Chapter 5

Ecological Competition

in

THE NEW SYSTEMS COMPETITION

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Chapter 5

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Ecological Dumping or Excessively Green Policies?

The connection between a country's competitiveness and its environmental policy has been central to the political debate in recent years. Time and again, economy and ecology have been thought of as conflicting elements which are very difficult to reconcile in an open economy trying to hold its ground in international competition. From the business community, there have been warnings about too extreme environmental policies because these are thought to be detrimental to domestic competitiveness.

Green parties, on the other hand, voice warnings about ecological dumping which can result from intensive systems competition. The problem of global warming, cross-border hazards from nuclear power stations, dying forests, the pollution of common water pools, hazards from rusty tanker fleets and many other environmental problems are attributed to the inability of the current world economic order to appropriately care for nature's resources.

In the academic literature opinions are also divided about whether fiercer systems competition is compatible with environmental policy goals. On one hand, there are pessimistic studies, dating back to Cumberland (1979), which deny that there can be a functioning systems competition in the area of environmental policy and which tend to confirm the Green fears. On the other hand, approaches in the literature based on theoretical models tend to be optimistic. Long and Siebert (1991) argue that states using Pigovian taxes have adequate incentives to protect the

environment, and Oates and Schwab (1988) derive a similar result for the case of an environmental policy based on quantity standards.

This discussion will be taken up again in what follows, but the workability of ecological systems competition will be investigated under alternative sets of assumptions about international policy externalities. The analysis will begin with the case where such externalities are absent, move to the case of physical spillover effects between the countries, and then focus on rent dissipation effects resulting from cross-border ownership in firms whose waste emissions are regulated by the government. The point to be discussed is that, except in the case of Pigovian taxes, environmental policy will generally affect the size of rents or quasi rents which firms earn by being able to use the environment as a factor of production. To the extent that these rents flow to foreigners and are affected by environmental policies, the national government may have distorted incentives in making its policies. In general, this chapter will show that an optimistic view about systems competition is not justified and that the distortions do not always go in the direction of ecological dumping.

Conditions for a Functioning Ecological Competition

The analysis starts by presenting a basic model in which many of the relevant problems are ignored and which permits an optimistic judgement about 'ecological competition' to be made. This model will be a useful benchmark for understanding the distortions that arise under more realistic conditions.

A small open economy is considered which is linked to the rest of the world through a perfect mobility of capital and goods. The rate of return to financial capital, r is given in the rest of the world, and all equity capital, if any, is owned by domestic residents. The factor labour, L, is immobile internationally. Industrial production results in the emission of environmental waste,

but this waste settles exclusively within the national boundaries. No physical spillovers to other countries occur. An ecological or Pigovian tax at the rate p per unit of waste emissions is used to regulate the emission. The competitive firms produce a homogeneous good with a linearly homogeneous production function, $f(L, S, K)$, with the usual characteristics where S is the waste emission and K is the capital used. The emission is treated as a factor of production like labour and capital because increasing it allows production to be increased and/or less of the other factors of production to be used.[1] The firms maximize their profits with given prices for labour, w, environmental waste, p, and capital, r,

$$\max_{L,S,K} \; f(L,S,K) - wL - pS - rK, \tag{5.1}$$

which implies the usual input rules

$$f_L = w, \; f_S = p, \; f_K = r. \tag{5.2}$$

The output price of the internationally traded good is standardized to a value of one in all countries; the wage rate is given endogenously by the requirement that the labour market clears with the fixed supply of labour; the Pigovian tax rate p is set by the government; and the rate of return to capital is, as mentioned, given internationally. The households receive transfers equal to the revenue from the Pigovian tax,

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[1] An economic factor is an entrepreneurial activity which creates costs elsewhere and an economic good is an activity which creates benefits elsewhere. In a market equilibrium the factor is paid by the firm and the firm is paid for the good. That is why the firm produces at the place on its technical production possibility curve where tolerating a little more of the activities which elsewhere create costs opens more scope for those activities which elsewhere create benefits. In short, this is why factors are productive.

$$T = p\,S, \tag{5.3}$$

and they earn a wage income wL and a capital income $r\,\overline{K}$, where $\overline{K}$ is their given amount of overall wealth. $\overline{K}$ - K is the country's net foreign wealth position. The utility $U(Y, S^*)$ of the representative household is an increasing function of its income

$$Y \equiv wL + T + r\overline{K} \tag{5.4}$$

and a decreasing function of the pollution or waste immission S^*. For the time being it is assumed that immissions and emissions in each of the countries are equal, because waste cannot spill over to other countries:

$$S^* = S. \tag{5.5}$$

Later, this assumption will be relaxed by allowing for spillovers, and there will be strong behavioural implications. Nevertheless, in equilibrium it will still be true that immissions and emissions are equal, because a symmetry between the countries will be assumed.

