). The model suggests that the index should be relatively high (few restrictions) in countries that adopt green tax packages that recycle the ecotax revenue to polluters (rule II). Thirdly, a common proxy for the degree of political competition in established democracies is the fraction of seats in the legislature held by the ruling government [3]. The higher this fraction is, the lower is the degree of political competition. Based on the model, we expect that the average fraction of seats held by the ruling government is relatively high (i.e., political competition is low) in countries that refund the ecotax revenue to polluters (rule II). Fourthly, we approximate the number of informed voters using newspaper circulation

data (from 1998). This information is obtained from the World Development Indicators [33]. It is reasonable to suppose that the fraction of informed voters is higher in countries with higher newspaper circulation per capita. We, therefore, expect that average circulation is lower (and the population of uninformed voters is larger) in countries that adopt rule II and recycle the ecotax revenues to polluters. Finally, we follow Murrell [23] and approximate the lobbying strength of polluter interests by the number of trade associations per million inhabitants. This information is available, but only for a subset of countries[21], from the World Guide to Trade Associations [34]. We expect that the number of trade associations is relatively high in countries that adopt rule II and recycle the ecotax revenue to polluters.

[Table 2: Green taxes on air pollution in Europe and Japan: Recycling to polluters or to voters?]

To test the main predictions of the model, we have, for each of the five proxies, calculated the average for each of the groups of packages and tested if the difference is statistically significant in the direction predicted by the model. The results are shown in Table 2. The table has six columns and, besides the row with the headings, five rows, one for each of the five proxies. The first and second column link the underlying parameter of the model to the relevant empirical proxy. The third column summarizes the theoretical prediction. The fourth and fifth column report for each of the two groups of green tax packages, the average value and standard deviation of the proxy variable along with the number of cases. The sixth column reports the p-value of a one-sided t-test of the prediction.

For all five proxies the average difference between the two types of green tax packages is consistent with the model. Moreover, the difference is statistically significant at the

[21] The information for the former communist states in Eastern Europe is very sketchy and these countries are not included in the analysis.

10 percent level for the marginal cost of public funds and for the index of the leniency of campaign contribution legislation, while the p-value is 0.11 for newspaper circulation. In other words, this suggests that green tax packages that recycle the ecotax revenue to polluters are less likely to be introduced where the marginal cost of public funds is high, where campaign contribution legislation is strict, and, perhaps, also where newspaper circulation is high.

[Table 3: Green taxes on air pollution in Europe and Japan: Recycling to voters as tax cuts or as extra spending?]

The model also makes predictions about the choice between rule Ia and Ib (see equation (20)), i.e., about when and why the ecotax revenue will be recycled to citizen-voters as tax cuts rather than as extra spending. The key factors governing this choice are the marginal cost of public funds (μ) and the pre-reform level of government spending ($\widehat{g}$). Given that the ecotax revenue is going to be recycled to citizen-voters, it is more likely that it will happen in the form of tax cuts when the marginal cost of public funds and/or when the pre-reform level of spending is high. To investigate these predictions, we look at the 17 green tax packages that recycle the revenue to citizen-voters and divide these into two groups according to whether the revenue is recycled as additional spending (rule Ia) or as tax cuts (rule Ib). The results are reported in Table 3, which is organized in the same way as Table 2. We see that the marginal cost of funds is higher on average in countries that apt to recycle the ecotax revenue as tax cuts, although the difference is not statistical significant. We construct two proxies for the pre-reform size of government [26, 33]: central government spending out of GDP and general government spending out of GDP. It is important to consider both as some of the countries in the sample (e.g., Germany and Switzerland) have a federal structure. We see that government spending is higher on average in countries that apt to recycle the ecotax revenue as tax cuts, irrespective of which definition we use. This is, again, consistent with the model, and

the pre-reform difference in the level of government spending is statistically significant at the 5 percent level.

