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The role of foreign ownership in domestic environmental regulation under asymmetric information

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THE ROLE OF FOREIGN OWNERSHIP IN DOMESTIC ENVIRONMENTAL REGULATION UNDER ASYMMETRIC INFORMATION

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Abstract:

Regulation of a polluting export industry with private information about the emission technology is analyzed under various ownership regimes. With distortive domestic taxation, a benevolent regulator will trade off allocative inefficiencies against rent offered to the industry. Foreigners' ownership share will have an impact on the nature of the optimal regulation, through the welfare cost of rent. Some distortions from first best will be induced not only when domestic taxes are distortionary, but also when domestic taxes are non-distortionary, as long as there are some foreign owners. In a global economy, with higher foreign ownership share and more competition in the output market, optimal regulation should induce the industry to produce less of both output and net emissions. A higher foreign ownership share alone, with competiton unchanged, might lead to more pollution than under complete information. If the home government, as a response to globalization, puts more weight on domestic employment, rent extraction will be accomplished by inducing less pollution abatement, causing more harm on the local environment than under complete information.

Keywords: Asymmetric information, environmental regulation, foreign ownership.

JEL classification: D62, D82, H23, L51

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1. Introduction

In most industrialized countries exporting industries have for a long time been responsible for serious environmental costs due to local pollution. A number of these external costs have been internalized through a proper design of anti-pollution policies, like emission taxes. Until 20 - 30 years ago the understanding of how to cope with such externalities to achieve an efficient allocation of resources, was based on a conception of a world of complete information. However, complete information is probably a poor representation of real life phenomena. Externality-generating firms do normally possess some private information about the technology being used (or their cost functions), or they can take actions that cannot be verified by regulators.

During the last two decades, economic theory has made progress to cope with asymmetric information. The purpose of the present paper is to use this new ”Economics of Information” to analyze how to regulate an externality-generating export industry. Although environmental regulation under asymmetric information has been a frequently analyzed topic during the last two decades, with a number of important contributions, like Roberts & Spence (1976), Baron (1985a,b), Spulber (1988), Laffont (1994) and Lewis (1996), none of these are discussing explicitly the role of foreign ownership of the externality-generating industry. Hence there are still some problems to be analyzed.

The present paper attempts to analyze to what extent domestic environmental regulation is affected by ownership structure, when the industry (regarded as one agent) has private information about the emission technology, with no option for relocation. In other words, should an externality-generating export industry owned solely by foreigners be subject to regulation that will differ if the industry were owned solely by domestic citizens? One should pay attention to the impact of ownership structure or ownership regimes on domestic regulation within a world becoming more and more globalized with less and less restrictions on foreign ownership. (Hoel (1997) discusses among other things, the role of ownership for the design of environmental policy, but within a different framework - imperfectly competitive environment, non-distortive taxation, local pollution and symmetric information - and finds that ownership matters, but for another reason than proposed here.) In Vislie (1999), a similar problem as the one presented here is analyzed, but contrary to what is being assumed in the present paper, the industry can relocate if the domestic regulation becomes too unfavourable, but only by incurring a type-dependent exit cost. In order to focus solely on the role of foreign ownership for the design of optimal environmental regulation under asymmetric information, we'll make the simplifying assumption that relocation is not an option.

The approach taken in this paper is very similar to the multiproduct-regulation approach presented by Laffont & Tirole (1993; chapt. 3) and Laffont (op.cit.), with output as well as net emissions being verifiable. Gross emissions or primary discharges are proportional to output, with a type-dependent factor of proportionality, but the relationship between output and the level of externality (net emissions) can be modified through costly, and unverifiable pollution abatement.