The government regulates the environment by choosing the Pigovian tax rate. It acts on the instructions of the households which control its behaviour by voting collectively in an election in a way that maximizes their own utility. In contrast to maximizing utility by means of market decisions, maximizing utility by means of a collective political decision has to take account of the endogeneity of the wage rate. When the factor price exhaustion theorem is taken into account, the

sum of the wages income and the Pigovian tax revenue will equal the domestic product Y that remains after deducting the return to capital,

$$wL + pS = f(L,S,K) - f_K \cdot K \tag{5.6}$$

and, taking account of (5.2) and (5.3), equation (5.4) then becomes

$$Y = f(L,S,K) + r(\overline{K} - K)\,. \tag{5.7}$$

Thus, the income of domestic residents equals domestic output plus the return on capital earned abroad; i.e. it equals the country's national product. The government is faced with the task of maximizing its citizens' utility U, which is a function of national income and pollution:

$$\max_{S} \; U(Y,S^*) \tag{5.8}$$

s.t. (5.2), (5.5) and (5.7).

Regardless of a possible endogenous reaction by K to a variation in S, which satisfies the constraint that the marginal product of capital is kept in balance with the given world-wide rate of return to capital, (5.8) implies the marginal condition

$$p = f_S = -\frac{U_{S^*}}{U_Y} \equiv \left.\frac{\mathrm{d}Y}{\mathrm{d}S^*}\right|_U . \tag{5.9}$$

This requires the marginal product of waste emission, which because of (5.2) is equal to the Pigovian tax rate, to be equal to the marginal environmental damage as judged by the citizens. Figure 5.1 illustrates this result. S_0*, S_0, and p_0 are the optimal values for S*, S and p, and the grey area measures the Pigovian tax revenue T.

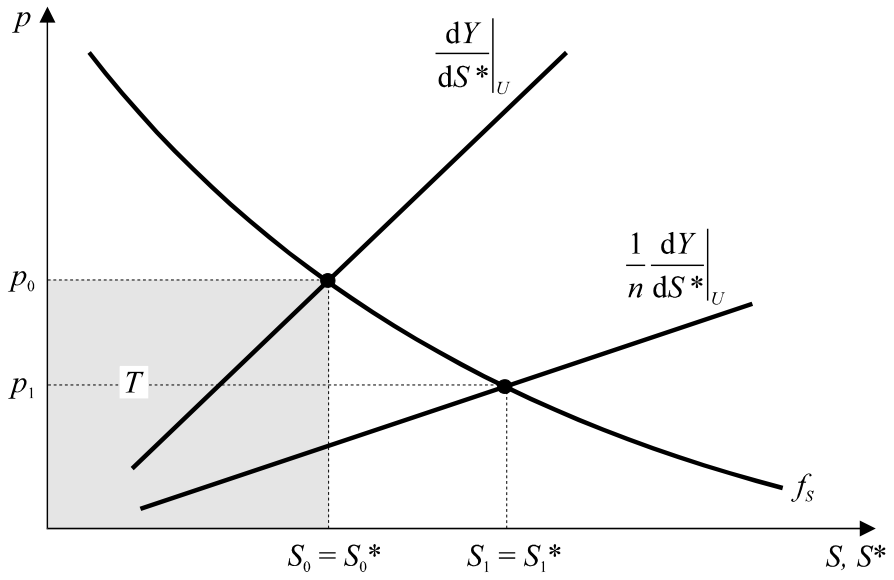

Figure 5.1 The optimal Pigovian tax rate.

The optimal environmental policy determined this way is the national optimum of a closed economy, given that Pigovian taxes are used to regulate the pollution and given that the government maximizes the sum of all national rents. However, the policy is optimal in other respects, too.

First, it is a first-best national welfare optimum regardless of how the government controls the environment. A benevolent national planner who is not constrained to use Pigovian taxes and can

command the allocation of resources directly would want to maximize the same utility function as used in (5.8), would define national income as in (5.7) and of course would have to respect the technological constraint (5.5). However, he would not have to respect the profit maximization constraint $f_S = p$ from (5.2). Nevertheless, he would choose the stock of capital and the environmental policy such that $f_K = r$ and $f_S = -U_{S*}/U_Y$ as in (5.9).

Second, the policy is also optimal from the viewpoint of all countries combined. A benevolent supra-national central planner would allocate the capital to the different countries so as to maximize aggregate income. Thus he would equate all marginal products of capital, attaining the same allocation as is implied by all countries following the rule $f_K = r$. Moreover, due to the absence of international spillover effects, he would choose each country's environmental policy so as to maximize national utility given the optimal stock of capital, and again this would be the same pollution as defined by (5.9).

Thus, nothing can be gained by coordinating environmental policies internationally. The regulation decision taken in the national interest already leads to a balance between the marginal product of waste emissions and the marginal damage caused to the environment as judged by the citizens. It is not rational for a country that competes internationally for mobile capital not to have a 'green' policy and there is also no need to fear that systems competition will lead to ecological dumping. This is essentially the result that Long and Siebert (1991) derived in a different model.

Proposition 5.1: *As long as the environmental damage only occurs within the country's borders and is regulated by means of a Pigovian tax, the national government has no incentive to engage in ecological dumping and also will not choose excessively green policies that hurt domestic competitiveness. Its environmental policy is efficient both from a broader national perspective, where the policy tools are not constrained, and from a common international perspective.*

Whether this result holds when the very strict assumptions are relaxed must now be investigated.

