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Vth EUROPEAN CONGRESS OF AGRICULTURAL ECONOMISTS

RESOURCE ADJUSTMENT AND EUROPEAN AGRICULTURE

BALATONSZÉPLAK, HUNGARY
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AGRICULTURAL POLICY AND ENVIRONMENT IN DEVELOPED COUNTRIES

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Wealthy countries'agricultural policies were set up in a scarcity period, therefore they aimed at self sufficiency or an export position. A productivity increase was necessary to reach these two goals, which have followed one another in time according to the countries. Besides, these policies allowed the increase of the remaining farmers'incomes at a time where economic growth needed labour force.

But this agricultural policy has been too successful and resulted in expensive surpluses and environmental degradation. One might question its effects on social welfare.

To take a right view of the relationship between agricultural policy and environment we have to identify the main features of agricultural pollution and analyze them from an optimal allocation point of view. Then we have to discuss the corrective measures to implement in order to improve social efficiency.

1. FEATURES OF AGRICULTURAL POLLUTION AND OPTIMAL ALLOCATION

1.1. Features of agricultural pollution

1.1.1. Agricultural intensification

The environmental problems associated with agriculture are supposed to be entailed by intensification. This comes from changes in factor costs, in particular the considerable increase of labour costs compared with capital and agro-chemical costs. As a result per hectare output has been increasingly higher. Agricultural product price programs are generally seen as the main reason of this intensification, especially in the European Economic Community (Bowers and Cheschiss, 1983).

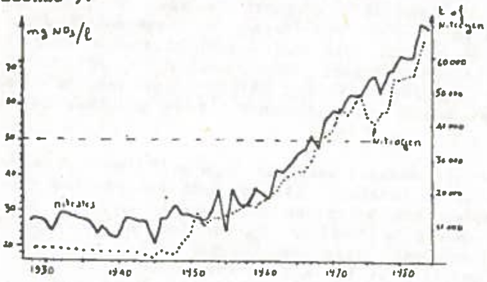
But nominal protection rates vary according to the commodities. For instance, during the period 1977-1983 in the EC's nominal protection rates were 1.32 for cereals, 1.30 for pork, and 1.17 for poultry. Using the effective protection rates, i.e., a rate of protection measured at the value added stage, important differences for the same commodity among countries are found (Mahé and Courgeon, 1986). For instance, the effective rates for pork are 1.97 for Germany and 1.27 for Denmark.

Thanks are due to Hervé GUYOMARD (INRA-Rennes) for helpful comments.

Intensification and the increase of productivity which goes with it, leads to the economic and social marginalisation of many small farmers. In a period of overproduction these small farmers cannot compete and have to leave. This involves the impoverishment of the poorer farmers and the abandonment of less favoured areas and an alteration of some environmentally sensitive regions.

The best example demonstrating the relationship between intensification and pollution is the contamination of groundwater by nitrates, which implies a human health hazard, mainly for infants (methaemoglobinaemia). Even if there are other sources of nitrates, there is no denying that the liability of agriculture is important, especially in rural areas where cropland prevails. The case of "La Petite Traconne", a spring located in Seine et Marne, a French intensive cereal region, is enlightening. The level of nitrates in the drinking water evolves in connection with the increased use of fertilizers, namely nitrogen, particularly from the fifties (sec. graph 1).

Graph 1. Sales of nitrogen in Seine-et-Marne and nitrato concentration in the drinking water (the example of the spring "La Petite Traconne").



Sources : L'écho des nitrates - Bulletin de liaison de la mission eau-nitrates du Ministère de l'Environnement n°12 Juillet-Août 1985 - Statistique Agricole annuelle (livraisons d'engrais).

1.1.2. Irreversibility

The impacts of intensive farm pratices can be analysed in the way of nature protection, and distinctions can be made among decisions and actions on the basis of whether their consequences are difficult or impossible to ameliorate. The key concept of irreversibility raises here.

Some ecosystems are prized for their genetic uniqueness, their special scientific rarity, or their unusual biological assemblages. The current high technology agricultural production system and the decreasing diversity of cropping and livestock patterns are leading to the extinction of wild species in fauna and flora. At present only 20 plant species provide 90 % of human caloric intake. Two thousands years ago mankind used 5000 species (OECD, 1985 p. 151). Loss of natural populations can adversely affect human welfare with the loss of a genetic information that may in the future be useful in some form of economic activity or health.

