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Summary

In actual environmental policy, the design of actual pollution emission taxes differs significantly with the optimal Pigovian tax. In particular, earmarking prevails and actual taxes are usually combined with regulation. Furthermore tax rates are generally too low to significantly influence polluters' behavior. The paper develops a political economy model to explain these design parameters: the tax rate, earmarking pattern and whether the tax is combined with a regulation. An incumbent government selects these parameters under the influence of a green and a polluters' lobby groups. An earmarked tax is introduced in equilibrium which rate is lower than the regulatory shadow price when the status quo regulation is imperfectly enforced and if the green lobby is sufficiently weak.

Keywords: Environmental tax, political economy, earmarking, tax design, common agency politics, lobbying, public choice

JEL: D72, D78, H23, Q28

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1 Introduction

For years, economists militate in favor of the use of taxes in environmental policy. Key arguments are that environmental taxes help to save pollution abatement costs and provide higher incentives to innovate in abatement technology than the traditional Command and Control approach based on technological or performance-based standards. If regulation remains by far the dominant approach in actual environmental policy, environmental taxes are no longer a theoretical curiosity. In 1995, more than 300 environmental taxes were in place in OECD countries and covered the quasi-complete range of environmental concerns: water or air pollution, noise, waste, land use etc. (OECD, 1995). However, these actual taxes diverge significantly from what economists recommend in textbooks. They are not Pigovian taxes set at a level where marginal environmental damage equals marginal abatement cost.

Several studies suggest how real taxes work (Hahn, 1989, OECD, 1995, 1997, EEA, 1997). Restricting our attention to emission taxes – based on polluting emissions as opposed to product taxes based on potentially polluting products like fuel taxes - three main features are worth mentioning. First of all, tax revenues are generally recycled in the domain they were collected. In particular, their revenue frequently finances pollution abatement projects through grants and subsidized loans.[1] This is the standard case for water effluent taxes in many countries, or for the SO_2 taxes that exist in France, Norway, Sweden, or Denmark. Another example is the Swedish NOx tax, for which revenues are refunded to the plants according to their energy production leading to revenue neutrality, such that the group of tax-payers does not face any tax burden.

A second feature is that taxes usually coexist with regulations. As summarized in a recent survey of the European Environmental Agency, "new tax schemes almost

[1] Earmarking remains prevalent even though it has been recently less favored with the current so-called Ecological tax Reforms going on in several EU countries. The general principle of this reform is to use environmental tax revenues to cut labor taxes thus allowing for a "double dividend" in terms of employment and environment.

always enter a policy field already crowded with other players: permits, standards, bans, agreements, etc." (EEA, 1996, p 29). Hence, taxes do not substitute but are combined with the pre-existing regulatory system. It should be stressed that the interrelationships between the two instruments are very tight. Standards and taxes usually target the same pollutants. For instance, water effluent charges are based on water quality parameters - BOD, toxic substances, and heavy metals, etc.- that are also covered by water quality permits. Other illustrations are the $S0_2$ and NOx taxes, which exist in many EU countries, while the European Large Combustion Plant Directive (88/609) specifies emission standards for the same sources and pollutants.

A last stylized fact is that tax rates are low. Clearly rates are below the socially optimal level. But they are usually even too low to have a significant incentive effect on polluters' behavior. Their main role is thus to raise fund. One should immediately recognize that econometric studies of tax effectiveness are needed to support the claim. As a matter of fact, surveys by the European Environmental Agency (1996) and OECD (1997) recently argued that empirical evaluations of environmental tax effectiveness were in fact very scarce. However, there exists a consensus between observers based on qualitative evidence (Hahn, 1989, OECD, 1995, Pearson, 1995). The latter feature is probably the most social welfare-damaging feature. If a tax is not capable of influencing the polluters' behavior, it is a precondition for the policy instrument to bring efficiency benefits that is not being met.

In this paper, we construct a political economy model to explain the characteristics of emission taxes. We address three design issues: why is earmarking prevalent? Why are charge rates low? How does the combination of the taxes with regulatory standards affect the different tax design parameters? It should be stressed that explaining the observed values of these design parameters – a low tax rate, complete earmarking combined with a regulation – is not a priori evident. The puzzle is the following. Complete earmarking *de facto* suppresses any financial transfer outside the polluting sector. In addition, a low tax rate, in particular lower than the regulation shadow price, implies that the tax does not have any environmental impacts. If a tax has neither financial nor environmental impacts, what are the political forces driving the introduction of taxes?[2]

In the model, a Government under the influence of a green lobby and an industrial lobby making campaign contributions simultaneously elects three design parameters –

[2] One possible reason, which is not addressed by the paper, is the influence of the environmental buraucracy, which could favor complexity in the environmental policy mix (in order to increase his own budget for instance) and that promote no-impact policy options in order to avoid lobby pressures in this exercise.

the tax rate, earmarking pattern and whether the tax is combined with a regulation. Two features of the model, which capture stylized facts of the actual environmental policy mix, are central. Firstly, we assume there exists an environmental policy in the status quo: a regulation was set in the past through the same political procedure and is still in force. This captures the idea that the environmental tax is a "second generation" instrument. It strongly affects the political equilibrium since the agents evaluate policy change against the status quo. The second essential feature of the model is that we explicitly model the enforcement of the regulation. This is how we solve the puzzle mentioned above: a non-earmarked tax with a low rate emerges in equilibrium only when enforcement is imperfect. The reason is that the tax positively influences the compliance decision of the polluters. The story told by the model is thus that taxes are introduced to promote compliance with pre-existing regulation. Put differently, they play a role of enforcement incentive.

Our paper is related to the rapidly growing political economy literature on environmental tax pioneered by Buchanan and Tullock (1975). Most papers focus on earmarking. Bös has recently offered a very rich analysis of the issue by entering into the government "black box" (2000). In his model, a tax is selected by a Parliament controlling two ministers. One is the finance minister in charge of collecting tax, the other being the tax spender. Bös stresses the importance of uncertainty over the future states of the world. If the Parliament or the ministers face high uncertainties, the scope for earmarking is reduced. The reason is that they will prefer to benefit from the non-affected tax revenue to face a possible worsening of the economic situation. In other words, in Bös' framework, earmarking is a "safety net" against future negative shocks on the economy (and thus on public spending). In the same vein, a model by Marsiliani and Renström stresses that earmarking might be an efficient way for the regulator to solve a time consistency problem (2000) while Brett and Keen focuses on the role of political uncertainty (2000). Dijkstra (1999, chapter 10) studies the impact of the timing of the budgetary decision on earmarking.

