1 Road Map

- Ecological Competition
- Dynamic Programming / Social Dumping in the Transformation Process
- The Competition of Product Standards
- Competition and Banking
- The Competition of Competition Rules

2 Ecological Competition

There exist a potential conflict between economic and ecological goals.

Unregulated firms have incentive to pollute more than what is optimal from the society's perspective.

In other words, there will typically be a negative externality created by the firms.

When there is international competition these externalities will be enlarged since national governments have no incentives to care about environmental effects in other countries.

However, this problem can be remedied by

- taxes
- regulation
- market for tradeable permits

The major question of chapter 5 is: Is systems competition compatible with ecological goals?

It will be shown that an optimistic view about systems competition is not always justified.

2.1 A Model of Systems Ecological Competition

- We start with a benchmark-model without any international spillovers.

- Industrial production results in waste, but the waste settles only within the national boarders.

- A small open economy is considered.

- The market interest rate is given by r and the wage rate is given by w.

- An ecological (or Pigouvian) tax rate, p, per unit of waste emissions is used to regulate emission.

- The production function is given by $f(L, S, K)$ where S is the waste emission.
  - More emission implies more production such that $f_S > 0$, $f_{SS} < 0$. L is labor, which is internationally immobile, and K is capital used.

- A nation's waste immission is given by S^*.

- $\overline{K}$ is the households given amount of overall wealth. $\overline{K} - K$ is therefore the country's net foreign wealth position.

The firms maximize their profits. Their problem is therefore

$$\max_{L,S,K} f(L,S,K) - wL - pS - rK \tag{1}$$

Solving this problem gives the following first order conditions:

$$f_L(L,S,K) = w, \tag{2}$$

$$f_S(L,S,K) = p, \tag{3}$$

and

$$f_K(L,S,K) = r. \tag{4}$$

The tax revenues, T, go back to the households.

These revenues are equal to the incomes from the Pigouvian tax

$$T = pS. \tag{5}$$

Citizens also earn a wage income, wL, and a capital income $r\overline{K}$.

Total income for the representative household is therefore

$$Y = wL + T + r\overline{K}. \quad (6)$$

Apart from income, pollution is assumed to be included in the utility function, which is given by

$$U(Y, S^*) \quad (7)$$

where $U_Y(Y, S^*) > 0$ and $U_{S^*}(Y, S^*) < 0$.

What characterizes the benchmark model is that emissions, S, and immissions, S^*, are equal, $(S = S^*)$.This assumption will later be relaxed.

The government, acting on behalf of the citizens, selects the tax rate.

In doing this, it has to take into account the endogeneity of the wage rate.

We note that the Euler theorem implies that 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,

$$wL + pS = f(L, S, K) - f_K K \tag{8}$$

The income, Y, can now, by substituting for

$$wL = f(L, S, K) - f_K K - pS,$$

be rewritten as

$$Y = f(L, S, K) - f_K K - pS + pS + r\overline{K}. \tag{9}$$

Since $f_K = r$, it follows that

$$Y = f(L, S, K) + r(\overline{K} - K) \tag{10}$$

Hence, the income of domestic residents equals domestic output plus the return on capital earned abroad.

The government selects the Pigovian tax through the level of pollution S.

Therefore, the (benevolent) government's problem is to solve

$$\max_{S} U(Y, S^*) \tag{11}$$

given the firms' behavior.

The first order condition is equal to

$$U_Y f_{S^*} + U_{S^*} + U_Y(f_K \frac{dK}{dS^*} - r\frac{dK}{dS^*}) = 0.$$

More emissions attract capital but, in equilibrium, there is no change in utility since the cost of borrowing capital exactly out weights the benefit of in-flowing capital ($f_K = r$).

Therefore, the equation simplifies to

$$U_Y f_{S^*} + U_{S^*} = 0$$

Since firms maximize their profit such that $p = f_s$ we get

$$p = f_S = -\frac{U_{S^*}}{U_Y}. \tag{12}$$

Note finally that total differentiating $U(Y, S^*)$ holding U constant implies

$$U_{S^*} dS^* + U_Y dY = 0,$$

or

$$-\frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*}.$$

So we achieve the result that

$$p = f_S = -\frac{U_{S^*}}{U_Y} = \frac{dY_j}{dS_j^*}\,|_U \,. \qquad (13)$$

The intuition is simply that the tax rate is equal to the marginal damage as judged by the citizens.