Whereas the product "net emissions" is fully consumed at home creating a domestic environmental cost or damage (local pollution), the final output itself is consumed solely by foreigners. For most of the time we'll adopt the single-benevolent regulator approach whose objective is to maximize expected welfare (a weighted sum of consumers' (or tax-payers') surplus and the domestic share of industry rent). We rule out lump-sum taxation, so any rent offered to the industry has a welfare cost, which, in addition to the marginal cost of public funds, will be affected by foreign ownership share. Hence, we expect that the second-best or informationally-constrained optimum in general will be affected by ownership regime.

This conjecture turns out to be verified as we show that the more of an industry being owned by foreigners, whose welfare does not enter the objective function of the home government, the higher is the welfare cost of rent. Then rent extraction becomes more important, which is accomplished by inducing the industry to produce less output (as compared to first best), whereas net emissions can go either way, depending upon foreign demand for the final output. What would happen if the government, contrary to what has been assumed so far, should dislike reductions in the number of jobs (assumed to be positively correlated with output)? Suppose that this kind of preference can be translated into a goal keeping output fixed. In that case rent extraction is accomplished solely by inducing more pollution under asymmetric information than under complete information. Therefore an implication of the results derived in the present paper is that globalization with fewer restricitions on foreign ownership, might cause more harm on local environments than in a regime with only domestic owners. But to assess the full impact of globalization, which is beyond the scope of this paper, we also have to take into account how competition is affected. If the competitive forces increases, then we show that output as well as net emissions will be reduced in the optimal regulatory regime under asymmetric information, as compared to complete information. If the home government in a phase of increased globalization should be more concerned about job destruction, then regulation will not be targeted against output. Rent extraction will in that case be accomplished by inducing less pollution abatement, causing more harm on the local environment.

The paper is organized as follows: In section 2 the basic model is presented and the solution under complete information is derived as a benchmark. In section 3 we turn to the design of optimal environmental regulation under incomplete information for some arbitrary ownership structure, when the regulator is benevolent. The second-best solution is derived and we discuss in what way local pollution is affected by ownership regime. In section 4 we relax the assumption of a benevolent planner, by assuming that as a response to increased globalization (higher foreign ownership share) the government becomes more concerned about job destruction. Optimal regulation is then derived when output is kept fixed so as to meet this new goal. Section 5 concludes.

2. The model

Consider an export industry, as a single economic agent, that is located in some country, called the home country. The final output of the industry is sold in a foreign market (no domestic consumption). The industry is owned partly by domestic citizens, with an exogeneous ownership share $\alpha \in [0, 1]$. Net revenue from exporting y units of output is given by $\pi(y)$, which by assumption is strictly concave, with $\pi(0) = 0$. Along with output, an amount of primary discharges ("gross emission" prior to abatement), proportional to output (θy) is produced, with θ as a one-dimensional technology parameter, known in general only by the industry. The smaller value θ takes, the cleaner is the emission technology, as the level of emissions (prior to abatement) per unit output is smaller. (Later we'll restrict attention to a type space $\Theta = [\underline{q}, \overline{q}]$.)

Net emissions x will be equal to the difference between the amount of primary discharges θy and pollution abatement A = θy – x. Although we assume a fixed type-dependent relationship between the level of output and primary discharges, the relationship between output and the level of externality (net emissions or pollution) can be modified through costly (and unverifiable) pollution abatement. Let the (unverifiable) cost of abatement be v(A); which is thrice continuously differentiable, strictly increasing and strictly convex for A > 0, with v(0) = v′(0) = 0. (In addition we assume $v'''(A) \geq 0$.)

The social damage or domestic environmental cost caused by net emissions is D(x); which is assumed to be twice continuously differentiable, strictly increasing and strictly convex for any x > 0, with D(0) = D′(0) = 0.

The industry's rent, when producing y units of the final output for foreign consumption, and complying with environmental regulation and paying taxes T, is given by

(1) $$U = \pi(y) - v(\theta y - x) - T$$

The consumers' or tax-payers' surplus will consist of the social value of tax revenue minus the social cost due to pollution D(x). Because we rule out lump-sum taxation, any tax revenue collected from the industry has a social value equal to (1 + m)T, where m is the marginal cost of public fund; hence consumers' surplus is CS = (1 + m)T – D(x).

