Volume 10
Issue 1 *Journal of Natural Resources & Environmental Law, Volume 10, Issue 1*

Article 2

January 1994

The Economics of Pollution Taxes

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The Economics of Pollution Taxes

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Pollution is an economic problem as well as an environmental problem. In order for an economy to reach its full potential, that is, to achieve an optimal level of production, there are three basic features which its system of property rights must have: universality, exclusivity, and transferability.[1] The first requirement, universality, means that all valuable, scarce resources must be owned. Any resource which cannot be owned is unavailable, and, therefore, constrains the economy. The second requirement is exclusivity. If an owner is unable to exclude others from the use and enjoyment of the property, then the owner has no incentive to invest in the property. The final requirement for an optimal economy is transferability. Without transferability, resources cannot be reallocated to their highest and best use.

Pollution is a violation of the exclusivity requirement. Someone else is interfering with another's enjoyment of the land, water, or air. A market burdened by pollution is out of equilibrium. The good is over-produced and under-priced and a social welfare loss results. The market can be put back into equilibrium through governmental intervention by way of imposition of a tax on pollution. This article reviews the economics of pollution in its various forms, beginning with the simple case of nuisance, and building to an explication of the remedial consequences of an enlightened system of taxation.

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[1] *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 32-34 (4th ed. 1992).

I. NUISANCE

A nuisance is an identifiable interference by one person with the enjoyment of another person's property.[2] A nuisance may be enjoined and may trigger damages. For instance, a new airport opens and planes take off over a neighborhood. The airport is a nuisance to the neighborhood as the noise of the planes taking off disturbs the homeowners. The homeowners can collect damages or possibly alter or close the airport's operations.

The economics of a nuisance situation can be understood in light of the Coase Theorem,[3] which states that the assignment of liability will not alter economic behavior where negotiation costs are low. To illustrate this concept, let us examine a paper mill and a trout farmer who share a lake. The trout farmer harvests $100,000 of trout from his fishery each year. The paper mill begins operation and grosses $500,000 each year. The paper mill dumps untreated sewage into the lake on a regular basis in excess of the lake's ability to absorb the sewage. The trout farmer's revenues fall to $50,000 per year.

First, let us suppose that it costs $10,000 per year to treat the sewage.[4] What will the parties do? The paper mill will operate, the trout farmer will fish, the sewage will be treated. We know all these economic outcomes will occur without knowing whether or not the paper mill is liable. Why? If the paper mill is liable, then it has three choices:

1) Stop operating and not earn $500,000 per year.
2) Operate but pay the trout farmer $50,000 per year damages.
3) Operate but pay $10,000 per year to treat the sewage.

The third option obviously is the most profitable solution.

Now suppose that the paper mill is not liable. The trout farmer has three choices:

1) Stop operating and not earn $50,000 per year.
2) Operate and earn $50,000 per year.
3) Operate, pay the $10,000 treatment expenses, and earn $90,000 after treatment expenses.

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[2] *See id.* at 50; *see also* BLACK'S LAW DICTIONARY 1065 (6th ed. 1990).

[3] R. Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1, 44 (1960); *see also* R. PINDYK & D. RUBINFELD, MICROECONOMICS 632, 634 (1989).

[4] Assuming that both parties know it will cost $10,000 to treat the pollution and that the treatment is effective.

Obviously, the sewage treatment option is the most profitable alternative. Economically, liability is irrelevant. The same productive behavior occurs despite the placement of liability.

Now suppose that the sewage treatment expenses are $60,000 per year. Again, the same economic behavior will result despite the placement of liability. Suppose the paper mill is liable. The paper mill faces three choices:

1) Stop operating and not earn $500,000 per year.

2) Pay the trout farmer $50,000 and pollute, netting $450,000.

3) Pay $60,000 to treat the sewage, netting $440,000.

The paper mill will pollute and pay the trout farmer damages.

Now suppose the paper mill is not liable. The trout farmer faces three choices:

1) Stop operating and not earn $50,000.

2) Operate and earn $50,000.

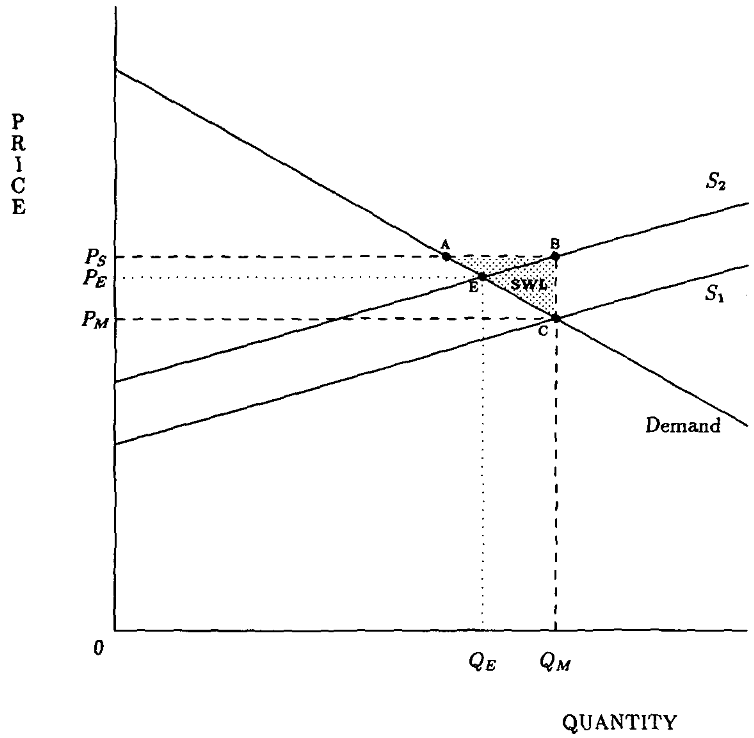
3) Pay $60,000 to treat the sewage, and net $40,000 after sewage treatment expenses.