Overall, the evidence presented in Tables 2 and 3 suggest that the model's predictions are consistent with the observed pattern of refunding rules employed in Europe (and Japan) over the past decades. Economic factors such as the marginal cost of public funds and the pre-reform size of government were important, as were some political factors related to restrictions on campaign funding and, perhaps, to the general level of information amongst voters. It should, of course, be borne in mind that our sample is small, that the proxies we use are far from perfect, and that the observed correlations could be consistent with other models than ours.

4.2 Green taxes in Sweden, France and Germany

Another way to put the model to work is to use it as a vehicle for interpreting particular green tax packages.[22] One particularly interesting case is the tax on NO_x emissions – a major contributor to acid rain – levied in Sweden in 1992 [32]. It was levied at a very high rate (about $4000 per ton) and all the revenue was refunded to the 200 combustion plants originally covered by the scheme. The marginal cost of public funds is high in Sweden and the benefits of cutting the personal income tax correspondingly large, so how did the combustion plants manage to get the entire revenue reimbursed? Olsonian reasoning [27] suggests that the lobbying power of the 200 combustion plants covered by the scheme must have been significant: they were few in numbers (making it easier to control free riding) and the per-plant benefit of getting the emissions charges refunded was large, about half a million dollars per plant. Cleaner-than-average plants, in fact, made a net gain on the scheme [13]. All this suggests that the political influence of organized polluter interests was so large that it dwarfed any other considerations. This

[22] This discussion draws on Sterner [31, chapter 24].

can then explain why the revenue was refunded to polluters rather than to citizen-voters. The example illustrates another feature of the model. The tax levied on NO_x emissions in Sweden was about 200 times larger than a corresponding tax levied in France. The fact that the revenue was recycled to polluters in Sweden but not in France provides a convincing explanation for this difference. Effectively the choice of refunding rule made the high Swedish NO_x tax politically acceptable as suggested by the analysis in section 3.3.

Another interesting case, which can illustrate why it sometimes is in the interest of organized polluter interests to refrain from lobbying for tax burden compensation, is the green tax reform introduced in Germany in the late 1990s [20]. The reform introduced a tax on energy consumption and specified that the ecotax revenue should be used to reduce social security taxes. This suggests that organized polluter groups at least implicitly accepted that the energy tax revenue was recycled to citizen-voters. The model suggests that the reason for doing so might have been an attempt at lowering the cost of "buying" a lenient energy tax. The fact that, as part of the political compromise reached at the time, the tax for all industrial users was levied at rate that was five time lower than that levied on households is consistent with this interpretation. A similar interpretation can be given to the Swedish SO_2 tax levied in the 1990s: organized industrial polluters accepted that the revenue was used to reduce the personal income tax rate in return for a lower tax on SO_2 emissions (see Sterner [31, p. 291]).

5 Conclusion

This paper develops a political economy model of environmental taxation in which we treat the tax rate *and* the refunding rule as endogenous variables. We study how electoral politics and lobbying by polluter interests shape the tax package adopted. Motivated by recent experiences with green taxes in Europe, we consider three different uses of

the ecotax revenue: income tax cuts, extra public spending or tax burden compensation to polluters. We show that the polluter lobby group may lobby for a refunding rule that allocates all revenue to citizen-voters, despite the fact that it could ask for tax burden compensation for its members. We also show that in the absence of tax burden compensation, the lobby group acts in the best interest of (informed) voters. To the extent that they like tax cuts better than extra public spending, the lobby group induces the political parties to introduce tax cuts in their platforms. Both of these results are driven by the same underlying logic. By lobbying for a refunding rule that pleases voters, the lobby group can reduce the "price" of buying a reduction in the green tax. In the case where the ecotax revenue can be used to compensate the lobby group's members, this benefit must be sufficiently large to out weight the value of the foregone tax burden compensation. In the case where the ecotax revenue cannot be refunded to polluters, the lobby group has no direct stake in the refunding rule and will, therefore, support the rule that voters prefer.