The welfare measure is the sum of consumers' (or tax-payers') surplus and the domestic share of the industry's net utility or rent. Let the "tax-adjusted" welfare weight put on rent be $\gamma \equiv 1 + m - \alpha > 0$. Then welfare can be expressed as

(2) $$W = CS + \alpha U = (1 + m)[\pi(y) - v(\theta y - x)] - D(x) - \gamma U \equiv S(\theta, x, y) - \gamma U$$

This welfare measure consists of the social value of profits (net of abatement cost), generated from selling the output abroad, environmental cost and the social value of rent left to the industry, where the weight put on rent captures domestic ownership to the industry. (We also make the assumption that the reservation utility of the industry is type-independent, and normalized to zero.)

When information is complete and symmetric, maximal welfare W^* will be determined as the solution to the following problem

(3) $$W^* = \text{Max}\ \{0, \text{Max}_{x,y,U}\, [S(\theta, x, y) - \gamma U \mid U \geq 0]\}$$

where a decision involving the industry to close implies W = 0. Suppose that for any $\theta \in \Theta$, there exists a pair (x, y) so as to make $W \geq 0$. (Note that the regulator's programme is concave as W in (2) is strictly concave in (x, y). Letting subscripts denote partial derivatives, then we directly see that $S_{xx} = -(1 + m)v''(A) - D''(x) < 0$, and $S_{xx}S_{yy} - S_{xy}^2 \equiv G = (-\pi''(y))(1 + m)[D''(x) + (1 + m)v''(A)] + (1 + m)\theta^2 v''(A)D''(x) > 0$.)

Because leaving rent to the industry is socially costly, taxes T are adjusted so that no rent above the reservation level is offered under complete information. Hence, any type of the industry is active, with output, net emission, rent and welfare as stated in proposition 1:

Proposition 1: First-best allocation $\{x^*, y^*, U^*, W^*\}$ is characterized by the following conditions:

(4-i) $-D'(x^*) + (1 + m) \cdot v'(\theta y^* - x^*) = 0$

(4-ii) $\pi'(y^*) - \theta v'(\theta y^* - x^*) = 0$

(4-iii) $U^* = 0$

(4-iv) $W^* = S(\theta, x^*, y^*) \geq 0$

These conditions are standard and tell us: net emissions x^* should be set so that marginal damage equals social marginal cost of abatement (i.e. cost efficiency), whereas output exported y^* should be set so that net profits are maximized; i.e. revenue extraction. Because leaving rent is socially costly, no rent in excess of the reservation utility should be left to the industry. (Any excess profit should be taxed away.) At last, first-best welfare, which by assumption is higher when the industry is complying with domestic regulation than being shut down, is given by the social value of the net surplus S, and it can easily be verified that W^* is smaller the higher is θ.

This first-best allocation can be implemented by imposing a pollution tax $\tau(x) = \frac{D(x)}{1+m}$ along with a profit tax so that no rent is left to the owners of the industry. Note that this first-best allocation (x^*, y^*) is unaffected by ownership regime, but the more distortive is domestic taxation, so that the cost of raising tax revenues, m, becomes higher, will make both x^* and y^* higher.)

Let us have this first-best solution in mind as a benchmark when turning to asymmetric information about the emission technology. Our main focus is to see how environmental regulation will be affected by private information about the emission technology as well as how regulation is affected by different ownerhip regimes.

3. Optimal regulation under asymmetric information

When the industry is privately informed about the parameter θ, optimal environmental regulation becomes very similar to multiproduct regulation as analyzed by Laffont & Tirole (op.cit.), with output, as well as net emissions being verifiable, whereas abatement and abatement cost are not. The interesting aspect of the present model is to see whether foreign ownership will have any impact on optimal regulation under incomplete information.

