VASSILIOS KALAITZIS* and STAVROS XIARCHOS*

WHO BEARS THE COST OF WATER POLLUTION?

* Graduate Industrial School of Thessaloniki, Thessaloniki, Greece.

I. Introduction

Pollution brings us to one of the most vexing and sometimes tremendously complicated problems in our economic system; and that is the problem of controlling externalities. The term external effects on firms makes its appearance in Alfred Marshall's Principles of Economics as external economies, i.e., economies external to the firm but internall to the industry (Mishan E. 1979, p. 1).

Externalities are considered to be classified as one among the failures of the price mechanism or, as a standard exception to the equation of optimality with universal perfect competition and, in general, refer to interactions among the economic agents which are not adequately reflected in markets.

Externalities are associated with private and public property rights) and they give genesis to the divergencies between «private net product» and «social net product» (Pigou A. 1962).

Before launching into our presentation, it is better to define externalities as technical features of technology (leaving tastes aside) without initially refering to markets at all. Generally speaking then, externality is said to be Pareto relevant that is, to have important allocative significance, when the activities of one producer directly affect the technological abilities of another producer. «There can be no doubt that the existence of goods with public or social elements inhibits the achievement of Pareto optimality in a market-organized economy regardless of the state of competition or the convexity of production functions. That is,..., market failure results when individuals or firms cannot adjust quantity taken, and information necessary for price discrimination is not revealed (Burkhead and Miner 1971, p. 104). Head (1962), Buchanan (1966), Samuelson (1969), Musgrave (1969), Arrow (1970) and others agree more or less that the problem of externalities and the market failure[1] is «a fact of nature».

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1. Market failure is taken to mean (within a set of mutually exclusive and

Consider two chemicals processing firms —one producing product A, another producing product B— where each one of them uses only local inputs as an input. The production of B is said to have an e x t e r n a l e f f e c t on the production of A if the output of A depends not only on the amount of labor used by the A - firm but also on the level at which the production of B is carried on. Using notation, the production function for product A can be written as:

$$A = f_1 (L_A ; B) \tag{1}$$

Where L_A stands for the amount of any input devoted to the production of product A and B represents the level of output of product B over which the firm which produces product A has no control. The two firms mentioned above can equally be placed as located on a river with firm producing A being downstream from firm producing product B. Suppose now that firm B pollutes the river during its productive process. Then the output of firm A may depend not only on the level of inputs it uses but also on the amount of pollutants flowing past its factory. Consequently, $\partial f_1/\partial B<0$, and that means that there exists a n e g a t i v e e x t e r n a l e f f e c t between the output of B and the production function for product A.

The relationship between the two firms can be beneficial as well. The best-known example from the economic literature is that proposed by J. Meade (1952, pp. 54-67), where there exist two firms, one producing honey (raising bees) and the other producing apples. Because of the bees feed on apple blossoms an increase in apple production will improve productivity in the honey industry. The beneficial effect of having well-fed bees is a positive externality to the beekeeper. In this case $\partial f_1/\partial B>0$.

Externalities may also occur between a firm and one or more individuals. The characteristic feature of all the examples referred to externalities is that technologies (and tastes and technologies) are related in some direct way, not necessarily htrough the market.

exhanstive categories) the full range of factors which prevent an economy from achieving the utility possibility frontier.

II. Externalities and Markets

It has usually been argued that the presence of externalities such as those described earlier can cause a market to operate inefficiently. Suppose the production function of the pollution-producing firm is given by

$$B = f_2(L_B) \tag{2}$$

Where L_B is the quantity of labor devoted to B production. The production function for product A which exhibits an externality was given by (1). By the Pareto conditions for an optimal allocation of labor is required that the social marginal value product of labor ($SMVP_L$) be equal in both occupations. If P_A and P_B are the prices of products A and B respectively, the SMVP of labor in the production of product A is given by

$$SMVP_L{}^A = P_A \frac{\partial f}{\partial L_A} \tag{3}$$

Because of the productive externality the statement of the SMVP of labor in the production of B is somewhat more complex. An additional unit of labor employed by firm B will produce some extra units of B. But it will also produce some extra pollution, and this will reduce the production of A. Hence,

$$SMVP_L{}^B = P_B . \frac{\partial f_2}{\partial L_B} + P_B . \frac{\partial f_1}{\partial B} . \frac{\partial B}{\partial L_B} \tag{4}$$

