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ON ECOLOGICAL DUMPING

by

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On Ecological Dumping¹

Abstract

Ecological dumping is a catchword used in the public discussion on environmental policies in open economies to characterize situations in which a country uses a too-lax environmental legislation as an instrument of achieving trade-related economic policy goals. The paper first tries to define ecological dumping and then looks at economic motives underlying this kind of environmental policy. The approaches considered in this paper are the terms-of-trade argument, strategic trade policy and a public choice model in which the government either maximizes tax revenues or supports sector-specific interest groups.

1. Introduction

Environmental legislation provides a means to the government to influence the competitiveness of an economy or of some of its sectors. According to the standard theorems of international trade theory, a restrictive policy towards the users of environmental resources will distract internationally mobile factors of production and, inside the economy, cause factor movements from the pollution-intensive sectors of the economy to the cleaner sectors. The comparative advantage of the former is diminished by such a policy. Thus, environmental legislation affects the international division of labour and can be used to achieve trade-policy objectives. This is particularly appealing if the appropriate instruments, tariffs and quotas, are not available, for instance if the country has signed treaties that prohibit restrictions on imports from other countries. Examples are the EC treaties and the GATT. Thus, the politician may be tempted to use the tools of environmental policies to achieve objectives other than the internalization of the social costs of pollution. The main objectives are the improvement of the terms of trade, strategic trade-policy considerations, and the protection of infant or ailing industries or sectors which are supported by powerful lobbies.

¹ Earlier versions of the paper have been presented in seminars at the Kiel Institute of World Economics, the Universities of Munich and Konstanz, and during the 1992 European Research Workshop in International Trade held at the Universidade Nova of Lisbon and I am indebted to the participants for helpful comments and suggestions. Moreover, I have benefitted considerably from discussing problems of environmental policies in open economies with Kym Anderson, Richard Blackhurst, Scott Barrett, Carlo Carraro and Henry Tulkens. None of them is responsible for any deficiencies of this paper.

The protection of particular sectors or subgroups of a society by means of environmental policies may result in an environmental legislation which is too lax in some sense. Producers obtain hidden subsidies in terms of low pollution abatement requirements and they can dump their products in international markets at prices that do not reflect the true cost of production. This is considered to be a practice of unfair trade. Thus, the term 'ecological dumping' is often used in the public discussion to paraphrase the phenomenon. This catchword will be taken up for the following investigation. It should be kept in mind, however, that, in contrast to normal dumping, ecological dumping is an activity performed by the government and not by an individual firm. Moreover, it does not in the first place affect the price of a tradeable commodity but that of a factor of production which is internationally immobile: nature's capability to provide environmental resources.

This paper is an attempt to cast some more light on the issue of eco-dumping. In a first step, a sensible definition of the subject is sought. Three possibilities to define eco-dumping will be discussed and it will be seen that the definition corresponding to the public-opinion view of ecological dumping is not very useful. Thus, there remain two sensible alternatives of defining the subject of the investigation. We shall then try to identify economic motives underlying a government's decision to engage in ecological dumping. In this scenario, environmental policy instruments are used not only to internalize the social costs of pollution but also to influence the terms of trade. Thus, there will be some similarities with the literature on optimum tariffs. It will be seen that environmental policy may indeed serve as an instrument of trade policy (an idea which is by no means new in economics), but it is generally not optimal to use it in a way which may be described as ecological dumping. If eco-dumping is not optimal from an welfare-theoretical point of view and if it, nevertheless, exists in the real world, how can it be explained? Some ideas of where explanations should be sought will be presented in sections 5 and 6.

Finally, it may be useful to say what is missing in this paper. The theoretical framework of the analysis is an international-trade model in which the production of traded commodities harms the environment. Of course, there are also environmental problems connected with the consumption of these goods and they may have strong implications on international trade (as the Danish bottle case in the EC has vividly demonstrated). Nonetheless, the issue will not be addressed in this paper in detail. Another omission is the neglect of transfrontier pollution. It has been shown by Merrifield (1988) and Rauscher (1991), that the combination of transfrontier pollution spill-overs and international trade create interesting phenomena in the standard model of international trade. But since this paper is concerned with the impact of international trade on domestic environmental policies merely, transfrontier pollution would only complicate the analysis without providing additional insights into the issue under consideration. Therefore, I shall deal with purely national environmental problems. Moreover, I assume that, due to international trade agreements,

restricting international trade is prohibited. Thus, there will be neither tariffs nor quotas but only free international trade.

2. Three Definitions of Ecological Dumping

In the public opinion, the term 'ecological dumping' characterizes a situation in which the environmental standards in one country are lower than those in other countries. By undercutting the environmental standards of other countries, a government reduces the production costs of domestic firms. They can produce at lower costs than their foreign competitors and this is considered to be unfair. As a consequence, a desirable world of fair trade would be characterized by complete harmonization of environmental policies: all countries should use the same environmental standards. This view of ecological dumping corresponds in a sense to the traditional definition of dumping in commodity markets. It is an activity which violates the law of one price. Commodities are sold at lower prices in foreign than in domestic markets. See Viner (1923). In the case of eco-dumping, it is not the price of the final good but that of a factor of production which differs between countries.