We have by assumption a single regulator who is delegated the authority to regulate both output and net emissions from the industry. The regulator does not know the industry's type, but has prior beliefs, which are common knowledge, given by the strictly increasing and twice continuously differentiable cumulative distribution function F(θ), with strictly positive density f(θ) on the fixed support Θ = $[\underline{q}, \bar{q}]$. We assume that the distribution satisfies the "monotone hazard rate property", which can be expressed as the ordinary assumption that $\frac{F(q)}{f(q)}$ is non-decreasing in θ; ∀θ∈Θ. The regulator knows that the industry will take advantage of its private information so as to capture a socially costly informational rent. To counteract this incentive for misrepresenting type, the regulator will, as is now well known, design contract rules that will make it socially desirable to deviate from ordinary allocative efficiency. The problem is therefore to design a mechanism so that the industry will reveal its private information at the lowest possible cost to society.

According to the revelation principle, any regulatory scheme can be represented by a direct revelation mechanism, where the industry is asked to report its type. Since the regulator, by assumption, is able to design (and commit to) a mechanism so as to induce truth-telling, we can restrict attention to the class of direct incentive-compatible mechanisms. Within the present context, where both output (y) and level of pollution or net emissions (x), along with some transfers or taxes (T), can be verified, such a mechanism is formally represented by a triple, which specifies a transfer, a required output level and net emissions for any report $\hat{q} \in \Theta$ of the industry's type $\{T(\hat{q}), y(\hat{q}), x(\hat{q})\}$. Let the set of types that accept to participate in the domestic regulatory game be Ξ ⊆ Θ, whereas the complementary set (which might be empty), i.e. those types that do not accommodate to domestic regulation and therefore close down, is Σ. For types in the set Ξ, which is to be determined, we restrict attention to piecewise continuously differentiable mechanisms.

Let $u(\hat{q}, q) \equiv \pi(y(\hat{q})) - v(qy(\hat{q}) - x(\hat{q})) - T(\hat{q})$ be the net utility or rent achieved by a θ-industry when announcing its type to be $\hat{q}$. Optimizing at points of differentiability yields a first-order condition (IC_1) and a local second-order condition (IC_2) for incentive compatibility, both necessary for truthful revelation; i.e. $\hat{q} = q$, as given by

(IC_1) $\pi'(y(\theta))y'(\theta) - v'(\theta y(\theta) - x(\theta)) \cdot (\theta y'(\theta) - x'(\theta)) - T'(\theta) = 0$

(IC_2) $v''(\cdot)y(\theta)[\theta y'(\theta) - x'(\theta)] + v'(\cdot)y'(\theta) \leq 0$

These conditions are (normally) sufficient for global incentive compatibility; so that $u(\theta) \equiv u(\theta, \theta) \geq u(q, \hat{q})\ \forall\theta,\ \hat{q} \in \Xi$. For any allocation that satisfies (IC_1) and (IC_2), rent accruing to the industry has to satisfy

(5) $\dot{u}(q) = - v'(\theta y(\theta) - x(\theta)) \cdot y(\theta)$; with $u(\theta) \geq 0\ \forall\theta \in \Xi$

Because the industry will take advantage of its superior information by pretending to be less efficient than what it actually is, and by so capture a socially costly rent, the regulator will counteract this incentive by offering a set of type-dependent contracts, which will trade off rent extraction and allocative inefficiencies. The overall problem is then to choose, within the class of functions that satisfy (5), a triple $\{x(\theta), y(\theta), u(\theta)\}$ and the set $\Xi \subseteq \Theta$, so that expected welfare is maximized. Let us for a moment assume that any type of the industry is wanted by the regulator so $\Xi = \Theta$. (Later we impose restrictions on the problem so that this will hold in equilibrium.) The regulatory problem (RP) is then