Where the second term represents the effect that hiring additional workers in the firm producing the product B. This effect will be negative if $\partial f_1 / \partial B < 0$. Efficiency then requires that:

$$SMVP_L{}^A = SMVP_L{}^B \tag{5}$$

The separate decisions-calculations made by the two firms will not bring this condition about if only perfect market reactions are allowed. The firm which produces product A will hire labor up to the point at which its private marginal value product ($PMVP_L$) is equal to the prevailing wage rate:

$$W = PMVP_L{}^A = P_A . \frac{\partial f_1}{\partial L_A} \tag{5a}$$

The firm which produces product B will follow a similar course of action, that is, it will hire labor up to the point at which its private marginal product is equal to the prevailing wage rate:

$$W = PMVP_L{}^B = P_B \cdot \frac{\partial f_2}{\partial L_B} \qquad (6)$$

The market will consequently cause the following equalization:

$$PMVP_L{}^A = PMVP_L{}^B \qquad (7)$$

since the prevailing wage rate W is taken to be the same. Now it is readily seen that the condition of equation (7) will establish Pareto efficiency only if $\partial f_1/\partial B=0$ in (4). In other words, so long as the externality exists, the managers' decisions will not bring about an optimal allocation. In our example we assumed $\partial f_1/\partial B<0$, so this implies that labor will be overallocated to the production of good B.

Labor's social marginal value product ($SMVP_L$) in the production of good B will fall short of its value in the production of product A. The value of output could be increased by shifting labor from the production of B into the production of A. In other words, externalities, hence pollution, hence water pollution in our case here, exists because it is the cheapest way to produce chemicals given the existing set of property rights allocation.

That brings us to the question of what is water pollution. From an economic point of view, it is the production of wastes for the disposal of which the (chemicals) processing industries do not pay anything at all or they pay very little. Water pollution in the (chemicals) processing industries example is part of the output process that those industries produce for use or for consumption by other industries or by consumers.

Polluted water, air, ground etc, or wastes, dirt, noise congestion, smoke, smoge etc., which are produced during the production process of goods and services consumed by society are called in the economist's jargon «bads» to contrast their relation to goods and services society wants and which are called «goods».

We already have mentioned that externalities —and water pollution is one of them— refer to the fact that the output of «bads» does not pass through the market system. A chemical plant (factory) may produce polluted water, etc., without having to pay anyone for producing these «bads». Thus, water pollution exists because it is the cheapest way for the chemical industry to produce its products. That is, it is cheaper for the particular firms (industry), but it may not be cheaper for the community or the society (local or global) as a whole. Thus, the chemical industry may dump its wastes for free into a river (sea, air, ground), but people (other organisms etc.) living downstream from the industry will suffer the cost of having to cope with polluted water[2].

From what has been said so far it is clear that the market-mechanism (bying and selling) is not a means for effectively allocating a great deal of the «goods» and «bads». We have seen that private costs (or private marginal value product) are less than social costs (social marginal value product). The «social» costs of the chemical industry are, of course, private costs incurred by other people some of whom do not even consume the products produced by the industry in question.

The market thus is an instrument for bringing marginal p r i v a t e costs and benefits together as it is shown by (7). It c a n n o t handle marginal s o c i a l costs and benefits. This is because, social costs and benefits are «external» to the market i.e., they escape the registration of the price system.