A benevolent planner who do not need to take into account the firms' profit maximization, constraint, $f_S = p$, would select the same stock of capital and the same level of pollution as the equilibrium outcome.

A supra-national planner would also allocate capital such that all countries follow the rule $f_K = r$ and have the same level of pollution as in the national equilibrium

Hence, in this simple setup, there is no need to fear that systems competition will lead to ecological dumping.

2.2 Ecological Dumping with International Spillover Effects

However, CO_2, rusty tankers, pollution in water, etc., will not stay within the boarders of different countries.

So consider the more realistic model where pollution in one country affects the utility of people in other countries.

In particular, it is assumed that one country's emission of pollution spreads evenly over n countries.

In terms of the model, this implies that

$$S_i^* = \sum_{j=1}^{n} S_j/n \quad i = 1, ..., n \tag{14}$$

The income for country i is given by

$$Y_i = f(L_i, S_i, K_i) + r(\overline{K}_i - K_i)$$

The government solves

$$\max_{S_i} U(Y_i, S_i^*)$$

given the firms' behavior.

We note that this is the same as

$$\max_{S_i}(Y_i, \sum_{j=1}^{n} S_j/n)$$

Assume that the countries play Cournot, that is each country optimizes its waste emission under the assumption that its behavior has no influence on the emissions of the other countries.

The first-order condition now looks somewhat different from before

$$f_S(L_i S_i K_i) U_Y(Y_i, S_i^*) = -\frac{1}{n} U_{S^*}(Y_i, S_i^*),$$

From the firms' first-order condition we have as before

$$p_i = f_s(L_i S_i K_i).$$

We therefore get

$$p_i = f_s(L_i S_i K_i) = -\frac{1}{n}\frac{U_{s^*}(Y_i, S_i^*)}{U_Y(Y_i, S_i^*)} = \frac{1}{n}\frac{dY_j}{dS_j^*}\,|_U \;\forall i = 1, ..n.$$

Compared to the case without spillovers, it differs with the factor $\frac{1}{n}$.

The intuition is that each country does only take into account the pollution on its own inhabitants, neglecting the effect on the $n-1$ other countries.

Therefore, the tax rate, p_i, it selects will be very low (and certainly not optimal). The more countries, the larger is the externality.

This is a strong argument in favour of co-ordinated environmental policy.

There exists however a mechanism, which can create an optimal solution.

The idea is to let countries that inflict pain on other countries pay for the damage it causes.

In other words, a country's Pareto optimal pollution policy follows from maximizing this 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.

So consider an efficient policy where each country makes side-payments to the other countries to compensate for the costs it inflicts on them.

The compensation from country i to country j is given by $Y_j - \overline{Y}_{ij}$, where $\overline{Y}_{ij}$ is country j's income without the payments from country i.

The problem for government i is now

$$\max_{S_i, Y_j} U(Y_i, S_i^*) \tag{15}$$

$$\begin{aligned} s.t.\ S_i^* &= \sum_{j=1}^{n} S_j/n \quad i = 1, ..., n \\ Y &= f(L_i, S_i, K_i) + r(\overline{K} - K) - \sum_{\substack{j=1 \\ j \neq i}}^{n} (Y_j - \overline{Y}_{ij}) \\ U(Y_j, S_j^*) &= \text{constant} \end{aligned}$$

Note that the government now selects both the level of pollution, S_i, and the size of the side-payment, Y_j.

The marginal damage on part of country j is given by

$$\frac{dY_j}{dS_j^*} |_{U_j} = -\frac{U_{S_j^*}}{U_{Y_j}} \quad \forall j = 1, ...n,\ j \neq i \tag{16}$$

Since country j's marginal immission is $\frac{1}{n}$ of country i's marginal emission, the first order condition with respect to S is

$$U_{Y_i}(f_{S_i} - \sum_{\substack{j=1 \\ i \neq j}}^{n} \frac{1}{n} \frac{dY_j}{dS_j^*} |_{U_j}) + U_{S_i^*} = 0 \qquad (17)$$

or equivalently

$$f_{S_i} - \sum_{\substack{j=1 \\ i \neq j}}^{n} \frac{1}{n} \frac{dY_j}{dS_j^*} |_{U_j} = -\frac{U_{S_i^*}}{U_{Y_i}}$$

Since

$$-\frac{U_{S_i^*}}{U_{Y_i}} = \frac{dY_i}{dS_i^*}$$

we have that

$$p_i = f_S(L_i, S_i, K_i) = \sum_{\substack{j=1 \\ i \neq j}}^{n} \frac{1}{n} \frac{dY_j}{dS_j^*} + \frac{dY_i}{dS_i^*} = \sum_{j=1}^{n} \frac{1}{n} \frac{dY_j}{dS_j^*} |_U \qquad (18)$$

This is the Samuelson condition for the provision of public goods.

