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Institutional Competition versus Ex-Ante
Harmonization: The Case of
Environmental Policy

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**INSTITUTIONAL COMPETITION VERSUS EX-ANTE
HARMONIZATION: THE CASE OF
ENVIRONMENTAL POLICY**

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1. Introduction

The establishment of a single market in Europe raises the question whether the institutional arrangements should be centralized in Brussels or whether they should be left to national legislation. At issue are such areas as competition policy, consumer protection, taxation, social policy, environmental protection and regulation for specific sectors such as transportation, electricity generation, banking, and insurance. The debate on centralization versus regulatory federalism also refers to the strategy of integration. Should harmonization occur ex-ante or can be left to a process of institutional competition?

Institutional competition has its origin in the 1979 *crème-de Dijon* ruling of the European Court of Justice. A product legally brought to market in one country can be sold in the other country of the single market as well. This procedure will be extended to the service sector such that the British insurance firm can sell in Germany according to rates licenced in Great Britain and the Dutch trucker can operate in other European countries without cabotage restraints. According to this principle of mutual recognition the rules of the country-of-origin apply.

At the heart of institutional competition is locational arbitrage. Households can take advantage of value added tax differentials in other countries and firms can locate elsewhere. In the production area, the mobile factor of production can move. This will imply locational competition between countries (and regions) where countries compete for the mobile factors of production. This may result in substantial changes in the characteristics of the national economies, changes which in turn may necessitate revisions of regulations and

tax rates. How will the process of institutional competition work? Will this competitive process lead to chaos or perhaps to the collapse of the national regulatory structures? To what extent can different national preferences come to play, for instance on public goods?

In this paper we look at the case of environmental policies. Environmental quality is a public good, the preferences for which may not be the same in all countries. Should national environmental agencies be given a free hand in their choice of policies? Or is there a need for coordination among these agencies? Would the uncoordinated adjustment process be unstable or lead to unacceptably low environmental standards?

Environmental policy in a Single Market has many facets ranging from pollutants being sustained in consumer goods, being generated by mobile sources (cars) to environmental accidents of the Seveso type and to vintage damages or the deterioration of habitats and the congestion in land use (Siebert 1989). We here only consider emissions from stationary sources.

The paper is organized as follows: Section 2 introduces a two-country model and shows that a Pareto optimal allocation of resources can be achieved under decentralised environmental controls. Some comparative statics results are reported in Section 3, assuming instantaneous adjustment to the new equilibrium. In Section 4 we study the process of dynamic adjustments and show that the fear that environmental standards may be depressed down to unacceptably low levels by competition is unfounded. Section 5 considers briefly the strategic behaviour that would arise if environmental regulations are used not only to control pollution but also to achieve other economic objectives. In Section 6, we introduce the spillover effects and show that in this case some coordination would be required.

2. The Basic Model

Consider two economies, each with its own EPA (environmental protection agency). Suppose the two economies form an economic block, allowing goods and capital to move freely across their border. In this section, it will be shown that in the absence of spillover effects (i.e. the emission in one country does not have any direct effect on the other country), then there is no need for the harmonization of environmental policies.

Assume that each country produces a manufacturing good with the use of capital and labour

$$Q = F(K, L) \quad (1a)$$

$$Q^* = F^*(K^*, L^*) \quad (1b)$$

where starred variables denote the foreign country. The two outputs are perfect substitutes. The production functions have the usual neoclassical properties, and in particular

$$F_K(0, L) = \infty, \quad F_{KL} > 0 \quad (2a)$$

$$F^*_{K^*}(0, L^*) = \infty, \quad F^*_{K^*L^*} > 0 \quad (2b)$$

The production process gives rise to pollution. We assume that the emission level is a function of capital

$$E = G(K) \quad (3a)$$

$$E^* = G(K^*) \quad (3b)$$

where

$$G(0) = 0, \quad G'(K) > 0, \quad G''(K) \geq 0 \quad (3c)$$

(and the same properties apply to G^*)

For simplicity, we postulate that all individuals in the home country are identical and have the utility function

$$U = U[C - bD(E)] \quad (4)$$

where C is the consumption of the manufacturing good, $bD(E)$ is the damage cost (or "disutility" of pollution) measured in terms of the consumption good, and b is a shift parameter representing the strength of preference for environmental quality. We take it that

$$D(0) = 0, \quad D'(E) > 0, \quad D''(E) \geq 0, \quad (5a)$$

$$U'(0) = \infty, \quad U' > 0, \quad U'' < 0. \quad (5b)$$

Similar assumptions are made for the foreign country.

