THE PROBLEM OF POLLUTION: AN ECONOMIC EVALUATION AND POSSIBLE METHODS OF CONTROL

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The Nature of Pollution: A Problem or a Natural Phenomenon?

Introduction

This study aims to examine the relationship between pollution and externally, and to measure, as well as to estimate, the optimal level of pollution by using marginal net price benefit function.

Data for this study have been complied from available literature, including published and unpublished material. Several methods were used to achieve the optimal level of pollution. These include Pigouvian Tax and Subsidy, other subsidies, marketing permits and others. The broad hypothesis underlying this study is that the optimal level of pollution occurs when marginal net private benefits are equal to marginal external costs.

The Organization for Economic Cooperation and Development (OECD) defines pollution as defilement, uncleaning or impurity. Since it is extremely rare to discover an example of an entirely clean or pure things, it is clear that most of the earth is suffering from pollution. It has also become clear that nature itself pollutes and that pollution is a natural process. Things have been rendered unclear or impure sdely by perfury nature process since time began.

From a scientific point of view, the term pollution is usually used to refer to specific harm inflicted on a particular person or object by the action of another. When scientists express fears of pollution, they usually refer to the harm inflicted by the action of man upon the natural environment.

Economists take a more pragmatic view : the rule is to constantly improve the allocation of resources with a view to increasing the net welfare of the world. In economics, it is acceptable to damage resources through pollution if the value of the polluting activity is greater than the value lost through pollution, and provided the effects of pollution can be cleared away. In this case, pollution is acceptable if the value of the polluting activity is greater than the cost of the clearing operation.

Pollution as an Externality

The general definition of externality concerns the effects of one economic act in terms of the consequences of another economic agent. Baumol (1988) lays down more specific conditions for the existence of externality:

1) Some agent's utility or production relationship consider real variables (non-monetory) which are more determined by others, with no special consideration for the individual agentís utility. Baumol goes on to make it quite clear that this is different from economic independence, since in simple interdependence there will not necessarily be any negative effects.

2) Those whose decisions often affect the agent do not receive or make payment in relations to the losses/ benefits they inflict on the agent.

If this was the case then a "Price" would exist for the action and it would become "internalized" into the price mechanism and cease to be an externality.

It is easy to see how pollution of any sort fulfills both criteria. The manager of a smoke producing factory clearly affects the inhabitants of the surrounding area by his decision, and certainly he does not consider it in his decision making process. Equally, he does not have to pay a price for using the atmosphere as a dumping ground, since if he does the cost would affect his production decision.

Since cleaning environment is a public good available to all at no cost, the pollution of that environment is a public "bad'. Pollution of the air, for example, is observable by everyone and is unlikely to affect some individuals more than others. Such pollution is classified as a public extension.

3) In some cases, the externalism may be private - suffered only by a particular individual. Banmol (1981) uses the example of a quantity of rubbish dumped in a garden. It is only an individual who suffers. This is

referred to as private externality, and in terms of the nature of the environment as a public good, it is less common than public externality.

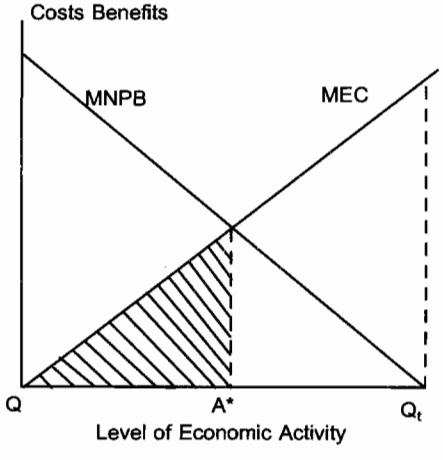
The economic view of pollution leads us to a rather different conclusion from than that reached by life scientists. Life scientists seeks to reduce all pollution to preserve the environment as a public good economists realize that there is an optimal level of any externality, and pollution is no exception.

The Optimal level of Pollution

Any externality is worth enduring so long as the benefit from it (in terms of production) exceeds the cost. The optimal level of that externality is reached when net costs and benefits are exhausted, i.e. when the cost of the last unit externality is equal to the benefit. (standard ML = MR theory). This is also the case with pollution, and it leads us to conclude that there is an optimal level which is anathema to most life scientists).

Fig (1)

The Optimal Level of Pollution.



MNPB = Marginal net private benefit

MEC = Marginal External cost of pollution

//// = Optional amount of Environmental damage.