Programs of land consolidation aiming at the establishment of more efficient farm organisation and rural structure lead to the alteration of the landscape with the destruction of small woodlands, hedge-fringed fields and wetlands.

A second sort of damage includes the degradation of agricultural potential and human health hazard. The former damage deals with farm pratices and their impacts on soil erosion and the consequences on productivity. The substitution of maize to grassland worsens the effect of run-off waters, so that off-farm costs of sediment damage are more important than on-farm costs of soil productivity loss (Crosson, 1987). Nevertheless soil conservation programs avoid massive erosion.

Concerning risks to human health the most important factors are contamination of groundwater by nitrates and pesticides, and bacterial contamination of marine shell fish by pathogenes.

The significance of irreversibility in economic processes can be widened to agricultural policy. This concept was developed to deal with the case of a hydroelectrical site located on a free-flowing stream suitable for inclusion in a scenic area of unique interest. In this case the destruction of the site was virtually impossible to reverse. So we have to take into account the loss of goods having special characteristics : uncertain demand, no close substitutes, not readily reproduced. We have to note that a part of the benefit of a preserved natural environment arises from uncertainly of the future demand (Fisher and al., 1972 ; Henry, 1974). Since agricultural policy has irreversible impacts an environment it is possible to use a similar outline.

In order to measure benefits from wilderness preservation a two-period setting is retained (1). The decision problem when traditional grazing marshes are converted into cropland, is : how much arable cultivation should be developed in each of the two periods. There are two main assumptions. First, development in any period is irreversible; second the benefits at the end of the first period are not known. At the beginning of the second period the decision maker has to choose whether to continue or not. If new information is forthcoming the risk will be reduced. If the expected benefits deals with uncertainty and if there are irreversible consequences we have to choose the conservative option because of the central postulate of welfare economics reduction of options represents a welfare loss.

As things stand at present, from an environmental point of view, we are at the end of the first period concerning the agricultural policy. The consequences of the policies implemented are known. Now we can see what type of structural changes are needed in agriculture to help reconcile the agricultural and environmental objectives in the perspective of social optimum.

1.1.3. Speficic features of agricultal pollution

In comparison with other industries agricultural pollution sources present a different and more complex problem. The reason lies in the fact that there are nonpoint sources. When flows of pollutants come from nonpoint sources, they cannot be monitored accurately or at a reasonable cost. Otherwise nonpoint pollutions are inherently stochastic.

(1) For more details, see Amigues, 1987.

For instance, the slurry spreading on the spot can have different consequences, through infiltration and run-off water, on the quality of the water or the disruption of ecosystems. It depends on the nature and the state of the soil, the type of crop. According to climatic conditions (rain, frost), the extent to which land is saturated, and the incline of the land, run-off water pollution is more or less important.

The situation with off-farm sediment damage is typical (Crosson, 1987). Referring to the flow of pollutants from run-off there is a spatial discontinuity, between the place where the soil is detached and the place where, as sediment, it causes damage. But there are also temporal discontinuities. The time between soil detachment and sediment damage can vary from a few hours, to years. Because of the spatial and temporal discontinuities between site of run-off and site of damage one cannot be sure that controlling run-off pollution will give proportional and timely reductions in water quality.

This highly tenuous relationship between run-off from farms and sediment damage downstream makes the application of the emission based policy instruments which have been the focus of economic inquiry, difficult. Models which estimate of predict non point pollutant flows utilizing information on farm management practices, weather, soil characteristics... are avalaible. But their efficiency is limited and they are used just as a tool for diminishing the uncertainty about non point loading. Hence the estimation of the damage fonction is not easy.

1.2. Socially efficient allocation

The agricultural industry uses the environment as a factor of production and generates social costs. Those are not borne by agriculture, therefore the cheapest way is for it to keep on polluting and henceforth market equilibrium does not achieve a socially efficient allocation. A competitive economy with a pollution externality will reach a Pareto-optimum through the market mechanism if it imposes tax on that externality.

The basic issues of taxation of production externalities can be captured in a simple model involving two economic agents, the polluter and the polluted. For the latter, let us take the example of a water treatment plant for which pollution leads to extra costs. For the former we will consider two cases. The first one is intensive livestock production for which polluting emissions depend on the level of output. The second one is crop farming for which pollution is influenced by a specific input.

