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Article — Digitized Version

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Suggested Citation: Siebert, Horst (1975) : Resource withdrawal, productivity effect and environmental policy: comment, Weltwirtschaftliches Archiv, ISSN 0043-2636, Mohr, Tübingen, Vol. 111, Iss. 3, pp. 569-572

This Version is available at:

<https://hdl.handle.net/10419/3588>

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Resource Withdrawal, Productivity Effect and Environmental Policy: Comment

By

Horst Siebert

In his comment to Ingo Walter¹ Charles Pearson² suggests that the potential increase in productivity due to an improvement in environmental quality may reverse the findings on the effects of environmental policy on international specialization. Specifically he suggests that the productivity effect may outweigh the resource effect and that consequently the transformation curve may shift outward beyond the original curve. Prima facie this result seems to be consistent with common sense; this comment, however, shows that in a general equilibrium setting the productivity effect cannot be greater than the withdrawal effect.

(1) In arguing with a "net transformation curve" one should realize that in a general equilibrium approach the transformation curve shifts with a set of variables. Take a one-resource world³ and define inverse functions to the production function (input functions) as

$$R_i = G_i(Q_i) \quad i = 1, 2 \quad (1)$$

and

$$R_3 = G_3(S_r) \quad (2)$$

The quantity of pollutants abated depends on the effluent charge z which in the system is a function of marginal abatement costs (i.e. also of the level of abatement activities), the evaluation of environmental quality (λ), environmental damage etc. Consequently we have from the resource constraint

$$\bar{R} = G_1(Q_1) + G_2(Q_2) + G_3(S_r[z(\lambda)]) \quad (3)$$

¹ Ingo Walter, "International Trade and Resource Diversion: The Case of Environmental Management", *Weltwirtschaftliches Archiv*, Bd. 110, 1974, pp. 482sq.

² See Charles Pearson, "International Trade and Environmental Controls: Comment", this issue, pp. 564sq.

³ On the notation and underlying assumptions compare Horst Siebert, "Environmental Protection and International Specialization", *Weltwirtschaftliches Archiv*, Bd. 110, 1974, pp. 494sq.

or in explicit form

$$Q_1 = \varnothing (Q_2, z [\lambda]) \quad (4)$$

Since the net transformation curve shifts with z and λ , there is the danger that it blurs economic analysis.

(2) Pearson is correct in pointing out that an improvement in environmental quality may increase output. However, he does not take into consideration that (i) increased productivity from an improvement of environmental quality is a component of damage prevented and that (ii) the effluent charge z (influencing his net transformation curve) or other policy measures such as emission norms must be set to equalize marginal costs of pollution abatement and marginal damage prevented. Consequently, the higher Pearson's productivity effect, the higher is marginal damage prevented, the higher is the effluent charge and the higher is the quantity of resources used for pollution abatement, and consequently the higher is the withdrawal effect of resources from the production of commodities 1 and 2. As a result we have that the withdrawal effect of resources and the productivity effect are linked to each other via the level of the effluent charge.

(3) In order to discuss Pearson's above mentioned statement and in order to compare the withdrawal effect and the productivity effect, assume that in problem (8 iii)¹ Pearson's productivity effect is included in the production function

$$Q_i = F_i (R_i, S) \quad (5)$$

with

$$F'_{is} < 0$$

so that a pool of pollutants negatively affects private production (and that reducing this pool increases production). Then problem (8 iii) has a revised restriction and we have as a result

$$\frac{\delta L}{\delta S} : \lambda_S = \lambda U' - \sum \lambda_i F'_{is} \quad (6)$$

The effluent charge z has to be set so that

$$\frac{\lambda_3}{F'_3} = \lambda U' - \sum \lambda_i F'_{is} \quad (7)$$

¹ Siebert, *op. cit.*, p. 499.

i.e. that marginal cost of abatement equals marginal damage where marginal damage includes damage of the public consumption good "environmental quality" and damage in production.