Papers addressing other design aspects (tax rate, the relationship with regulation) are much scarcer. A lobbying model by Fredriksson (1997) explores the relationship between tax rate, abatement subsidy rate, lobby membership, and product price. There is no earmarking in the model since the abatement subsidy is exogenous. Fredriksson's analysis yields classical results about the influence of lobby membership on the tax parameters (for instance, the more members in the industrial lobby, the lower the tax rate) or other exogenous variables (e.g. the product price). One interesting, counter-intuitive, result is that total pollution may be increasing in the abatement subsidy rate because of political distortions. This is so because *inter alia* the abatement subsidy

reduces the industry's marginal cost and hence output increases. This may stimulate lobbying activity of industry because a higher level of output makes a low pollution tax rate more important. Another paper by Cremer, De Donder and Gahvari (2000) also pay attention to both tax rate and the way tax revenue is recycled in the economy. However their analysis is complementary to ours in that it only deals with *non-earmarked* (product) taxes. The discussion focuses on whether the environmental tax revenue should be used to cut labor or capital taxes. Consistent with the focus on non-earmarked taxes, it is a voting model in which the polluters do not intervene in the political game.

Our paper is organized as follows. A second section introduces the model, which uses the common agency approach of lobbying popularized by Grossman and Helpman (1994). In section 3, we characterize the status quo policy and discuss the general properties of the political equilibrium that is used throughout the paper. Section 4 enters into the core of the analysis. It focuses on a situation of perfect enforcement of the regulation, so that the pollution abatement level in status quo corresponds to the level prescribed by the status quo regulation. Our analysis predicts that the introduction of a tax only occurs only under very restrictive conditions in this case. More specifically, the green lobby needs to be much more influential than the industrial lobby to be able to foster its best policy option: an non-earmarked tax with a high rate. The preferences of the greens for non-earmarking are basically determined by the fact that they receive a share of the tax revenue. In that configuration the tax rate is high (more specifically higher than the regulation shadow price).

In section 5, we consider the case where regulation is imperfectly enforced. It modifies the status quo since pollution abatement is now initially reduced due to incomplete compliance with the regulation. It widens the room for policy change: a tax is systematically introduced but its design depends on the strength of the green lobby group relative to the industrial lobby group. In particular, when the green lobby group is not very powerful, the political equilibrium involves the introduction of non-earmarked tax, which complements the imperfectly enforced regulation. Tax rate is predicted to be low, that is under the regulation shadow cost. The basic reason is that earmarking permits to subsidize regulatory compliance and thus rises abatement levels even at a low rate. Therefore, our analysis predicts that the prevalent tax design encountered in reality only occurs when regulatory enforcement is not perfect. Section 6 concludes.

2 The model

We consider an open economy with one sector producing a private good x and emitting pollution and a heterogeneous population of citizens-consumers that differ in their preferences for pollution.

2.1 The polluting sector

Since the focus of our analysis is the polluting behavior of the producers, we greatly simplify the production aspect in the model. We assume that the sector is a continuum of identical producers of mass 1 producing one unit of the good with a linear technology at zero marginal cost in a competitive environment. Let p denoted the exogenous market price of good x meaning that we assume that the economy is open and sufficiently small so that a change in the polluter's total production cost does not alter the good's market price.[3] We further assume that p is superior to the unit production cost. Hence each polluter produces one unit of good x leading to a surplus denoted Π°. We assume that the producer initially emits a quantity of pollution Q that he may reduce at a cost $C(q)$ where q is the quantity of pollution abated. Pollution abatement entails decreasing returns to scale. Therefore $C_q > 0$ and $C_{qq} > 0$. Based on these assumptions, in the absence of environmental policy, the producer maximizes:

$$\Pi(q) = \Pi^\circ - C(q) \qquad (1)$$

We maintain throughout the paper that $\Pi(q) > 0$ for all q [pollution abatement cannot lead to bankruptcy].

2.2 The environmental policy

The producer is potentially constrained by an environmental policy made of three components: an emission tax, a direct regulation, and, where applicable, a pollution abatement cost subsidy financed by (part of) the tax revenue.

The producer pay a tax on each unit of pollution discharged at a flat rate t. Tax

[3] This assumption greatly simplifies the analysis driving away general equilibrium aspects. It is made in other contributions where consequences on the labour, or good markets are not the core of the analysis (see for instance Fredriksson, 1997). It is a reasonable assumption for many European economies where environmental taxes are the most widespread.

payment generates a revenue, denoted Ω given by $\Omega(q,t) = t(Q - q)$. The revenue may be recycled in two ways. A fraction is used to finance abatement cost subsidy. The subsidy is granted to the polluter if he decides to abate beyond *Q*, its initial level of pollution. It is equal to a fixed proportion *s* of its abatement cost with $s \in [0, 1]$. Hence total subsidy is $s.C(q)$. The fact that the subsidy is based on abatement cost (and not on the quantity of pollution abated for instance) is in line with the reality where revenues are distributed to polluters through investment grants and soft loans in order to reduce net abatement costs. The rest is redistributed to the whole population as a lump sum subsidy.[4] It follows from these assumptions that the subsidy rate, *s*, may vary between 0, when the total revenue is redistributed to the population, and s^{max}, when tax revenue is used in totality to finance the abatement subsidy (complete earmarking). s^{max} is implicitly defined by the budgetary constraint:

$$\Omega(t,q) = t(Q-q) = s^{\max} C(q) \qquad (2)$$

We maintain throughout the paper $s \leq s^{max}$.[5]

It will prove convenient in what follows to identify the response of the polluter to the tax cum subsidy scheme. In this case, his maximization problem is:

$$\max_q \Pi(q) = \Pi^\circ - (1-s)C(q) - t(Q-q)$$

where the first term is the production-related profit, the second term being abatement cost minus the subsidy, and the last term is tax payment on polluter's residual pollution. We immediately get the first order condition:

$$C_q(q) = \frac{t}{1-s} \qquad (3)$$

In the following, we pose $\tau = t/[1-s]$. It is the price signal jointly generated by the tax and the abatement subsidy. To facilitate the resolution, we will keep using τ instead of *t* in the rest of the paper.

The regulation is a quantitative constraint prescribing the polluter to abate a minimal quantity of pollution $R \geq 0$. We explicitly model its enforcement. The non-compliant polluter bears a fine *F* with a probability π, corresponding to the probability of being inspected. As usual, the penalty, *F*, varies with the size of the violation. We

[4] We assume that there is no shadow cost for providing public funds. This assumption is justified by the willingness to avoid any efficiency advantages to one of two instruments (tax versus regulation). Assuming a shadow cost would have de facto given a cost advantage to the regulation.

[5] Showing that $s^{max} < 1$ is straightforward. If $s^{max} = 1$, polluter's profit maximization implies $q = Q$ and thus $\Omega(t, q) = 0$, which is not compatible with $s \neq 0$.

assume a simple linear function:

$$F(q) = F^{\circ} + f(R - q) \tag{4}$$

In this context, the produce decides whether to comply by considering the difference, Δ^R, between the sanction and the cost of compliance:

$$\Delta^R = \pi F(R) - C(R).$$

In section 5., we consider the case where Δ^R is positive resulting in compliance with the status quo regulation. The opposite case is analyzed in section 6.

In the end, the producer faces a three dimensional policy vector **h** = (τ, *s*, *R*).