There are two objections against applying this concept to international differences in environmental regulations. First, if one believes in factor price equalization, the implicit prices of environmental resources should be the same in all countries if there is trade. To detect eco-dumping activities, one would have to employ the autarky prices. The second critique is more important. To a trade theorist, it does not make much sense to postulate that all countries should use the same level of environmental regulation. International differences in the endowments with environmental resources do exist, be it because of differences in physical characteristics of the countries, be it due to differences in the tastes of the people. Removing these differences by means of harmonization is equivalent to removing a part of the basis of gains from trade. See Hansson (1990) for instance. Thus, ecological dumping by employing lower environmental standards than the rest of the world can be a good thing and there is no need to rack one's brains about it as a problem.

Nonetheless, I think that ecological dumping is a problem. With another definition of the subject, this becomes obvious at once. The definition is related to the modern view of dumping in commodity markets which defines the subject of its analysis as pricing at less than marginal cost. See Davies/McGuinness (1982) and Ethier (1982). Correspondingly, eco-dumping can be defined as pricing the activities that affect the environment at less than the marginal social cost of environmental degradation. Or more generally, ecological dumping occurs when, due to international trade, a country's government does not fully internalize domestic environmental externalities. It is now obvious that eco-dumping is a

problem which deserves investigation into its origins and into the appropriate policy measures to cope with it.

However, useful as it may be for the academic researcher, the definition is still not very helpful in real-world applications. There are many reasons for too low a level of environmental regulation. Among these, trade-related motives are only one aspect. As a way out of this dilemma, one may compare the sectors producing tradeable and non-tradeable goods. The hypothesis is that trade-related measures of environmental policy are primarily targeted at the sectors of the economy that produce traded goods, i.e. the import-competing and the export sectors. This implies a third definition of eco-dumping. Eco-dumping occurs whenever the (explicit or implicit) price of environmental resources is lower in the tradeables than in the non-tradeables sector. A prerequisite for this to hold is that the government has the power to use sector-specific instruments of environmental policy. Anecdotal evidence tells is that this is indeed the case. There are even plant-specific differences in pollution abatement requirements, as is vividly testified by the electricity generation sectors in various countries.

Given that the public opinion view does not provide a sensible definition of eco-dumping, there remain two approaches to the subject of investigation. The major difference between the two definitions of ecological dumping is their point of reference. In the first case, it is the full internalization of the social costs of pollution. In the second case, it is the policy applied to the non-tradeables sector, which is not subject to international competition in the world market.

3. The Model

Ecological dumping will be analysed in a two-factors, three-goods model of an open economy. In order to reduce complexity, I assume that only two goods are produced domestically. Sector 1 of the economy produces non-tradeable goods and sector 2 produces the export good. There is no import-competing sector since commodity 3 is produced only in the foreign country.² The two factors of production are capital and an environmental resource, which will also be referred to as 'emissions'. Let K^i be the capital stock and E^i be the quantity of the environmental resource employed in the i th sector. The output of this sector, Q^i , then is

$$(1) \quad Q^i = F^i(K^i, E^i), \quad i=1,2$$

² A similar model with traded and non-traded goods has been analysed by Jones (1974). In his model, however, the exported good is not consumed in the home country.

The production functions are assumed to be well-behaved. They are concave and exhibit constant returns to scale. The partial derivatives are positive. The second derivatives F_{KK}^i and F_{EE}^i are negative and the cross derivatives F_{KE}^i are positive. This implies that capital and emissions are imperfect substitutes or, more technically speaking, that their elasticity of substitution is finite and has the normal sign.³

Let P^2 and P^3 be the prices of commodities 2 and 3 in terms of the non-traded good which serves as the numéraire. $P = P^2/P^3$ denotes the country's terms of trade, i.e. the price of the export good in terms of the import good. Moreover, let C^i denote the domestic consumption and let $m(P)$ be the foreign country's excess demand function for commodity 2. An equilibrium requires that the excess supply of the home country equals the excess demand of the foreign country:

$$(2) \quad Q^2 - C^2 = m(P).$$

Moreover, if international trade is balanced, we have

$$(3a) \quad P^2(C^2 - Q^2) + P^3 C^3 = 0$$

or, together with (2),

$$(3b) \quad C^3 = P m(P).$$

The demand for commodities 1, 2, and 3 and the optimal environmental policy can be derived from the national welfare function $W(.,.,.,.)$ which has as its arguments the consumption of the three goods and environmental quality, A . For the sake of simplicity, I assume that the welfare function is additively separable in its arguments.⁴ Therefore,

$$(4) \quad W(C^1, C^2, C^3, A) = U^1(C^1) + U^2(C^2) + U^3(C^3) + V(A)$$

with positive but decreasing partial derivatives.⁵

³ Algebraically, the condition $f_{KE}^i > 0$ follows from constant returns to scale and $f_{EE}^i < 0$ or $f_{KK}^i < 0$.

⁴ Even with this restrictive assumption, there will be a large variety of feasible results and a more general welfare function would not add much to the analysis in this respect.

⁵ This type of welfare functions is known from models with endogenous factor supply. See Kemp/Jones (1962).

