

TAXATION OF POLLUTION

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A pollution tax is recommended. Two types of pollution taxes and their economic effects are discussed. The first type is the per unit pollution tax, a governmental charge for every unit of pollution or product produced. The economic effects of the per unit pollution tax would be a higher price for the consumer, and lower levels of output, employment, and profit for the polluter. The second type of tax, the one recommended, is the percentage of profit pollution tax, a lump-sum tax which the polluter cannot shift to the consumer. It does not affect output or employment levels and does not bring inflationary pressure to the economy.

Manufacturers, municipalities, and farms discharge pollutants into air, water, and land. Polluters are concerned with minimizing their costs. Inadvertently, they have been shifting the costs to society. The social costs of pollution are damage to human health, fish, wildlife, and property, as well as waste of air, land, and water resources, (1, p. 1).

According to the Environmental Protection Agency report, "... the monetary annual cost of air pollution is estimated at about \$16 billion. The costs of meeting air and water quality standards and providing solid waste disposal for the 1970 to 1975 period have been estimated at about \$105 billion, of which about 42 percent is the public's cost share paid by tax payers and consumers, and 58 percent of which will be costs to industry, ..." (2, p. 257).

The idea behind the urgently needed pollution tax is to internalize part of the costs and force the polluter to reduce environmental pollution.

The objectives of this paper are to justify a pollution tax, analyze the types and economics of pollution taxes, and discuss applications and economic effects of pollution charges.

JUSTIFICATION FOR POLLUTION TAXES

A pollution tax, requiring a polluter to pay a fee for harmful pollution discharged into air, water, or land, can be a percentage of profit tax. The pollution tax rate would depend on the amount of pollution and the size of profits of the polluter. For higher profits and higher pollution, higher taxes would be charged. The principle of this taxation is based on the capacity to pollute

and it is analogous to the ability-to-pay principle of income taxation.

Exemptions from the pollution tax would depend upon the employment condition, need for the industry, and the size of profits. Profits below a minimum level (set by a joint public-private committee) could be exempted to encourage continuation of employment and production for society. Polluters whose profits were above the minimum level would be subject to pollution taxes on excess profits. Deductions could be considered if polluters invested in pollution-abatement devices.

TYPES AND ECONOMICS OF POLLUTION TAXES

Pollution taxes can be classified into two types, a per unit pollution tax and a percentage of profit pollution tax.

A per unit pollution tax would be a governmental charge for every unit of pollution (or product) produced. An economic model of a firm paying pollution tax can be developed as presented in Figure 1. It is assumed that the average and marginal revenue curves of an industrial firm which discharges pollutants are AR and MR, respectively. Similarly, the average

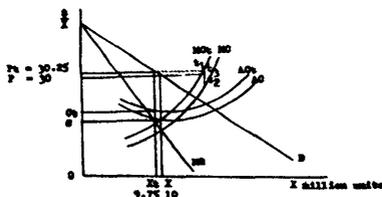


FIGURE 1. A per unit pollution tax firm model.

and marginal cost curves are AC and MC, and the profit maximizing levels of output and price are OX and OP before tax.

Mathematically one can assume that the polluting firm's demand function is:

$$D = P = 40 - Q$$

and its total cost function is

$$TC = Q^2.$$

The output level is Q million units. The total revenue (TR) is price multiplied by quantity.

$$TR = PQ = (40 - Q)Q = 40Q - Q^2$$

The marginal revenue (MR) is the first derivative of TR with respect to Q.

$$MR = \frac{dTR}{dQ} = 40 - 2Q$$

The average revenue (AR) is the TR divided by the output Q.

$$AR = \frac{40Q - Q^2}{Q} = (40 - Q)Q = 40 - Q$$

The marginal cost is the first derivative of the total cost with respect to Q.