Let us assume that labour is internationally immobile, and capital is mobile. The total stocks of capital owned by the two countries are \bar{K} and \bar{K}^* , and the labour forces are fixed at \bar{L} and \bar{L}^* .

Conditions for a Pareto optimal allocation of capital can be found by solving the following joint maximization problem, where α and β are positive weights:

$$\begin{aligned} &\text{Maximize} \quad \alpha U[C - bD(G(K))] + \beta U^*[C^* - b^*D^*(G^*(K^*))] \\ &C, C^*, K, K^* \end{aligned} \quad (6)$$

subject to

$$C + C^* \leq F(K, \bar{L}) + F^*(K^*, \bar{L}^*) \quad (7)$$

$$K + K^* \leq \bar{K} + \bar{K}^* \quad (8)$$

Form the Lagrangean

$$\begin{aligned} \hat{L} = & \alpha U + \beta U^* + \lambda [F(K, \bar{L}) + F^*(K^*, \bar{L}^*) - C - C^*] \\ & + \mu [\bar{K} + \bar{K}^* - K - K^*] \end{aligned} \quad (9)$$

Because of assumptions (2), (3), and (5), we can be certain that the optimal values of C , C^* , K , and K^* are all positive. The necessary conditions are:

$$\partial \hat{L} / \partial C = \alpha U' - \lambda = 0 \quad (10a)$$

$$\partial \hat{L} / \partial C^* = \beta U'^* - \lambda = 0 \quad (10b)$$

$$\partial \hat{L} / \partial K = -\alpha U' b D' G' + \lambda F_K - \mu = 0 \quad (10c)$$

$$\partial \hat{L} / \partial K^* = -\beta U'^* b^* D'^* G'^* + \lambda F_K^* - \mu = 0 \quad (10d)$$

It follows that the allocation of capital must satisfy the rule

$$F_K - bD'G'(K) = F_K^* - bD^*G^{**}(K^*) = \mu/\lambda \quad (11)$$

The variable μ/λ is the shadow price of capital in terms of the consumption good. We assume that for all K and K^* in the relevant interval $[0, \bar{K} + \bar{K}^*]$ the marginal product in manufacturing exceeds the marginal damage cost, so that the net marginal product of capital is positive. This implies that the world's stock of capital is fully employed.

It can be easily seen that the allocation rule (11) can be achieved by the decentralized operation of two independent environmental protection agencies. Each country's EPA simply sets an emission tax equal to the marginal damage cost in the country. Thus, let the emission taxes be

$$\tau = bD'(E) \quad (12a)$$

$$\tau^* = bD^{**}(E^*) \quad (12b)$$

Profit maximizing firms will employ capital to the point where its net marginal product is equal to the rental rate. It follows that the competitive process and the international mobility of capital leads to an efficient allocation of resources

$$\begin{aligned} F_K(\bar{K} - \Delta K, \bar{L}) - \tau G'(\bar{K} - \Delta K) \\ = F_{K^*}^*(\bar{K}^* + \Delta K, \bar{L}^*) - \tau^* G^{**}(\bar{K}^* + \Delta K) = \bar{r} \end{aligned} \quad (13)$$

where ΔK is the amount of capital owned by the home country and invested abroad, \bar{r} is the equilibrium rental rate (\bar{r} can be seen to be equal to the shadow price of capital given by (11) above).

Our result can be summarized as follows:

Proposition 1: In the absence of spillover effects, there is no need for the harmonization of environmental policies.