Ecological Dumping with International Spillover Effects

A particularly strong and unrealistic assumption which underlies the optimistic result of the last section relates to the regional distribution of pollution. It was assumed that the waste stays within the country's borders and is not spread by wind and water to other countries. This corresponds to reality only in the very smallest number of cases. Norway's forests are damaged by Britain's emissions, French nuclear power stations endanger German districts on the upper Rhine, and part of the Thuringian Forest is being destroyed by the emissions from the Czech brown coal power stations. The Dutch drink the salty effluents from French potash mines, and the quality of the Mediterranean and the Baltic is deteriorating because the maintenance of common property resources is being neglected. In the atmosphere, the environmental damage from the production of carbon dioxide, which results from burning oil, gas and other fossil fuels, affects the whole world. The global warming of the earth's atmosphere as a result of CO_2 production is considered by many scientists to be the most important environmental problem of all, but it is precisely here that the damage is least able to be restricted to the countries that cause it.

If it is assumed that one country's emission of pollution spreads evenly over n countries, then emissions and immisions are no longer equal ex ante, as they were in (5.5), but are related to one another in the following way:

$$S_i^* = \sum_{j=1}^{n} S_j / n, \qquad i = 1,..., n. \tag{5.10}$$

S_j is the argument of the country specific production functions as in (5.1) or (5.7), and S_i* is, as before, the argument of the utility function of the country's representative household as in (5.8). For each individual country it again holds, as in (5.7), that:

$$Y_i = f(L_i, S_i, K_i) + r(\overline{K}_i - K_i), \qquad i = 1,...,n \ , \tag{5.11}$$

but instead of (5.8) the government is now faced with the task

$$\max_{S_i} \ U(Y_i, S_i^*) \ , \quad i = 1,...,n \ ,$$
$$\text{s. t. (5.2), (5.10) and (5.11),}$$

where constraint (5.5) has been replaced with (5.10).

Assuming that countries play Nash strategies with regard to their waste emissions,[2] the marginal condition

$$p_i = f_S(L_i, S_i, K_i) = -\frac{1}{n}\frac{U_{S^*}(Y_i, S_i^*)}{U_Y(Y_i, S_i^*)} \equiv \frac{1}{n}\frac{\mathrm{d}Y_i}{\mathrm{d}S_i^*}\bigg|_U \qquad \forall \ i = 1,...,n$$

can be derived from the optimization approach.

This condition differs from condition (5.9) by the factor $1/n$, which appears in front of the expression for the marginal damage. From the point of view of the individual country, the marginal immission it suffers from is only one nth of the marginal emission it allows for by reducing its

[2] The individual country optimizes its waste emission under the assumption that its behaviour has no influence on the emissions of the other countries.

Pigovian tax rate. It is therefore optimal for it to choose a lower tax rate and a higher level of pollution than when there are no spillover effects.

The flatter of the two marginal damage curves in figure 5.1 illustrates the course of the new marginal damage function of the optimizing country, assuming a symmetrical equilibrium where all countries behave alike and each country's emissions equal its immissions.[3] The national optimum is now given by the values indicated by 1, that is, by the lower of the two points of intersection shown in the figure.

The solution is not a Pareto optimum from the viewpoint of all countries taken together. A Pareto optimal pollution policy follows from maximizing country's utility with regard to its waste emission subject to the assumption that it makes sufficient side payments to all other countries so as to compensate for the damage imposed upon them. Let $\overline{Y}_{ij}$ be the income of country j resulting from country j's own actions and the side payments of other countries except country i. By making a side payment of size $Y_j - \overline{Y}_{ij}$, country i can effectively control country j's income so as to avoid a change in country j's welfare despite the physical spillover of waste emissions. Thus, the formal optimization problem of country i becomes:

$$\max_{S_i, Y_j} \; U(Y_i, S_i^*) \qquad \forall \; j = 1,...,n, \quad j \neq i \;,$$

$$\text{s.t.} \qquad (5.10),$$

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[3] The resulting ex post equality of emissions and immissions should not be confused with the technical equality of the two variables when there are no spillover effects. In the case at hand, the individual country can correctly assume that its emissions can be varied by its own decision independently of the immissions, even if, because of the assumption of symmetry, in equilibrium it does not behave differently from the others. In the case analysed in the previous section the country must already assume at the planning stage that varying its emissions will bring about a same sized change in its immissions. The decisive difference between the two cases shows up in the marginal calculus. In the present case, the derivative of a country's immissions with regard to its emissions is equal to $1/n$, in the previous case it was equal to one.

$$Y_i = f(L_i, S_i, K_i) + r(\overline{K}_i - K_i) - \sum_{\substack{j=1 \\ j \neq i}}^{n} (Y_j - \overline{Y}_{ij}),$$

$$U(Y_j, S_j^*) = \text{const.}$$

Since country j's marginal immission requires a compensation of size

$$\left.\frac{\mathrm{d}Y_j}{\mathrm{d}S_j^*}\right|_U = -\frac{U_{S_j^*}}{U_{Y_j}} \qquad \forall\ j = 1,\ldots,n,\ j \neq i,$$

and since country j's marginal immission is $1/n$ of country i's marginal emission, the optimization approach implies the following overall marginal condition for country i's emissions:

$$p_i = f_S(L_i, S_i, K_i) = \sum_{j=1}^{n} \frac{1}{n} \cdot \left.\frac{\mathrm{d}Y_j}{\mathrm{d}S_j^*}\right|_{U_j} . \qquad (5.12)$$

Equation (5.12) is the Samuelson condition for the provision of public goods. It states that the Pigovian tax rate p_i be chosen such that the marginal product of waste emissions in country i (the marginal cost of improving the environment) be equal to the sum of the marginal damages in all countries (the sum of the marginal willingness to pay for an improvement of the environment) that this country causes, where the marginal damage of country j is that country's marginal cost of immissions times its share in country i's marginal emission, $1/n$.