The Pigovian tax rate, p_i, is chosen such that the marginal product of emission in country j is equal to the sum of the marginal damages in all countries.

Since all countries are identical, it follows that the optimal tax rate is given by

$$p_i = f_s(L_i, S_i, K_i) = \frac{dY_j}{dS_j^*} \mid_U \quad \forall i = 1, ...n, \tag{19}$$

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

Proposition: In the case of international waste spillover, 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 marginal damages that this emission causes.

Importantly, for the solution to be efficient all countries have to use a transfer system. However, all countries have incentives to deviate.

Therefore, only collective action can overcome the misallocation problem.

But history has shown that it is very difficult for countries to agree upon environmental policy.

A recent example is the “Kyoto agreement”, which Bush early defected from. Putin later (perhaps in consequence to Bush’s policy) did the same.

3 A Quick Repetition of the Basic Model

- A small open economy is considered.

- The market interest rate is given by r and the wage rate is given by w.

- An ecological (or Pigouvian) tax rate, p, per unit of waste emissions is used to regulate emission.

- The production function is given by $f(L, S, K)$ where S is the waste emission. More emission implies more production such that $f_S > 0$ and $f_{SS} < 0$.

- A nation's waste immission is given by S^*.

- $\overline{K}$ is the households given amount of overall wealth. $\overline{K} - K$ is therefore the country's net foreign wealth position.

The firms maximize their profits. Their problem is therefore

$$\max_{L,S,K} f(L,S,K) - wL - pS - rK \tag{20}$$

Solving this problem gives the following first order conditions:

$$f_L = w, \tag{21}$$

$$f_S = p, \tag{22}$$

and

$$f_K = r. \tag{23}$$

The tax revenues, T, go back to the households. These revenues are equal to the incomes from the Pigouvian tax

$$T = pS. \tag{24}$$

Citizens earn a wage income, wL, and a capital income $r\overline{K}$. Total income for the representative household is therefore

$$Y = wL + T + r\overline{K}. \tag{25}$$

The utility function is given by

$$U(Y, S^*) \tag{26}$$

where $U_Y(Y, S^*) > 0$ and $U_{S^*}(Y, S^*) < 0$.

In the benchmark model we have $S = S^*$.

The government, acting on behalf of the citizens, selects the tax rate. In doing this, it has to take the endogenity of the wage rate into account.

We note that the Euler theorem implies that

$$wL + pS = f(L, S, K) - f_K K. \tag{27}$$

Hence,

$$Y = f(L, S, K) - f_K K - pS + pS + r\overline{K}, \tag{28}$$

and since $f_K = r$ it follows that

$$Y = f(L, S, K) + r(\overline{K} - K) \tag{29}$$

The government selects the Pigouvian tax through the level of pollution S. Therefore, the (benevolent) government's problem is to solve

$$\max_{S} U(Y, S^*) \tag{30}$$

given the firms' behavior.

The first order condition is equal to

$$U_Y f_{S^*} + U_{S^*} = 0$$

Since firms maximize their profit such that $p = f_s$ we get

$$p = f_S = -\frac{U_{S^*}}{U_Y}. \tag{31}$$

Note finally that total differentiating $U(Y, S^*)$ holding U constant implies $-\frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*}$. Hence, we achieve the result that

$$p = f_S = -\frac{U_{S^*}}{U_Y} = \frac{dY_j}{dS_j^*} \mid_U \tag{32}$$

The intuition is simply that the tax rate is equal to the marginal damage as judged by the citizens.

4 Alternatives to Taxation

We have seen that taxation can be used as an instrument to make the allocation of resources efficient.

An alternative is to set up a market for tradeable permits.

4.1 Tradeable Permits

Under this mechanism, countries (or industries within countries) buy, or are given, the right to pollute. To the extent that the marginal benefit of polluting are different, there will be possibilities for trade.