2.3 The population

The economy is populated with *N* heterogeneous citizen-consumers of two distinct types *C, G* representing the consumers and the greens, respectively. For the sake of simplicity, the size of the population is normalized to one. The greens are in proportion α. The consumers from group C derive utilities from a numeraire good z and the good x produced by the polluting sector. They all have identical individual utility given by

$$z + v(x)$$

where *v*(.) is an increasing and strictly concave function. We assume the price of the numeraire good to be equal to 1. When complete earmarking does not prevail ($s \neq s^{max}$), each consumer eventually receives a fraction of the tax revenue equal to $(1-\alpha)[\Omega(h) - sC(q)]$. Assuming that each individual is initially endowed with $\bar{z}$ units of the numeraire good, the indirect utility of any individual from the group C is thus given by $\bar{z} - pd(p) + v(d(p)) + (1-\alpha)[\Omega(h) - sC(q)]$, where *d*(.) is the demand function of the good *x* [and the inverse of $v_x(x)$].

Individuals of the green group *G* differs from consumers in that they derive disutility from the pollution generated by the production of *x*.[6] Their individual utility is

$$z + v(x) + \tfrac{1}{\alpha} D(Q - q)$$

[6] Another difference is that they organize themselves in a lobby group to make campaign contributions. This will be developed further.

where $D(.)$ is an increasing and strictly concave environmental damage function. Assuming an initial endowment with $\bar{z}$ units of the numeraire good and ignoring at this stage campaign contributions, the indirect utility of a green individual is given by $\bar{z} - pd(p) + v(d(p)) + \alpha[\Omega(h) - sC(q)] - \frac{1}{\alpha} D(Q-q)$.

2.4 The lobby groups' and the Government's utility function

The greens and the polluting sector organize themselves into lobby groups.[7] This hypothesis introduces the political distortion that will make the political equilibrium deviating from the utilitarian optimum. This is justified on the ground that they are the two groups with special interests in the environmental policy. In comparison the consumers from group C are only concerned by the general interest aspect of the policy: the redistribution of the non-earmarked tax revenue. In the model, the existence of lobby groups is completely exogenous and their membership is fixed. More specifically, we assume that all individuals of group G join the lobby group, resulting in a fraction α of the population with membership in the green lobby group whereas the membership in the industrialists' group is equal to one (that is the number of firms in the polluting sector).[8] It is convenient to state the utility function of the lobby group in the absence of campaign contributions. Omitting the terms $\bar{z} - pd(p) + v(d(p))$ and Π° that are constant in the analysis, industrial and green lobby groups' utilities are, respectively,

$$U^I(\mathbf{h}) = -(1-s)C(q) - \Omega(\mathbf{h}) \text{ and,}$$

$$U^G(\mathbf{h}) = \alpha[\Omega(\mathbf{h}) - sC(q)] - D(Q-q) \qquad (5)$$

Organized groups have the capacity to contribute to the campaign of the incumbent government. Here we follow Grossman and Helpman (1994). There is no explicit political competition in the model. The incumbent maximizes his probability of re-election facing an implicit challenger by the maximization of a weighed sum of aggregate campaign contributions and aggregate social welfare. What we have in mind is a democratically elected government that during a term in office collects campaign

[7] Our model differs here from either Fredriksson (1997) or the seminal Grossman & Helpman (1994) common agency models in two respects. They assume that industrial lobby group's members are not companies but individuals endowed a sector-specific capital factor used to produce the good x. As the capital is sector specific, one could think of a human capital made of some of the employees in these companies. Our assumption is closer to what is observed in reality where polluters' lobby groups do not bring together polluting companies' employees.

[8] This difference between the two lobbies in the treatment of membership aims at reflecting the fact that, in reality, green lobbies' influence is ultimately determined by membership contrary to industrial lobbies.

contributions he will use in a later, un-modelled, election. In this situation, he is facing a tradeoff between (i) higher campaign contributions that help to convince undecided or uninformed voters but at the cost of distorting policy choices in favor of contributing groups and (ii) a higher social welfare, which increases the probability of re-election, given that voters take their welfare into consideration in their choice of candidate. The gross aggregate social welfare obtained under the implementation of the policy vector **h**, ignoring contributions, is

$$W(\mathbf{h}) = -C(q) - D(Q-q), \tag{6}$$

and the Government's utility function is

$$U(\mathbf{h}) = gw^G(\mathbf{h}) + w^I(\mathbf{h}) + aW(\mathbf{h}). \tag{7}$$

where w^G and w^I are green and industrial campaign contributions and $a, g \geq 0$ are the exogenously given weights that the Government places, respectively, on aggregate social welfare relative to campaign contributions and on the green lobby contributions. The parameter g introduces an heterogeneity between lobby groups, which is not determined by differences in political stakes. This is a different assumption from that of Grossman & Helpman (1994) or Fredriksson (1997) who both assume that contributions have the same weight whoever the contributor. This traditional assumption heavily constrains the political equilibrium in assuming equal strength of lobbies. Instead, our parametrization of relative strength allows for a broader range of equilibrium. Our assumption is not absurd when one does not restrict campaign contributions to monetary transfers to the candidates. Lobbies can contribute in kind, by working for the candidates, by communicating and convincing citizens. These non-monetary contributions may have differential impacts depending on who is the contributor. For instance, for a given level of contributions, the greens may have a higher capability for channeling votes than industrial lobby groups.

2.5 The political game

The environmental policy vector is the outcome of a two-stage extensive form game between the two lobbies and the incumbent Government:

- In stage 1, each lobby group simultaneously offers the incumbent government a campaign contribution schedule $w^G(\mathbf{h})$ or $w^I(\mathbf{h})$ which is contingent on the policy vector **h** that will be chosen. Each lobby group takes the other lobby group's strategy as given.

· In stage 2, the Government selects a policy vector and receives from each lobby the contribution associated with the policy selected. Although this is not a one-shot game, we assume that lobby groups cannot renege on their promises in the second stage.

3 The status quo political equilibrium

In status quo, a regulation is in force. It was selected in the past following the same political procedure. This section characterizes this status quo regulation. It also gives the opportunity to discuss the general properties of the political equilibrium that is used in the rest of the paper.