3. Comparative Statics

Suppose that starting with an efficient allocation of resources, the individuals in the home country experience an increase in the strength of their preference for environmental quality. This is represented by an upward shift in the value of b . The environmental protection agency in the home country responds to this by increasing the emission charge. This would create an incentive for capital owners to shift some capital to the foreign country. As a result, there will be more pollution in the foreign country, and that country's EPA will adjust its emission charge upwards. What happens to the wage rates, pollution levels etc. at the new equilibrium?

Recall that the equilibrium conditions are

$$F_K(\bar{K} - \Delta K, \bar{L}) - \tau G'(\bar{K} - \Delta K) = \bar{r} \quad (14a)$$

$$F_{K^*}^*(\bar{K}^* + \Delta K, \bar{L}^*) - \tau^* G^{*'}(\bar{K}^* + \Delta K) = \bar{r} \quad (14b)$$

$$\tau = bD'[G(\bar{K} - \Delta K)] \quad (14c)$$

$$\tau^* = b^*D^{*'}[G^*(\bar{K}^* + \Delta K)] \quad (14d)$$

From these four equations we obtain an implicit relation which determines ΔK uniquely:

$$\begin{aligned} H(b, b^*, \Delta K) &= F_K(\bar{K} - \Delta K, \bar{L}) - bD'(G)(\bar{K} - \Delta K) \\ &\quad - F_{K^*}^*(\bar{K}^* + \Delta K, \bar{L}^*) + b^*D^{*'}(G^*)(\bar{K}^* + \Delta K) = 0 \end{aligned} \quad (15)$$

The effect of an increase in b on ΔK is given by

$$\partial \Delta K / \partial b = -(\partial H / \partial b) / (\partial H / \partial \Delta K) \quad (16)$$

Now

$$\begin{aligned} \partial H / \partial \Delta K &= -F_{KK} + bD'G'' + bD''(G')^2 - F_{KK}^* + b^*D^{*'}G^{*''} \\ &\quad + b^*D^{*''}(G^{*'})^2 > 0 \end{aligned} \quad (17)$$

and

$$\partial H / \partial b = -D'G' < 0.$$

Therefore

$$\partial \Delta K / \partial b > 0, \quad (18)$$

indicating that an increase in the home country's environmental standard will drive capital to the foreign country. At the new equilibrium, the emission level in the foreign country is higher:

$$\partial E^* / \partial b = (\partial E^* / \partial \Delta K)(\partial \Delta K / \partial b) > 0 \quad (19)$$

The emission charge in the home country will rise unambiguously¹. The emission charge in the foreign country will rise, too. The stricter environmental policy of the home country has made the environment scarcer in the foreign country. At the initial emission charge demand to get rid of emission has increased. Consequently, the emission charge has to increase. It can be shown that the emission charge in the home country will rise more than the emission charge in the foreign country if both countries are identical with respect to the technology and if the initial conditions are identical.²

The wage rate in the home country will fall and that in the foreign country will rise:

$$w = F_L(\bar{K} - \Delta K, \bar{L}), \quad w^* = F_{L^*}(\bar{K}^* + \Delta K, \bar{L}^*)$$

$$\partial w / \partial b = (-F_{LK})(\partial \Delta K / \partial b) < 0 \quad (20)$$

$$\partial w^* / \partial b = F_{L^*K^*}(\partial \Delta K / \partial b) > 0 \quad (21)$$

The net rental rate falls. From (14b)

$$\partial \bar{r} / \partial \Delta K = F_{K^*K^*}^* - b^* D^{*'} G^{*'} - b^* (D^{*'}) (G^{*'})^2 < 0 \quad (22)$$

The real income R^* of the foreign country rises in spite of the worsening of its environmental quality. The loss of environmental quality is more than offset by an increase in factor income.

$$R^* = F^*(\bar{K}^* + \Delta K, \bar{L}^*) - \bar{r}\Delta K - b^*D^*(E^*)$$

$$dR^*/d\Delta K = F^*_{K^*} - \bar{r} - \Delta K(\partial \bar{r}/\partial \Delta K) - b^*D^{*'}G^*$$

$$= -\Delta K(\partial \bar{r}/\partial \Delta K) \quad (\text{using (14b) and (14d)})$$

$$> 0 \quad (\text{using (22)})$$

To summarize the results obtained in this section, we state:

Proposition 2: An increase in the standard of ambient environmental quality in the home country will

- increase the emission charge in both countries with a higher rise in the home country's emission charge (if both countries are twins),
- drive capital to the foreign country,
- increase the foreign wage rate and depress the wage rate in the home country,
- decrease the world rental rate,
- increase the pollution level in the foreign country,
- increase the foreign country's real income (welfare).