«If we are interested ultimately in maximizing everyone's well-being, we want the price system to act as a guide to firms and factors and consumers, urging them to buy more or produce more of socially useful goods and to make or but fewer socially deleterious ones. We want an economy that produces more goods and less «bads». But under a pricing system that takes no account of the externalities brought by consumption and production, the economy will produce too many bads and too few goods» (Heilbroner R. and L. Thurow 1978, p. 181).

Since the market system is unable to cope with externalities what is left then? «Coase (1937) and knight (1933) have urged that hierarcies supplant the price system for some resources allocation

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2. It is assumed that the detrimental effects of the chemicals processing industry production do not affect any other agent in the economy other than other firms within the same industry and the consumers (the public or the society). Similarly, the discussion of externalities usually takes place within a partial equilibrium framework in which «second-best» problems are assumed to be negligible.

activities, because for combining factors of production into some products, coordination by central direction is more efficient than the price system. The size of an efficient hierarchy in a market system is limited to the point at which information and control loss within the hierarchy make it less efficient than the market system or alternative organizational forms» (Bish R. 1971, pp. 10-11).

Beyond the market system (market mechanism, price system) and the hierarchies (where an individual takes the place of the price system for allocating resources and coordinating economic activity) the voting system (determining allocation either by direct vote or by electing a representative who will subsequently allocate resources) and the bargaining system (exchanging resources over which the parties involved have discretion) can be used as alternative means for allocating resources. These systems do not exhaust the potential mechanisms for allocating economic resources. Action may also be organized by recourse to legislative or judicial process (these might also be considered special cases of voting and bargaining), although these processes —especially the judicial— are usually costly and elisted only after earlier accommodation attempts have failed.

How can we attack the problem of externalities in order to minimize their impacts on the production of the water pollution? Basically the problem is attacked in three ways: a) by regulating the activity that creates it, b) by taxing the activity that creates it, and c) by subsidizing the polluter, to stop or lessen his activity.

III. a) Regulate the Activity that Creates Water Pollution

The first way, regulation, means to pass a law to forbid chemicals processing industries polluting the water (or the enviroment). (Most ecologically minded persons cry for regulations). This means that the chemicals processing industries must stop the polluting activity entirely or bear the cost of whatever payment is imposed by law, or else find ways of carrying out their activities without giving rise to pollution.

Finding ways of carrying out activities without giving rise to pollution means that the chemicals processing industries should «partially internalize» a previous externality. The market internalization of the externality implies that, once priced, it comes under the control of chemicals processing industries which, hitherto, could only be a passive recipient. That is, a regulation imposes a cost on the chemicals processing industries on an activity that was previously «free» for them not free, however, for the society.

Next we ask: what are the economic effects of regulation? Or, to ask the same thing in other words, who bears the cost of internalization of the water pollution caused by the chemicals processing industries? Suppose for the moment that a regulation is passed forcing the chemical industries to install water-treatment facilities. Who bears this cost? «The firm must bear it;» it is an easy and obvious answer at first thought. In fact it would, in the form of reduced profits, if it were a monopoly or an oligopoly prevented from raising prices, say by price ceiling.

If the firm, however, is a competitive one or if does pass its higher costs along in higher selling prices then someoneelse bears the cost of installing the water-cleaning devices. Now, elementary economic analysis will show us that the cost is borne by at least three distinct groups, not just by the firm. The three groups are: First, the firm will bear some of the cost because at the higher price, it will sell less of the product produced. How much less depends on the elasticity of demand for its product. But unless demand is totally inelastic (a vertical line) its sales and income must contract.