In a symmetrical equilibrium the marginal damages in all countries are alike. It follows that it would be optimal from an international perspective to set the Pigovian tax rate such that

$$p_i = f_S(L_i, S_i, K_i) = \left.\frac{\mathrm{d}Y_i}{\mathrm{d}S_i *}\right|_U \quad \forall\ i = 1,...,n, \tag{5.13}$$

which is obviously the same as the single country's optimality condition (5.9) in the absence of international spillovers. Figure 5.1 demonstrates this. The international marginal damage curve which sums up the marginal damages in all countries runs the same way as the national marginal damage curve in the case without spillovers. Thus the international optimum is shown, as before, by the variables indicated by 0. The comparison with the solution characterized by variables with the subscript 1 illustrates the misallocation of a decentralized solution.

Proposition 5.2: *In the case of international waste spillovers, the Pareto optimal pollution policy is given by the equality between the national marginal product of the waste emission and the sum of the world-wide marginal damages that this emission causes.*

Proposition 5.3: *In the case of international waste spillovers, the national government will choose a too low Pigovian tax rate; that is, it will engage in ecological dumping.*

In contrast to the previous section, a pessimistic picture of the viability of systems competition in environmental issues arises. Border crossing environmental damages are negative policy externalities of national environmental policy that greatly distort the cost-benefit comparison of such a policy. The incentive to make use of the positive production effect of a lax environmental policy is stronger than the fear of environmental damage because most of this damage falls elsewhere. A single country can enrich itself at the expense of other countries by neglecting the environment, but if all countries neglect the environment, they only end up damaging themselves.

Unfortunately, it does not help the individual country if it takes heed of this knowledge and departs from the equilibrium by unilaterally tightening its environmental standards. The utility in the form of an improvement in the quality of the environment is shared by all countries, but the country itself must bear the cost in the form of a reduction in output alone. Only collective actions can overcome the misallocation problem.

Pollution Certificates, Foreign Direct Investment, and the Rent Dissipation Effect

Up to now the analysis has referred to regulating the environment by means of Pigovian taxes. This regulatory method is popular among economists, but it is unpopular in practice. In general, environmental exchanges and certificates, which are entitlements to pollute (USA), or technical standards (Germany), are preferred to Pigovian taxes. These instruments are similar in many respects. There is, however, a significant difference with regard to the implicit assignment of property rights. Levying Pigovian taxes means giving the citizens implicit ownership of the environment and letting the firms pay the citizens periodically for using the environment via the government budget. Certificates that are rented periodically from the government also have such implications, because they result in a variable flow of payments to the government just like a Pigovian tax. In fact, from an economic point of view they are no different from Pigovian taxes, and the results derived in the previous section also apply to them.

It is different, however, with permanently valid certificates and environmental standards. Both of these imply that property rights to the environment have been given away by the government and are now held by the firms, either through a formal ownership of the certificates, or through the right to pollute the environment within certain limits. The factor reward or rent resulting from waste emissions accrues to the firm's owners rather than to the general public which receives the tax revenue in the case of Pigovian taxation, as was assumed with (5.3).

This cannot influence environmental policy if international capital movements are exclusively financial, as was assumed in the second section, because the environmental rent will then flow to domestic residents alone. However, when direct investment and cross-border ownership of equity is allowed, things are different, because foreigners are implicit co-owners of the domestic environment and may receive a considerable part of the implicit factor income from waste emissions, $f_S S$. An environmental policy operated in the national interest will not take a possible flow of environmental rents to foreigners into account in its calculations and thus will generally result in distorted regulation decisions. This effect was briefly discussed by Sinn (1994, p. 104 n.) in an environmental context and by Huizinga and Nielsen (1997) in the general context of rent taxation, though without an allusion to environmental problems.

In a paper that has received much attention, Oates and Schwab (1988) attempted to prove that systems competition between states that set environmental standards is efficient. In their model, the national government chooses policy measures that are optimal from an overall perspective. Although the authors allow for international direct investment, they abstract implicitly from the possibility of international rent dissipation by making an apparently innocent assumption in the model. They assume that the right to pollute is given to the firms in strict proportion to their use of labour. This assumption makes the employees implicitly the owners of the environment and ensures that the total rent from the free use of the environment goes into their pockets. Since in the Oates and Schwab model it is, moreover, only the employees who direct the regulation policy, and since the model abstracts from the border-crossing spillover effects of pollution, it is hardly surprising that the authors find that systems competition would not lead to an inefficient use of the environment.

In the following an attempt will be made to bring out the particular problems of the certificates, using less arbitrary assumptions. The model will abstract from the technological spillover effects

examined above in order to focus on the role of the ownership structure. As before, the government's aim is to maximize the sum of all incomes going to domestic residents, but not all income earned at home will accrue to the domestic residents. Instead, the share α, $0 \leq \alpha < 1$ of the environmental return – that is, the profit and implicit factor reward which results from using the environment – flows to foreign countries in addition to the usual interest payments to the physical capital invested. Let *r* be the world rate of return on debt and equity which the single country takes as given.