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Table 1
Overview of CO_2 taxes in selected European countries

Country	Year of introduction	Revenue use
Sweden	1991	No earmarking but exemptions. Reduction in personal income tax
Denmark	1992/1995/1998	Tax burden compensation and reduction in income taxes.
Norway	1991	No earmarking but exemptions
Netherlands	1990/1996	No earmarking (after 1992) but exemptions. Personal income tax reduction.
Finland	1990/1997	No earmarking and few exemptions
Austria	1996	Earmarking, reimbursement
Germany	1999/2000	Reduction in Social security tax
Italy	1999	Reduction in employment Charges
United Kingdom	2001	Reduction in employers' contribution to national insurance

Source: [8, 11, 24, 25].

Table 2
Green taxes on air pollution in Europe and Japan: Recycling to polluters or to voters?

Parameter in the model	Empirical proxy	Prediction: Is the average of "proxy" higher or lower under rule I than under rule II?	Rule I: Recycling to voters as tax cuts or more spending	Rule II: Recycling to polluters as tax burden compensation or subsidies to abatement	P-value for one-sided t-test of prediction
μ	Marginal cost of funds	Higher	1.60 (0.25) (16)	1.41 (0.32) (9)	0.08
θ	Index of the leniency of campaign contribution legislation	Lower	9.4 (3.55) (17)	11.3 (3.31) (9)	0.09
λ	Fraction of seats in the legislature held by the government	Lower	0.52 (0.11) (17)	0.55 (0.12) (7)	0.29
n_I	Newspaper circulation per 1000 inhabitants	Higher	353.3 (157.7) (16)	274.5 (117.1) (6)	0.11
½ + b	Number of trade associations per million inhabitants	Lower	59.4 (45.9) (16)	106.3 (80.2) (4)	0.17

Notes: The first figure in columns 4 and 5 is the average, the second is the standard deviation and the third is the number of cases. Rule I combines Rule Ia and Ib.
Sources: See text.

Table 3
Green taxes on air pollution in Europe and Japan: Recycling to voters as tax cuts or as extra spending?

Parameter in the model	Empirical proxy	Prediction: Is the average of "proxy" higher or lower under rule Ia than under rule Ib?	Rule Ia: Recycling to voters as more spending	Rule Ib: Recycling to voters as tax cuts	P-value for one-sided t-test of prediction
μ	Marginal cost of funds	Lower	1.53 (0.25) (9)	1.68 (0.25) (7)	0.14
$\hat{g}$	Central government spending in proportion to GDP (%)	Lower	37.5 (8.02) (10)	44.1 (5.03) (7)	0.03
$\hat{g}$	General government spending in proportion to GDP (%)	Lower	50.2 (8.26) (8)	58.0 (8.03) (7)	0.04

Notes: The first figure in columns 4 and 5 is the average, the second is the standard deviation and the third is the number of cases.
Sources: See text.

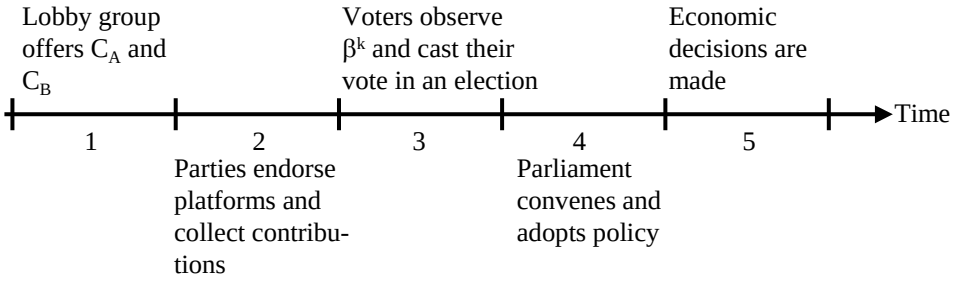

Figure 1: The Time Line