Secondly, the factors of production. Fewer factors will be employed because output has fallen. Their loss of income is also a part of the economic cost of antipollution regulation. Thirdly, is the group of consumers. Prices are higher now but the rise in price is less than the full rise in costs so that the consumer will not bear all the costs. These three groups and the general public are compensated by having a cleaner water enviroment. As part of the public, all three groups will benefit from cleaner air, but each is likely to feel its specific loss more keenly than its general gain. Regulations are good or bad depending on their ease of enforcement which in turn is largely a matter of cost and the number of the participants involved in the regulation.

b) Tax the Activity that Creates Water Pollution

A second way to cope with water pollution is to tax the chemical processing industries which pollute the water. When the State decides to tax water pollution (often called effluent charges), it is essentially creating a price system for disposal processes. If an individual chemicals processing company found that it could clean up its own pollutants more cheaply than paying the tax, it would do so, thereby avoiding the tax. If the company could not clean up its oun pollutants more cheaply than the tax cost, it would pay the necessary tax and look to the state to clean up the water.

The effluent charge looks like, but is not, a licence to pollute. It is a license that allows the chemical prossecing industries to give some of their pollutants to the state for a price. Thus, as a result of effluent charges, an activity that was formerly costless is no longer so. That is, in terms of their economic impacts, these charges are just like government regulations. The difference is that each producer can decide for himself whether it pays to install clean-up equipment and not pay the tax or to pollute and pay whatever tax costs are imposed. The effluent charges raise the supply for the good in question, with all of the corresponding consequences.

Comparing regulation and taxation can we decide on safe ground which one is better? Regulation affects all the polluters alike, and this is both its strength and its weakness. Taxation, on the other hand, gives the opportunity to each polluter to settle for himself what courses of actions are best. Here, of course, practical considerations are likely to be all-important. Moreover, to be effective, a water pollution tax to chemicals processing industries should vary with the amount of pollution. One of the problems with taxation is that of installing monitoring equipment. It is difficult to make accurate measurements of pollution or to allow for differences in enviromental harm caused by the same amount of water pollutanrs coming from two factories located in the same area.

c) Subsidize the Chemicals Processing Industries to Stop or Lessen their Activity

The third way of dealing with water pollution is to subsidize polluters to stop polluting; that is the state pays the industrial chemicals processing industries to install the necessary water-cleaning-equipment to clean-up their effluents. Because the state bears the costs of the water-cleaning-equipment, the individual private chemical processing industry incurs no cost. Its supply curves do not shift. No fewer factors are employed. Prices to the consumers remain unchanged.

The total amount of resources devoted to water pollution control will therefore be larger under subsidy than under taxation or regulation and that is because there is no reduction in output, as in the case of the other two techniques.

Economists do not usually like subsidies because, they say, subsidies camouflage the true economic costs of producing goods and services cleanly. When regulations or taxes increase the price of chemical products (produced by the chemicals processing industries) the firm and the individual consumer becomes aware of the fact that the water enviroment is not a free good and that there may be substantial costs in producing the chemical products in a way that will not damage the enviroment. The increased costs will lead the individual firm to produce less, while if will lead the individual consumer to consume less, too.

But whenever the individual producer produces chemicals at no pollution costs, he will produce more product (causing thus heavier damage to water) while the individual consumer, getting clean environment through the allocation of a portion of his taxes, he has no price signal to show him the cost of pollution associated with particular commodities produced by the chemical industry.

Nevertheless, there are cases where subsidies may be the easiest way to avoid pollution. In our case here it may be the easiest and the most efficient way to subsidize the chemical industry (or another independent industry) to install water-cleaning-equipment instead of trying to regulate their disposals or to tax them for each kilogram of pollutant given away.

In summing up what we have said until now, it is clear that the market system has weaknesses or ineffective mechanisms peculiar to its institutional nature. Market's inability to put a price on external effects (or to give a producer the rewards ot producing external benefits) means that the system, left to itself, will work poorly or even dangerously. The remedy requires political intervention of one kind or another —regulation, taxation, or subsidy— for there is no recourse other than political action when the self-regulating economic mechanism fails.

The basic starting point for our analysis is the simple fact that pollution, in most cases, originates in our economic activity of production and consumption. The simplicity of our analysis is a deliberate one; we do not intent to pass judgment on the numerous, proposals made to deal with aspects of pollution.