In equilibrium, the market price of the permits will be such that the marginal benefit of polluting is identical in all countries, which is the cost minimizing condition. (This can also be achieved with taxes.)

Markets for tradeable permits for e.g. SO_2 and NO_2 have been used in the US since 1974. More recently markets have developed in the UK, Canada, Singapore and within the European Union.

4.1.1 The allocation of permits – grand fathering versus auction.

Most markets are characterized by grand fathering, i.e., permits are given away. There are, however, good arguments for using auctions.

- Considering the efficiency aspect only, trading will lead to an efficient outcome independent of the allocation of the permits.

- The money can be used to reduce other distortions.

However, on the international level auctions may be difficult to use.

- It is very important to include poorer countries. To do this, they will have to be given a large amounts of the permits.

- Compensation in forms of side-payments may also be necessary in order to make poorer countries participate.

4.1.2 Market power

It may be a problem that large agents hoard permits in order to influence the market price. For example Russia and Ukraine, who will be sellers, may hoard permits. On the other hand, US, as the largest buyer, may act as a monopsonist, pressuring the price below the price in perfect competition.

Burniaux (1999) estimates that the cost for permits in the Kyoto market would be about 20 percent higher than under the competitive scenario.

4.1.3 Transaction costs

Transaction costs may be a problem because it will reduce trading of permits.

This could be finding out what the prevailing price is, identifying possible buyers and sellers, and making the transaction. There is some small scale evidence from Chile showing that this has been a significant problem (Borregaard et al. 2001).

On an international market, however, the traders would probably be professionals and there are reasons to believe that trade will work smoothly.

4.1.4 Enforcement

Firms of course have incentive to pollute more than what they are entitled to.

Also, firms may set the level of emission such that marginal profits equal the permit price plus the expected fine, which distorts the environmental outcome.

Now, the permits may be of two kinds, either periodical or permanent. Periodical tradeable permits result in a variable flow of payments to the government just like a Pigouvian tax and is in fact, from an economic point of view, no different from a tax.

We now study two different mechanisms. One where permits are given out periodically and one where the permits are given out permanent. This latter case is equivalent to environmental standards.

4.2 A Model of Tradeable Permits where a Fraction of Domestic Rents Flows to Foreign Countries.

- The linear homogenous production function is still given by $f(L, S, K)$.

- L is international immobile.

- A share, α, of the environmental return flows to foreign countries (in addition to the usual interest payments to the physical capital invested).

- It is assumed that a fixed number of permits is already in circulation at the time the reform is made.

- The annual flow of environmental waste is given by Q.

- The government carries out a environmental policy by granting $S - Q$ permits.

- The annual rental income per unit of waste is given by p.

As before, the market's evaluation of waste is reflected in the following first order condition

$$p = f_S(K, S, L) \tag{33}$$

where S is the sum of old and new permits.

The stock price of the permits among private firms is p/r.

If the government invests its sales revenues in the international market it will receive

$$r\frac{p}{r}(S - Q) = p(S - Q)$$

The only difference when solving this model compared to the model before is that $T = p(S - Q)$ instead of $T = pS$ and that the rental income from owning the existing certificates, which accrues to the domestic residents, is given by $(1 - \alpha)Qp$.

Therefore,

$$Y = wL + (1 - \alpha)Qp + T + r\overline{K}$$

By taking into account that $T = p(S - Q)$ we get

$$Y = wL + (1 - \alpha)Qp + p(S - Q) + r\overline{K},$$

which is equal to

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

Hence, national income is the sum of wages and capital income earned at home and abroad. In addition, the rental income from owning and using the old and new certificates, S, except for the old certificates owned by foreigners, αQ is included.

Using the fact that

$$wL + pS = f(L, S, K) - f_K K$$

the income can be rewritten as

$$Y = f(L, S, K) - pS - f_K K + r\overline{K} + p(S - aQ).$$

Now, we know from the firms' behavior that $r = f_K$.

Therefore,

$$Y = f(L, S, K) + r(\overline{K} - K) - f_S(L, S, K)\alpha Q. \quad (34)$$

That is, the income, Y, is the sum of the domestic product, $f(L, S, K)$, and the capital income earned abroad, $r(\overline{K} - K)$, minus the rental income accruing to foreigners, $f_S \alpha Q$.