The analysis starts with the regulation of the environment through the use of permanent certificates, which are needed by the firms if they want to emit waste products and which can be traded among them. The model allows for two consecutive environmental policy decisions in continuous time, a previous one and a current one, and the analysis focuses primarily on the latter. Think of a major reform programme to be passed by parliament which will hold for many years to come. It is assumed that a fixed number of certificates is already in circulation at the time the reform is made, and that these allow an annual flow of environmental waste equal to *Q*. The government carries out its environmental policy by selling additional certificates *S*-*Q*, which generate an implicit annual rental income of *p* per unit of waste. One certificate allows for one unit of waste per period of time. The rental rate *p* is similar to the Pigovian tax analysed above. In particular, the market for certificates among the firms will evaluate the certificates at the marginal product of pollution rights, as in (5.2),

$$p = f_S(K, L, S),$$

where *S* is sum of old and new certificates. With a given rate of return to capital, *r*, the stock price of the certificates among private firms will be p/r. This is also the price at which the

government sells the new certificates, $S - Q$. If it invests the sales revenue in the international capital market, it will permanently receive the flow equivalent of this revenue, $r \cdot (p/r)(S - Q) = p \cdot (S - Q)$, which obviously is equal to the implicit rental income which the new certificates generate for their new owners. The owners of the existing certificates of quantity Q earn the same rental rate as the government, regardless of what they once paid for the certificates. If the government considers a marginal change in the number of new certificates, this will change the rental rate and the stock price of the existing certificates, p/r, implying marginal windfall gains or losses and corresponding changes in the rental income earned by the existing owners. As the owners include foreigners, the government may not appropriately take account of all private benefits and costs resulting from its policy choice and may therefore make distorted decisions.

To analyse the issue formally, the above model, which is based on a linearly homogeneous production function with labour, capital and waste emissions as factors of production, is used again. Nothing changes in equations (5.1) to (5.6) except that the expression for the flow of government transfers financed with the revenue from renting the right to pollute, pS, is replaced with $p(S - Q)$,

$$T = p(S - Q), \tag{5.14}$$

and the rental income from owning the existing certificates, $(1 - \alpha)Q \cdot p$, which accrues to the domestic residents, is added in equation (5.4). Thus, national income can be expressed as the sum of wage income, rental income from owning the existing certificates, transfers received from the government, and the income from capital invested at home and abroad,

$$Y \equiv wL + (1-\alpha)Qp + T + r\overline{K} \,. \qquad (5.15)$$

The past wealth effects resulting from selling certificates to foreigners are sunk and can be assumed to be captured by the size of the private agents' fixed wealth $\overline{K}$.[4] Inserting (5.14) into (5.15) yields the equation

$$Y = wL + r\overline{K} + p(S - \alpha Q) \,, \qquad (5.16)$$

which shows that national income is the sum of wages, capital income earned at home and abroad as well as the rental income from owning and using the old and new certificates, S, except for the old certificates owned by foreigners, αQ.

Applying (5.6) and (5.2), (5.16) can be transformed to

$$Y = f(L,S,K) + r(\overline{K} - K) - f_S(L,S,K)\,\alpha\, Q \qquad (5.17)$$

which is the sum of the domestic product, f, and the capital income earned abroad, $r(\overline{K} - K)$, as in (5.7), minus the rental income accruing to foreigners, $f_S \cdot \alpha Q$. From the point of view of the voters, the optimal environmental policy is given, analogously to (5.8), by the solution of the maximization task

[4] It may be easiest to understand the equation (5.15) if it is supposed first that the previous certificates were given away for free. If they were not given away for free, the government collected revenue which it transferred to private agents. Compared to the case of free issues, these agents acquired wealth by receiving the transfers and they lost wealth to the extent that they bought the certificates. In a closed economy the wealth effects cancelled; in an open economy their net effect was positive for domestic residents, because foreigners contributed to government revenue. In any event, the net wealth effect can be assumed to be captured by $\overline{K}$.

$$\max_{S} U(Y, S^*)$$

s. t. (5.2), (5.5) and (5.17)

which gives the marginal condition

$$p = f_S = \left.\frac{\mathrm{d}Y}{\mathrm{d}S^*}\right|_U + \left.\frac{\mathrm{d}f_S}{\mathrm{d}S}\right|_{f_K = r} \alpha Q \qquad (5.18)$$

instead of (5.9). The condition says that the government chooses the number of certificates such that the marginal product of waste emissions, and hence the rental rate for certificates, equals the marginal social damage plus the marginal change in the rental income accruing to foreigners, i.e. the marginal policy externality imposed on people who do not belong to the electorate and whose preferences are therefore neglected. Note that the latter derivative does not simply refer to the second derivative of f with regard to S but also captures the impact of an endogenous reaction of capital that satisfies the condition that the marginal product is kept equal to the market rate of interest, as required by (5.2).