QTC = Profitable level of pollution (which occurs if MEC is not considered)

Pearce and Turner (1991)

The MNPB from production is equal to the price of the last unit sold minus marginal cost, in a perfectly competitive firm. Hence:

MBPB = P-ML

At the optimal level of externalism

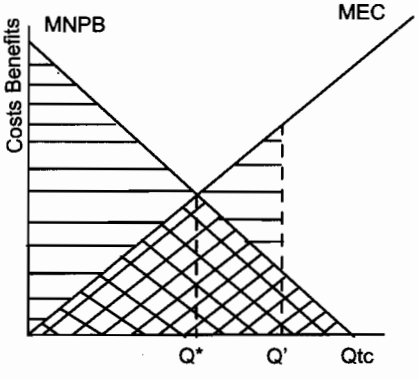
MNPB = MEC
MEC = P-MC
P = MC + MEC
If P = MC + MEC then the optimal level of pollution will be achieved. (See Fig. 2).

Since MEC is P-mc. no matter whether the burden falls on a single individual (private externality) or on a group of individuals (public externality), the condition for optimality holds in both cases.

The Need For Pollution Control

Fig 2 shows that the optimal level of pollution (Q) provides the largest net benefit since area(A) represents benefits minus total costs. Any sub-optimal level of pollution will therefore produce a net welfare loss.

Fig (2)
Sub Optimal Level of Pollution



The diagram shows that increase in pollution from the optimum of Q to Q1 produces a net welfare loss of QCC = Profitable level of polluting activity if MEC is not considered

Control of pollution is therefore necessary to ensure that levels do not exceed the optimum.

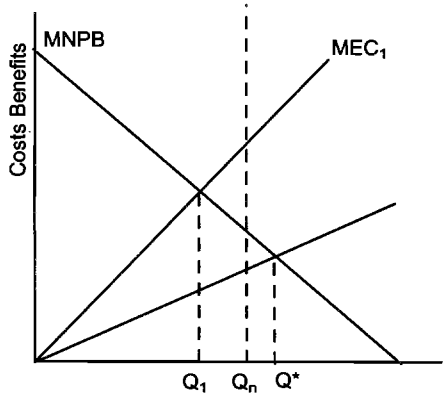
Where pollution levels are less than the optimum, normal economic theory would advocate encouraging more production until optimum levels are reached. In a situation where pollution is below the optimum level, the "public" usually increases their net welfare, at the expense of firms, and this is often regarded as desirable. At any rate the "problem" of pollution is usually defined in terms of maintaining levels at no more than the optimum.

Modern scientific methods have allowed us to realize the true effects of

pollution. During professor pigous time (1920 – 1930) , analysis of private losses and benefits were usually concerned with the present period, and with welfare which was relatively easy to assign monetary value. Today the global environment is widely acknowledged as an infinitely complex and interdependent system, which bears the scars of maltreatment for many years after the initial injury.

If we take into account the interdependence nature of our ecosystem, the effects of pollution on one part connot merely be assessed in terms of the costs to that part. The effects on other parts of the ecosystem must also be considered. If this is done then marginal external cost is likely to rise. Similarly, if the intergenerational effects of pollution are considered, so the marginal external cost must reflect the present value of future costs. In that case MEC is unlikely to rise.

Fig (3)
Marginal External Cost.



QN = Normal level of Economic:

At the original estimate of MEC

Q* was above QN so that no action was needed to keep pollution from rising above the optimum level.

At the new estimate of ME (MECI) we have incorporated modern research findings. The true optimal level of pollution Q 1 is below the original estimate QN Q1' so action is necessary.

Frey, B. (1992)

As our estimates of Q* are falling, it is becoming necessary to activley control pollution.

Level of Q* are also determined by the assiliative capability of the earth. The more capable is the global ecosystem of self-repair and regeneration, the more pollution we can discharge without incurring higher

external costs. However, it is becoming apparent that precious pollution effects may be reducing the earth's capacity for waste assimilation. If this is so then estimates of Q* should be reduced further (See fig (3).

The effect of these inter- sectoral and inter- generational considerations was noted by Meadous et al in their book "Limits to Growth" in which they included the Pessimistic Model through the use of negative feedback loops (1).

As time passes, estimates of Q* appear to be falling, while levels of Q are rising. Fabricant (1966) pointed out that as people pollute, a rising population leads to more pollution (2).