1.2.1. Intensive livestock example

To be more specific, consider the pig industry in a watershed. We adapt a classical model (Varian 1984, p. 259-263) with only one input : labour.

Assume that pigs are produced with a production function :

$Y_1 = Y_1\ (N_1)$ meeting usual regularity conditions.

Polluting emissions increase with the output :

$$dY_1 / dN_1 > 0 \text{ and } d^2Y_1 / dN_1^2 < 0$$

and have a negative impact on the production of drinking water :

$$Y_2 = Y_2 (N_2 , E) \quad \text{with } \partial Y_2 / \partial N_2 > 0 \text{ and } \partial Y_2 / \partial E < 0$$

Farmers are price takers and profit maximizers, then the pig industry will employ labour until :

$$(1) \; p_1 \, dY_1 / dN_1 = w$$

where p_1 is the price of pigs and w is the wage rate.

It is fairly clear that this situation is not an efficient allocation of resources. The output of the pig industry adversely affects the output of the water treatment plant, but this externality is ignored by farmers and so the number of pigs fed is too high. If there are externalities, price-taking profit maximization behaviour will not necessarily lead to a social welfare optimum. To make it evident consider what would happen if aggregate profits are maximized.

Total profit, including both industries, is :

$$p_1 Y_1 (N_1) + p_2 Y_2 (N_2 , E) - w_1 N_1 - w_2 N_2 ,$$

with p_2 for price of drinking water. The first order condition (1) is now replaced by : $\left(p_1 + p_2 \frac{\partial Y_2}{\partial E} \frac{dE}{dY} \right) \frac{dY_1}{dN} = w$

$$\text{where } p^*_1 = p_1 + p_2 \frac{\partial Y_2}{\partial E} \frac{dE}{dY} < P_1$$

Since dY_1 / dN_1 decreases when N_1 increases, the optimal output of the pig industry will be less when the externality is taken into account than when the two industries operate independently.

The social price of pigs is p^*_1 ; in order to ensure efficient resource allocation we only need to ensure that the pig industry faces the social price rather than the private price. This could be done by taxing pigs by an amount $p_1 - p^*_1$. This discrepancy can be viewed as a shadow price for pollution, it equals the change in profits of the treatment plant due to change in manure emission. A market for externalities could be a solution to achieve an efficient allocation of resources. Both solutions are equivalent and lead to a Pareto-optimum allocation.

1.2.2. Crop farming example

In order to simplify, the production function of the crop farming industry depends on two inputs, labour and fertilizers X. This concave function is given by :

$$Y_1 = Y_1 (N_1, X)$$

Polluting emissions are due to fertilizers :

$$E = E(X) \quad dE/dX > 0$$

and the production function of the water treatment plant is the same as before.

First consider the situation where industries operate independently. Farmers will employ fertilizers until :

$$(2)\ p_1 \partial Y_1 / \partial X = q$$

where p_1 is the price of crops and q is the price of fertilizers. As a result the crop farming industry will employ too much fertilizer because it does not take into account its adverse effects on the treatment plant.

We get an efficient allocation by maximizing aggregate profits :

$$p_1 Y_1 (N_1, X) + p_2 Y_2 (N_2, E) - w N_1 - w N_2 - q X$$

where p_2 and w are always the price of drinking water and the wage rate.

Equation (2) is now replaced by :

$$p_1 \frac{\partial Y_1}{\partial X} = q - p_2 \frac{\partial Y_2}{\partial E} \frac{dE}{dX} = q^* > q$$

The social price of ferlitizers is q*, it is higher than the market price q because it takes into account adverse effects on the water treatment plant. A tax on fertilizers equal to the difference between the social price and the market price would imply a decrease of fertilizer demand. Taxation would produce a Pareto-optimum allocation as a market for pollution would do, once one has identified pollution as just another output of production.