4. Can Institutional Competition Lead to Unacceptably Low Levels of Environmental Quality?

In the preceeding section, we started at an equilibrium, introduced a parametric shift in preferences, and studied the properties of the new equilibrium on the assumption that the latter is reached instantaneously. We now allow for sluggish adjustments on the part of the two environmental protection agencies. Thus at any point of time a country's emission charge may fall short of (or exceed) the current marginal damage cost. Its EPA will then adjust the emission charge upward (or downward) accordingly. This will lead to further movement of capital and changes in emission level. Would the adjustment processes, which take place in both countries, converge to a new equilibrium or display unstable behaviour? Could the two economies experience unacceptably low environmental quality as a result of the uncoordinated actions of their EPAs?

In this section we show that, under reasonable assumptions about the rules for adjustment of emission charges, there are no grounds for pessimism about the outcome of uncoordinated responses of the two EPAs.

We assume that at each time t , the home country's EPA calculates the gap between the current marginal damage cost of pollution and the current emission charge. If this gap is positive (respectively, negative), it will increase (respectively, reduce) the emission charge. This rule is expressed by the following differential equation

$$\dot{\tau}(t) = S[bD'(E(t)) - \tau(t)] \quad (23)$$

where $S > 0$ represents the speed of adjustment. Similarly, in the foreign country

$$\dot{\tau}^*(t) = S^*[b^*D^{*'}(E^*(t)) - \tau^*(t)] \quad (24)$$

Capital movement is assumed to be instantaneous in the sense that at any point of time, given the two emission charges $\tau(t)$ and $\tau^*(t)$, the net rates of return to capital in the two countries are equalized:

$$F_K(\bar{K} - \Delta K(t), \bar{L}) - \tau(t)G'(\bar{K} - \Delta K(t)) \quad (25)$$

$$= F_{K^*}^*(\bar{K}^* + \Delta K(t), \bar{L}^*) - \tau^*(t)G^{*'}(\bar{K}^* + \Delta K(t))$$

Equation (25) implies that the amount of the home country's capital invested in the foreign country at time t , denoted by $\Delta K(t)$, is a function of $\tau(t)$ and $\tau^*(t)$ with derivatives given by:

$$\partial \Delta K(t) / \partial \tau(t) = -G' / [F_{KK} - \tau G'' + F_{K^*K^*}^* - \tau^* G^{*''}] > 0 \quad (26a)$$

$$\partial \Delta K(t) / \partial \tau^*(t) = G^{*'} / [F_{K^*K^*}^* - \tau^* G^{*''} + F_{KK} - \tau G''] < 0 \quad (26b)$$

From (23), (24), (25), and (26), we obtain a pair of differential equations in (τ, τ^*) :

$$\dot{\tau} = S[bD'(G(\bar{K} - \Delta K(\tau, \tau^*))) - \tau] \equiv M(\tau, \tau^*) \quad (27)$$

$$\dot{\tau}^* = S^*[b^*D^{*'}(G^*(\bar{K}^* + \Delta K(\tau, \tau^*))) - \tau^*] \equiv N(\tau, \tau^*) \quad (28)$$

It is easily seen that zero emission charges cannot be an equilibrium, because at that point both EPAs will adjust their emission charges upwards, as revealed by (27) and (28).

In fact, under the assumptions stated so far, the equilibrium of the system (27) - (28) involves positive emission charges in both countries and coincides with the Pareto optimal solution of Section 2. It remains to investigate the properties of the adjustment paths.