Controlling Pollution

Estimating the optimal level of pollution, as we have seen, involves the use of the polluters marginal net private benefit function and the marginal external cost function. Deriving the MNPB function is relatively easily done by using disaggregated data on the polluters cost and revenue. Estimating the MEC is more problematical.

A true estimate of MEC need to include value for loss of option, value for future use and existing value (intrinsic worth) as well as use value (present use). In order o take account of inter - generated effects , future values of the site of pollution must be discounted to provide a present value - this entailing further problems related to the choice of an appropriate discount rate. Taking account of inter - sectoral effects is also difficult, since we simply do not know the full extent of environmental connections.

Many life scientists, and "Deeep Green" ecologists would place infinite value on the existence of an area. They also would be much attracted towards very high rates of discount in order to preserve environmental features for future generations. Thus their MEC curve is likely to be very steep creating a lower value for the optimum level of pollution. The extent of pollution control which is considered necessary depends heavily on the individual point of view.

Methods of Pollution Control

There are several methods that may be employed to achieve the optimal level of pollution and these are as follows:

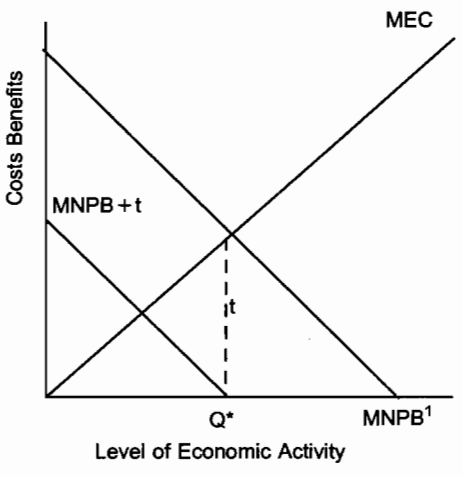
a) The Pigourian Tax:

We have already identified pollution as an externality, and therefore it

would seem logical to inernalize it in the same way as any other externality. The method of doing this, still used today, was first introduced in 1920 by Arthur Pigou. This method involves incorporating the costs of externality into the price mechanism so that an optimal level may be achieved. It works by inflicting upon the producer a tax representing the cost of the pollution damage. This has the effect of reducing the marginal net private benefit from polluting, thus reducing the amount of pollution.

Fig (4)

The Optimal Level of the Tax



The optimal rate of the tax is that level where t = MEC of pollution

Fig. (4) shows the optimal level of the tax which forces producers to take account of the MEC, thus reducing the profitable level of pollution so that it equals the optimal rate (3).

As Basmol (1988) points out Pigouvian Tax is equally suitable to preventing public and private pollution costs, and its universality is a strong point in their favour. It should be noted that once MEC is calculated, they are simple to impose and should provide significant revenues which may be used for further environmental benefit. The Pigouvian Tax meets Adam Smiths criteria for a sound tax.

In practice, there are problems with the tax, in particular in estimating MEC. However this is less important than it would seem. Pearce and Turner (1991) note that optimal levels of pollution are not usually the basis for pollution control policies; rather they are based on the "acceptable

level" of pollution. This is a much less rigorous approach and would not require wholly accurate optimal calculations, since it would rely more on public preference indicators.

Neither is it always simple to identify the exact pollutent. The identification of environment damage due to pollution frequently entails complex detection work to arrive at the orginal source. There may be several sources in which case it would be necessary to determine the ultimate degree of responsibility of each allocated tax accordingly.

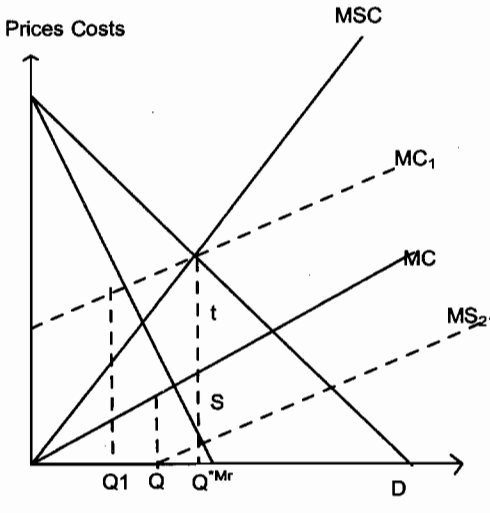
Pollution is not just a domestic problem, and its effects cannot be to national boundaries; for example, over 90% of Norway's sulphur pollution is generated abroad, much of it from the U.K. It is almost impossible to determine the degree of responsibility of individual countries ,let alone of individual factories.