In what remains we take a look at the existing dominant approach by means of examining just one study of pollution control and the economic tools used in it.

IV. A Case Study Behind Water Pollution Control in the United States of America

Kneese and Shultze writing in 1974 state: «Over the past two decades a body of federal policy has gradually developed to deal with air and water pollution on a national basis. That policy has had two central copmonents; first, increasingly detailed federal regulations, limiting the amount of pollutants that business firms, municipalities, and consumers may discharge into the enviroment; and second, increasingly large subsidies to municipalities and business firms for the construction of plants to treat waste water (A. V. Kneese and C. L. Schultze 1974, p. 1).

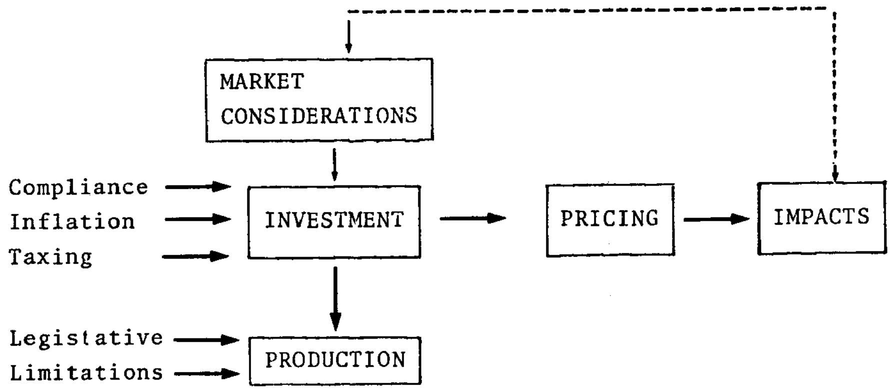
It will be readily recognized that the chemical industry is important to the economy (of the USA) in any discussion of pollution control and associated price increases for two reasons: 1) Go-away quantity of pollution associated with production of its wide range of intermediate and final outputs, and 2) The close interrelationships of the chemical industry with all the other industries as a producer of many of their inputs.

Further, the chemicals processing industry has many of the characteristics which make the application of only one economice approach impossible. Among these are oligopolistic or monopolistically competitive market structures, multiproduct plants and firms, alternate processes, joint products production etc.

Object of the study was to assess the price increase in chemical products due to pollution abatement standards set for the period 1977-1981 and to translate those price increases into impacts in: the investment of the industry, the market structure of the industry, the profit margins, and the regional effects (investment, employment).

Given the problem of the diverse nature of the industry the task was not an easy one to be accomplished. A central feature of the analysis was the assessment of competitive market behavior in the industry. This is the hinge upon which pricing and output decisions turn. Much of the rest of the complete model is rather straightforward application of accepted concepts to a particular problem. The models of market structure and plant-product concentration were based on newer conceptions.

Diagram 1, below, indicates the factors which impinge upon impact of water quality control.



S o u r c e: IR and T, page 6-2.

Diagram 1. Factors affecting the economic impact of water pollution control.

The study was performed to assess the impacts of enforcement of Enviromental Protection Act (EPA) regulations putting into effect Public Law (PL) 92-500 of 1972. Focus of this Act is the use of effluent guidelines as the main instrument for control of water pollution. This was a step backward from the basic objective of achieving specified water quality standards.

This basic objective was found to be unworkable in most cases due to synergistic effects of chemical discarges, other activities in watersheds, and physical factors affecting the water quality. Standards can be used or, when effluent guidelines fail to do a reasonable job, they should be used instead of effluent guidelines.

Effluent guidelines allow each producer of a specific product by a given process to discharge quantity of a specific pollutant per unit of manufactured product over a specific period. Location of the manufacture makes no difference in this allowance. Such guidelines have the advantage of being easy to enforce and are not open to misinterpretation.