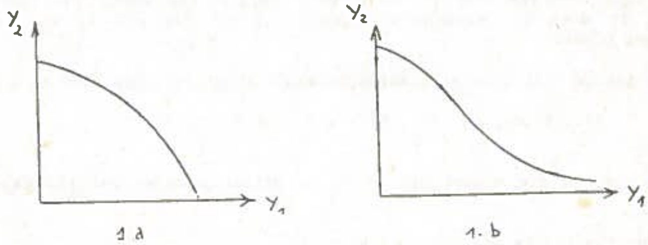
1.2.3. Some practical difficulties

Tax is on pollution and it is designed to reduce the level of emissions therefore policy instruments are identical in both examples just reviewed. Their incidences on agricultural output are different. Given current technology the intended policy would imply an appreciable drop in the output of intensive livestock industry. The shift would be smaller for crop farming for which large factor substitution possibilities exist.

Taxation of externalities is an important reason for government intervention. An environmental agency which has to maximize social welfare can stand for it. If very restrictive hypotheses are not met (linearity of the damage function...) taxation must be tailored to each polluter (Bohm et Russel 1985, p. 406-411). Finding the full set of such taxes requires a lot of information and an intricated computation model. Otherwise the monitoring and the enforcement of this system seem difficult.

When there are externalities, threshold effects often occur and involve discontinuities in consumer and producer behaviour. This results in multiple equilibria (Fisher 1981, p. 177) and the production set is no longer convex. Starret (1972) provides an interesting example of such a situation (figure 1). The output Y_2 of the water treatment plant is plotted as a function of the output Y_1 of the pig industry holding all inputs at fixed levels.

Figure 1. Convexity hypothesis

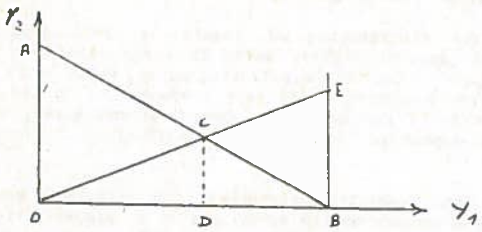


In case 1a, convexity hypothesis holds : the water treatment plant undergoes a marginal damage increasing with pollution. The output of drinking water decreases up to the point when the plant quits, after which it is zero. In case 1b, convexity hypothesis does not hold : marginal damage increases up to a point and then decreases toward zero. This latter example turns to be realistic when the concentration of pollution is very high. For instance when a river is so polluted that it becomes a sewer the benefits for the water treatment plant from a marginal improvement may be negligible. It is the same for households, water based recreation activities are still impossible.

1.2.4. The Coasian market solution

Coase (1960) has stated a process in which both parties, the polluter and the polluted, negociate a voluntary agreement in order to achieve an optimal resource allocation. To illustrate this process, consider the example of the water treatment plant and the pig industry. Figure 2 depicts the marginal benefit AB of the pig industry and the marginal damage OE suffered by the treatment plant, both as function of Y_1.

Figure 2. The Coasian market solution



Without considering externalities the pig industry will produce OB pigs. This amount maximizes its profit which is equal to OAB. The area OBE gives an assessment of damage suffered by the water treatment plant. The difference between these two quantities represents the aggregate profits.

Figure 2 is a market equilibrium diagram adapted to the specific pollution problem. Social welfare corresponds to the output OD of the pig industry, this level of output equalizes the marginal benefit and the marginal damage. Maximum aggregate profits are represented by OAC. The corresponding area is greater than the difference between areas OAB and OBE.

It is possible to lead to an optimal level of pig output without government intervention. Given well defined property rights, a negociation between parties is a simple means to restore social efficiency. To make this point clear consider two opposite rules. The first one is defined as the zero liability rule, there is no law against pollution. The second one is the full liability rule, it requires that externalities be limited to zero.

Under the zero liability rule, the pig industry can operate without taking into account pollution, the level of output maximizes private profit. The affected party is able to offer bribes as high as its marginal damage and the polluter is willing to accept this compensation provided it is as high as its marginal benefit. A process of negociation will start between parties and an agreement will be reached wherein the level of pig output is socially efficient. For its lost profit the pig industry will receive an amount of money equal to the area BCD. This dealing is favourable to the polluted party because it involves a decrease of its own damage equal to the area BCE.

Under the full liability rule the water treatment plant enjoys a right to clean water which means no environmental deterioration due to the pig industry. In order to operate the polluting industry must offer bribes to the affected party. The dealing process will achieve social welfare. The polluted party receives a compensation that is exactly equal to extra costs incurred, they are measured by the area OCD. The pig industry profit increases by a quantity represented by the area OAC. Both parties are better off after this negociaton.