(b) Pigouvian Subsidy

It would seem strange to advocate the use of a subsidy to producers as a means of achieving optimum pollution emission; however in particular instances. it may be appropriate.

In the case of imperfect competition, firms may produce at a level of MC = MR which is less than optimal. Changing a pollution tax equivalent to MEC would increase MC and reduce polluion levels (4). In fact MC should be reduced so that MC = MR occurs at Q* the optimal level of pollution.

Fig. (5) Pigouvian Subsidy.



KSC = Marginal Social Cost

= MEC + MC

Q* = Level of output generating optional level of pollution

Generating and appropriate valuee for tax by MSC-MC, MC reducing the level of activity still further below the optimum.

To achieve the optimum a subsidy (5) is required.

(Pearce & Turner 1991)

Q = Out put

* The use of Pigouviau taxe is likely comatible with the "'Polluter - Principle" There are two broad definitions:

- Standard polluter pays rates more than a polluter, and should be liable to pay for the abatement of effects of pollution which he causes.

- Extended polluter pays recommended rates and may also be liable for damage caused from residual pollution which may not necessarily be attributed to it.

"Deep- Green" ecologists would record any reduction of pollution as an improvement and it is possible that an "Acceptable" rather than an optimal solution is desired. The orginal tax might still be the best way of achieving the objective.

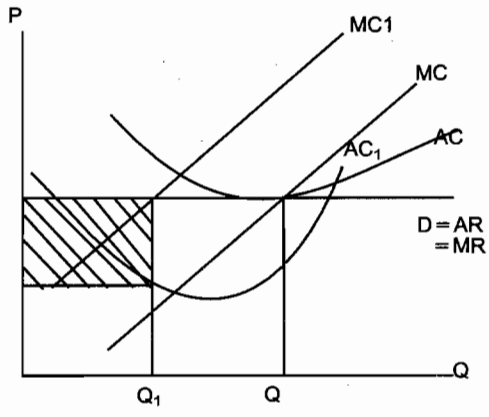
Pearce and Turner (1991) go on to clarify the case for subsidy still further by demonstrating that it is only desirable in situations where MR = ML This naturally occur at a level below Q, where MR = ML occurs at a level of output that Q, output still needs to be therefore a tax is still appropriate (See fig 5).

C) Other Subsidies

In order to reduce its level of pollution a firm may face a high level of net investment which in terms of profitability may not be worthwhile. A government subsidiary may enable the firm to move the net investment and ensure no loss in profit.

Subsidy may also be used as an incentive for procedures to restrict pollution. Firms will receive a subsidy of a specified amount for every unit below a certain level of production they supply. Thus, the average losses of firm are expected to fall; if this is so then for a competitive industry, abnormal (or excess) profit may be earned. If this is the case then in the line with Staword theory, more firm will be in the industry and total industy pollution will rise (Fig 6). It would also be noted that since the subsidy is awarded for production below the specified amount, any extra production subsidy is awarded for production below the specified limit, therefore ML rises individuals firms output falls. Moreover, this is more than offset by new entrants into the industry (5).

Fig. (6) Subsidy and Pollution.



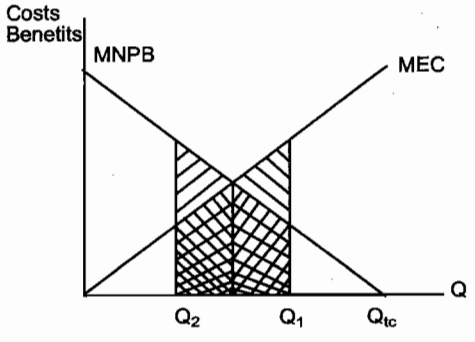
AC, MC = Cost before subsidy
AC1, MC1 = Cost after subsidy.
Q = Firm Quantity produced before subsidy
Q1 = Firms quantity produced after subsidy.
//// = Temporary abnormal profit due to subsidy

D) Property Rights Allocation

Property rights refer to the jurisdiction of an individual or a group over the use of a particular area of land/ resource. In a true situation of common property, anyone has the right to use the resources as they fit. Thus polluters have every right to pollute and victims have no right to demand compensation. Allocation of property rights would allow formal permission to be required for pollution and compensation to be paid. This suggestion is based on the coase theorem and is favoured by many free market economists since it requires very little government intervention.