Use (27) to obtain the locus of points along which $\dot{\tau} = 0$. Its slope is given by

$$d\tau/d\tau^* = -(\partial M/\partial \tau^*)/(\partial M/\partial \tau) \quad (29)$$

where

$$\partial M/\partial \tau^* = -(bD''G')(\partial \Delta K/\partial \tau^*) > 0 \quad (30a)$$

$$\partial M/\partial \tau = -1 - (bD''G')(\partial \Delta K/\partial \tau) < 0 \quad (30b)$$

Similarly, from (28), the locus for $\dot{\tau}^* = 0$ has the slope:

$$d\tau/d\tau^* = -(\partial N/\partial \tau^*)/(\partial N/\partial \tau) \quad (31)$$

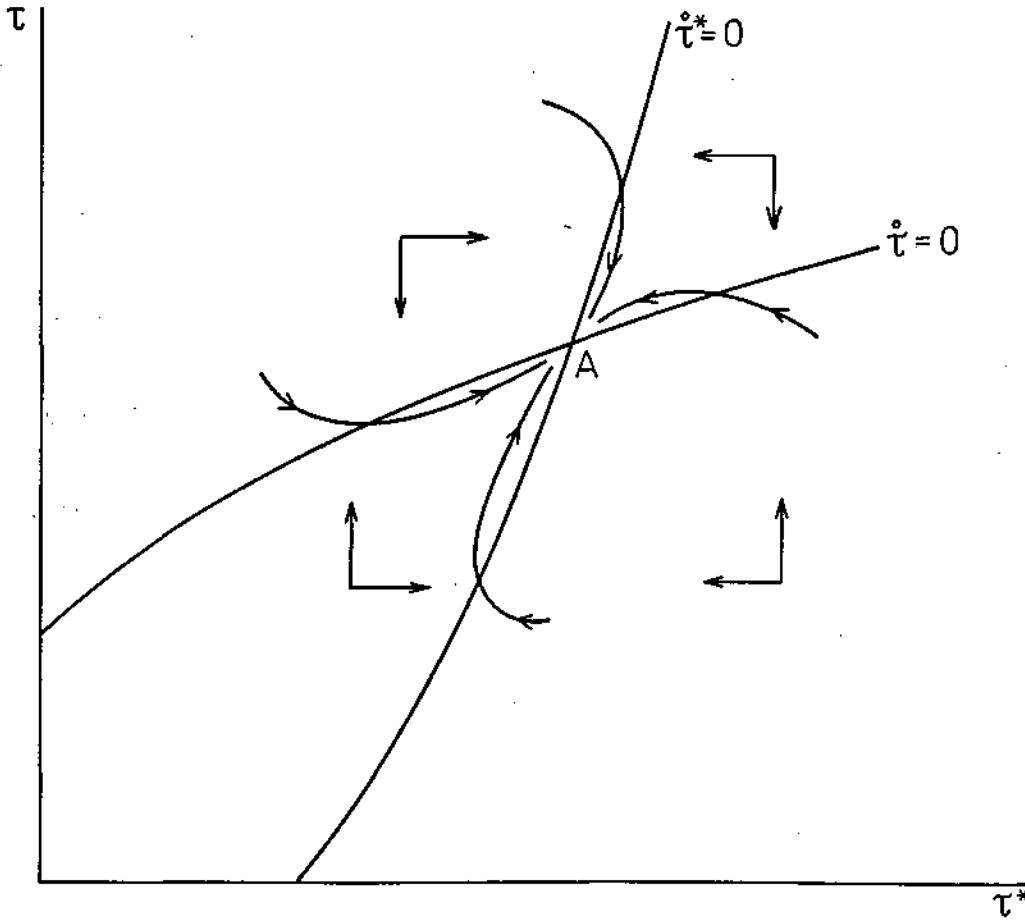
with

$$\partial N/\partial \tau^* = -1 + (b^*D^{*''}G^{*'}) (\partial \Delta K/\partial \tau^*) < 0 \quad (32a)$$

$$\partial N/\partial \tau = (b^*D^{*''}G^{*'}) (\partial \Delta K/\partial \tau) > 0. \quad (32b)$$

The two loci are illustrated in Figure 1 where for simplicity the two countries are assumed to have identical technology, endowments, and preferences. At the intersection point A, the slope of the curve $\dot{\tau} = 0$ is smaller than unity, and that of the curve $\dot{\tau}^* = 0$ exceeds unity.