Since $\frac{1}{F'_3} = \frac{\delta R_3}{\delta S_r}$ and dividing both sides by the consumer's price λ_1 and remembering that according to (8 iv) $\lambda_3/\lambda_1 = F'_1$, we have

$$F'_1 \frac{\delta R_3}{\delta S_r} = \frac{\lambda}{\lambda_1} U' - F'_{1s} - \frac{\lambda_2}{\lambda_1} F'_{2s} \quad (8)$$

Assume for simplicity that resource R_3 will be withdrawn from sector 1 only; then the left side of equation (8) is the withdrawal effect expressed in terms of commodity 1 (opportunity costs of pollution abatement in terms of commodity 1). The term

$$- F'_{1s} - \frac{\lambda_2}{\lambda_1} F'_{2s}$$

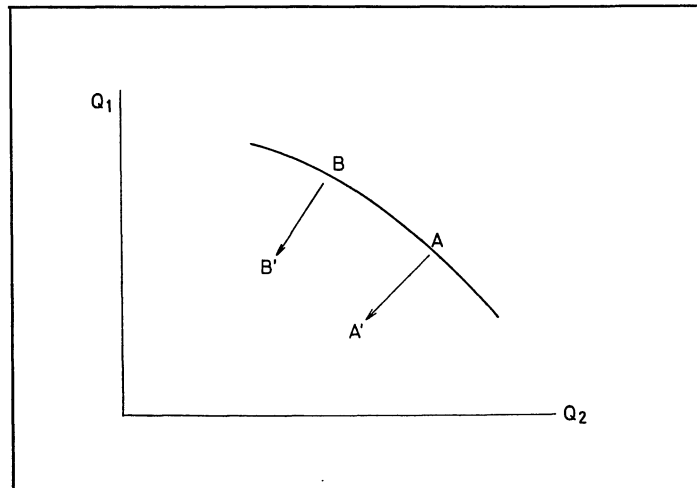
represents Pearson's productivity effect, expressed in terms of commodity 1.

For a reduction of S this term is positive. From (8) we have the result that Pearson's productivity effect never can outweigh the withdrawal effect. This is due to the fact that productivity effect and withdrawal effect are linked to each other via the correct setting of the effluent charge. As long as the productivity effect outweighs the withdrawal effect, the effluent charge must be increased and the withdrawal effect will become higher. Also if the environment is a public consumption good with $\lambda > 0$ and $|U'| > 0$ the withdrawal effect will definitively outweigh the productivity effect. This result suggests that the magnitude of the productivity effect in Pearson's Diagram 2 cannot be chosen so that the net transformation curve shifts outward beyond the original transformation curve. It must be left open here whether this result may also be obtained if the productivity effect is introduced by other hypotheses such as $R^* = \alpha R$ with R^* indicating efficiency units of R and $\alpha(U) > 1$.

(4) One can agree with Pearson that the comparative price advantage will not only depend on the pollution intensity of the two sectors, their productivity F'_1 , but also on the productivity gains from differences in the reduction of pollution (F'_{1s}) and differences in resource abatement technologies between the sectors.

(5) The concept of the net transformation curve completely loses its meaning in a general equilibrium setting.

Consider a given transformation curve before environmental policy is undertaken with product mixes A and B. Related to a product mix (Q_1^A, Q_2^A) is a given quantity of emissions S^{eA} .



Reducing emissions requires resource use and gives a new product mix (Q_1', Q_2') with new gross emissions (S'). There is a variety of net emissions $\{S'\}$, product mixes $\{Q_1', Q_2'\}$ and resource use for abatement purposes $\{R_3'\}$. In a general equilibrium approach, once z^A is determined, and if there is only one z^A for a given situation A, R_3^A is given and we have a unique "net product mix" (Q_1^A, Q_2^A) .

Assume a situation B with product mix (Q_1^B, Q_2^B) and gross emissions S^{eB} . Since marginal damage depends on the quantity of emissions and since marginal damage determines z , it can be assumed that $z^A \neq z^B$. Associated with z^B is a specific resource use R_3^B and consequently a specific net product mix. Since z can be expected to vary with the product mix, the concept of the net transformation curve loses its meaning. It seems safer to only state that due to environmental policy the production point shifts inward in the Q_1 - Q_2 -plane.

(6) An interesting case arises if labour mobility depends on environmental quality as in regional problems. Then an improvement in environmental quality may attract additional workers and the (regional) production point shifts outward.