Because the production function is linearly homogeneous and L is a constant, the degree of homogeneity is less than one with respect to only two of the three factors, S and K. Thus the factor demand curve for S is downward sloping when the employment of capital is adjusted optimally,

$$\left.\frac{\mathrm{d}f_S}{\mathrm{d}S}\right|_{f_K = r} < 0 ,$$

as was assumed in Figure 5.1. This implies that the policy externality is negative and that (5.18) indicates excessive pollution, if compared to the social optimum as defined in (5.13):

$$p = f_S < \left.\frac{\mathrm{d}Y}{\mathrm{d}S^*}\right|_U \quad \text{for} \quad \alpha Q > 0.$$

Proposition 5.4: *When the environment is regulated by means of permanently valid certificates and when some of the certificates have found their way into the pockets of foreign owners, a government that maximizes national welfare will, in a second stage, implement too lax an environmental policy even though the waste emissions do not spread across the country's borders.*

Once again we find a reason for ecological dumping, and once again the result can be traced to a negative policy externality of such a policy. This time, however, the externality does not result from a technological spillover effect but from a rent dissipation effect affecting foreign direct investors who came before the environmental policy was chosen. If the government pursues a lax policy, the rental rate of the pollution certificates, *p,* falls and with it the firms' return, pQ, from using the existing certificates. One part of the reduction in the environmental return on existing certificates falls on the domestic residents and thus enters into the decision of the national government. Another part, however, falls on the foreigners and this is the negative policy externality. Since this externality does not enter into the government's calculations, the decision will be distorted in favour of too lax an environmental policy.

If the technological spillover effects analysed in the previous section are added to the rent dissipation effect, the two effects will reinforce one another. The national government then has a

dual incentive to neglect the environment as neither the environmental damage abroad nor the damage to foreign owned certificates caused by the depreciation of the property rights enters into its planning.

The suspicion may arise that the depreciation of property rights is an artefact stemming from the neglect of the prior decision of foreign investors to buy the certificates. Would it not be possible that the vigilance of the international investors prevents this depreciation? Would there not be a disciplinary effect which will put the national environmental policy on the right track? These questions can be answered in the negative. It is true that the foreign investors may have rational expectations of what will happen and foresee the effects of the environmental policy on the value of the certificates. If the existing certificates, Q, were acquired in the expectation that the environmental policy would be lax and the rental rate for certificates low, the stock price of the certificates would be correspondingly low, and the optimizing country would be unable to exploit the investors.

This, however, has no implications for the policy externalities that are modelled here, because they refer to marginal variations in the number of certificates sold, whatever the expected policy was. Even if the original purchasers of certificates correctly foresaw the number of certificates the government sells today and the rental rate p that this implies, it will still be true that a marginal variation around this number generates marginal windfall gains or losses which partly fall on foreigners and are therefore not fully incorporated in the government's decision problem. To be more specific: with rational expectations about the lax policy which the government chooses, it does not pay for the government to deviate ex post by deciding on a tighter policy because this will create windfall gains for people who do not belong to the electorate. There is a serious time consistency problem which cannot be overcome.

The only way to avoid the time consistency problem would be to make binding contracts between the initial purchasers of certificates and the national government, where the government commits itself to a particular environmental policy, or to paying compensation for wealth losses caused by its actions. However, this way has to be ruled out as impractical and unrealistic. It is not legally possible for a government to bind the environmental policy of its successors in such a way, and it is unimaginable for it to promise to make compensation payments for changes in market prices caused by the political decisions of its successors, because such changes can hardly ever be defined in a way which is sufficiently straightforward for legal procedures.

Environmental Standards

In the previous section it was assumed that the firms already have a certain stock of pollution certificates and that the environmental policy is operated by selling or repurchasing marginal amounts of these certificates. In principle, the section was still dealing with regulating the environment by means of prices.

In contrast, pure quantity standards, such as those used in Germany, are devoid of any pricing elements. To model their effects, it is sufficient to put $Q = S$ in equations (5.14) – (5.17), because marginal and infra-marginal waste emissions no longer need to be distinguished. Instead of (5.17), national income is given by

$$Y = f(L,S,K) + r(\overline{K} - K) - f_S(L,S,K)\,\alpha\, S \ , \qquad (5.19)$$

which is the sum of the domestic product and the capital income earned abroad minus the foreigners' share of the total return from waste emissions. Even though foreigners did not formally acquire certificates, they may have bought company shares, and via the ownership of

these company shares they receive a fraction, α, of the total implicit rental income that results from exploiting the right to pollute. The rental income now shows up as pure rent which flows to shareholders as the residual claimants of the production process. Note that in comparison to (5.17), the given historical quantity *Q* has been replaced with the actual emission volume *S*. This means that a rent dissipation to foreigners will not only result from a price effect, but also from a countervailing quantity effect.