There is a fixed capital stock, K , which can be moved without costs between sectors 1 and 2:

$$(5) \quad K = K^1 + K^2.$$

For reasons of comparability, let us assume that all sectors discharge the same pollutant. Then, the environmental quality may be defined as

$$(6) \quad A = -E^1 - E^2.$$

Inserting eqs. (1), (2), (3b), (5) and (6) into the welfare function yields

$$(7) \quad W = U^1[F^1(K^1, E^1)] + U^2[F^2(K - K^1, -A - E^1) - m(P)] + U^3[Pm(P)] + V[A].$$

This is to be maximized by employing the appropriate environmental policy. If the country is large, it is able to affect its terms of trade, P . In the small-country case, P is given and the excess demand of the rest of the world is perfectly elastic. This case will be considered first.

The government chooses the optimal state of the environment, A . The firms decide on the allocation of capital to the producing sectors of the economy. The emission levels E^1 and E^2 can be chosen either by the producers or by the government. In one case, the government chooses just the level of environmental policy and then leaves it to the producers to allocate the emissions. This can be done by choosing appropriate emission taxes or by using a tradeable permit scheme. On the other hand, the government itself may wish to determine the emissions of the two producing sectors. The optimal level of environmental quality, A , is determined by

$$(8) \quad U_C^2 F_E^2 = V'$$

where primes and subscripts denote (partial) derivatives of functions. Under the assumption of perfect competition, factors are remunerated according to their marginal productivity. If the government left the allocation decision to the producers, the equilibrium price of environmental resources (equalling the Pigouvian tax rate), T , would be

$$(9) \quad P^2 V' / U_C^2 = P^2 F_E^2 = F_E^1 = T.$$

If the government itself decides on the allocation issue, it maximizes (7) also with respect to E^1 , which implies

$$(10) \quad U_C^1 F_E^1 = U_C^2 F_E^2.$$

Noting that utility maximization of the households implies $U^1_C = U^2_C/P^2 = U^3_C/P^3$, it follows from (10) that $F^1_E = P^2 F^2_E$.

This implies that the results of economy-wide and sector-specific environmental regulation are the same. The same tax rate will be applied to all sectors. Thus, it does not pay to discriminate one sector and favour another if the country under consideration is small. Moreover, the emission tax rate covers the marginal social cost of environmental degradation. Thus, there is no ecological dumping, independently of the definition applied.

4. The Terms-of-Trade Argument

Matters may be different if the country under consideration is large. It has an impact on its terms of trade and this affects its welfare. The effect is

$$dW = [-U^2_C m' + U^3_C(m + Pm')] dP$$

Noting that due to utility maximization of the households $U^2_C = PU^3_C$, this can be re-written

$$(11) \quad dW = U^3_C m dP.$$

As an exporter of good 2, the country will benefit from an increase in the relative price of this good compared to the imported good. One can now determine the impact of the supply of the environmental factor of production on the terms of trade.

In a first step, we shall deal with a scenario in which the government determines merely the level of environmental quality and then imposes a tradeable-permits scheme or levies an emission tax, which the firms use to decide on the allocation of the environmental factor of production to the two producing sectors of the economy. For the standard model without non-tradeable goods, the optimal environmental policy has been investigated by Markusen (1975) and Rauscher (1991a,b). A country should use its public policy to increase the relative price of the factor it is relatively well-endowed with to improve its terms of trade. The reduction of the availability of this factor tends to increase its price and (if the country is) the relative price of the commodity that uses this factor intensively in its production. Since this good is the export good, the terms of trade are improved by such a policy. Applying this to a model with environmental resources yields the result that a country well-endowed with environmental resources should employ a particularly restrictive policy towards users of environmental policy. In contrast, countries not so well endowed with

environmental resources should reduce their emission tax rates in order to increase the relative prices of the other factors of production.

Matters are different in a case of complete specialization, i.e. if there is no domestic consumption of the imported good. Under normal parameter constellations, it is optimal to reduce the supply of the export good in order to raise its price. This can be done by reducing the supply of the environmental factor of production - regardless of whether the country is well-endowed with resources or not. In the model considered here, there is an additional complication since there is the non-traded goods sector which itself uses environmental resources. The impact of a change in the environmental policy A on the terms of trade, P , is determined by by:

$$(12a) \quad U_C^2 - P^2 U_C^1 = 0.$$

$$(12b) \quad U_C^2 - P U_C^3 = 0.$$

$$(12c) \quad F_K^1 - P^2 F_K^2 = 0.$$

$$(12d) \quad F_E^1 - P^2 F_E^2 = 0.$$

Eqs. (12a,b) are derived from utility maximization by consumers whereas (12c,d) follows from profit-maximizing behaviour of firms. Eliminating P^2 yields

$$(13a) \quad U_C^2 - P U_C^3 = 0. \quad \checkmark$$

$$(13b) \quad U_C^1 F_K^1 - U_C^2 F_K^2 = 0. \quad \checkmark$$

$$(13c) \quad U_C^1 F_E^1 - U_C^2 F_E^2 = 0. \quad \checkmark$$

Total differentiation with respect to P , K^1 , E^1 and A gives the desired result. Some basic but cumbersome algebraic exercises show that the sign of dP/dA is ambiguous: there are nine positive and two negative terms.