Fig 7 shows how bargaining will logically conclude to the attainment of the optimal level of pollution.

Fig. (7) Property Right Allocation.



An increase Q-> Q will not occur since the loss of victim ////.
gain of procedures ////
A decrease in Q– Q2 will not occur since the loss of procedure /// is greater than the gain of victims ////
(Tietemberg 1993).

Level of Economic Activity

This is undoubtedly a seductive solution, but it is not perfect. One of the most frequently a concern is the implicit assumption of zero- wealh effects from allocation. The marginal net private benefit curve is effectively the polluter's demand curve for pollution. Allocating property rights to polluter would increase his wealth and would therefore be likely, through a positive wealth effect, to increase demand for pollution. The level of output would therefore be raised above the optimal. Thus, the existence of strong positive wealth effects invalidate the theorem (Tietenberg, 1993).

In reality, however, wealth effects are usually small and the main objection to coase theorem is practical. Tietenberg (1993) indicates that allocation of right to the producer of pollution turns pollution into a profit making activity. This may provide incentives to those previously not polluting to begin producing a non-optimal outcome. Secondly, efficient negotations between polluter and victim are not always practical. If there are several victims, the free-rider problem would probably lead to an insufficient compensation for non-pollution and a non optimal outcome. Identification of the pollution is also a problem, particularly in cases where several pollutions react to cause and effect.

E) Marketing Permits

Following on from property right allocation, a system of marketable permits would formalize the bargaining procedures making explicit what is implied by cost.

Marketable permits are essentially tradeable rights which are created (persumabuy by governments) and released on to the market for sale to the higher bidder. The market price would reflect the demand upon resources therefore to some extent reflecting the true opportunity cost of pollution (Banned 1988).

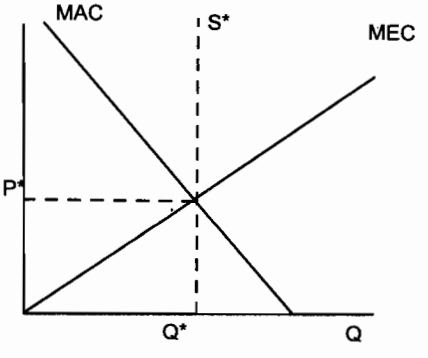
MAC = Marginal Abatement Cost (if the only way to about pollution is to reduce output, then MAC is effectively MNPB).

MEC = Marginal External Cost

Q = Optimal level of pollution

Pearce + Turner 1991

Fig. (8) Marketing Permits.



The diagram clearly shows that if governement wishes to achieve QÆ then it should supply only S Marketable permits and their optimal price will be P* (See Fig(8)).

But one question arises: What advantage do marketable permits have over simple fee for pollution. A fee approach could be simply used for the same effect, and both can be done a minimum cost. However, the fee system entails authorities determining the level of the fee which will achieve optimal allocation of ressources by trial and error. The measuring system allows the price level to be automatically determined by the market (Tietenberg, 1993).

Marketable permits also allow for new firms the entry into industry. A fixed allocation of pollution rights would either prohibit new entrants or raise the absolute amount of pollution. In the marketable case, the supply of permit remain fixed while demand rises. Price rises allowing the new firms to enter but still restricting quantity of pollution (Bound, 1988).

Marketable permits also provide excellent opportunity to resource pollution. If a government receives new information leading it to conclude that previously acceptable levels of pollution are too higher, it simply should back some of the permits. Equally if pressure groups wish to reduce pollution, they too are able to buy permit merely to prevents them being used (Pearce and Turner 1991).

Change in abatement cost may also be automatically connected. As the resource becomes polluted, assimilative capacity could fall leading to higher abatement costs. Price of permits would rise reducing pollution. Similarly, improvements in technology could reduce abatement costs. This could reduce permit prices and increate pollution levels. (Turner 1991).

As Baumal (1988) points out these permits need not initially be sold at auction, but may simply be distributed. If this occurs then they provide a significant advantage to producers over the charging of straight fees for pollution. He goes on to say that geographic differences are also more easily taken into consideration the market: as the price of polluting in this area rises, the value falls.