Clearly, the trout farmer will ignore the pollution and continue to operate. The same economic decisions result regardless of the placement of liability.

II. POLLUTION

Unlike a classic nuisance situation, pollution is often a difficult problem to handle on an individual, case-by-case basis because the contribution from any one polluter is relatively negligible. The air quality in a city will improve if everyone takes a bus to work. However, the air quality in a city won't improve if only one extra person takes a bus to work today instead of driving a car. By the same token, the air quality in a city won't degrade if the one extra person drives a car today. The contribution to air pollution by one person is too small to monitor and calculate. The transaction cost for identifying any one person as a polluter, determining the amount which was polluted, estimating the value of the damages from the marginal contribution to pollution, and identifying and organizing the affected individuals for the purpose of seeking compensation from each specific polluter far exceeds the damage done by any specific polluter. One of the requirements of the Coase Theorem is relatively small transaction costs. Pollution is a social problem caused by the collective and suffered by the community. That is why pollution must be regulated at the public level. Enforcement of pollution rules at the individual private level is inefficient.

Pollution is an externality. That is to say, pollution is a legitimate expense of the production process which ought to be borne by the manufacturer. The parties to the transaction do not face all the costs because the manufacturer avoids the pollution clean-up costs. These clean-up costs are, therefore, not reflected in the price of the good. The total social expenses exceed the private purchase expenses. Because part of the costs are not internalized, there is over-production and a social welfare loss.



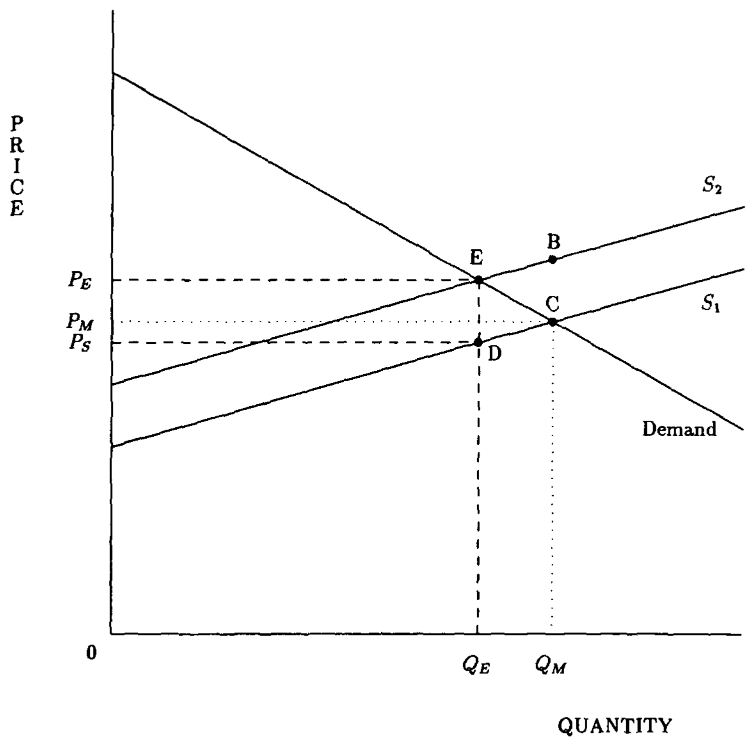
Graph 1. Pollution as an Externality

In Graph 1, the manufacturer prices along the supply curve, S_1. The market price is determined by the intersection of demand and supply at point C, with market quantity Q_M and market price P_M. The cost of pollution, a constant increment per unit (*BC*), is created by the manufacturer, suffered by society, and ignored by the consumer. If the manufacturer paid to clean up the pollution, pricing would be along supply curve S_2. The market equilibrium would be at point E, with equilibrium quantity Q_E and price P_E. When the manufacturer is allowed to shift private costs onto society, the good is under-priced by amount P_SP_E and over-supplied by amount Q_MQ_E.

A social welfare loss (SWL) of area Δ ABC is incurred.