Basic to the study is the fact that effluent guidelines apply to three levels of technology available to the firm, and that use of these different levels is applicable to chemical plants of different vintages. The three levels are: 1) BPT: Best Practicable Technology (Jul 1, 1977), 2) BAT: Best Available Technology (by July 1, 1983), and 3) BADT: Best Available Demostrated Technology. The later level of technology indicates the intention of upgrading requirements as new available methods of pollution abatement control come on stream. Distinction between these three levels of abatement facilities enter into the model at two points; the production model and the investment model.

Production Aspects

One data base for the study expected cost increases associated with governmental water pollution limitation («standards»). These were formulated by technology contractors using the three different control standards discussed above.

The contractors were faced immediately with the complex structure of the industry. «Most chemical products are produced in intergrated facilities that concurrently manufacture a number of other chemical products, sometime in excess of 1,000; and the treatment costs for each product are very much a function of the number, type, and production volume of other products» (IR and T, p. 5-1).

Since effluent guidelines had been developed for only a small percentage of products, the contractor for the organic and inorganic chemicals industries developed generaliezed plant configuration, sets of product/processes based on a selected number of representative actual plants angmented by hypothetical compatible products processes. Sixteen such plants were identified for the inorganic chemical industry and twenty-four for the organic chemical industry.

For cases in which joint treatment of wastes appear to be of litt e benefit in reducing costs, product/processes were evaluated both as a part of a generalizzed plant configuration and as a single or specific plant configuration. This tool was proved to be valuable in that joint treatment appeared to affect costs more than did scale economies for the specific products. The output of this analydis is used as input in the investment model.

Market Aspect

A second set of data inputs is projection of economic activity for future periods and translation of these into division of demand among 185 sectors by uses of the EPA's Strategic Enviromental Assessment System (SEAS). These final demand are then translated into demands for specific chemicals by means of the Chemical Input Output Table (CIOT).

The complex nature of the chemical industry made necessarity use of this table, since many chemicals serve as intermediate products many of them captive. The CIOT suffers from all the usual defects of input-output tables. The analysis incorporated alternative coefficients in the cases of chemicals whose coefficient have tended to change with time. In addition the table is not complete; sales of each chemical to other chemical industries and other economic industries are identified, but inputs from each other industry to chemicals processing industries are not included.

In addition to estimating future chemicals demand, the table was used to estimate change in product value added based on own pollution control-abatement costs plus those of chemicals used as inputs to the process, and also to make comparisons between these estimates and impact of cost increases in fuels both as fuels and as chemical feedstocks. These data then go to both the pricing and model of changes in production capacity.

Market Structure

The structure of the chemicals processing industry is extremely complex. This complexity means that chemical producers have more discretion over pricing policies than is found in many industries. A method is needed in order to indicate points where such practice as price leadership of loading the costs of one product onto another, might be possible and probable.

Concentration ratios are often used to describe the structure of an industry. These are percentages representing the aggregate share of some indicators (e.g. sales, value added, shipments) of the N largest firms in an industry. These are percentages representing the aggregate share of some indicators (such as value added, shipments etc.) of the N largest firms in an industry. Their main defect is that they conceal much information which would be of aid in analyzing possible industry behavior. Basic shortcomings are:

1) The arbitrary number of firm induced in the ratio may be of great importance or, it may be of little significance, depending on the industry. An ideal measure would include all firms in the industry, but weighted as to reflect their respective shares in the activity chosen.

2) Changes in the distribution of shares within the group of included firms and within the group of excluded firms may be of economic importance, but concentration ratios do not reflect these so long as the aggregate N firms share remains unchanged. Again, an ideal weighted measure would reflect these changes in distribution of shares.

3) Although many changes in concentration within an industry are due to horizontal or vertical intergration activity, such changes are not measured accurately with conventional N firms concentration ratios.

The measure of market structure used in this study was the concept of entropy[3] borrowed from Physics. An identical measure has been developed in several different disciplines (IRT, p. 6-18). The entropy measure does not overcome all the difficulties entered in the multiproduct, multi-process; and interrelated nature of the chemicals processing industry, but it is a definite improvement over the conventional N-firms concentration ratios and overcomes the three defects mentioned above.