Then the final allocation is Pareto-optimal and independent of the initial distribution of the property rights. This result is true provided these is no transaction costs.

The ultimate distribution of income is influenced by the specification of property rights. Under the zero liability rule the affected party pays bribes to the polluting party, while under the full liability rule the polluting party pays compensation to the affected party. Consequently if income effects cannot be neglected, the final allocation will depend on the initial distribution of the property rights.

Under the more realistic assumptions the efficient quantity of pollution abatement depends on the specification of property rights, but it is still true that a compromise is possible and gainful. The process of negociation can be generalized to take into account many economic agents using the concept of Lindahl equilibrium (Mäler 1985 p. 29).

2. POLICY INSTRUMENTS

2.1. Policy approaches and the polluter pays principle

Using new developments in welfare economics it is possible to determine the conditions that characterize a Pareto optimal allocaion of resources in the presence of pollution externalities. But there are theoretical, political and administrative constraints which lead to consider second best optima. The optimal amount of pollution being unknown, the aim of the policies implemented becomes pollution control at minimum cost. The socially efficient allocation is not aimed at since the analysis of externalities proceeds in a partial- equilibrium framework.

2.1.1. An overview of the policies

Commonly suggested methods of controlling pollution are focused an economic approaches (market incentives, public investments) or on direct controls. The suitability of each method must be taken into account regarding its efficiency, the farm income distribution and its feasibility (see table 1). Market instruments, or market-line policy instruments are mainly used for reversible effects, whereas regulation deals with less reversible, or irreversible effects. The former supposes an administrative setting to manage the system, like French "bassin" agencies, or German "bassin" associations for water pollution control. The latter needs just a national system with local adaptations.

Table 1. A taxonomy of policy instruments.

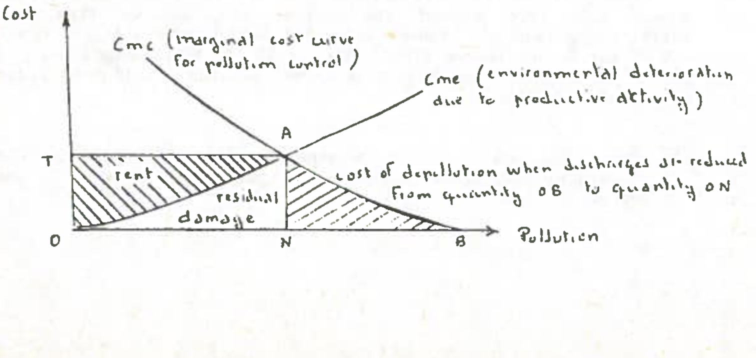
Type of instruments	Suitability regarding			
	efficiency (Performance)	farm income distribution	Feasibility: farmer view	Feasibility: Government view
1. Economic instruments				
a) Market incentives				
- taxation of environmental damage	Theoretically	-	--	++
- subsidy + per unit of reduction of effluents	these	+	++	++
+ to cover the costs of damage-control equipment	incentives			
- tradeable permits (rights, licenses)	achieve		--	-
- refundable desposits	social welfare	?	--	--
- specification of property rights			+	+
b) Public investments				
- damage prevention and waste treatment facilities	+			
- extension and reduction services			+	++
- research				
2. Enforcement instruments (including monitoring and police)				
- general regulation	These incentives		+	+
- specific regulation	perform	-	-	--
- standards + on effluents	differently		-	--
+ on technology	according to cases		-	--

2.1.2. The polluter pays principle

If environmental values are regarded as community rights, then polluter pays principle may be considered as an extension of property rights. Besides a tutelary right is sometimes given to organizations to manage public goods. That is the case for inland fishable waters in some countries. This principle leads to the internalization of negative externalities with good conditions of acceptability, feasibility and resource allocation.

The aim should be that the producer should use the environment as a production factor up to the limit at which its marginal production equals the cost to society of the marginal unit of pollution. Therefore the firm will set its output so that its contribution to collective well-being (its marginal product) is equal to what it costs to society (marginal cost of pollution). The intersection between the marginal evaluation of environmental deterioration according to the activy of the enterprise (curve Cme) and the cost to society of controlling the pollution (curve Cmc) allows for an optimum distribution of resources (fig. 3). OT is the charge, here at the optimum rate, levied upon the polluter while ON is the standard.