⁶ This is due to the fact that both sectors compete for the environmental factor of production. A reduction of the availability of these resources reduces the marginal

⁶ An additional ambiguity arises when the determinant of the matrix of the partial derivatives of (13a,b,c) with respect to P , E^1 and E^2 has the "wrong" sign. An explanation of this will be given below.

productivity of capital in both sectors since since $F_{KE}^i > 0$. If this reduction is larger in the non-tradeables than in the tradeables sector, capital will be moved from the non-tradeables to the tradeables sector of the economy. Thus, the output of traded goods may actually rise if the reduction of emissions is dominated by an increase in the capital stock. As a consequence, the terms of trade may be reduced. Under certain circumstances, it may be advisable to relax environmental regulations to improve the terms of trade. It is not optimal to fully internalize the domestic costs of environmental disruption and this may be called ecological dumping. If, however, the direct effects of environmental policy changes dominate the indirect general-equilibrium effects, it is advisable to use more-restrictive policies.

The type of environmental policy considered here uses one instrument to cope with two distortions. There are the social costs of environmental degradation and the potential to improve the terms of trade. In this case, two policy instruments are better than one. Of course, the optimal combination of policy measures would be an emission tax plus a tariff. However, if tariffs are not available as an instrument of economic policy, the government may wish to enlarge its set of policy measures by imposing sector-specific environmental policies. The question to be considered here is whether such a policy tends to discriminate against the sectors producing non-traded goods. For this purpose, it is convenient to rewrite the objective function by substituting for A :

$$(7) \quad W = U^1[F^1(K^1, E^1)] + U^2[F^2(K-K^1, E^2) - m(P)] + U^3[Pm(P)] + V[-E^1 - E^2].$$

The allocation of capital and the terms of trade are determined by

$$(13a) \quad U_C^2 - P U_C^3 = 0$$

and

$$(13b) \quad U_C^1 F_K^1 - U_C^2 F_K^2 = 0.$$

Using (13a,b), one can derive the welfare effects of changes in sector-specific environmental policies. Optimal policies are characterized by:

$$(14a) \quad dW/dE^1 = U_C^1 F_E^1 - V' + U_C^3 m(dP/dE^1) = 0.$$

and

$$(14b) \quad dW/dE^2 = U_C^2 F_E^2 - V' + U_C^3 m(dP/dE^2) = 0..$$

Noting that in a competitive economy the marginal productivities of emissions equal the emission tax rates, i.e. $T^1 = F_E^1$ and $T^2 = P^2 F_E^2$ where $P^2 = U_C^1 / U_C^2 F_E^2$, one can easily

determine a condition for eco-dumping defined in the sense of discrimination of non-traded goods production. Eco-dumping according to this definition when the emission tax rate in the export sector is lower than that in the non-traded goods sector or, equivalently,

$$(15) \quad T^2 < T^1 \quad \text{iff} \quad \frac{dP}{dE^1} < \frac{dP}{dE^2}.$$

Eco-dumping is optimal if the terms-of-trade effect of additional emissions in the non-tradeables sector is smaller than the corresponding effect in the sector producing traded commodities. If this condition holds, the improvement in the terms of trade by an additional unit of emissions in the tradeables sector exceeds the improvement achieved by increasing emissions in the non-tradeables sector. Therefore, it is optimal to apply lower environmental standards to the exporting industries.

The terms-of-trade effects of sector-specific environmental policies can be determined by total differentiation of the private sector's optimality conditions (13a,b). This yields

$$(16) \quad \begin{bmatrix} -m'U_{CC}^2 - U_C^3 - P(m + Pm')U_{CC}^3 & -U_{CC}^2 F_K^2 \\ m'U_{CC}^2 F_K^2 & U_C^1 F_{KK}^1 + U_{CC}^1 (F_K^1)^2 + U_C^2 F_{KK}^2 + U_{CC}^2 (F_K^2)^2 \end{bmatrix} \begin{bmatrix} dP \\ dK^1 \end{bmatrix} \\ = \begin{bmatrix} 0 & -U_{CC}^2 F_E^2 \\ -U_C^1 F_{KE}^1 - U_{CC}^1 F_K^1 F_E^1 & U_C^2 F_{KE}^2 + U_{CC}^2 F_K^2 F_E^2 \end{bmatrix} \begin{bmatrix} dE^1 \\ dE^2 \end{bmatrix}$$

The sign of the determinant, D , of the matrix on the left-hand side is ambiguous. This is due to the terms occurring in its first-row first-column element. If the foreign country's import demand is inelastic, then m' is close to zero, implying that this element may be positive. In this case, the determinant is negative. But the opposite scenario is also feasible. In order to give an economic interpretation, imagine a situation in which the supply of good 3 is increased exogenously, e.g. by some manna from heaven. The intuition is that this should improve the terms of trade, since the scarcity of the import good is reduced and it gets cheaper. It can be shown that this happens only if the determinant is positive.⁷ If the det-

⁷ Let M be the quantity of manna falling from heaven. Then

$$\frac{dP}{dM} = D^{-1} P U_{CC}^3 (U_C^1 F_{KK}^1 + U_{CC}^1 (F_K^1)^2 + U_C^2 F_{KK}^2 + U_{CC}^2 (F_K^2)^2).$$

It follows that $\text{sign}(dP/dM) = \text{sign}(D)$.

eterminant is negative, general-equilibrium interdependencies produce the counter-intuitive result of declining terms of trade. In what follows, I will assume that the intuition is correct and that the determinant has a positive sign.