$$MC = \frac{dTC}{dQ} = 2Q$$

The profit is π :

$$\begin{aligned} \pi &= TR - TC = (40Q - Q^2) - Q^2 \\ \text{Setting } MR &= MC \\ 40 - 2Q &= 2Q \\ 40 &= 4Q \end{aligned}$$

$$\text{The output: } Q = \frac{40}{4} = 10 \text{ million units}$$

The pre-tax selling price per unit is:

$$P = AR = 40 - Q = 40 - 10 = \$30$$

The profit (π) before the pollution tax is:

$$\begin{aligned} \pi &= PQ - Q^2 = (30)(10) - (10)^2 \\ \pi &= 300 - 100 = 200 \text{ million dollars} \end{aligned}$$

Assuming that the government levies a pollution tax, t dollars, per unit of product, then the per unit tax would shift the cost curves to AC_t and MC_t by the amount of the tax t (3, p. 212). The product price would rise to OP_t and the output decrease to OX_t . The polluter would shift part of the pollution tax to the consumer of the product in a form of a higher price. The

proportion of the pollution tax shifted to the consumer would depend upon the slope of the marginal cost and the slope of the demand. The proportions paid by the consumer and the polluter can be figured by extending a horizontal line from P_t and P_t to the MC and MC_t curves. The difference between P and P_t is the amount of pollution tax shifted to the consumer. The remainder of the tax per unit would be paid by the polluter.

If the government levied \$1 pollution tax per unit of product, the average cost would increase by one dollar, $(AC + t)$.

$$AC_t = Q + 1$$

The total cost becomes

$$TC_t = Q^2 + Q$$

and the marginal cost,

$$MC = \frac{dTC}{dQ} = 2Q + 1$$

Setting MR equal to MC_t

$$\begin{aligned} 2Q + 1 &= 40 - 2Q \\ 4Q &= 39 \end{aligned}$$

The output after per unit tax

$$Q_t = \frac{39}{4} = 9.75 \text{ million units}$$

The per unit post-tax (P_t) selling price paid by the consumer

$$\begin{aligned} P_t &= AR = 40 - Q_t = 40 - 9.75 \\ P_t &= \$30.25 \end{aligned}$$

The producer could shift 25 cents to the consumer of the product and he could pay 75 cents of a dollar tax. The resulting output would become less and post-tax selling price higher. The total tax ($t \times Q_t = 1 \times 9.75$) would equal \$9.75 million.

The total profit (π) after the per unit tax would be

$$\begin{aligned} \pi &= TR - TC \\ \pi &= P_t Q_t - (Q_t + 1) Q_t \\ \pi &= (9.75)(30.25) - (10.75)(9.75) \\ \pi &= 294.8775 - 104.8325 \\ \pi &= 189.7850 \text{ million dollars} \end{aligned}$$

Thus, the total profit after the per unit tax would be less than before the tax.

Per unit pollution tax shifting

The polluter might shift the per unit pollution tax to the consumer in a form of higher post-tax price. The amount of the tax shifted to the consumer would depend upon the price elasticity of demand for the pro-

duct. The more elastic the quantity demand is to price change, the more difficult it is to shift a pollution tax burden forward to the consumer. Conversely, the more inelastic the quantity reaction to a price change, the greater the possibility of shifting the tax to the consumer. Therefore, shifting the per unit pollution tax partially or totally to the consumer would depend upon the price elasticity of demand of the product. Thus, in levying this type of tax, we should recognize the elasticity of demand to avoid the unfavorable inflationary pressure on consumer post-tax price, output, and employment level of resources (such as labor, capital and management).

Economics of a percentage of profit pollution tax

A percentage of profit pollution tax is a charge or license that remains the same amount regardless of the output level and the amount of pollution. It is a lump-sum and a fixed cost to the polluter. The producer cannot avoid a lump-sum tax (4, p. 173).

The percentage of profit pollution tax is independent of the output level. It would shift the average cost curve to AC_t , but it would have no effect on the marginal cost curve. The price and output would remain at OP and OX. However, the total profits would fall from CPLM to C_t PLN, as shown in Figure 2.