Figure 3. Optimum charge and standard



In this situation the charge allows the cost of pollution associated damages to be fully internalised. This is because the polluter bears the charge equal to OTAB with ANB as the equivalent to the cost of pollution control as such, ANO being the cost of the residual damage to the existence of the pollution ON. At least OTA can be analysed as a tax upon the environmental resource from which the polluter benefits, since we suppose there is a community right to have unpolluted environment.

However, as one cannot know the damage function for certain, there is no equivalence between the pollution standard and the charge. It is easy to show that the charge, if properly set, is more effective than the standard ; it is a better incentive (OECD, 1980, p. 11).

2.2. Implementation for crop farming

The operation of the polluter pays principle for crop farming relies on fertilizer taxation. It is efficient for arable farms specially for the cereal oriented type but some authors disagree with this point. Such a policy instrument would cause a smaller loss in the profitability of agriculture than a decrease in the price of crops. Tax receipts could be allocated to the financing of public treatment plants. Therefore the treatment of residual wastes would supplement the abatement of effluents.

2.2.1. The efficiency of fertilizer taxation

Several studies using similar methodologies (De Haen, 1984 ; England, 1986) question whether fertilizer taxation is an efficient means in order to reduce pollution due to nitrogen. Conclusions are drawn from the estimation of yield response curves to fertilizer applications for different crops. These authors also consider the changes in fertilizer demand and in gross margin with changes in fertilizer and crop prices. They use linear programming to aggregate the results for individual crops to farm level taking into account the rotational constraint on the total area. As a conclusion the own-price elasticity of fertilizer demand is low (1).

Own-price elasticities obtained by De Haen range from - 0.16 to - 0.50 ; Ray (1982) gets similar values for the United States (- 0.32 to - 0.49 for different years) as Boyle (1981) does for Ireland (- 0.54 to - 0.62 for different periods). Given these estimates a significant impact on fertilizer demand would require a very high level of taxation. But all these estimations rely on the concept of Hicksian demand.

Own-price elasticities derived from the estimation of Marshallian demand take into account the various compensations through crop substitutions and are higher. Shumway (1983) quotes a figure equal to - 0.70 for Texas, Weaver (1983) get - 1.38 for North Dakota and - 2.16 for South Dakota. Finally Higgins (1986) obtains - 1.38 from a random sample of Irish farms.

(1) There are discrepancies between De Haen and England results concerning fertilizer response with respect to changes in output price.

Estimations from French time series for the period 1959-84 confirm these results. Thus the fitting of a simple demand equation gives figures ranging from - 0.39 to - 0.55 according to different regions. In order to split into short run and long run effects, a more sophisticated modelling has been considered. It specifies expectations and adjustment lags in response to price changes. Short run own-price elasticity is - 0.33 and long run one reaches - 1.10 a full adjustment needs a little more than two years.

Taxation is proving efficient in order to reduce fertilizer demand for cereal oriented farms and more generally arable farms. Otherwise it will induce a decrease of output if and only if fertilizer demand is output elastic (Silberberg, 1978 p. 211), that is true for crops concerned.

2.2.2. Effects of taxation

The effects of taxation in the profitability of agriculture have to be compared with the effects of a fall in crop prices having a similar impact on fertilizer use. This can be done through a duality framework with value-added as a proxy variable for income. Let us compare two policies, a tax on the price q of fertilizers and a decrease in the price p of cereals.

Value added is defined in terms of p, q and also the price-vector r of other variable input and output prices and the vector z of fixed inputs (Waver, 1983).

$$VA = f\ (p, q, r, z)$$

The share of fertilizers in value added is given by :

$$S_X = - (\partial \mathrm{Log}\ f / \partial \mathrm{Log}\ q) = qX / VA$$

where $X = - \partial f / \partial q$) is fertilizer demand.

The share of cereals equals :

$$S_C = (\partial \mathrm{Log}\ f / \partial \mathrm{Log}\ p) = pY / VA$$

where $Y = \partial f / \partial p$ is cereal supply.