The benevolent government has the following problem

$$\max_S U(Y, S^*) \quad (35)$$

The first order condition is equal to

$$U_Y f_{S^*} + U_Y(f_K \frac{dK}{dS^*} - r\frac{dK}{dS^*}) - \frac{df_S}{dS}\alpha Q U_Y + U_{S^*} = 0$$

Since, in equilibrium, $f_K = r$, this simplifies to

$$U_Y f_{S^*} - \frac{df_S}{dS}\alpha Q U_Y + U_{S^*} = 0$$

We note again that total differentiating $U(Y, S^*)$ holding U constant implies

$$U_{S^*} dS^* + U_Y dY = 0, \tag{36}$$

which is the same as

$$-\frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*} \mid_U .$$

Therefore,

$$f_S = -\frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*} \mid_U + \frac{df_S}{dS}\alpha Q. \tag{37}$$

From the firms' first order condition we know that $p = f_S$.

So we can finally achieve the condition determining the level of pollution

$$p = f_S = \frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*} \mid_U + \frac{df_S}{dS}\alpha Q. \qquad (38)$$

This looks similar to the first order condition in the benchmark model above.

However, the term $\frac{df_S}{dS}\alpha Q$ is new. This condition says that the government selects the number of permits such that the marginal product of waste emissions equals the marginal social damage plus the marginal change in the rental income accruing to foreigners.

So this is a marginal policy externality imposed on people who do not belong to the electorate and whose preferences are therefore neglected.

Because the production function is linear homogenous and because L is internationally immobile the policy externality is negative, i.e. $\frac{df_S}{dS} < 0$, which implies excessive pollution compared to the social optimum.

Proposition: When the environment is regulated by means of permanently valid permits and when some of the permits have found their way into the pockets of foreign owners, a government that maximizes national welfare will implement too lax an environmental policy.

The result comes from a rent-dissipation effect affecting foreign direct investors who came before the environmental policy was chosen.

By granting more permits, the government reduces the market price for permits. The point is that it does only care about owners in the home country. The loss foreign owners suffer from a lax environmental policy is not taken into account.

Over time, this effect will become increasingly important, because globalization will cause the ownership structure to become more and more diversified.

Note that the result holds independently of whether the waste emission spread across the country's borders or not. However, if the technological spillover effect analyzed in the previous section is added to the rent-dissipation effect, the two effects will reinforce one another.

4.3 Environmental Standards

We now model the case when the government regulates the economy with quantity standards. In the present setup, this implies that $Q = S$. In other words, there is no initial stock of permits. We are first looking for the national income, which is given by

$$Y = f(L, S, K) + r(\overline{K} - K) - f_s(L, S, K)\alpha S. \quad (39)$$

Note that compared before, the given historical quantity, Q, has been replaced with the actual emission volume S. The first order condition is given by

$$U_Y f_{S^*} + U_Y(f_K \frac{dK}{dS^*} - r\frac{dK}{dS^*}) - \frac{df_S}{dS}\alpha Q - \alpha f_s + U_{S^*} = 0$$

Again, we note that the firms' maximize their profit such that $f_K = r$ and $p = f_S$. We also note that $-\frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*}\mid_U$. Therefore, we get the following condition determining the amount of pollution:

$$p = f_S = -\frac{U_{S^*}}{U_Y} = \frac{dY}{dS^*}\mid_U + \alpha(f_S + \frac{df_S}{dS}S). \quad (40)$$

Once again, the marginal product of waste emissions may differ from the marginal damage to the households because there is a policy externality on foreigners ($\alpha > 0$).

The price effect, $\alpha\frac{df_S}{dS}S$, which we just analyzed is still there (but here $Q = S$).

There is also an additional term, αf_S. It 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 certificates are granted for free to firms that have foreign shareholders, they do. This externality goes in the direction of a too restrictive environmental policy.

In other words, part of the benefits of pollution goes to foreign owners and is therefore not taken into account when the decision of how many certificate to issue is taken.

Or in other words, a marginal increase in emissions increases the overall return from using the environment, and this effect partially dissipates to foreigners.

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 f_S is steeply downward sloping (inelastic), then then the price effect is strong, which speaks in favor of too lax environmental standards.

However, we note that $\frac{df_S}{dS}$ also reflects the mobility in capital and labor. More mobile K and L leads to a more elastic demand curve for the environmental factor. Because K and L can be assumed to become more mobile in the future, the price effect may be reduced and we may expect the tendency to go toward tighter standards. In fact, if K and L are perfectly mobile, there will be no price effect at all.