Beforehand, it is useful to start the equilibrium analysis considering the utilitarian optimum, which provides a benchmark to compare "distorted" political equilibria. It is given by the maximization of the welfare function W. [9] It leads to the condition for an interior optimum that implicitly defines R^S* the optimal status quo regulation:

$$D_q(Q\text{-}R) = C_q(R) \tag{8}$$

When the greens and the polluter are organized in lobby groups, the environmental policy, $\mathbf{h}$, and the campaign contributions, $\{w^G, w^I\}$, are determined as a sub-game perfect Nash equilibrium of the two stage political game (see Bernheim and Whinston, 1986). The derivation of the political equilibrium follows closely Grossman and Helpman (1994) or Fredriksson (1997) and is left out for ease of exposition. The key point of the resolution is that, in equilibrium, the contributions are *locally truthful* around the equilibrium policy $\hat{\mathbf{h}}$; i.e., around the equilibrium point, each lobby formulates its contribution schedule so that the marginal change in the contribution for a small change in policy equals the impact on lobby group's gross welfare of the policy change:

$$w_R^i(\hat{\mathbf{h}}) = U_R^i(\hat{\mathbf{h}}), \qquad \text{for} \quad i = G, I$$

The contribution is thus equal to the gross indirect utility function less a constant. The constant distributes the rent between the government and lobby group i. For ease of

[9] Here we assume that the regulation was set up “myopically”, that is considering that enforcement would have been perfect ($q = R$). This is a very classical assumption in positive analysis of enforcement that reflects the naivete of political agents and voters with respect to the effectiveness of policy implementation.

exposition, we assume that the contribution schedules are globally truthful.[10] It implies that the politically optimal environmental policy can be derived as the solution of the following optimization problem:

$$\max_{\mathbf{h}} gU^G(\mathbf{h}) + U^I(\mathbf{h}) + aW(\mathbf{h})$$

In the case where the policy mix is limited to an emission standard, we have $s = \tau = 0$. Substituting Eq. (5) and Eq. (6) in the maximization equation yields:

$$\max_{q} U^S = -(1+a)C(q) - (g+a)D(Q-q),$$

leading to the condition for an interior maximum, which defines the status quo regulation R^S:

$$(1+a)C_q(R^S) = (g+a)D_q(Q-R^S). \qquad (9)$$

It is the parameter g that leads the regulation deviating from the optimal regulation R^S*. Unsurprisingly, if $g < 1$, that is if green lobby's contributions are less effective than producer's in increasing the probability of re-election, abatement level is lower ($R^S > R^S$*). Another point deserves attention in Eq. (9): when lobbies' contributions are equally effective (g=1) , the political equilibrium involves the efficient regulation, R^S*, in political equilibrium. Hence the fact that a part of the population, the consumers from group C, is not organised into a lobby group does not induce any political distortions when using a regulation. The reason is that consumers are not affected by the environmental policy in this case: using a regulation restricts environmental policy to its environmental dimension whereas using a tax also entails a financial dimension (which potentially concerns consumers in that they may receive a fraction of the tax revenue).

4 The political equilibrium when enforcement is perfect

Having characterized the status quo policy against which current policy change will be judged, we can now characterize the policy vector **h**. In this section, we assume that enforcement is sufficiently strong so that the producers complies with the regulation in

[10] The implications related to local truthfulness and global truthfulness (which is equivalent to the term locally and globally compensating) are extensively discussed in chapter 8 of the recent Grossman & Helpman's book (2001).

status quo ($\Delta^R \geq 0$). We will see that an earmarked tax is unlikely to emerge in equilibrium in this configuration. Beforehand, we need to derive the reaction function of the polluter to the policy mix.

4.1 The polluter's response to the policy mix

The polluter is targeted by three policy signals: an emission standard, an emission tax, and a cost subsidy (if earmarking prevails). How does he set his abatement level? It is convenient to begin with the characterization of the polluter's reaction function to the sole tax cum subsidy scheme. This function denoted $q^t(\tau)$ is given by the two conditions:

$$C_q(q) = \tau$$

and, $s \leq s^{max}$.

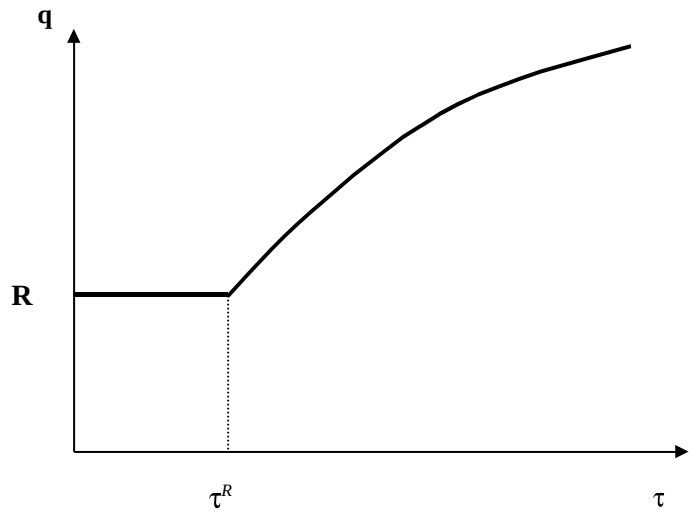
We have then a first useful lemma.

Lemma 1. *The function $q^t(\tau)$ is strictly increasing in τ.*

Proof. See the appendix.

Given the response of the polluter to the sole tax cum subsidy scheme, the abatement level simply depends on the relative level of $q^t(\tau)$ and R. If $q^t(\tau) \geq R$, the polluter abates until $q^t(\tau)$. In this case, the standard does not have any influence on the polluter and the environmental outcome is fully determined by the tax and the subsidy. On the contrary, if $q^t(\tau) < R$, the regulatory constraint is binding and the polluter abates until R. $R = q^t(\tau)$ implicitly defines the shadow price of the regulation that we denote τ^R. The reaction function is denoted $q = q_{\Delta \geq 0}(\mathbf{h})$ in the following and is depicted in Figure 1.

Figure 1. Polluter's response to the policy mix when the regulation is perfectly enforced



4.2 The political equilibrium

In order to identify the vector $\hat{\mathbf{h}} = (\hat{\tau},\ \hat{s},\ \hat{R})$ in political equilibrium, we substitute Eq. (5) and (6) in Eq.(7) and simplify. It gives the political support function:

$$\begin{aligned} U(\mathbf{h}) &= -(1+a)C(q) - (g+a)D(Q-q) + (\alpha g - 1)\left[\Omega(q,\tau,s) - sC(q)\right] \\ &= U^S(q) + (\alpha g - 1)\left[\Omega(q,\tau,s) - sC(q)\right] \end{aligned} \qquad (10)$$

where U^S is the political support function in the status quo regime. The solution is obtained through the maximization of $U(\mathbf{h})$ subject to the following set of constraints:

$q = q_{\Delta\geq 0}(\mathbf{h})$	(polluter's reaction function)
$s < s^{max}$	(budgetary constraint)
$U(\mathbf{h}) > U^S(R^S*)$	(status quo constraint)

A first interesting point is that a totally earmarked tax ($s=s^{max}$) cannot be introduced in political equilibrium. By definition, $s = s^{max}$ implies that $\Omega(q,\tau\, s^{max}) = s.C(q)$ and thus $U(\mathbf{h}) = U^S(q)$. As R^S is the unconstrained extremum of U^S and $\hat{\mathbf{h}}$ is a *constrained* optimum of that same function, $\hat{\mathbf{h}}$ cannot yield a higher political support. Therefore, when enforcement is perfect, the prevalent form of tax observed in practice - an earmarked tax combined with regulation- does not emerge in equilibrium in this case.[11] Intuitively, this is so because the introduction of an earmarked tax does not bring any gain to the different groups of the population in comparison with the status quo (a regulation fully enforced so that the pollution abatement level is R^S). It does not generate revenues, which could have been distributed to the consumers or to the greens otherwise whereas the industrialists are indifferent between the status quo regulation and a tax fully recycled in the polluting sector via cost subsidies. Redistributing a part of the tax revenue to the population modifies the situation. Deviations from R^S become possible, if not systematic. A view on Eq. (10) suggests that the possibility for deviating from the status quo crucially depends on the sign of $(\alpha g - 1)$.

