CHAPTER XXII

EFFECTIVE ENVIRONMENTAL PROTECTION[1]

Carlos San Juan Mesonada

University Carlos III of Madrid, Spain

ABSTRACT

The use of Pollution Added Tax (PAT) as a means of internalizing external diseconomies generated by productive processes, when levels of pollution are directly connected to the amount of material inputs used, is hereby analyzed from the point of view of international trade.

The application of PAT according to the principle of the country of receipt allows the creation of an efficient environmental tax model from an international trade perspective, since it does not require international agreements and allows the internalisation of external diseconomies without affecting the competitiveness of companies in the country or area of application. It also avoids giving incentives to polluting industries to export while giving incentives to technical change towards less polluting processes.

The aim of this study is to show the effects on the structure of a company of the added value of a Pigouvian tax-- the Pollution Added Tax (PAT). Its essential features are the following:

First: It does not affect competitiveness regarding the import or export of equivalent products of home trade, even when international agreements are not reached with non-participating countries not possessing equivalent environmental legislation.

[1] This research was supported by the CICYT project SEC 94-0430.

Second: It allows an optimum paretian allocation of production, aimed at the domestic market (or the single market, when applied to member states of the European Union).

Thirth: The tax has a strong capacity for collection. However, the creation of PAT could generate employment by two means: 1) by expanding anti-pollution industry and services, and 2) by substituting labour taxes (which increase labour costs) for PAT (which reduces pollution levels).

Fourth: It does not give incentives to export "dirty industries" (polluting activities) to non-participating countries, and consequently does not eliminate "home" employment. Furthermore, it gives incentives to non-participating countries to progress in environmental legislation for import supplying countries.

EFFECTIVE ENVIRONMENTAL PROTECTION

INTRODUCTION

In order to calculate levels of environmental protection I propose the use of a model based on the theory of effective protection and the use of Pollution Added Tax (PAT). This viewpoint is especially relevant at the present time where everything appears to point towards an increasing internationalization of all productive activities. In addition there is an increasing concern with environmental protection. In this context, any environmental measure should take into account any possible distortions in international trade and particularly the problem of "ecological dumping".

It is possible that the decrease in tariffs agreed upon for the following years may be followed by a greater development of non-tariff barriers. In particular, imposing a tax on pollution is sometimes hindered by the fear of losses in competitiveness the industry of the country or Economic Union concerned could have, as opposed to other countries which do not have a tax on pollution. In this context, I propose a model which; allows the imposition of a pollution added tax without affecting international competitiveness in national production, does not require agreements with third countries for its enforcement, does not encourage the movement of contaminating industries to areas with underdeveloped environmental legislation, has a high potential for profits, and directs technical change towards less contaminating technology.

POLLUTION ADDED TAX

Whereas the environmental issue originates from no point sources export of equivalent products or of home trade, even when international agreements are not reached with non-participating countries not possessing equivalent environmental legislation.

The solution in this case, may be a Pigouvian tax on the input used, e.g. Norway and Sweden have a tax proportional to their content in sulphur from the carburates used to control the risk of acid rain, and the Netherlands (amongst others) has established taxes on the content of nitrogen in fertilizers in order to moderate the pollution of underground waters. The latter case is equivalent to a tax proportional to the added pollution using the input.

It is generally easier to design a tax (following the "polluters pay" principle) to moderate the use of an input (e.g. pesticide products), by applying it to the relatively few input producing (or importing) industries, rather than designing a similar method for the relatively more numerous and diverse consumers who use these products (e.g. drivers or farmers).

In this respect, proposals to internalize external diseconomies originated by the use of pesticides in agriculture-- by taxing the original seller of the chemical product-- are already well-known.

Some applications put into practice (e.g. to moderate the use of pesticides in Georgia, U.S.A.) allow some optimism for its feasibility. However, when the feasibility of extending experiences and these pilot is evaluated, immediately the problem raises of reaching an international agreement to avoid distortions in world trade-- which also requires an analysis of the possibilities of applying the system at an international level (Allison, 1990). The need to reach an international agreement to avoid losses in competitiveness for industries in countries with a developed environmental legislation, is presently a serious obstacle for enforcing these measures, which entail new taxes or "green" levies.