[RP]

$$\text{Max}_{x,y} \int_{\underline{q}}^{\bar{q}} [S(q, x(q), y(q)) - gu(q)] f(q) dq$$

where $S(\theta, x, y) \equiv (1 + m)[\pi(y) - v(\theta y - x)] - D(x)$

s.t. for all $\theta \in \Theta$,

$\dot{u}(q) = - y(\theta) \cdot v'(\theta y(\theta) - x(\theta))$

$u(\theta) \geq 0$

with no conditions on $u(\underline{q})$, but $u(\bar{q}) \geq 0$,

where the optimal controls, $(\bar{x}, \bar{y})$, both non-negative, will obey (IC_2)

Let λ(θ) be the costate variable for the state equation in [RP]; hence the Hamiltonian is

(6) $\quad H(\theta, x, y, u) = [S(\theta, x, y) - \gamma u]f(\theta) - \lambda y v'(\theta y - x)$

A candidate for an optimal solution ($\bar{x}, \bar{y}, \bar{u}$), with both $\bar{x}$ and $\bar{y}$ strictly positive, has to satisfy the following necessary conditions: For any θ∈Θ

(7-i) $\quad S_x(\theta, \bar{x}, \bar{y})f(\theta) + \lambda \bar{y} v''(\theta \bar{y} - \bar{x}) = 0$

(7-ii) $\quad S_y(\theta, \bar{x}, \bar{y})f(\theta) - \lambda[v'(\theta \bar{y} - \bar{x}) + \theta \bar{y} v''(\theta \bar{y} - \bar{x})] = 0$

(7-iii) $\quad \dot{l}(q) = -\dfrac{\partial H(q, \bar{x}(q), \bar{y}(q), \bar{u}(q))}{\partial u} = \gamma f(\theta) \Rightarrow \lambda(\theta) = \gamma F(\theta) + \lambda(\underline{q})$

(7-iv) $\quad \lambda(\underline{q}) = 0$, as no conditions were imposed on $u(\underline{q})$; hence $\bar{u}(\underline{q}) > 0$

(7-v) $\quad l(\bar{q}) = \gamma F(\bar{q}) > 0$; hence $\bar{u}(\bar{q}) = 0$

(Note that if we have $2qD''(x) - \dfrac{l(q)}{f(q)} v''(qy - x) \geq 0, \forall q \in \Theta$, then the Hamiltonian is jointly concave in (x, y, u) for any θ∈Θ, and the candidate in (7), will satisfy the Mangasarian sufficiency theorem; see Theorem 4 in chapter 2 of Seierstad & Sydsæter (1987).) However, in order to be assured that the candidate in (7) in fact will be a solution to our problem, we should in principle have checked that this candidate will obey the second-order condition for local incentive compatibility (IC_2). Because this turns out to be a difficult task, we will only assume that ($\bar{x}, \bar{y}$) does obey this condition. A set of sufficient conditions for (IC_2) to hold is that $\bar{y}(\cdot)$ is non-increasing and $\bar{x}(\cdot)$ being non-decreasing. If these restrictions were imposed as constraints on the control variables in the opimization problem [RP], we might falsely be induced to impose some type of ”semi-bunching”; with a fixed emission quota and a type-dependent output profile. These sufficient conditions will in general be too restricitive, as we can easily construct an example, in which both $\bar{x}$ and $\bar{y}$ can be declining in θ, while at the same time obey (IC_2). Hence, by constraining the control variables to satisfy the sufficient conditions for (IC_2) to hold, might create an efficiency loss beyond what incomplete information itself will produce.)