$\alpha\, g \leq 1$

In this case, the last term of the political support function enters negatively in the political support function U since the budgetary constraint imposes $\Omega\,(q,\,\tau,\,s) - s.C(q) \geq 0$. Hence, in the status quo, U is systematically inferior to the status quo political support (that is $U(\mathbf{h})<U^S(R^S)$). This cannot be overcome by deviating from R^S since any move diminishes the first term $U^S(q)$: R^S is its maximum. Hence, the status quo constraint is binding.

$\alpha\, g > 1$

A move away from the status quo becomes possible because the last term now enters positively in the political support function. The status quo constraint holds in $q = R^S$ in this case. The size of the deviation will depend on the marginal properties of the last term of the political support function $\Omega\,(q,\,\tau,\,s) - s.C(q)$. One can firstly show that $s = 0$ since the partial derivative of U with respect to s is strictly negative:

$$\frac{\partial U(h)}{\partial s} = (\alpha g - 1)\left[-\tau\,(Q - q) - C(q)\right] < 0$$

[11] As we will see, this is no longer be true as soon as we relax later on the assumption of perfect enforcement of the regulation.

Substituting $s = 0$ in Eq.(10), it is immediate that a deviation of pollution abatement away from R^S increases political support up to the point where:

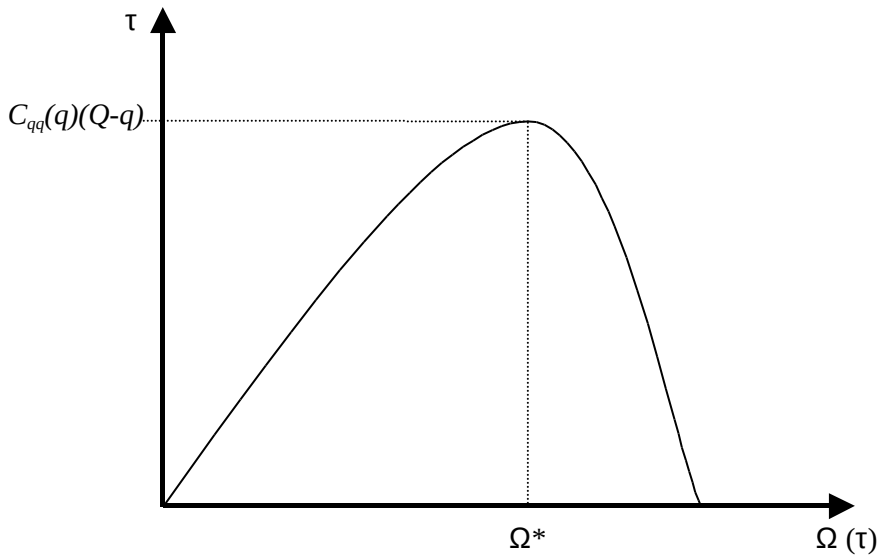
$$(1+a)C_q(q) - (g+a)D_q(Q-q) = (\alpha g - 1)\Omega_q(q) \qquad (11)$$

The left-hand side of Eq. (11) represents the marginal loss in terms of abatement cost and environmental benefit from deviating from R^S whereas the right hand side term is the marginal benefit of additional tax revenue. Eq. (11) also highlights what determines the sense of the deviation from the status quo. It depends on how tax revenue varies with q. As a matter of fact, the relation between revenue and tax rate is not monotonic. We have

$$\Omega_q(q) = \left[C_{qq}(q).(Q-q) - C(q)\right].\frac{\partial \tau}{\partial q},$$

which sign is ambiguous. It is the classical story told by the Laffer curve depicting how tax revenue varies with the level of the price signal (which is equal to the tax rate here since $s = 0$). As shown in figure 2, this curve is upward sloping up to the maximal revenue Ω^* for which $\Omega_q^*(q) = 0$ [corresponding to $\tau = t = C_{qq}(q)(Q-q)$]. Then tax revenue decreases since τ is now too high for the decrease in tax basis to be compensated by rate increase.

Figure 2. Tax revenue and level of the price signal: the Laffer curve



Looking at Eq. (11), the inverted U shape of the Laffer curve implies that the abatement level in equilibrium, denoted $\hat{q}$, is higher than in the status quo when the Laffer curve is upward sloping around the status quo. By contrast, $\hat{q}$ is inferior to the status quo abatement level if the Laffer curve is downward sloping.

The intuition behind these results is very simple. When $\alpha g > 1$, the greens are powerful either because they are numerous in the population (a high α) or because their contribution are "electorally" effective (a high g). Hence, the greens are able to prohibit any financial transfer to the industry ($s = 0$). Furthermore, if tax revenue (and hence redistribution to the population) is decreasing in the tax rate t around R^S, the greens find advantageous a reduction in pollution abatement (via a reduction of the tax rate) since this is compensated by an additional tax revenue partly redistributed to them. Conversely, if revenue is increasing in the tax rate, the greens are better off in two respects: they get more pollution abatement and tax revenue. To summarize, we have:

Proposition 1 *If regulation enforcement is perfect* ($\Delta^R \geq 0$)*, the political equilibrium crucially depends on the sign* of (g-1).

1) If g < *1, the equilibrium policy vector corresponds to the status quo.*

2) If g > *1, policy change occurs. A non-earmarked tax, which rate is thus higher than the regulation shadow price, is introduced. More precisely, the policy vector in equilibrium* $\hat{\mathbf{h}}$ *is given by:*

$$\hat{\tau} = \hat{t} = C_q(\hat{q})$$
$$\hat{s} = 0$$
$$\hat{R} < \hat{q}$$
$$(1+a)C_q(\hat{q}) - (g+a)D_q(Q-\hat{q}) = (\alpha g - 1)\Omega_q(\hat{q},\hat{\tau},0)$$

Moreover when the tax revenue function $\Omega(q)$ *is upward sloping (that is* $\Omega_q(q) = C_{qq}(q)(Q-q)-C_q(q)$ *is strictly positive), pollution abatement is higher than in status quo. If the function is downward sloping, abatement is lower.*

Hence, the room for policy change centrally depends on the sign of (g-1). It should be stressed that the room is narrow. It deserves an important remark:

Remark 1 *In the special case where the two lobbies are equally effective g = 1, the coefficient is negative whatever the share* α *of the greens in the population and no tax is introduced.*[12]

This is so because the greens benefits only partly from the tax revenue when it is not earmarked (they get a share $\propto$) while the industrialists lose the totality of tax revenue. As a consequence, the green lobby needs to be much more efficient that its industrialists' counterpart to obtain a policy reform favorable to its interest. In the political economy literature it is usually admitted that this cannot be true based on the Olson's argument: the green lobbies would be structurally weaker than industrial pressure groups because the size of individual members' unit stakes is much smaller and because they gather more individual members.