Figure 1: Adjustment of Emission Charges



The adjustment toward the equilibrium may involve non-monotone behaviour of emission tax rates: they may fall, then rise again. However, along any given path, this change of direction can occur at most once, and only in one country. There are no cycles, nor explosive behaviour.

If one linearizes the system (27) - (28) around the equilibrium point, it can be shown that the roots are real and negative, implying local asymptotic stability.

Starting at the equilibrium point A, suppose that the home country's preference for environmental quality undergoes a sudden change (an upward shift in b). This will cause an initial jump in $\dot{\tau}$, but no overshooting. Emission charges in both countries will rise to new, higher equilibrium levels, with τ higher than τ^* .

5. Strategic Behaviour when EPAs are Contaminated by Non-Environmental Interests

So far we have assumed that the environmental protection agencies are supposed to carry out environmental policies by equating emission charges to marginal damage cost, and that they do not concern themselves with matters such as the impact of environmental policies on the total earning of the home country's investment abroad. Consider now the case where the EPAs are instructed to bear in mind the consequence of emission charges on capital flows. Given the assumption that in each country it is not allowed to have discriminatory tax against any particular category of capital income, the EPAs might manipulate emission charges in order to restrict capital outflow (for example, by understating marginal damage cost, emission charges can be lowered, thus reducing the extent of capital export, raising the marginal product of capital invested abroad, and consequently improving total earning from this source.)

To analyse this problem, let us write the emission tax as

$$\tau = \theta bD'(E) \quad (33a)$$

$$\tau^* = \theta^* b^* D^{*'}(E^*) \quad (33b)$$

where $\theta < 1$ (respectively > 1) signifies that the home country understates (respectively overstates) the marginal damage cost.

For simplicity, assume $\bar{L} = \bar{L}^* = 1$ and

$$F(K, \bar{L}) = aK - 0.5K^2, \quad (a > 1 + \bar{K} + \bar{K}^*) \quad (34a)$$

$$F^*(K^*, \bar{L}^*) = a^*K^* - 0.5(K^*)^2, \quad (a^* > 1 + \bar{K} + \bar{K}^*) \quad (34b)$$

$$bD(E) = E, \quad G(E) = K \quad (34c)$$

$$b^*D^*(E^*) = E^*, \quad G^*(E^*) = K^* \quad (34d)$$

Given θ and θ^* , the equilibrium amount of home capital invested abroad (ΔK), is determined by

$$a - (\bar{K} - \Delta K) - \theta = \bar{r} = a^* - (\bar{K}^* + \Delta K) - \theta^*, \quad (35a)$$

or

$$\Delta K = (\bar{K} - \bar{K}^* + \theta - \theta^*)/2. \quad (35b)$$

The home country's real income is

$$R = (a - 1)(\bar{K} - \Delta K) - (0.5)(\bar{K} - \Delta K)^2 + [\Delta K(a - \bar{K} + \Delta K - \theta)] \quad (36)$$

For given θ^* , suppose that the home country's EPA is asked to choose θ so as to maximize R . From (35b) and (36), we obtain the first order condition

$$dR/d\theta = (\partial R/\partial \theta) + (\partial R/\partial \Delta K)(\partial \Delta K/\partial \theta) = 0. \quad (37)$$

Upon simplification, this condition yields

$$\theta = (\bar{K}^* - \bar{K} + \theta^* + 2)/3. \quad (38)$$

Equation (38) is the reaction curve of the home country's EPA. To see the intuition behind this result, suppose that $\bar{K} > \bar{K}^*$, and that initially both countries were truthful so that $\theta = \theta^* = 1$. The home country's net investment abroad is given by (35b). By reducing θ , the home country would be able to reduce its investment abroad, thus achieving a higher rate of return to its capital. There is an optimal level of restriction of capital export³ - just like OPEC's policy of restricting oil supply.