An alternative to an international agreement to establish a tax on the input created by pollution **after** the productive process, is the Pollution Added Tax (PAT). The PAT would operate at the frontier following the principle of **country of receipt.** This means that, as in the case with indirect taxes, the amount of PAT paid would be rebated when the merchandise leaves the country of origin (exporting country), and a PAT, equivalent to that which the merchandise would have borne had it been manufactured in the

importing country, would be levied upon entry in the country of receipt[2]. Importing country levy a tax on imports based on the pollution intensity of input that will be used on the downstream industry.

This process has the advantage of avoiding the incentive to transfer polluting industries to areas with underdeveloped environmental legislation, and subsequently allowing export to industrialized areas. Therefore, if it were applied in developed countries, international agreements would not be necessary to extend the legislation to non-participating countries. However, this would require the development of a legislative technique to establish a kind of "green tariff" which identifies the type of PAT according to the type of merchandise.

Since it is an indirect tax, its effect on input depends on the demand-price elasticity of each type of merchandise which determines the relative decrease in input. From the point of view of supply, the capacity to transfer tax to consumers depends on the particular characteristics of the market: the more market power for companies, the more possibilities for transferring tax to consumers.

Obviously, there are also substitution effects between some goods and others, depending on their cross elasticity and the possible difference in the kind of PAT applied. But this characteristic is, in fact, positive from the point of view of its effectiveness in achieving environmental objectives, since it leads to an increase of less polluting inputs and their replacement with alternatives.

The application of PAT at an international level is actually limited by GATT/WTO rules that no allow advanced environmental countries to "level the paying field".

Moreover, exporter industries **should** pay for the full social cost of its pollution. But if the PAT is rebate at the border they don´t have incentives to reallocate resources to clean technologies if the importer country has not a PAT system. If the last don´t incentive importer government to start a

[2].-Border adjustments for taxes, and especially indirect taxes on inputs (physically incorporated and no) are illegal under current GATT/WTO rules but my proposal is that these rules should be changed greening the WTO.

PAT and increase his fiscal revenues the local government of exporter industry should applied a complementary schedule like command and control regulation. But full exporter industries are rare thus, even partial exporter industries will have and incentive (in the percent of home consumption) and border tax adjustment might increase political support.

However, some European states have already begun to apply differentiated taxes on products with a wide negative impact on the quality of water, such as oils for motors and combustibles.

One of the problems which stand ont in these pilot applications is that the levy imposed is less effective on the environment if its does not achieve the necessary level for a significant price effect, i.e. raising the price of the most polluting product by a sufficient among when compared to the more "ecological" one, so as to generate effective reactions from the consumers.

Another important aspect is that, in practice, citizens who are conscientious about environmental problems, have higher willingness to pay taxes connected to the promotion of employment (e.g. Denmark) or to financing management or environmental recovery projects, rather than non-finalist taxes.

Generally it could be say that one of the fundamental principles in deciding whether to impose a PAT on a product is the extent of the environmental damage caused **by the input itself** and not by its productive process (Jacobs, 1991). No point pollution problems are the apropiate approach to be faced with the PAT when the pollution is produced using the product downstream (not on the original production process).

In this work I propose to use the theory of effective protection, applying it in carrying out comparisons on effective environmental protection. In this context, effective environmental protection is defined as a tax comparing the added value obtained by a company without PAT to the added value for a company with PAT. It is understood that there is a type of PAT levy tj for the output which is different from levies ti charged on inputs.

The tax for effective environmental protection allows the comparison of the different levels of environmental protection between sectors and countries. For this reason, it is interesting when comparing countries integrated within a common market or economic union (San Juan, 1994).

NOMINAL AND EFFECTIVE PROTECTION

Nominal protection (of a final product or an intermediate product which could be imported) refers to the manner in which the tariff for each product diverts domestic prices away from world price and subsequently affects consumers preferences for that particular product.

Effective protection (of a certain sector or productive activity of national economy) highlights how the structure of tariffs affects decision-making by producers and the localization of productive resources, following the guidelines given by the system of relative added values (not relative prices).

Taxes which are levied on finished products (output) allow an increase on the national price on the imported product which is equivalent to an amount equal to the nominal protection. However, those taxes levied on imports of raw materials, intermediate goods and capital goods used by the national industry raise the price of inputs. This means that the effective protection enjoyed by a sector depends on how the tariff structure affects its imported products. It will be greater or less than that for nominal protection.

The analytical instrument used to prove this hypothesis is provided by the "theory of effective protection" which has been studied in depth[3].