Let us now make an assumption which guarantees that Ξ = Θ. Define the principal's "virtual surplus" as

(8) $$s(\theta, x, y, u) = S(\theta, x, y) - \gamma u - g\,\frac{F(q)}{f(q)}\,yv'(\theta y - x)$$

which is the welfare adjusted for informational rent required for incentive compatibility. Suppose that $s(\theta, \bar{x}, \bar{y}, \bar{u}) \equiv \frac{\bar{H}(q)}{f(q)} > 0$, ∀θ∈Θ, where $(\bar{x}, \bar{y}, \bar{u})$ is the solution to the regulator's programme [RP]. Then full participation; i.e. Ξ = Θ, will be realized for the equilibrium contract, as shown from using some sensitivity results in Seierstad & Sydsæter (op.cit.; theorem 9, chapter 3):
Define the value function for [RP] for an arbitrary set Ξ = [ξ_0, ξ_1] ⊆ Θ, where ξ_0, as well as ξ_1, should be determined:

(9) $$V(u(\xi_0), u(\xi_1), \xi_0, \xi_1) \equiv \int_{x_0}^{x_1} [S(q, \bar{x}(q), \bar{y}(q)) - g\,\bar{u}(q)]\, f(q)\, dq$$

with no conditions on $u(\xi_0)$, while constraining $u(\xi_1)$ to be non-negative.
Let $\bar{H} := H(\theta, \bar{x}, \bar{y}, \bar{u})$. Then we have

(9-i) $$\frac{\partial V(u(x_0), u(x_1), x_0, x_1)}{\partial x_0} = -\bar{H}(\xi_0) < 0$$

(9-ii) $$\frac{\partial V(u(x_0), u(x_1), x_0, x_1)}{\partial x_1} = \bar{H}(\xi_1) > 0$$

When the set Ξ = [ξ_0, ξ_1] itself is to be determined as part of the problem, we observe that it is socially desirable to have $\xi_0 = \underline{q}$ and $\xi_1 = \bar{q}$, given that $s(\theta, \bar{x}, \bar{y}, \bar{u}) > 0$ ∀θ∈Θ, so that full participation will be the case in the optimal solution. Including more types will increase welfare as long as the ”virtual surplus” is positive.

Furthermore, it is seen from (8), when making use of (5) and (7), that

$$(10) \quad \frac{ds}{dq} = -\alpha v'(q\bar{y} - \bar{x}) - \gamma\bar{y}\,[v'(\theta\bar{y} - \bar{x})\frac{d}{dq}\frac{F(q)}{f(q)} + \frac{F(q)}{f(q)}\bar{y}\,v''(q\bar{y} - \bar{x})]$$

is negative with our assumptions. Above we assumed explicitly that the ”virtual surplus” was everywhere positive, implying full participation. However, what (10) tells us is that if the ”virtual surplus” should become negative, then a lower bound $\xi_1 < \bar{q}$, in the set Σ is determined. Hence, if some types should be shut down, the set of excluded types, will be in the upper part of the distribution; $\Sigma = [\xi_1, \bar{q}]$, where the lower bound, ξ_1, is determined as the smallest value of θ, which makes the value of the Hamiltonian equal to zero. As long as the inequalities in (9) hold, no type will be induced to shut down.)

Rewriting the conditions for the optimal control variables in (7), when sticking to our assumption that no type is excluded, yields:

Proposition 2: For any $\theta \in \Theta$, optimal regulation under incomplete information, will be characterized by

$$(11) \quad -D'(\bar{x}) + (1+m)v'(\theta\bar{y} - \bar{x}) + \gamma\frac{F(q)}{f(q)}\bar{y}\,v''(\theta\bar{y} - \bar{x}) = 0$$

$$(12) \quad (1+m)[\pi'(\bar{y}) - \theta v'(\theta\bar{y} - \bar{x})] - \gamma\frac{F(q)}{f(q)}[v'(\theta\bar{y} - \bar{x}) + \theta\bar{y}\,v''(\theta\bar{y} - \bar{x})] = 0$$