4.3 Welfare evaluation of the political equilibrium

One may wonder whether the introduction of a non-earmarked tax improves the social welfare in comparison with the status quo. In order to investigate this point, one firstly needs to derive the utilitarian optimum. As the social welfare function is the same as in status quo, the optimal policy vector is the solution of the optimization problem:

$$\max_{\mathbf{h}} W(\mathbf{h})$$

subject to $q = q_{\Delta \geq 0}(\mathbf{h})$

$s < s^{max}$

$W(\mathbf{h}) > W(R^S*)$

In fact, it is immediate that the last inequality constraint cannot be satisfied since R^S* is the global extremum of the social welfare function. This leads to a simple proposition.

Proposition 2 *In the case of perfect enforcement of the regulation (*$\Delta^R \geq 0$*), the*

[12] Note that this special case corresponds to the traditional Grossman&Helpman parameter' s value.

utilitarian optimum corresponds to the status quo. No tax is introduced.

The proposition simply reflects the fact that our assumptions do not confer any efficiency (dis)advantage to the tax over the regulation. There is no efficiency rationale for deviating from the status quo. It will change with the introduction of political distortions. We are now able to see whether the introduction of a non-earmarked tax improves the social welfare in comparison with the status quo.

In the case where $\Omega_q(q)$ is positive, the answer is straightforward. When $\propto g > 1$, then g > 1, which together with Eq. (8), Eq.(9) and Eq.(11) imply:

$$\hat{q} > R^S > R^S*$$

and thus $W(\hat{q}) < W(R^S) < W(R^S*)$

This is a classical argument: the existence of tax revenue to redistribute is an additional motive for rent seeking increasing political distortions in comparison with a policy approach, a regulation, entailing no financial transfer. When the Laffer curve is downward sloping, the result is ambiguous. Simple manipulations of Eq.(11) yields:

$$D_q(Q-\hat{q}) = \frac{a+\alpha g}{a+g} C_q(\hat{q}) - \frac{\alpha g - 1}{g+a} C_{qq}(\hat{q})(Q-\hat{q})$$

As $a+\alpha g < a+g$ and as the second term is strictly negative, the comparison between Eq. (9) and (11) yields

$$R^S > R^S* > \hat{q}$$

As $\hat{q}$ lies below R^S*, the impact on welfare is ambiguous. If $\hat{q}$ is very close to the optimal level R^{S*}, the introduction is welfare improving since $\hat{q}$ is much closer to the efficient level that the status quo level R^S. But if the Laffer curve is very steep, $\hat{q}$ can fall very far from the efficient level so that $W(\hat{q}) < W(R^S)$. Intuitively, this ambiguity can be explained in the following way. The greens pursue two objectives: rising revenue and reducing pollution. When the Laffer curve is downward sloping, these objectives become contradictory. Of adequate forces, it can mitigate political distortions so that the introduction of a non-earmarked tax is welfare improving.

5 The regulation is imperfectly enforced

We now make the hypothesis that the regulation is imperfectly enforced. We assume that $\Delta^R = \pi F(R) - C(R)$ is strictly negative. Hence, in the absence of tax or subsidy, the polluter's response is non-compliance. The major consequence is that status quo now entails reduced pollution abatement even though the status quo regulation R^S remains the same. The room for policy change is thus *a priori* larger than in the previous case. In fact, the status quo level of abatement corresponds to the size of the violation, which is determined by the marginal penalty: the producer abates up to a level, denoted $q°$, which minimizes the expected cost of the penalty $\pi F(q) + C(q)$. For the sake of simplicity, we assume an interior solution (implying f is sufficiently high to induce a non-zero abatement level)[13]. Therefore $q°$ is implicitly defined by the first order condition $C_q(q°) = \pi f$.

5.1 The polluter's reaction function

When the regulatory constraint is not binding ($\tau \geq \tau^R$), the polluter's response remains the same as in the perfect enforcement case since it is fully determined by the fiscal scheme. But it holds no longer true when $\tau < \tau^R$. In the perfect enforcement case, the polluter abated until R and the tax cum subsidy scheme had absolutely no impact on the polluter's behavior. We will see that the tax cum subsidy scheme may affect regulatory compliance decision now even when the price signal τ is inferior to the regulatory shadow cost.

To analyze compliance with the regulatory standard, we consider the difference, denoted Δ, between non-compliance and compliance cost:

$$\begin{aligned}\Delta(\mathbf{h}) &= \left[\pi F\left(q^{nc}\right) + (1-s)C\left(q^{nc}\right) + \tau(1-s)\left(Q - q^{nc}\right)\right] - \left[(1-s)C(R) + \tau(1-s)(Q-R)\right] \\ &= \pi F° + \left[\pi f + \tau(1-s)\right]\left(R - q^{nc}\right) - (1-s)\left[C(R) - C\left(q^{nc}\right)\right]\end{aligned}$$

where q^{nc} is the non-compliance abatement level. This level corresponds to the minimization of non-compliance cost $\pi F(q) + (1-s)C(q) + \tau(1-s)(Q-q)$. It thus satisfies:

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[13] More precisely it imposes $\pi F° + \pi f R - C(R) < 0$. Relaxing this assumption does not change any of our results. It would simply require to analyze the further (simpler) case where in status quo, $q = 0$.

$$C_q(q^{nc}) = \tau + \frac{\pi f}{1-s} \qquad (12)$$

We then have a lemma establishing key properties of the reaction function.

Lemma 2
1) $\partial\Delta(\mathbf{h})/\partial\tau > 0$
2) $\partial\Delta(\mathbf{h})/\partial s > 0$
3) *If* $\tau = 0$, *then* $\Delta(\mathbf{h}) < 0$
4) *Let* $\tau^E(s,R) = min(\tau \mid q=R)$. $\forall s$, $\forall R$, $\tau^E < \tau^R$

Proof. See in appendix.

Lemma 2 simply establishes that the price signal promotes compliance. More specifically, it states that there exists a threshold denoted $\tau^E(s,R)$ inferior to the regulation shadow price ($\tau^E<\tau^R$) above which the producer complies. The level of the threshold depends on *s*: the higher the subsidy rate s, the lower the threshold. It means that, *keeping the price signal constant*, *s* promotes compliance. Put differently, the higher the contribution of the subsidy to the price signal, the larger the incentives to comply. In the following, we denote the two "corner" values $\tau^E_{s=0}$ and $\tau^E_{S\max}$ for $s = 0$ and s^{max}, respectively. We have $\tau^E(s) \in [\tau^E_{s\max}, \tau^E_{s=0}]$. In the end, the polluter's behavior is depicted in figure 2. and summarized by proposition 3. In the following, we denote $q = q_{\Delta<0}(\mathbf{h})$ the corresponding reaction function, which properties are detailed in the following proposition.