This theory departs from the assumption that the movement amount industries of primary resources is a function of payment offered by one industry compared to another. Basically formulation, within a model of partial equilibrium with various simplifying assumptions, the effective protection tax for a certain industry is equivalent to the percentage which, together with the added value (i.e. the sum of payments for primary factors) for that industry, exceeds the added value in a free exchange situation, due to tariff rights.

---

[3] V. Corden, W.M. "The theory of protection". London, 1971 and Grubel, H.G. and Johnson H.G. eds. "Effective Tariff Protection". Geneva, 1971.

The simplifying assumptions are: homogenous production functions of the first degree; a zero price-elasticity of substitution for material inputs and between primary factors of more than zero; infinite price-elasticity for the demand of exports as well as for the supply of imports; perfect competition in the markets for goods and factors; total mobility for primary factors within the country and total immobility between countries; full employment; and the absence of transportation costs.

Since the simplifying assumptions underlying this analysis imply that domestic prices are equal to world market prices plus tariff rights, the domestic added value per unit of production j is:

$$V_j = (1 + t_j) - \sum_i a_{ij} (1 + t_i)$$

The added value for free exchange per unit of production is:

$$W_j = 1 - \sum_i a_{ij}$$

The effective protection tax is expressed as:

$$E_j = \frac{t_j - \sum_i a_{ij} t_i}{1 - \sum_i a_{ij}} \equiv \frac{\textit{ADDED VALUE AT DOMESTIC PRICES}}{\textit{ADDED VALUE AT INTERNATIONAL PRICES}} - 1$$

There are three ways for writing the same thing where:

$W_j \rightarrow$ Added Value at world prices per unit of output j

$V_j \rightarrow$ Added Value at domestic prices per unit of output j

$t_j \rightarrow$ Tariff rights borne by the final product per unit

$t_i \rightarrow$ Tariff rights borne by inputs per unit

a_{ij} → Unitary cost of these inputs in the absence of tariffs [assuming technical coefficient at international prices]

EFFECTIVE ENVIRONMENTAL PROTECTION

If we introduce PAT into the country (or region of the Customs Union) the taxes at the barrier per unit of final product would be:

$$t_j^* = t_j' + t_j$$

where:

t_j' → PAT of the final product j.

t_j → Tariff rights for the final product j.

and the taxes, at the frontier, per unit of imported input would be:

t'_i → PAT of the input

t_i → Tariff rights for the input

In this way we can quantify E^* when converted into Effective Environmental Protection which takes into account the pollution added by the material inputs used in the productive process, and that generated by the manufacture of the final product (output):

$$E_j^* = \frac{t_j^* - \sum_i a_{ij}\, t_i^*}{1 - \sum_i a_{ij}}$$

Following this model, the inputs used by the industry would reach the frontier without levying of PAT, since, according to the principle of the country of receipt, these would be rebated at the barrier of export from the

country of origin, and would be charged with the current PAT of the country (or Customs Union) of receipt.

In this way, if the country of origin does not have PAT, the product has pay the PAT in any case of the country of receipt. This avoids having to negotiate with non-participating countries so they should introduce environmental legislation up to the standards of developed countries.

On the other hand, the incentive is reduced to move "polluting industries" to countries with less developed environmental legislation, since suppliers will be aware that they will not avoid payment of external diseconomy if they wish to sell in markets of countries with a developed environmental legislation.

Likewise, this system may be applied to the sources of dispersed pollution which originate from the use of cheap imported inputs at world prices.

The effective protection enjoyed by a company, given a proportion of added value in the final price of the product, is a decreasing tariff rights function, plus the PAT, of used inputs t_i^* and an increasing tariff rights function plus the PAT of the final product t_j^*.

In other words, whereas a nominal tariff, plus PAT, on a final imported product t_j^* protects national industry by allowing domestic prices to surpass world prices, the nominal tariffs plus the PAT on material inputs t_i^* reduce the level of protection by raising their prices.

If the nominal tariffs, plus PAT, applied to the final product are higher than those carried on average by material inputs, effective environmental protection is higher than the nominal and the industry in question may produce at a higher direct cost than in free exchange situations, without risking the loss of national markets to the foreign competitor.

Likewise, once PAT is introduced, the companies using input saving technology with a higher PAT (i.e. more polluting) are protected from their competitors-- both national and foreign-- which use more polluting inputs. Either, effective environmental protection **favours technical changes** which reduce the use of polluting raw materials (or scarce natural resources).