The maximization problem of the government now is

$$\max_{S} \; U(Y, S^*)$$

s.t. (5.2), (5.5) and (5.19),

and the first-order condition for a maximum is

$$p = f_S = \left.\frac{\mathrm{d}Y}{\mathrm{d}S^*}\right|_U + \alpha\left(f_S + \left.\frac{\mathrm{d}f_S}{\mathrm{d}S}\right|_{f_K = r} \cdot S\right). \qquad (5.20)$$

Unlike the previous cases, *p* now is only an implicit or shadow rental rate which does not have an analogue in an observable market price. A comparison with (5.9) shows once again that the marginal product of waste emissions may differ from the marginal damage to the households, because there is a policy externality on foreigners ($\alpha > 0$). Note, however, that there is the additional term $\alpha \cdot f_S$. As before, the second term in the brackets captures the decline in the implicit rental rate resulting from a laxer policy, given the emission quantity. However, the first term in the brackets, f_S, measures the marginal return from an increase in waste emissions, given

the implicit rental rate. When new certificates are sold, foreigners do not participate in the marginal return, but when the emission rights are granted for free to firms that have foreign shareholders, they do. Both terms taken together are the marginal revenue to the polluters from an increase in waste emissions, and it is unclear whether this marginal revenue is positive or negative.

If the marginal revenue is positive, the marginal return from waste emissions, f_S, is higher than the marginal damage, $\left.\frac{\mathrm{d}Y}{\mathrm{d}S^*}\right|_U$, and this indicates that too little waste emission is permitted. A marginal increase in emissions increases the overall return from using the environment, and this effect partly dissipates to foreigners. There is a positive policy externality which the national government does not take into account and which results in an excessively restrictive emissions policy.

It cannot conclusively be said whether the marginal revenue will be positive or negative because knowledge about the form of the production function, which, next to capital and labour, includes the environment as a factor, is lacking. If the factor demand curve has an elasticity of more than one in absolute terms, the relationship between the environmental rent and the amount of pollution is positive and this means that the marginal revenue is positive. If, however, the elasticity is less than one, the marginal revenue is negative and there is an incentive to choose too lax an environmental standard.[5]

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[5] Bovenberg and van der Ploeg (1996) show, for the case of a linear homogeneous 'nested' production function of the type $f[Q(K,S),L]$, that the demand elasticity is equal to

$$\left[\sigma_{QL}\frac{\alpha_S}{\alpha_L}+\sigma_{KS}\alpha_K\right]\frac{1}{\alpha_K+\alpha_S}$$

where σ_{QL} is the elasticity of substitution between L and the linearly homogeneous sub-function $Q(K,L)$, σ_{KS} is the elasticity of substitution between K and L, and α_S, α_L and α_K are the partial production elasticities or factor income shares of S, L and K. I would like to thank Ronnie Schöb for this reference.

Proposition 5.5: *If the environmental policy involves setting technical standards and if some of the equity of firms entitled to pollute the environment is owned by foreigners, while the emission of environmental waste does not spread across the country's borders, the direction in which the policy deviates from the international Pareto optimum is not clear. It is too lax when the elasticity of the demand for the environmental factor is less than one in absolute terms; it is too tight when this elasticity is more than one in absolute terms; and it is just right when the elasticity is equal to one.*

Unfortunately there is no empirical information available that would permit a reliable estimate of the size of the elasticity to be made. However, it should be considered once again that the differential quotient $\mathrm{d}f_S / \mathrm{d}S$ in equation (5.20) does not only measure a partial change in the marginal product of waste emissions with given quantities of capital and labour but also covers the endogenous change in the amount of capital used which results from the profit maximizing reaction of the firms. This in itself speaks in favour of a highly elastic demand curve for the environmental factor. Looked at in this way, the case of an excessively tight environmental standard seems more plausible – a result which contrasts sharply with the two reasons for environmental dumping that were analysed above and could be the economic reason behind business leaders' accusations that excessively green environmental policies are chosen.

The Environmental Policy Externalities: A Suggested Interpretation

If there are no international policy externalities, there is no reason for doubting the fundamental efficiency of systems competition. This conclusion also holds for the environmental problem. Countries that are linked by trade in goods and capital and that regulate their local environmental

pollution by means of Pigovian taxes have no incentive to engage in ecological dumping or to carry out excessively green policies.

Problems arise, however, when the environmental damage is not just local, or when regulation is carried out by means of environment certificates or standards and the returns from waste emissions accrue partly to foreigners. Physical spillovers and rent dissipation across a country's borders imply policy externalities that distort the national policy decisions.

The policy externalities are a reflection of the private decision externalities which led to market failure and legitimated government intervention in the first place. The reason for the failure of the private competition shows up again as the reason for the failure of systems competition, which is what the Selection Principle suggests.

If waste emissions spread not only beyond a firm's but also beyond a country's borders, systems competition does not work well because the single country does not have a sufficient incentive to take account of the environmental damage it causes. It alone carries the full cost of protection measures, in the form of a loss of production, but only gets part of the benefit. The policy decision is distorted in the direction of too lax environmental constraints, and the fear of ecological dumping is justified.

Things are somewhat more complicated with the international rent dissipation effect because this externality has no direct analogue on the micro level. Nevertheless, this effect also results from the public-goods nature of the environment, which excludes a self-regulation by competitive market forces and calls for a government action.

If the government allows for a marginal increase in waste emissions, it incurs a quantity effect and a price effect on the implicit or explicit factor reward for tolerating more pollution. The price effect can be explicit as in the cases of Pigovian taxes and certificates or implicit as in the case of environmental standards. The quantity effect results from the increase in a firm's output

because of a marginal increase in waste emissions. It benefits those who receive the marginal environmental factor reward. The price effect results from the accompanying decline in the marginal product of waste emissions whose counterpart is an increase in the wage rate. The price effect represents a redistribution between the factors of production due the changed relative scarcity brought about by a change in allowed waste emissions. Taken by itself, the price effect makes workers richer, and it makes the recipients of the infra-marginal factor reward from using the environment poorer. Depending on the extent to which foreigners participate in the price and quantity effects on the return from using the environment, the government's decision may be distorted in the one or the other direction.