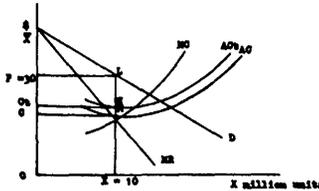


FIGURE 2. A percentage of profit pollution tax firm model

The polluting firm could not shift the lump-sum taxes to the purchaser of its product through higher prices. The output level would not be affected and the price would remain the same. The tax revenue could be used to clean up the environment and/or if the polluter reduced his pollution the tax could be reduced. This type of pollution tax is recommended because the polluter pays the tax charge from his own profit.

Mathematically, one can assume that the percentage of profit pollution tax, T , is \$9.75 million dollars levied as a lump-sum amount.

The total cost is:

$$TC = Q^2 + T$$

$$TC = Q^2 + 9.75$$

The average cost is:

$$AC = \frac{Q^2 + 9.75}{Q} = \frac{Q^2}{Q} + \frac{9.75}{Q}$$

$$AC = Q + \frac{9.75}{Q}$$

The marginal cost remains the same because this tax is considered a fixed cost:

$$MC = \frac{dTC}{dQ} = 2Q$$

Setting the MR equals to MC:

$$40 - 2Q = 2Q$$

$$4Q = 40$$

$$Q = 10 \text{ million units}$$

Therefore, the output Q is not affected by the percentage of profit pollution tax. The post-tax selling price is:

$$P = AR = 40 - Q = 40 - 10 = \$30$$

The price paid by the consumer is the same after the percentage of profit pollution tax.

The profit of the polluter, π , is:

$$\pi = TR - TC$$

$$\pi = PQ - (Q^2 + 9.75)$$

$$\pi = (30)(10) - (100 + 9.75)$$

$$\pi = 300 - 109.75 = 190.25 \text{ million dollars}$$

Therefore, the percentage of profit pollution is taken from the profit of the polluter. This type of tax is recommended because it is not inflationary and does not affect the level of output and employment of resources, e.g., labor, capital, and management.

APPLICATIONS OF POLLUTION CHARGES

Pollution charges have been applied in some states. However, their application so far has been limited. According to the Council of the Environmental Quality report, "Vermont passed a law in 1969 levying a charge on polluters not in compliance with state water quality standards." (2, p. 58). Michigan enacted legislation estab-

lishing an efficient water-quality monitoring fee system. That law requires all manufacturing and other commercial discharges to pay a fee "for the cost of surveillance of industrial and commercial discharges and receiving waters. The fee assessed annually by the Water Resource Commission and based on the volume and strength of discharge may range from a \$50 minimum to \$9,000 per location discharge in conformance with the Commission's effluent restrictions." (2, p. 159).

The report also indicated limited experience with sewer service charges to cut down pollution. "A Springfield, Mo. packing plant, faced with a waste treatment charge of \$1,400 per month, so modified its production processes that monthly payment was scaled down to \$225. When a treatment plant became seriously overloaded, Orsego, Michigan decided to charge a larger industrial user. In response, the company cut its waste discharges from 1,500 pounds BOD a day prior to the date the charge became effective. In the second month, it reduced discharges to 733 pounds; within 90 days daily discharges were down to 500 pounds, (a level the plant could treat effectively)," (2, p. 137). These examples illustrate the effectiveness of pollution taxes in reducing pollution and cleaning up the environment.

As the percentage of profit pollution tax is levied and paid by the polluters through

the reduction of their profits, polluters will control and abate their effluents, consumers will not pay higher taxes, and society faces no cut in production of goods and services.

As the per unit pollution tax is levied, the polluters pay part of the tax in a form of lower profits, the consumers of pollution-causing goods would pay part of the tax in a form of higher prices, and society would have fewer units of goods and services produced. As prices of goods reflect the relative costs of pollution abatement, consumers would, to some extent, shift to goods that embody lower pollution taxes and charges.

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