The terms-of-trade effects of sector-specific environmental policies can be determined by applying Cramer's rule to eq. (16). This yields

$$(17a) \quad dP/dE^1 = -D^{-1} U_{CC}^2 F_K^2 [U_{CF}^1 F_{KE}^1 + U_{CC}^1 F_K^1 F_E^1],$$

$$(17b) \quad dP/dE^2 = D^{-1} [U_{CC}^2 F_K^2 U_{CF}^2 F_{KE}^2 - U_{CC}^2 F_E^2 (U_{CF}^1 F_{KK}^1 + U_{CC}^1 (F_K^1)^2 + U_{CC}^2 F_{KK}^2)].$$

The terms-of-trade effect of an increase in emissions is negative in the traded commodities sector and ambiguous in the non-tradeables sector. This can be explained as follows. An increase in the availability of environmental resources in sector 2 increases the supply of exportable goods and, under normal circumstances, their price will decline. For sector 1, which produces the non-traded good, there are two opposing effects. On the one hand, an increase in emissions increases the marginal productivity of capital since $F_{KE}^1 > 0$. If commodity prices are given, capital is moved from sector 2 to sector 1. This reduces the supply of the export good and tends to improve the terms of trade. On the other hand, the increase in the availability of the environmental factor of production in the non-tradeables sector increases the supply of this good. Its price relative to that of the other good which is produced at home is reduced. For given productivities, capital tends to move from sector 1 to sector 2, this raises the supply of the exported good and leads to a deterioration of the terms of trade.

Given the terms-of-trade effects of sector-specific environmental policies, the policy implications can easily be derived. Since under normal circumstances the terms-of-trade effect of additional emissions in the export sector is negative, one should attempt to reduce these emissions below those of the reference scenario in which the terms-of-trade effects are not taken into account. The policy implication for the non-tradeables sector is ambiguous. If capital and emissions are good substitutes in this sectors (if F_{KE}^1 is large), then there is a positive terms-of-trade effect, and the environmental policy measures applied to the non-tradeables sector should be relaxed. In this scenario the policy implication is the opposite of eco-dumping: discriminate the sector which produces traded goods. It should be noted, however, that a number of different scenarios are imaginable some of which can indeed result in the discrimination of the non-tradeables sector. But such an outcome is not particularly likely.

We can summarize that there is a tendency towards stricter environmental legislation, either in the export sector or for the economy as a whole, if policy makers wish to improve the terms of trade. Due to general-equilibrium considerations, however, the opposite policy recommendation is also possible for some parameter combinations. It should be noted that the tendency towards better protection of the environment is an artifact of the assumptions used in this model. The crucial assumption is the absence of an import-competing industry. If such a sector existed, the policy recommendation would mainly depend upon whether the economy is well-endowed with environmental resources or not.

5. Strategic Trade Policy

In the previous sections, it has been assumed that perfect competition prevails on factors and goods markets. Over the last decade, numerous models have been developed which differ from the standard Heckscher-Ohlin-Samuelson framework in this respect and allow to derive interesting policy implications. One of them is the strategic trade policy framework which shows that, under certain circumstances, it may be advisable to subsidize domestic firms in order to increase their market power in international markets.

The basic model is that of Brander/Spencer (1985). They show that the government can turn a firm playing Nash-Cournot into a Stackelberg leader by subsidizing its production. Rents are shifted into the home country and this is welfare-improving. Direct subsidies, however, can easily be detected by foreign competitors. Therefore, it may be better to use indirect methods of subsidization. One possibility is to subsidize domestic research and development. See Spencer/Brander (1983). Another alternative is to impose relatively modest pollution abatement requirements on the firms competing in international oligopoly markets. There have been some recent attempts to analyse this possibility in theoretical models. See Barrett (1991), Conrad (1991) and Ulph (1992). I will refer mainly to Barrett's paper and try to apply his results to the general-equilibrium framework used above.

Barrett (1991) uses the standard model of strategic trade policy extended by the introduction of costly pollution abatement. There are two firms, one domestic and one foreign. They sell their production in a third country. Each firm takes as given the quantity supplied by the other firm and the environmental policy of its home government. In this situation, the market solution is the Nash equilibrium which is represented by point N in Figure 1. Q and q denote the quantities supplied by the domestic and the foreign firm, respectively, and R and r are their reaction curves. Let B and b be the iso-profit curves of the two firms. If a direct subsidy is given to the domestic firm, it increases its output. The

equilibrium moves along the foreign country's reaction curve. This is beneficial to the home country as long as the net profits (profits minus subsidies) of the domestic industry increase. The optimum is given by point S , where the foreign firm's reaction curve touches the best-possible domestic iso-profit curve. This is the Stackelberg solution.