A taxation of fertilizers and a fall in cereal price imply the same decrease in fertilizer demand if and only if :

$$(1)\ \Delta p/p = (\varepsilon_{XX} / \varepsilon_{XC})\ (\Delta q/q)$$

where ε_{XX} is the own-price elasticity and ε_{XC} is the cross-price elasticity of fertilizer demand. Therefore the ratio of value-added decreases, implies by equivalent shifts of cereal and fertilizer prices, is equal to :

$$(2) - (\varepsilon_{XX} / \varepsilon_{XC})\ (S_C / S_X)$$

the policy using cereal price as an instrument is more costly for farmers than taxation if this ratio is greater than one.

Apart from the case where the share of cereals is very small, the ratio (2) is always higher than unity. On the other hand, the ratio (1) can be lower than unity in the very specific case of a single output agriculture if inputs are gross complements (Sakai 1974). But for the normal case of an arable-cereal oriented agriculture the ratio (1) is higher than unity. Therefore the taxation policy is cheaper in terms of agricultural profitability. This result strengthens the idea that the best way is to act on the source of pollution.

The preceeding argument can be illustrated with an example based on French data. Take the following values for the parameters :

$$\varepsilon_{XX} = -0{,}42 \quad \varepsilon_{XC} = 0{,}73 \quad S_X = 0{,}10 \quad S_C = 0{,}36$$

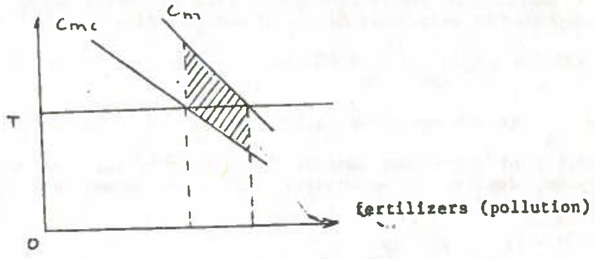
In the short run a 10 % tax on fertilizer price and a 5.8 % decrease in cereal price are quivalent in terms of fertilizer demand, the resulting reduction is 4.2 %. The former policy induces a 1 % drop of value-added but the latter is two times more costly with - 2.1 %.

2.2.3. The design of a realistic policy

The implementation of fertilizer taxation can initiate a gradual process of pollution abatement. Even if its effectiveness is limited in the short run, it is a means to collect a lot of money that can be allocated to cover the costs of processing units, like water treatment plants, in order to get an extra abatement of pollution.

Figure 4 depicts marginal cost curves of pollution abatement Cm for the agricultural industry and Cmc for a public water treatment plant. Both curves are expressed as function of fertilizer consumption and Cmc is lower than Cm. Faced with the emission tax rate OT the agricultural industry will use fertilizer up to ON_1. The operation of a treatment plant will allow more abatement, in terms of fertilizer it is equivalent to $N_1 N_2$. An emission standard equivalent to ON_2 would be more costly for the agricultural industry, total welfare would decreased by the hatched area.

Figure 4. Socially efficiency of public treatment plants.



In the long run there are two main approaches to reducing the levels of fertilizer applied. An improvement in the efficiency which nitrogen is taken up by the crop could be achieve through agricultural training and extension services. Otherwise nitrogen fixing organisms could gradually substitute for nitrogenous fertilizers. Therefore social welfare purposes justify to some extent an allocation of taxation receipts to the agricultural education and research system.

The implementation of this policy to market gardening which causes important environmental stress is questionable because fertilizer demand is own-price inelastic. Anyway it can supplement the operation of quality standards for vegetables.

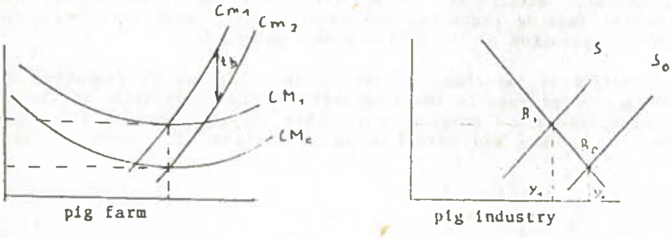
2.3. Implementation for intensive livestock industry

The major stress to the environment results from the pig industry. Polluting emissions, animal waste, are closely dependent on output level. The initial incidence of the operation of the polluter - pays - principle falls on the farm sector. The less efficient farms exit the industry and the ultimate incidence of this burden will depend on the ability of the farm sector to shift the cost burden to consumers by raising prices.