In a system of equal likelihood of occurance of n possible events, entropy is given by the following equation

$$H = -\sum p_i \log_2 p_i = \sum p_i \log_2 \frac{1}{p_i} \tag{1}$$

Where p: denotes possibilities (probabilities) of appearance. Where only one event occurs, p=1 and H=0; where two equally likely possibilities can occur then p=1 and H=1. As he number of equally likely possibilities doubles from any base, H increases by one. Where each

3. The entropy of a system is a measure of its degree of disorder. The total entropy of any isolated system can never decrease in any change; it must either increase (irreversible process) or remain constant (reversible process).

one of n equally likely possibilities can occur then $p_i=1/n$ and $H=\log_2 n$.

A relative entropy measure R can be defined as the ratio of actual entropy in a system to the maximum possible value for that system. Use of entropy measure for industrial analysis could be interpreted as follows. If the p_is are defined as market shares of the firms in industry y, entropy H, then, is the weighred average of the logarithms of the market shares of those firms, or

$$H = \sum y_i \log_2 \frac{1}{y_i} \qquad (2)$$

The entropy H reaches its maximum value ($H=\log_2 n$) when each of the n firms has an equal share in the market. The relative entropy figure

$$R = \frac{H}{\log_2 n} \qquad 0 < R < 1 \qquad (3)$$

allows (us) comparison between actual degree of competition in the industry and the maximum possible figure representing equal market shares. Relative entropy values range from zero to one. The closer to zero, the greater the possibility that Market Power exists (and could be used); the closer to one, the greater the possibility that the Market Power is (equally) spread among the firms.

The following features of entropy measure make it convenient to the analysis: a) it varies directly with degree of competition bounded by $H=0$ and $H=\log_2=n$, b) the logarithmic form ensures that each firm in the industry is included in the measure, according to its probable market impact, c) change in the market share of any firm is registered by a change in H. This enables the measure to be used easity in order to analyze the effects of merger activity or to analyze competition over time, d) relative entropy can indicate probable inderdependent behavior of firms in an industry and give the possible structure, e) the measure can be used for any subset of production facilities within an industry. In this particular study it was used in two additional ways. Entropy measures were estimated: a) by product for both plants and companies. The y_i was then interpreted as the amount of total product capacity used for production of the jth product, b) by both plant and company for its of its n products. The y_i was then interpreted as the share in total value added of each product the plant (company) produced.

This was done to identify products of special importance to each plant and company, signalling a need for further analysis in terms of price and quantity effects.

Investment Aspect sincreases the demand for specific chemicals identified by Inforum and CIOT must be met by expansion of existing plant (with due allowance for absolescence and capacity decreases and disinvestment) or construction of new facilities. Determination of how increased capacity will be, distribution between old and new plant is important because the standards applied differ in these cases. A further input into tihs model must come from the market structure model due to greater ability of large plants and firms to expand, and reap the greater economies of scale in pollution abatement costs. Once costs have been estimated the next step is establishments of probable compliance timelines. A variety of other factors such as regional differencies in costs and taxes must be used to adjust the cost figures arrived at.

Pricing Aspects

The linkages between cost increases and price changes are inferential only. Several alternative scenarios were identified assuming cost increases equal to price increases possibilities, i.e., price set by most efficient producer, price set by least efficient producer, and offloading of cost increases to products with privileged market position.

Impacts

This is the last step in the calculations. However, changes identified here may have significant consequences for elements within the model, in which case feedback effects must be considered e.g. increase in product value added leads to decrease in consumption of the product, whether PAE* is done in addition to or in place of increasing capacity. It will be readily apparent the large demands the complete system makes an information, both historical and projected. Each of

* Pollution Abatement Expenditure.

these is a source of error. The forecasts of demand drive the CIOT* but the forecasting models inherent weakness is their reliance on historical relationships.