We note that when the industry has private information about the technology parameter θ, the regulator will in a familiar way induce distortions or allocative inefficiencies so as to reduce informational rent to the industry. The incentive correction terms in (11-12); i.e. the last term in each first-order condition, pushes towards higher net emissions (for any given output) and lower output (for any fixed net emission) for any type, less efficient than the most efficient one. (The incentive correction will vanish for the most efficient industry type, as $F(\underline{q}) = 0$.) This seems reasonable as the slope of the rent function ($-\dot{u}(\theta) = y v'(\theta y - x)$) is made smaller either by lowering output y and/or by increasing pollution abatement $A = \theta y - x$, relative to complete information. When less output is produced and sold abroad, domestic pollution will automatically be reduced if abatement were kept unchanged. However, in order to reduce rent, not only y should be reduced, but it is expected that induced abatement $\bar{A} = q\bar{y} - \bar{x}$, should also be reduced. This will be accomplished by allowing higher pollution; hence compared to the first-best pollution (x^*), the second-best pollution might be higher.

Note also that when information is incomplete, the induced distortions will be affected by the type of ownership regime, and not only by the marginal cost of public funds as under complete information. The allocative distortions will, cet.par., be smaller the smaller is γ. Hence, if the industry is owned only by domestic citizens ($\alpha = 1$), then $\gamma = m$, and distortionary domestic taxes alone will be responsible for the induced distortions. On the other hand, if the industry is owned entirely by foreigners ($\alpha = 0$), then the welfare cost of industry rent will be higher as $\gamma = 1 + m$, and larger distortions (from first best) are now induced by the fact that rent now will accrue only to foreigners whose welfare does not enter the government's objective function.
Even if taxation is non-distortive, ($m = 0$), some deviations from first best will be desirable as long as foreigners own some share of the industry; $\alpha < 1$, but these distortions will vanish once α becomes equal to one. In the former case (i.e. with $m = 0$ and $\alpha < 1$) these distortions will be greater the more of the industry is being owned by foreigners. From (11-12) we can, for each $\theta \in \Theta$, calculate $[\frac{\partial \bar{x}}{\partial a}]_{\gamma=0}$ and $[\frac{\partial \bar{y}}{\partial a}]_{\gamma=0}$, and check how net emissions and output will change as α is being reduced from an initial situation with non-distortive domestic taxation ($m = 0$) and only domestic owners ($\alpha = 1$), so that $\gamma = 0$ initially. When using that the virtual

surplus s(θ, x, y, u) is strictly concave in the control variables (x, y), we find that second-best optimal output $\bar{y}$ will be reduced for any θ∈$(\underline{q},\bar{q}\,]$ as α gets smaller, whereas net emissions $\bar{x}$ might go either way, depending on the the elasticity of the marginal profit π′(y) w.r.t. output. With γ = 0, we have $p\,'(\bar{y}) = qv'(q\,\bar{y} - \bar{x})$ from (12), which from (11-12) gives $[\frac{\partial \bar{x}}{\partial a}]_{\gamma=0} = \frac{(1+m)F(q)v''}{f(q)G}[yp\,''(\bar{y}) + p\,'(\bar{y})]$.

This is zero for $q = \underline{q}$, but positive or negative for any $q \in (\underline{q},\bar{q}\,]$, depending on the (negative) value of the elasticity of marginal profit with respect to output. The less π′(y) is affected by changes in output sold abroad, the more likely is it that a higher foreign ownership share will cause net emissions to decline. On the other hand, if a large absolute value of the elasticity of π′(y) w.r.t. y can be associated with strong market power abroad, then optimal regulation might cause domestic pollution to increase (compared to complete information) when foreign ownership increases.

We then might conclude with:

Proposition 3: Foreign ownership matters for optimal regulation under asymmetric information. Even if domestic taxation is non-distortive, foreign ownership will make some distortions from first-best socially desirable. How pollution is affected by higher foreign ownership share will depend on the industry's market power in the foreign market.

This second-best solution can be implemented by a combined pollution-output tax scheme, with a total tax T = σ(y) + τ(y)x, where τ(y) is an output-contingent pollution tax per unit net emission, and output is taxed directly according to the non-linear output tax σ(y). (The tax scheme is designed so that T($\bar{x}(\bar{q})$, $\bar{y}(\bar{q})$) = $p\,(\bar{y}(\bar{q})) - v(\bar{q}\,\bar{y}(\bar{q}) - \bar{x}(\bar{q}))$, leaving no rent to the least efficient type.)