Figure 5 depicts the equilibrium positions of a representative competitive pig farm and the corresponding equilibriums of the industry (Baumol and Oates 1975, p. 176-184). At the farm level emissions equal by, they are strictly proportionate to output y. If there is no environmental program the farm is faced with the market price p_o, its equilibrium position is A_o (intersection point of the marginal cost curve Cmo and the average cost curve CMo). With a unit tax t on pollution emissions the marginal and average cost curves shift upward by a vertical distance tb, the corresponding equilibrium is A_1. The equilibrium output of the representative farm is exactly the same with and without taxation, and the shift of price correspond to the cost of taxation by unit of output.

The market supply curve shifts from S_o up to S1, the ultimate equilibrium position is B_1 instead of B_o. Therefore, there is a decrease of total output and consequently of animal wastes. Consequently less profitable pig farms exit the industry.

Figure 5. The polluter pays principle applied to intensive livestock industry



The result that all remaining farms produce the same amount arises from the assumption that the marginal cost curve shifts uniformly. If it does not, for instance because the economies of scale have been affected, the farm will not produce the same output.

Instead of having a taxation policy, let us consider a program of subsidies to induce a decrease in pollution emissions. A subsidy proportionate to animal waste decrease would have adversely impacts on total pollution. The output of the representative farm would decrease, but new firms would enter the industry, so a backward shift of the market supply curve would occur implying a decrease of price and an increase of total output.

Nonpoint pollution and the geographic distribution of agriculture are two factors inducing that a single charge is not optimal. The implementation of an individually tailored tax system is difficult, so transferable emission permits could be an option (Laffont 1982, p. 21). Given total pollution, at the equilibrium of the market for effluent permits, the optimal allocation of emission levels is achieved and the long run equilibrium of the industry is optimal (Spulber 1985).

The extent and the spatial pattern of the damages depend on the locations of the sources of pollution and the locations of the receptor points (for instance the sources of water supply). The implementation of a program of tradeable permits involves one market for each receptor point. Montgomery (1982) has proved that such a program achieves a predetermined quality objective at least cost and that the ultimate allocation of permits is independent of the initial distribution. This system is rather cumbersome for polluters because they must have a portofolio of licences for each market but its flexibility can be improved and it is possible to design a politically feasible as well as efficient program.

Concluding comments

Environmental stress created by the farm sector in developed countries is partly due to agricultural policy, but the prevailing factor has been the tremendous growth of the economy. Therefore an adjustment of agricultural policy with a downward shift of prices, will not modify the trend of environment deterioration drastically. In order to achieve social welfare it needs the implementation of specific environmental programs.

Under irreversibility, the consequences of deterioration are difficult or impossible to ameliorate, therefore a policy using regulation as an instrument must be prefered. While on the contrary for reversible impacts, economic incentives specially in the form of prices are socially efficient. The specific study of relationship between intensive farming practises and water quality made this point clear with the operation of the polluter pays principle.

Fertilizer taxation, as far as crop farming is concerned would cause a smaller loss in the profitability than a decrease in the price of crops, so such a program is feasible, otherwise it is efficient at least for arable and cereal oriented farming. The operation of the polluter pays principle would raise a decrease of output level and a price increase for intensive livestock production for which effluents closely depend on output.

In some regions, it is interesting to note that organic and synthetic nitrogen fertilizers are both applied. As quoted by Anderson (1986, p. 196) rates of application turn to be very high raising technical inefficiencies. A taxation of synthetic nitrogen would modify the ratio between its own price and the shadow price of organic nitrogen. It would be an incentive to shift to organic substitute and to promote manure banks. Otherwise manure treatment plants could be considered as an opportunity in order to reduce pollution.

The agricultural sector is now faced with surpluses but also income problems so the farm lobby should argue against the operation of the polluter pays principle. Nevertheless the present situation is very similar with the situation of other sectors two or three decades ago, when the first environmental programs were designed. These programs have been less costly than it was predicted and had effects on the rate and the direction of technical progress (Christainsen and Tietenberg, 1985, p. 356-358). Environmental deterioration is a challenge which needs the enforcement of a suitable policy in form of regulation and price incentives. It would encourage the adoption of environment saving technology.

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