Similarly, for given θ , we can determine that value of θ^* that maximizes the foreign country's real income. This yields the foreign reaction curve

$$\theta^* = (\bar{K} - \bar{K}^* + \theta + 2)/3. \quad (39)$$

Again if $\bar{K} - \bar{K}^* > 0$ and if initially $\theta = 1$, the foreign country would want to restrict its capital import so as to achieve its monopsony profit.

The two reaction curves (38) and (39) determine a unique Nash equilibrium. It can be shown that if $\bar{K} \neq \bar{K}^*$ then the equilibrium is not Pareto optimal, and that the capital exporting (respectively, importing) country will understate (respectively, overstate) its marginal damage cost.

6. Spillover Effects

We now return to our original assumption that the EPAs are not concerned with matters such as capital income per se, and introduce a different kind of complication: spillover effects.

Suppose that the damage cost in each country is a function of the sum of its own emission and a fraction of the other country's emission. Then the damage functions are $bD(E + sE^*)$ and $b^*D^*(E^* + s^*E)$, where $0 \leq s \leq 1$ and $0 \leq s^* \leq 1$.

For a Pareto optimum, it is now necessary that

$$\begin{aligned} F_K &= bD'(E + sE^*)G' - s^*b^*D^{*'}(E^* + s^*E)G' \\ &= F_{K^*}^* - b^*D^{*'}(E^* + sE)G^{*'} - sbD'(E + sE^*)G' \end{aligned} \quad (40)$$

If each EPA equates the emission charge with the marginal damage cost in its own country, then in equilibrium

$$F_K - \tau G' = F_{K^*}^* - \tau^* G' \quad (41a)$$

where

$$\tau = bD', \quad \tau^* = b^*D^{*'} \quad (41b)$$

It is clear that in general (41) is not equivalent to (40), because each EPA ignores the effect of its country's pollution on the other country's damage cost. Take the simple case where the home country is located upstream and the foreign country is located downstream, so that $s = 0$ and $s^* > 0$. In this case the lack of coordination leads to excessive employment of capital in the home country. Even in the face of transfrontier pollution environmental policy can be decentralized in a single market if international diffusion norms are agreed upon (Siebert 1989).

7. Concluding Remarks

We have been able to show that, in the absence of spillover effects, coordination of national environmental policies is not necessary for an efficient allocation of resources. If a country has a strong preference for environmental quality it can go ahead in making the environment as a receptacle of wastes scarcer by increasing the emission fee. There is no competing down of national environmental regulation⁴. This is due to the fact that the preferences of the foreign country for environmental quality enter its decision on the ambient quality standard. For environmental policy in Europe this implies that environmental policy can be left to the national governments (if spillover problems are solved by international diffusion norms).

The basic result that institutional or policy competition can be relied upon may be generalized to other areas as well. Whenever immobile factors compete for the mobile factors and when government activity influences the rates of return of both mobile and immobile factors while at the same time providing a national public good, the choice of regulation and of the provision of the public good can be left to the national governments. A competing down of national regulation is prevented by the self interest of the nations involved.

Footnotes

- ¹ Differentiating τ and τ^* with respect to b yields:

$$\frac{\partial \tau}{\partial b} = D' b D'' G' \frac{\partial \Delta K}{\partial b} ,$$

$$\frac{\partial \tau^*}{\partial b} = b^* D^{*'} G^{*'} \frac{\partial \Delta K}{\partial b} .$$

Substituting (16) into this, using the properties of F , G and D , it is easy to see that

$$\frac{\partial \tau}{\partial b} > 0 .$$

- ² Assuming that we start in a situation where $\tau = \tau^*$ - this might be the case if we assume identical technologies - the same procedure as in footnote 1 gives us the result that

$$\frac{\partial \tau}{\partial b} > \frac{\partial \tau^*}{\partial b} .$$

- ³ For discussion of restriction of capital flow. see Kemp (1962a) and (1962).
- ⁴ In the case of environmental policy it is sometimes argued that national preferences on environmental quality are not adequately reflected by the political process. This argument, however, does not support a centralization of environmental policy in Brussels because the argument of policy failure would apply to a European environmental policy, too.

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