To accomplish this, the only requirement is for types of tax on added pollution to be calculated correctly, to adequately reflect external diseconomies. We are therefore talking about a typical Pigouvian tax.

The opposite occurs if the tariffs on the final product are lower than the average tax for protection of inputs used. In this case there could even be cases of negative effective protection.

Likewise, if the Pollution Added Tax carried by the final product is proportionally lower than the average PAT for inputs, an unwanted and negative environmental effective protection could arise. In this case, the import of final products originating from polluting industries abroad would be encouraged. This situation would be as globally undesirable as the non-existence of PAT.

Only if the final product and the material inputs were subject to the same proportional nominal tariff, would nominal protection be identical to effective protection and the tariff system would not implicitly entail a subsidy or a tax on domestic manufacture of the product in question. In this case, in reality, it would indeed be preferable to eliminate tariffs and thus avoid management costs and delays in the international circulation of goods which every customs control entails.

Likewise, if all countries have similar types of PAT, the existence of PAT does not imply distortions in international trade. It would be equivalent to an international agreement.

Practical Calculation for Effective Environmental Protection

The purpose of this calculation is to determine what would be the appropriate level of environmental protection for each industry.

The effective environmental protection for product j shall be E^*_j. This can be calculated by the following formula (valid for any value of a_i).

$$E_j^* = \frac{V_j^* - W_j}{W_j} = \frac{V_j^*}{W_j} - 1$$

This means that

$$E_j^* = \frac{\textit{Added Value at domestic prices (tariff + PAT)}}{\textit{Added Value at world prices (without tariff + PAT)}} - 1$$

In the calculation of effective environmental protection two cases arise depending on the value of technical coefficients a_{ij}:

A) If a_{ij} technical coefficient valued at international prices (with no tariff).

$$E_j = \frac{V_j^*}{W_j} - 1$$

where:

Added Value to domestic prices with PAT

$$V_j^* = (1 + t_j^*) - \sum_i a_{ij} (1 + t_i^*)$$

Added Value to international prices without PAT

$$W_j = t_j - \sum_i a_{ij} t_i$$

where:

t_j^* → Nominal protection for the output + Pollution Added Tax (PAT).

$$t_j^* = t_j + t_j'.$$

having:

t_j → as the tariff per unit of output.

t_j' → as the PAT per unit of output.

t_i^* → Nominal protection for the input + Pollution Added Tax.

$$t_i^* = t_i + t_i'.$$

having:

t_i → as the tariff per unit of input.

t_i' → as the PAT per unit of input.

a_{ij} → Technical coefficient at international prices

Therefore, effective environmental protection is calculated as

$$E_j^* = \frac{(1 + t_j^*) - \sum_i a_{ij} (1 + t_i)}{t_j - \sum a_{ij} t_i} - 1$$

In this case, where the technical coefficient is calculated at world prices, one can also use the following formula:

$$E_j^* = \frac{t_j^* - \sum_i a_{ij}\ t_i^*}{t_j - \sum_i a_{ij}\ t_i}$$

but it is necessary to remember that this formula can only be used if the technical coefficients are valued at world prices. In this case:

$$E_j^* = \frac{t_j^* - \sum_i a_{ij}\ t_i^*}{t_j - \sum_i a_{ij}\ t_i} \equiv \frac{V_j^*}{W_j} - 1$$

B) If a_{ij} technical coefficients valued at domestic or national prices (with tariff)

Added Value to domestic prices with PAT

$$V_j^* = t_j^* - \sum_i a_{ij}\ t_i^*$$

Added Value to world prices without PAT

$$W_j = \frac{1}{1 + t_j} - \sum_i a_{ij} \frac{1}{1 + t_i}$$

The effective environmental protection in this case, where the technical coefficient was calculated at domestic prices, would be:

$$E_j^* = \frac{V_j^*}{W_j} - 1$$

Therefore:

[2] $$E_j^* = \frac{t_j^* - \sum_i a_{ij}\, t_i^*}{\frac{1}{1+t_j} - \sum_i \frac{a_{ij}}{1 + t_i}} - 1$$

An interesting result from this analysis is that it allows one to calculate the PAT paid on an imported product, equivalent to product manufactured in national ground, when this final product consumes inputs bearing PAT, so that the tax on effective protection does not vary when PAT is introduced.