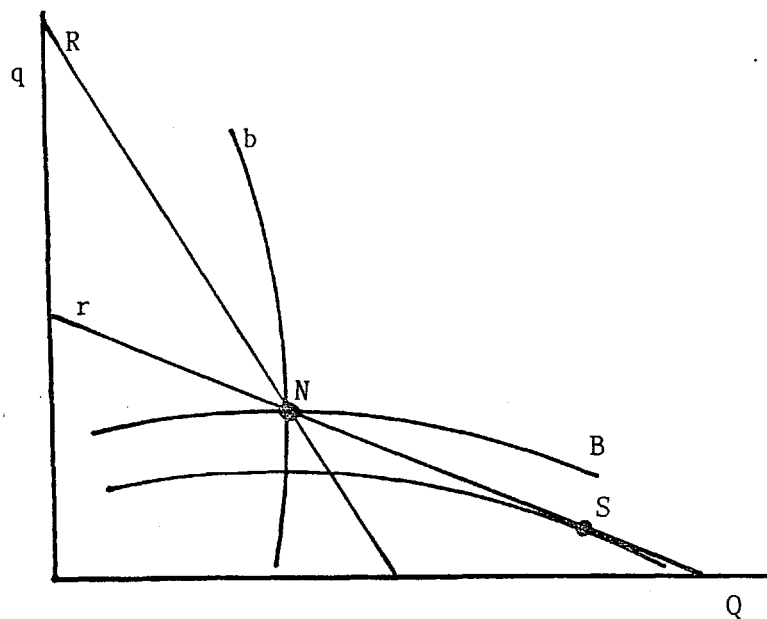


Figure 1

Matters are slightly different if the subsidy is given indirectly by relaxing environmental standards. This kind of subsidy is not merely a purely redistributive policy instrument but its application incurs some real cost. The environmental quality is deteriorated and this has to be taken into account by the government. The emission tax rate should be chosen such that the marginal social cost due to environmental degradation and the marginal benefit from the increase in the market position of domestic firm are equated. The optimal solution is to be found somewhere between the Nash and the Stackelberg points N and S .

Applying these results to the eco-dumping problem yields the following propositions. It can be optimal to favour the export industries if the supply side of the international market is oligopolistic. This implies that the non-tradeables sector is discriminated. Moreover, the environmental standards are lower than those that internalize the pure social

cost of pollution. Therefore, eco-dumping according to both our definitions may be explained by strategic trade policy considerations. Finally, there may be an international competition in environmental regulations which leads to undesirably low levels of environmental quality in many countries.

Matters can be rather different if the general-equilibrium effects are taken into account. [As can be seen in Figure 1, the objective of strategic trade policy is to raise the production of the domestic export industry for any given quantity supplied by the foreign competitor.] In a partial equilibrium, this is achieved by increasing the supply of the environmental factor of production for this sector. In a general equilibrium, the change in the allocation of capital must also be taken into account. We will look at a situation in which the government chooses sector-specific environmental policy measures. Let us, for the rest of this part of the paper, use the assumption often employed in the strategic trade literature that the good is not sold on the domestic market, i.e.

$$(18) \quad m(P) = F^2(K^2, E^2).$$

Let $m(P)$ now be the inverse demand function faced by the domestic oligopolist for a given level of production of its foreign competitor. If this firm acts as a price taker on domestic factor markets, its profits are passed over to the factor owners. The factors are remunerated at more than marginal cost. This implies

$$(19) \quad F_K^1 = (1+e) P^2 F_K^2.$$

where $e = m/(m'P)$, $-1 < e < 0$, is the elasticity of the residual demand function which will be assumed to be constant. Noting that $P^2 = P^3 P$ and $P^3 U_C^1 = U_C^3$, we obtain

$$(19') \quad U_C^1 F_K^1 - (1+e) U_C^3 P F_K^2 = 0.$$

Comparative static results can be derived by totally differentiating eqs. (18) and (19'):

$$(20) \quad \begin{bmatrix} m' & F_K^2 \\ -F_K^2(1+e)[U_C^3 + U_{CC}^3 P(m + Pm')] & U_{CC}^1 (F_K^1)^2 + U_{CK}^1 F_{KK}^1 + U_{CC}^3 P F_{KK}^2(1+e) \end{bmatrix} \begin{bmatrix} dP \\ dK^1 \end{bmatrix} \\ = \begin{bmatrix} 0 & F_E^2 \\ -U_{CK}^1 F_{KE}^1 - U_{CE}^1 F_{KE}^1 & U_{CE}^3 P F_{KE}^2(1+e) \end{bmatrix} \begin{bmatrix} dE^1 \\ dE^2 \end{bmatrix}$$

It can be shown that the determinant of the matrix on the left-hand side is positive since the world market demand for good 2 is elastic. The impact of changes in environmental policy on the allocation of capital turns out to be

$$(21a) \quad \frac{dK^1}{dE^1} = D^{-1} m' (-U^1_{CC} F^1_{KE} - U^1_{CE} F^1_{KE})$$

$$(21b) \quad \frac{dK^1}{dE^2} = D^{-1} (1+e) (m' U^3_{CP} F^2_{KE} + F^2_{EK} [U^3_C + U^3_{CC} P(m + Pm')])$$

In both cases, the effects of environmental policy changes are ambiguous. An increase in emissions in a sector makes capital more productive at the margin since F^1_{KE} and F^2_{KE} are positive. Thus, a policy which increases emissions in a sector attracts capital. On the other hand, a good produced in a more pollution-intensive process becomes cheaper and the marginal value product of capital tends to be reduced. This induces a capital movement into the opposite direction. In the case of a change in E^2 , however, this capital removal due to price changes is always dominated by the direct output expansion effect of the increase in emissions.⁸ Thus, in order to increase the output of the export industry, it is advisable to relax the sector-specific environmental policy. But it may be optimal to relax the policy for the other sector even more if this induces a very massive capital flow to the export sector. Although this is not particularly likely, it may be optimal to use an environmental policy which is the opposite of ecological dumping.