The θ-industry will then choose (x, y) so as to maximize after-tax rent, {π(y) – v(θy – x) – σ(y) – τ(y)x}. If the tax rates are designed so that no rent accrues to the least efficient type and with tax rates so that

(13) $$\tau(y) = \frac{[D'(x) - g\,\frac{F(q)}{f(q)}\,yv''(qy-x)]}{1+m}$$

(14) $$\frac{dT}{dy} = \frac{g}{1+m}\,\frac{F(q)}{f(q)}[v'(qy-x) + qyv''(qy-x)]$$

then the industry will choose an allocation which coincides with the one given in proposition 2. As compared to first best, the marginal Pigovian tax rate under incomplete information is adjusted downwards.

4. Regulation in a global economy when the regulator dislikes job destruction

Let us now use this simple model to discuss very briefly and a bit ad hoc the impact of ”globalization” on optimal environmental regulation. Suppose that globalization makes foreign ownership more prevalent, and suppose furthermore that as a response to increased foreign ownership, the home government becomes more reluctant to induce job destruction. (This change in goals, can be explained by labour union lobbyists.) We just take it for granted that the welfare objective is changed, in the sense that the government now does not want to impose regulatory rules so that employment is reduced. Suppose furthermore that employment is positively correlated with output. In that case, environmental regulation with output kept fixed (at the first-best level) will now trade off allocative inefficiencies and rent extraction, according only to the optimality condition (11), with $y(\theta) = y^*(\theta)$. We immediately see that if output (or employment) is not altered, rent extraction is accomplished by the inducing the industry to undertake less pollution abatement, causing domestic pollution to increase. Furthermore, more pollution will be produced the higher is the welfare cost of rent. In other words, the higher is the foreign ownership share (the lower α is), the more important will rent extraction be, which calls for a greater reduction in pollution abatement (cet.par.). Hence we may conclude with the following:

Proposition 4: If the response of the home government to increased foreign ownership is to protect domestic employment, then optimal regulation under asymmetric information will be more harmful to the local environment compared to regulation under compelete information.

5. Some conclusions

The present paper has analyzed a standard model for regulating an export industry producing a negative local externality under incomplete information. Not surprisingly we have seen that incomplete information and distortive domestic taxation call for some distortions from first best, because rent extraction now is an issue. These findings are in accordance with well-known principles from ”The Economics of Information”. Somewhat more interestingly is the impact of foreign ownership on optimal regulation. When some part of the industry is owned by foreigners, the welfare cost of rent to the industry is affected. Because only rent to domestic owners enters the objective function, a higher foreign ownership share will make the welfare cost of rent higher. (This point has also been noted by Laffont (1996), but within a different context.) Offering rent to the industry is socially undesirable, hence a higher foreign ownership share will increase the government’s incentive to extract rent. Rent reduction undertaken by a benevolent planner, will induce the industry to produce less when information is incomplete, whereas net emissions can either increase or decrease, depending among other things, on market power in the foreign market.. (The automatic adjustment in primary discharges as output is reduced, might then, despite lower pollution abatement, lead to less pollution.) Even with non-distortive domestic taxation, foreign ownership will induce allocative distortions.

If increased foreign ownership makes the government (for some reason) more unwilling to accept job reductions, the allocative distortions induced for extracting rent, will be placed on net emissions only, which in that case will increase, relative to complete information. Hence, one conclusion that might be drawn from the previous discussion is: In a globalized economy, where foreign ownership becomes more prevalent, domestic governments trying to regulate foreign-owned industries on a rational basis or semi-rational (if captured by domestic interest groups trying to protect domestic jobs), might end up with regulations which cause more harm on local environment.

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