Proposition 3.

When the regulation is imperfectly enforced, the polluter sets its level of pollution abatement q as follows:

1) If the price signal $\tau \geq \tau^R$, *the abatement level is given by the polluter's reaction function* $q^t(\tau)$. *That is the abatement level is only determined by the price signal of the fiscal scheme. The regulation has no impact on the polluter.*

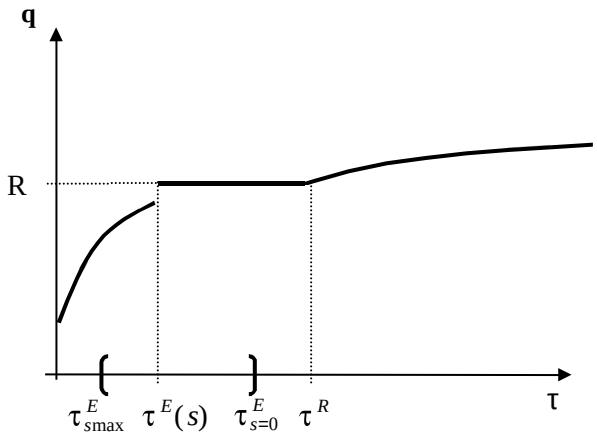
2) If the price signal $\tau^E(s) \leq \tau < \tau^R$, *then* $q = R$ *because* τ *is sufficiently high so that* $\Delta \geq 0$. *The polluter's best response is to comply with the regulation and the environmental outcome is R. In this intermediate interval, the charge and subsidy*

scheme thus has a role of enforcement incentive in that it leads to regulatory compliance.

3) If the price signal falls below $\tau^E(s)$*, then the abatement level is given by* $C_q(q) = \tau + \pi/(1-s)$.

4) The threshold price signal triggering compliance $\tau^E(s)$ *decreases in s. More specifically,* $\tau^E(s)$ *varies in the interval* $[\tau^E_{s\max}, \tau^E_{s=0}]$.

Figure 3: The polluter's response to the policy mix when enforcement is imperfect



5.2 The political equilibrium

The political support function remains identical to the perfect enforcement case. The optimization problem is thus very similar:

$$\max_{\mathbf{h}} U(\mathbf{h}) = U^S(q) + (\alpha g - 1)\left[\Omega(q,\tau,s) - sC(q)\right]$$

subject to: $q = q_{\Delta<0}(\mathbf{h})$
$s \leq s^{max}$
$U(\mathbf{h}) > U^S(q°)$.

In comparison with the perfect enforcement case, the only differences lie in the status quo constraint and in the polluter's reaction function. Like in the perfect enforcement case, one solves the problem by considering two cases. This leads to a final proposition.

Proposition 4

1) If $\alpha g < 1$, the equilibrium policy vector $\tilde{h}$ is an earmarked tax which complements the regulation. More specifically $\tilde{h}$ is given by:

$$\tau^{E}_{s\max} \leq \tilde{\tau} \leq \tau^{R}$$

$$\tilde{s} = s^{max}$$

$$\tilde{R} = R^S$$

In this case, the price signal is thus lower than the regulation shadow price.

2) If $\alpha g \geq 1$, the equilibrium policy vector is identical to the perfect enforcement case.

Proof. See in appendix

Proposition 4 only differs from Proposition 2. (the perfect enforcement case) when the greens are relatively weak ($\alpha g \geq 1$). In this case, the analysis predicts the design usually encountered in reality, that is an earmarked tax combined with the regulation and which tax rate remains below the shadow price of the regulation. The policy mix then induces a pollution abatement level identical that the one obtained under a fully enforced regulation. The intuition is that when enforcement is imperfect, the greens are in favor of an non-earmarked tax since it permits to improve regulatory compliance and thus abatement level. Nevertheless, they are not sufficiently strong to push abatement above the status quo regulation. As a result, the tax rate remains below the regulation shadow price. This proposition deserves a final remark:

Remark 2 *If $q° \to R^S$, that is when the enforcement scheme is on the verge of*

achieving compliance, it is still politically efficient to introduce a non-earmarked tax.

As soon as compliance is not 100% complete, political factors may drive the introduction of a tax. As in reality full compliance is far from being frequent due to limited administrative resources, there are many opportunities for earmarked tax to emerge in equilibrium. In the previous section, looking carefully at coefficient αg, we have argued intuitively how small the room for the introduction of an non-earmarked tax. Conversely, the same reasoning applies here to claim that the room for the introduction of an earmarked is very large. In particular, a non earmarked tax is introduced when the two lobbies are equally influential ($g=1$).

6 Summary

To summarize, the model predicts three possible policy outcomes:

The introduction of a non-earmarked tax in combination with a regulation at a tax rate above the regulation shadow price

This happens when $\alpha\, g \geq 1$. This product of parameters basically reflects the strength of the green lobby group: $\propto$ is the share of green individuals in the whole population whereas g is a parameter reflecting the influence of green lobby campaign contributions on the probability of re-election of the incumbent government.

The intuition of the result is the following. When the coefficient is positive, the greens are politically very influential and are able to foster their first best policy option: a non-earmarked tax. The greens benefit from non-earmarking since they get a share of the tax revenues redistributed to the whole population. The benefits in terms of redistribution of tax revenues also explain why tax rate is above the regulation shadow price: it allows for maximizing tax revenue for a given level of pollution abatement.

The status quo, that is no tax is introduced

This happens when the status quo regulation is perfectly enforcement and when $\alpha g<1$ (that is the relative green lobby's strength in comparison with the industrial lobby is below a certain threshold). The threshold is quite high. For instance, in the particular case where the two lobbies' contributions have identical impacts on electoral outcomes ($g=1$), the coefficient is negative whatever the share of green individuals in the

population.

In this case, the greens are simply not sufficiently influential to impose a non-earmarked tax, also because the status quo position is relatively satisfying for the greens: the enforcement being perfect, the polluter abates at the level of the status quo emission standard

The introduction of an earmarked tax in combination with the status quo regulation at a tax rate below the regulation shadow price

This happens when the greens are not very influential ($\alpha g < 1$) and when the status quo regulation is imperfectly enforced, so that the status quo abatement level is reduced. In this configuration, the loss for the greens in the status quo position is sufficiently large (due to reduced pollution abatement) to compensate their relative weakness vis-à-vis the pro-industrialists. They are thus able to obtain a policy change.

Why then an earmarked tax? This design presents an advantage for both sides. In the industrialist view, earmarking obviously implies that the polluter gets back his tax payment in the form of cost subsidy. The gain for the greens is more subtle: cost subsidies is more effective in triggering compliance with the status quo regulation. Earmarking thus helps to rise the incentive for the polluter to comply with the regulation and subsequently it leads to additional pollution abatement. This effect is sufficiently strong to compensate the loss due to the non-redistributed tax revenue. This peculiar impact of the tax on regulatory compliance exists even when the tax rate is below the regulation shadow price. To summarize the argument, an earmarked tax is simply introduced to promote compliance with the status quo regulation.