Matters become more complicated algebraically, if an economy-wide policy is sought which increases the output of the export industry. An additional equation for the cross-sector equalization of emission taxes has to be introduced and the effect of a change in environmental policy on the allocation of emissions to the two sectors has to be considered too. The result is ambiguous: at least one of the two sectors will raise its output if pollution abatement requirements are reduced. It may, however, happen that factors move to the non-tradeables sector of the economy. In this case, the output of the export industry may be reduced by ecological dumping.

Summarizing the results of this part of the paper, we can conclude that strategic behaviour in international trade does not necessarily lead to eco-dumping, independently of the definition applied. As an additional caveat, one should note that, as Eaton/Grossman

⁸ This can be verified by computing $dQ^2/dE^2 = F^2_E - F^2_E (dK^1/dE^2)$.

(1986) have shown, the policy implications are turned into the opposite direction when the oligopolists play Bertrand instead of Cournot.

6. Towards a Public Choice Explanation of Environmental Policies in Open Economies

In the previous sections environmental policies have been investigated which maximize an index of national well-being. It is a commonplace thing, however, that real-world political decision makers do not use this kind of welfare criteria. Instead, they try to follow their own objectives. In what follows, I shall consider two models that in which these objectives are taken into account. The first one looks at some of the intrinsic driving forces of a public bureaucracy, the second approach considers the impact of the power of sector-specific interest groups on governmental decisions. In order to make matter simpler and to separate the effects from the terms-of-trade effects, we shall consider a small economy for which the world market prices are given.

According to Niskanen (1977) and others, one major characteristic of a governmental bureaucracy is the desire to maximize the budget it has to administer. Taking this into account, the objective function has to be rewritten. Assume that the policy maker maximizes a weighted average of a measure of national welfare and the benefits from tax revenues. Let the benefits from tax revenues be measured by an increasing and strictly concave function $G(\cdot)$. The new objective function turns out to be

$$(22) \quad W^G = W + G(T^1 E^1 + T^2 E^2)$$

where W is given by eqs. (7) or (7').

If $T^1 = T^2$, both sectors face identical environmental regulations. In order to detect eco-dumping, one should compare the solution of the maximization of W^G with a policy which maximizes national welfare. There are two effects of a change in the emission tax rate on the tax revenue. First, for given emissions, the revenue will increase by $(E^1 + E^2)$ times the change in the tax rate. But with an increasing tax rate, emissions should be reduced which implies that, for given levels of the tax rate, the revenue is reduced. Either of these effects may dominate or there may be a bell-shaped Laffer curve. Depending on whether the revenue function is an increasing or decreasing function in the social optimum, the policy maker may wish to raise or reduce the tax rate. Of course, similar arguments apply to a situation in which the government chooses sector-specific environmental policies and it is not clear which sector is discriminated in an optimum.

A more promising approach to identifying motives of ecological dumping is the consideration of sector-specific interest groups. In a representative democracy, the voter

does not decide directly upon all the relevant issues but merely elects a government which she hopes to represent her will. The government has some discretion in interpreting the will of the electorate. Due to this discretion, interest groups have a chance to influence the government's decisions by lobbying, which may range from spending resources on public-relation and financial support of campaigns to bribing and blackmailing. There are good arguments in favour of the hypothesis that the traded-goods industries (cars, chemicals, pharmaceuticals, etc.) have a stronger impact on the government than the producers of non-traded goods (mainly services). If this is true, then the policy maker's objective function is changed by the impact of lobbying.

In what follows, it will be assumed that the lobbyists are concerned about the output of the export industry. This is a sensible approach if there are structural problems with a threat of unemployment and declining profits or if there are sector-specific factors that experience income increases when the output of the sector is increased. If the lobby's impact on political decisions is sufficiently large, the government will maximize an objective function which is a weighted average of the national welfare function and the utility function of the lobbyists. Thus, we have

$$(23) \quad W^L = W + L(Q^2)$$

where $L(\cdot)$ is increasing and strictly concave and W is defined by eq. (7').

To get an idea of what the major impacts are, the impact of a change in environmental policies on the government's objective function can be determined. In a first step, it is necessary to consider the impacts of the environmental policy on the allocation of the factors of production. This can be done by total differentiation of the first-order optimality conditions of the households and firms:

$$(13b) \quad U^1_{CF^1_K} - U^2_{CF^2_K} = 0.$$

$$(13c) \quad U^1_{CF^1_E} - U^2_{CF^2_E} = 0.$$

Total differentiation with respect to K^1 , E^1 and A shows that the impact of a change in environmental policy, A , on the allocation of factors is ambiguous. In the case of capital this may have been expected. But the same is true for emissions: although the overall level of emissions is increased by a relaxation of environmental policy, emissions in one of the two sectors may be reduced. The impact on production is also ambiguous. Ecological dumping may result either in an increase or a reduction of the export industry's output.