In the case where the government chooses a Pigovian tax to regulate the environment, both the quantity effect and the price effect of a laxer policy affect nationals only. Domestic workers benefit from the wage increase, and domestic residents, who are the residual claimants of a government budgetsurplus, suffer from the decline in the Pigovian tax revenue from inframarginal units of waste emissions. Moreover, the same domestic residents gain from the extra Pigovian tax revenue resulting from the quantity effect. There is no cross-border policy externality and hence no policy distortion.

The same result holds if certificates with a short-term validity are issued which cannot be traded as stocks but are periodically rented to the polluting firms. Such certificates are indistinguishable from Pigovian taxes.

Things are different with permanently valid certificates that are sequentially sold. Again, the quantity effect does not affect foreigners, because the revenue from selling the certificates, and hence the marginal factor return from allowing more waste emissions, flows to domestic residents. However, the price effect does affect foreigners. The resulting wage increase benefits domestic workers and hurts existing domestic and foreign owners of certificates by depreciating

the value of their certificates. The larger the share of certificates held by foreigners, the less will the national government care about the depreciation of existing certificates and the more certificates it will sell. Ecological dumping results. Anticipation of the policy decision by foreigners is no remedy. It avoids any expropriation ex post, but does not reduce the incentive to choose too lax an environmental policy. Given that no credible commitment strategy is available, the distortion in the cost-benefit calculation of the national government resulting from marginal gains or losses incurred on foreigners is independent of the degree of policy anticipation since the historic purchasing price of the certificates is 'sunk' and cannot be changed ex post.

Finally, in the case of setting environmental standards without charging for waste emissions, foreigners fully participate in the positive quantity effect and the negative price effect on the return from using the environment, while workers benefit from the wage increase. If, as seems plausible, the total environmental return increases when the environmental standard is relaxed, there is a positive net externality on foreigners which induces the national government to choose overly tight emission standards.

Over time, the international rent dissipation effect will become increasingly important, because globalization will cause the ownership structure to become more and more diversified. The electorate, which determines environmental policy, and the property owners affected by this policy drift further and further apart and this means that there is a growing potential for conflict and policy distortions.

Policy Implications

International policy coordination is urgently needed in view of the massive size of the policy externalities in the area of the environment. Everything speaks in favour of protecting the environment with Pigovian taxes and, if this is done, the tax rates should be harmonized

internationally so as to avoid ecological dumping. A factor which is freely tradable internationally needs the same price everywhere, and the price should reflect both the marginal product of this factor and the marginal cost of providing it. The environment is no exception to this basic economic wisdom. When it is a question of air and water flowing between countries, uniform tax rates are required. Environmental problems that are local in nature, like noise pollution or the quality of the national drinking water, do not, of course, require policy coordination. National incentives are not distorted here.

Coordination would also be appropriate when the national governments regulate the environment by setting standards. However, as is well known from the literature, standards are very inefficient regulatory instruments because, unlike certificates and Pigovian taxes, they cannot regulate a given environmental quality at minimum cost for the firms if the government does not know the shapes of the firm-specific production functions. In general, the government will be unable to equate the marginal products of waste emissions across the firms, and more output than necessary is sacrificed to bring about a given reduction in aggregate waste emissions. For this reason, it would only be a second-best policy to search for a harmonization of environmental standards internationally. Pigovian taxes are the better alternative.

If the certificate solution is introduced with the aim of controlling the environment, then policy coordination is also required, because the national government would otherwise try to expropriate the foreign owners of firms by dumping certificates. Disciplining of the government by foreign investors and forcing it to choose a time-consistent policy is difficult if not impossible in practice because it requires binding contracts which rule out subsequent changes in the number of outstanding certificates. Here, a possible solution could instead be international agreements on the numbers of certificates issued.

It is useful to take a look at the international tax treatment of direct investment in order to understand the nature of this coordination problem. A time-consistency problem also shows up with the taxation of direct investment, because a national government cannot credibly assure the foreign investors that their capital income will not be taxed excessively after they have made the investment and can no longer react. The government has a strong incentive to do just this later on. The instrument of a double taxation agreement between the countries affected has been developed to protect foreign capital tied up in the domestic country against excessive taxation and to make direct investment possible. To prevent the erosion of the environmental return by issuing too many environmental certificates, a similar form of international cooperation at the government level would be required in the area of the environment.

At the environmental conference in Kyoto in 1997, the U.S. suggested an international system of tradeble environmental certificates that offers a possible solution to the coordination problem.[6] In this system, every country is allocated a fixed limit of waste emissions and compliance is controlled internationally. It is left to the national government to decide which method it will use to regulate its environment, but it must keep total emissions within the agreed limit. Exceeding the limit is possible if the country sells the appropriate emission rights to other countries. The U. S. suggestion solves the international coordination problem and gets rid of the policy externalities stemming from the physical spillover and the rent dissipation effects that have been discussed in this chapter.

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[6] See United Nations (1997).