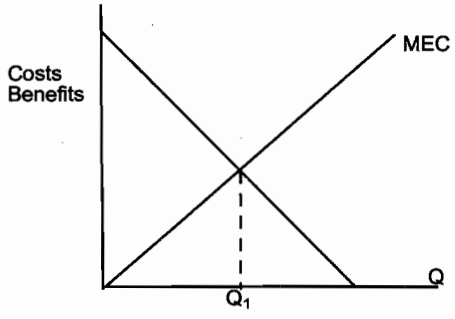
There are two catagories of permit system used by Pearce and Turner(1991): The ambient permit system which restrict the quantity according to levels of pollution at particular places and the emissions permit system which conversely sets pollution limit according to the discharge from firms. Ambiant system is perhaps more environmentally

useful since it is more concerned with damage from pollution. Though it is hard to assess the source of the pollution, emission system is simplier since it does not consider the direct effects from pollution nor its intersection effects.

F) Standard Setting

In a generally planned economy standard setting is a relatively common feature of many policies. The government decides on the optimum level for production and orders industry to conform. Given the complications of the methods we have so far discussed, does a standard setting provide a simple efficient alternative?

Fig. (9) Standard Setting



The diagram shows how setting a standard (which is adhered) produces a perfectly inelastic industry. Supply occur after that level of economic acticity is consistent with the standard reached.

As with most "impositions" on the market it is efficient, manner is unlikely it would imply that the standard setting authority had perfect benefits and abatement losses facing each processor, and the value of the pollution resoruces as appraised by every potential victim.

Even if this unlikely combination were to occur it is also unlikely that the chosen form of penality for the miscreant would be efficient. The current penalty would ensure that the polluter had no more incentive to pollute beyond the standard level (6). The penalty should therefore equal or be greater than the marginal net private benefit for the producer of producing one more unit of pollution. This is unlikely to be the case since MNPB will vary with each polluter and penalties are usually arbitrary amounts.

9) Conclusion

Pollution is a natural process resulting from the activities of plants, animals and man. Since man has developed a more complex system of

life, forms of pollution are general and complex. It is important to regulate pollution if we do not wish to damage our scarce resources and the earth capacity for waste assimilation.

The optimal level of pollution occurs when marginal net private benefit equal marginal external cost. Life scientists tend to attach high existence values to resources by raising MEC. This leads to lower estimates of optimal pollution levels than those reached by many economists.

There are many methods of pollution control. Standard setting is likely to be the least efficient, owing to real world violations of the assumption of perfect information. Taxes and subsidies are possible and may be sucessful, but marketable permits appear to be the most appropriate method of achieving a level of output consistant with the optimal level of pollution.

Footnotes

(1) See Tientberg "The Pessimistic Model in Environmental and Natural Resource Economics" (1992); and Meadows et al, "The Limits to Growth" (1972).

(2) In Gaia "A New Look at Life of Earth", James Lovelock Ellis (1991) suggests that the earth has a very great capacity for self-repair and regeneration.

(3) See Toman (1992), P.12.

(4) In "Wealth of Nations", Smith (1989) set down "Scannows of Taxation"; the tax should be economic (to raise more revenue that it costs), certain (everyone knows how much he / or she must pay), convenient (to leave minimum opportunity for evasion), efficient (simple to administer) and minute economic distortions. See also Pearce and Turner (1983) page 193. The Pigouvian Tax is strictly limited to cases in which the source of pollution can be easily traced and taxed.

(5) For a partial analysis of taxes and subsidies, see Baumol (1988).

(6) For a detailed appraising of a permit system - especially emissions trading - see Tietenberg (1992).

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The Problem of Pollution: An Economic Evaluation and Possible Methods of Control

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The aim of this paper is to study the relation ship between pollution and Externality in order to find the optimal level of pollution by using different measure such as net price benefit function. This paper is dealing with various items, such as the nature of pollution as an externality, the optimal level of pollution, the need for pollution Control, methods of pollution Control and level of Economic Activity. There are many findings in this paper: First, the optimal level of ppollution occurs when marginal net private Benefit equals marginal external cost, second, there are many methods of pollution control, standard setting is likely to be the least efficient. Taxes and subsidies are possible and may be successful.

Estimating Completeness of Child Mortality Registration Among The Kuwaiti Population

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This study assesses the completeness of child mortality data in Kuwait among Kuwaitis between the census years of 1975 and 1980 using census data on children ever born and surviving children. The Brass method, as an indirect method, was utilized in the analysis.

Results of the indirect method were compared with official vital statistics to determine the extent to which Kuwaiti child mortality registration between the census years 1975 and 1980 is complete. The analysis concludes that Kuwaiti child mortality between 1975 and 1980 is fairly complete.