Matters are a bit simpler if we consider sector-specific environmental policies. The first-order optimality condition

$$(13b) \quad U^1_C F^1_K - U^2_C F^2_K = 0$$

has to be differentiated with respect to K^1 , E^1 and E^2 . This yields

$$(24a) \quad \frac{dK^1}{dE^1} = \frac{-U^1_C F^1_{KE} - U^1_{CC} F^1_K F^1_E}{U^1_C F^1_{KK} + U^1_{CC} (F^1_K)^2 + U^2_C F^2_{KK} + U^2_{CC} (F^2_K)^2}$$

$$(24b) \quad \frac{dK^1}{dE^2} = \frac{U^2_C F^2_{KE} + U^2_{CC} F^2_K F^2_E}{U^1_C F^1_{KK} + U^1_{CC} (F^1_K)^2 + U^2_C F^2_{KK} + U^2_{CC} (F^2_K)^2}$$

An increase in emissions in sector 1 moves capital into this sector if F^1_{KE} is large, i.e. if there is a substantial increase in capital productivity, or if $-U^1_{CC}$ is small. The latter condition means that the price elasticity of demand is large and this implies that an increase in supply results only in a small price reduction. Thus the increase in E^1 has only a small effect on the marginal value product of capital for a given level of the physical productivity. The same arguments apply for the other sector of the economy.

Now consider the welfare effects of a change in environmental policy:

$$(25a) \quad dW^L/dE^1 = dW/dE^1 - L' F^2_K dK^1/dE^1,$$

$$(25b) \quad dW^L/dE^2 = dW/dE^2 + L' (F^2_E - F^2_K dK^1/dE^2).$$

Starting from a situation of a social optimum in which $dW/dE^1 = dW/dE^2 = 0$, ecological dumping by discriminating the non-traded goods sector is beneficial to the government if

$$(26) \quad (F^2_E - F^2_K dK^1/dE^2) > -F^2_K dK^1/dE^1.$$

Inserting eqs. (24a,b) yields

$$(27) \quad \frac{F^2_E (U^1_C F^1_{KK} + U^1_{CC} (F^1_K)^2 + U^2_C F^2_{KK}) - F^2_K (U^2_C F^2_{KE} + U^1_C F^1_{KE} + U^1_{CC} F^1_K F^1_E)}{U^1_C F^1_{KK} + U^1_{CC} (F^1_K)^2 + U^2_C F^2_{KK} + U^2_{CC} (F^2_K)^2} > 0.$$

It is the last term in the numerator in eq. (27) which may exhibit the "wrong" sign. Thus it is possible than the export industry is supported best by applying more-restrictive environmental policies there than in the non-tradeables industry. This is just the opposite of ecological dumping if it is defined as discrimination against non-tradeables producers.

However, this result is not very likely and, under normal parameter constellations, it is advisable to apply lower levels of environmental regulation in the export industry than in the non-traded goods sector.⁹

Summarizing the results of the models presented in this section, one arrives at the conclusion that it is by no means clear that it is in the interest of the exporters' lobby or the government itself to have eco-dumping as an environmental policy.

7. Summary and Conclusions

The preceding investigation has been an attempt to give more economic content to the catchword of eco-dumping, which has frequently been (mis)used in the recent public discussion on environmental policies in open economies. In a first step a definition of eco-dumping has been sought. There are two sensible definitions. One of them uses the optimal internalization of social costs as its point of reference, the second one is based on the comparison of regulations applied to sectors producing traded and non-traded commodities. A third definition based on an international comparison of environmental policies has been rejected. We have then tried to find the economic motives of eco-dumping. Under which circumstances is it optimal to employ a policy which may be termed 'eco-dumping' according to one of the two criteria? It has been seen that neither terms-of-trade considerations nor maximization of the revenues from emission taxation explain eco-dumping. Depending on parameters of the demand and supply side, these objectives may be achieved sometimes by ecological dumping and sometimes by its converse. Strategic trade policy and lobbying activities of the exporters are more successful in explaining ecological dumping. However, there are still a number of ambiguities and the general equilibrium repercussions of changes in environmental policy may turn the results around. Lobbyists would sometimes be surprised if they knew that relaxing environmental standards can make the exporters worse off.

Applied to the real world, the interest group approach is the most promising among different candidates for an explanation of ecological dumping. If an explanation of economic policy decisions is sought, it is not important what is optimal but what is thought

⁹ One can see from eqs. (24b) and (25b) that an increase in emissions in the export industry will always raise its output. At least in this model framework, a situation in which exporters benefit from more rigid environmental policies in their own sector is not possible. This may, however, change if more complicated versions of the model are considered, e.g. if the country is large and if more general utility functions are introduced.

to be optimal. It is a truism (but not always the truth) that a producer will benefit from relaxed pollution abatement requirements applied to the production processes she uses. But this conjecture, wrong as it may be, provides incentives to lobby for lower emission tax rates. If the exporters' lobbies are more influential than other lobbies, then this may explain ecological dumping. The model presented here has used a shortcut to translate the interest of lobbyists into political decisions. A complicated political process has been modelled by simply adding some terms to the government's objective function. It is desirable to model this process more explicitly. A promising approach is due to Hillman/Ursprung (1991) who model the impact of interest groups with motives related to emissions, pollution and the environment on international trade. If a similar analysis could be undertaken for the opposite problem of how trade-related interests affect environmental policies, this would be another major step towards an understanding of the driving forces of ecological dumping.

Another problem which has been neglected in the preceding analysis is that of retaliation. What happens, if the other country also uses environmental policy measures to improve its terms of trade or to support its export industries? It is likely that there will be prisoners' dilemma situations in which both countries would be better off by cooperating. The consequences of non-cooperative behavior on the environment are, however, less clear and this is another problem area where future research is desirable.

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