The tax per unit of output is calculated, where the technical coefficient a_{ij} is valued at domestic prices, with formula (2):

$$t_i^* = t_i + t_i'$$

Where:

$t_i \rightarrow$ Per unit tariff of the imput i

$t_i' \rightarrow$ PAT of the equivalent imported imput i per unit

The PAT rate for output j if a_{ij} is calculated at domestic prices (3) would be:

[3] $$E_j^* = \frac{V_j^*}{W_j} - 1$$

since we know that:

$$E_j^* = \frac{V_j^*}{W_j} - 1$$

$$W_j \; E_j^* = \frac{W_j \; V_j^*}{W_j} - W_j = V_j^* - W_j$$

substituting in (3)

$$t_j' = V_j^* - t_j + \sum_i a_{ij} \; t_i^*$$

[4] $$t_j' = V_j^* - t_j + \sum_i a_{ij} \; (t_i + t_i')$$

The above reflects the PAT of output j if the a_{ij} technical coefficient is calculated at domestic prices.

It seems clear that this analysis would allow one to resolve, to a great extent, the reluctance of companies where input prices increased with the introduction of PAT, since one would be guaranteeing that the increase in costs would not entail a loss in competitiveness compared to equivalent imported products on the domestic market.

Distortions in foreign markets would also not arise since PAT would be rebate to the exporters at the border. Environmental external factors are internalized by the PAT following the principle of the country receiving of the final product (output).

Consequently, the main practical problem remaining is that, since production aimed at export to countries with underdeveloped environmental legislation means that PAT is reverts to these countries at the border and that these countries are later charged no taxes in the importer country, lack incentives to reduce their added production pollution for export.

Therefore, the initial difficulty in establishing a system of effective environmental protection is to determine which products are generated by using inputs directly connected to the pollution caused. To follow up, the second step is to estimate the added pollution in each product for each polluting input used.

In the long term, the appearance of new technology, which reduces the use of polluting inputs, does not produce any theoretical problems, unless the technical coefficient a_{ij} is rapidly altered. But in any case, these coefficients are automatically recalculated every so often, usually when calculating the Input-Output Table, and one could even calculate specific coefficients more frequently for industries using less polluting advanced technology.

If different forms of technology coexist simultaneously and generate a different volume of pollution which consuming the same quantity of the same input, it would be necessary to calculate the types of PAT applicable to each form of production technology according to the polluting effect of each process. In order to do this, one would have to take into account different technologies --from the company's point of view-- and which would therefore require the calculation of a vector of specific technical coefficients a_{ij} .

Where:

$$\exists\ a_{ij}^{t}$$

Having:

$t = 1, 2, 3, ..., T$

which represents the T possible forms of technology available to manufacture output j using the same amount of input i, but generating T different levels of pollution.

CONCLUSION

In conclusion, these papers analysis suggest has many possible applications for controlling the quality of water or air when pollution origin is linked to input consumption which generates no point pollution. However there is a direct relationship between the total inputs used and the external diseconomy caused.

Pollution Added Tax applied at the border by the method presented here provides an effective environmental protection without international trade distortions; does not require general agreements with other countries; does not encourage the movement of polluting industries to world areas with underdeveloped environmental legislation, has a high potential for profit, and directs technical change towards less polluting technology. But for exporter industries maintains the output level at a higher level than the environment warrants, then local command and control or marketable permits programs should be required.

BIBLIOGRAPHY

ALLISON, J. R. (1990): "Internalizing and Controlling the external costs of Agricultural Chemical Use". *VIth European Congress of Agricultural Economists*. The Hague. Mimeo.

CORDEN, W.M.V.(1971): *The theory of protection*. London.

CORDEN, W.M.V.(1989): *Trade policy and welfare*. Oxford. Clarendon.

GRUBEL, H.G. and JOHNSON H. (eds.) (1971): *Effective Tariff Protection*. Geneva.

JACOBS, M. (1991): The Green Economy. Environment, Sustainable Development and the Politics of the Future. Pluto Press. London.

KIERZKOWSKI, H. (1987): Protection and competition in international trade: essays in honour of W.M. Corden. Basil Backwell. Oxford.

SAN JUAN, C. (1994): *The PAT and international trade*, mimeo., Universidad Carlos III de Madrid.

TURNER, K.R. (ed.) (1993): Sustainable Environmental Economics and Management. Principles and practice. Velhaven Press. London & N.Y.