These predictions seem in line with what is observed in reality. In actual environmental policies, the status quo dominates (the use of regulation). Furthermore, when taxes are introduced, we have already mentioned that earmarking prevails and that tax rates are generally below the incentive level, that is the regulation shadow price. Our analysis suggests that this is explained by the willingness to promote compliance with existing regulation.

It is worth mentioning that a non-earmarked tax at a rate above the regulation is the more efficient policy solution among the three possible political outcomes according to the "normative" environmental economics point of view. This solution avoids the drawbacks frequently attached to earmarking (lack of flexibility, the risk for competition distortion on international markets, etc.). It leads the tax to determine the abatement level across polluters with all the advantages attached in terms of incentives to innovate and pollution abatement cost savings. Finally, it confines regulation in a

role of "safety net" ensuring everywhere a minimal level of pollution abatement which can be very useful to avoid "hot spots", that is accumulation of pollution in certain locations. Our analysis is rather pessimistic as regards the possibility to implement this efficient solution.

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Appendix

Proof of lemma 1.

The proof is immediate when the inequality constraint $s < s^{max}$ is not binding (since $C_q>0$). If the constraint is binding, we have

$$C_q(q) = \tau$$

$$sC(q) = \tau (Q-q)(1-s),$$

which implies

$$\tau = \frac{sC(q)}{(1-s)(Q-q)} \qquad \text{if } Q \neq q$$

and thus $$\frac{\partial \tau}{\partial q} = \frac{s(1-s)\left[\tau (Q-q) + C(q)\right]}{\left((1-s)(Q-q)\right)^2} \quad ,$$

which is strictly positive because $Q>q$, and C is strictly positive for any q. If $q = Q$, s=0 and (A.1) implies $\partial\tau/\partial$q is positive.

Proof of lemma 2.

We have:

$$\frac{\partial \Delta(\tau, s, R)}{\partial \tau} = (1-s)\left(R - q^{nc}\right) > 0$$

and,

$$\frac{\partial \Delta(\mathbf{h})}{\partial s} = (R - q^{nc})\left[\frac{\pi f}{1-s} - C_q(q^{nc}) + \frac{C(R) - C(q^{nc})}{R - q^{nc}}\right],$$

which is strictly positive since $C_q(q^{nc}) < \left[C(R) - C(q^{nc})\right] / \left(R - q^{nc}\right)$ because of the convexity of the cost function.

Moreover, if τ=0, $\Delta(\mathbf{h}) = \left[\pi F^{\circ} + \pi f R - C(R)\right] - C(q^{\circ}) - \pi f^{\circ} < 0$ since $\pi F^{\circ} + \pi f R - C(R) \geq 0$ (see footnote 12). It directly implies $\tau^E < \tau^R$.

Proof of Proposition 4.

It is convenient to analyze separately the two cases $\alpha g \leq 1$ and $\alpha g > 1$

Case 1. $\alpha g \leq 1$

Deriving the political support function with respect to s yields:

$$\frac{\partial U(\mathbf{h})}{\partial s} = U_q^S(q)\frac{\partial q}{\partial s} - (\alpha g - 1)\left[\frac{\partial q}{\partial s}\left((1-s)\tau + sC_q(q)\right) + (Q-q)\tau + C(q)\right]$$

The difficulty lies in the fact that there are "kinks" in the reaction function, which leads to consider three cases.

$\tau \geq \tau^{\mathbf{R}}$

It implies that $C_q(q) = \tau$ and thus $\partial q/\partial s = 0$. Hence:

$$\frac{\partial U(\mathbf{h})}{\partial s} = -(\alpha g - 1)\left[(Q-q)\tau + C(q)\right],$$

Since $\alpha g \leq 1$, the sign of the derivative is positive. We then get the corner solution $s = s^{max}$. It follows that $U(\mathbf{h})=U^S(q)$, which implies that the pollution abatement level in equilibrium corresponds to the status quo abatement level R^S. The price signal maximizing political support is thus $\tau = \tau^R$. As $U(\mathbf{h})=U^S(R^S)$ is strictly superior to $U^S(q°)$, the status quo constraint is satisfied. Note that this is a global extremum of the political support function (since R^S is the global maximum of U^S).

$\tau^E \leq \tau < \tau^R$

It implies that $q = R$ and $\partial q/\partial s = 0$ as in the previous case. Hence,

$$\frac{\partial U(\mathbf{h})}{\partial s} = -(\alpha g - 1)\left[(Q-R)\tau + C(R)\right]$$

We have $s = s^{max}$ if $\alpha g \leq 1$. In this case, one gets the status quo pollution abatement level R^S corresponding to a price signal in the interval $[\tau^E(s=s^{max}), \tau^R]$ and the status quo constraint is satisfied. This local extremum yields exactly the same level of political support as the one we have just characterized on the interval $\tau \geq \tau^R$.

$\tau < \tau^E$

The resolution is straightforward since the extrema identified in the two previous cases (involving $s= s^{max}$ and $q = R^S$) are global extrema of the political support function. We only need to show whether we can get an abatement level $q = R^S$ in this interval. It is not possible since $\tau < \tau^E$.

Case 2. $\alpha g > 1$

$\tau \geq \tau^{\mathbf{R}}$

The partial derivative $\partial U/\partial s$ is negative implying $s = 0$ and $U(\mathbf{h})=U^S(q)+ (\alpha g–1)\Omega(q)$. The derivative of the political support with respect to τ is:

$$\frac{\partial U(\mathbf{h})}{\partial \tau} = -(\alpha g - 1)(Q - q),$$

which is strictly negative implying $\tau = \tau^R$ and $q=R$. Hence $U(\mathbf{h})=U^S(R)+ (\alpha g–1)\tau^R(Q-R)> U^S(q°)$. The status quo constraint is not binding. What regulation, R, do we obtain in equilibrium? In fact, it is identical to the perfect enforcement case. Since the second term of the political support function now enters positively in the function, deviating from the level R^S is possible. Like in the perfect enforcement case, it will be possible up to the point where $(1+a)C_q(\tilde{q}) - (g+a)D_q(Q-\tilde{q}) = (\alpha g - 1)\Omega_q(\tilde{q},\tilde{\tau},0)$.

$\tau^E \leq \tau < \tau^R$

This case is very similar to the previous one. We have $\partial U/\partial s < 0$, implying $s=0$, and $\partial U/\partial \tau < 0$ implying $\tau = \tau^E (s=0)$ and $q = R$. Note that the status quo constraint holds but the political support is lower than the one when $\tau = \tau^R$.

$\tau < \tau^E$

The reasoning we use in case 1 still applies here. The policy vector characterized in the interval defined by $\tau \geq \tau^R$ is a global extremum of the political support function

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(lviii) This paper was presented at the Workshop on "Game Practice and the Environment", jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002

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