Latent relationships or unprecedented types of change in technology in the social or political enviroment cannot be incorporated in the forecasted date. The CIOT which the forecast's feed, satisfies requirements of balance and general interdependency, but incorporates problems of its own. They are very difficult to make really up to date, hence always reflect somewhat lagged relationships. In addition, they implicitly assume static production technology and unchanging long-term seller customer relationships which cause too high estimates of PAE costs, however the degree of cost over estimation is unknown.

The other estimating techniques in the investment model incorporates a large element of guesswork («guess-timation») since in the final analysis the question they were formulated to answer can be answered finally by indusrty behavior in a variety of ways. The entropy model of market structure is a definite improvement over the older concentration ratios, as we have tried to show, but inference of industry pricing behavior based on it is still subject to error. Likewise, plant capacity and compliance timeline estimating are subject to error, the later especially because of historical tedency of regulatory agency to accept postoponements, change standards, etc.

Based on the difficulties of the task at hand, the model is logical and neat. However, the sophistication of the analysis should not odscure the fact that the legislative command approach to pollution control is at the end of the process that we have not moved away from a central system based on fiat. Suggestion is made that technology best suit to reduce water pollutants emitted will doubless change, and that the regulatory agency will upgrade PAE requirements based on the newer better technology, but no suggestions are incorporated as to whether it might be better to allow the plant/firm to choose its oun technology or to offer incentives for it to do so. The regulatory agency in this study stepped backward from a higher standard of water quality (which tended to be difficult to administrator) to a lower but achievable and enforceable level.

It would appear that, using the large informational inputs of stu-

* CIOT: Chemical of Input-Output Table.

dies such as this one, some control method(s) might be devised calculated to hardness the profit motive to move in the better interest of the society as a whole. To elliminate water pollution more control would be required for example taxing end-of-pipe discharges, perhaps at an increasing rate, and the data-laborial requirements would be decreased. Alternatively, selling rights to pollute, again perhaps with price increasing with quantity of pollutants, could achieve the same effects decreasing thus to a great extent data requirements.

V. Summary

The pourpose of this paper was to assess the policies of industrial abatement which serve as alternatives to the current governmental policy, labeled judicial action. The other alternative policies were labeled resource charge and abatement subsidy. As a case-study example a research on water pollution by the U.S. chemical processing industries was used to identify difficulties in assessing who bears the cost of water pollution in that country.

The judicial action approach relies on use of national standards, implying that violation of these standards would lead to economic sacrifice. The use of national standards make the policy, following the view of some economists - economically inefficient. There is a lack of flexibility in that policy, since national standards may be too tax to achieve adequate installation and operation of equipment. Hence the proposition of a more decentralized policy, whereby pollutants would be priced according to the quality and quantity of damage done in a particular geographic area.

Resourche charges, claim the economists, address the problem of relative cost assessment than does judicial action. Like the judicial action approach, resource charge policy utilizes negative incentives. However, it is believed, through implementation of charge approach, a perceive deviation (gap) would be closed between private production and social (pollution abatement) costs.

Another policy alternative is the what is called abatement subsidy. This policy utilizes positive incentives. Such a policy could have decentralized application, thereby making subsidies potentially more efficient than judicial action from an economic point of view. Economists criticize the subsidy alternative, however, because it inadequately addresses the problem of relative cost assessment, resulting in tax increases and/or consumer price likes.

In overall, to assess what policy makes the «best» job. Other factors have to be taken into account. Such factors could be for example, both biological and economic crisis (Esterlin 1971, Jansma 1971) the time element (Moore 1963), the economic efficiency (Jansma 1971) economic incentives (Hammer 1973), the employment-unemployment factor (Drucker 1972), etc. It may be concluded from the above exposition that there is no easy way to resolve the economics of pollution problem but we do believe that any serious try is worth of the effort involved.

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