III. POLLUTION TAXES

The problem of pollution, when understood as an externality, lends itself to a swift and simple solution. The government should impose a tax on goods which involve pollution. The tax revenue could or could not be used to clean up the pollution. From an economic standpoint, how the revenue is used is unimportant. Say the producer created $1,000 of pollution, and the government raised $1,000 in taxes. Society has been damaged $1,000 by pollution, but society has been paid $1,000 in taxes in compensation for the damage. Whether society chooses to use the $1,000 to clean up the pollution or to build schools is irrelevant. The important aspect of these taxes from an economic viewpoint is that the costs of production have been internalized so that prices reflect true total social values. The market can now arrive at the correct equilibrium.



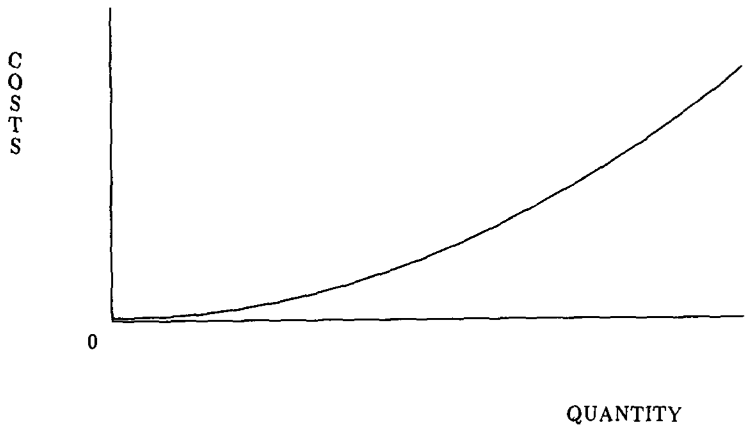
Graph 2. Pollution Taxes

In Graph 2, the producer produces along supply curve S_1, polluting a constant amount per unit BC as before. The total social cost curve is supply curve S_2. The market would clear at point C with quantity sold Q_M at price P_M. However, the government imposes a tax just equal to the amount of pollution, BC, raising the supply curve to S_2. The new supply curve, including the pollution tax, reflects all the social costs of production. The appropriate equilibrium is reached at point E, with Q_E units sold at price P_E. The consumer willingly pays the price of the good with the tax for a total revenue amount of □ OP_EEQ_E. The supplier receives revenue in the amount of □ OP_SDQ_E. The government collects tax revenues in the amount of □ P_SP_EED. There is no social welfare loss, nor overproduction. The market is operating efficiently, no longer misallocating too many resources to the good in question.

IV. THE ECONOMICS OF POLLUTION

In the previous section, a tax was placed on the good, not on the pollution. In many situations, that is all that can be done because monitoring individual sources of pollution is too expensive or is technically infeasible. In some situations, however, pollution *can* be directly monitored. The economic consequences of these situations are more sophisticated and more interesting.

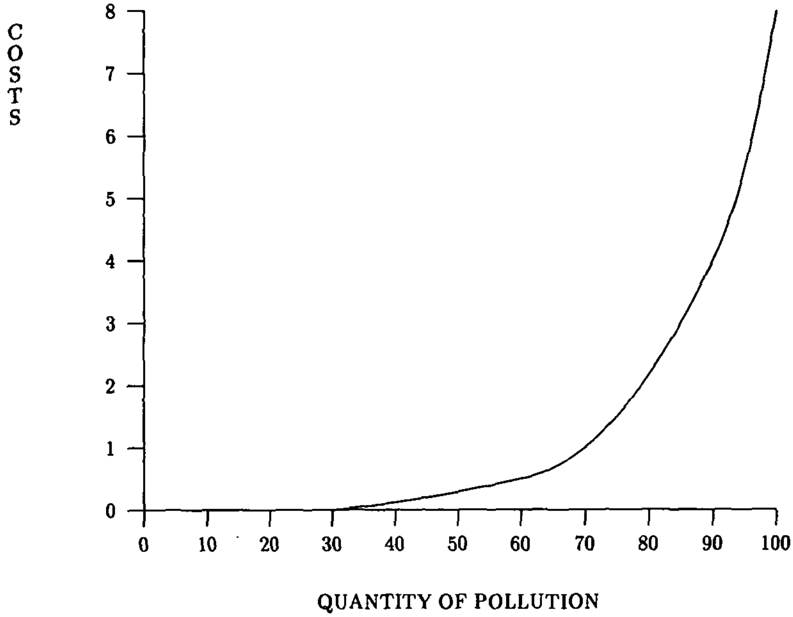
Let us take, for example, a steel plant in a small town in a remote part of Pennsylvania. The steel plant produces not only steel but also gross amounts of air pollution. The steel plant is the only significant source of pollution in the area. The steel plant can emit great amounts of pollution with absolutely no harmful effect whatsoever, as the air pollution diffuses into the atmosphere harmlessly. After a point, though, the environment is no longer able to absorb the pollution. It has reached its natural saturation point. Additional amounts of pollution are now detectable. At first the air pollution's only detectable impact is visual. The air begins to discolor. This is aesthetically unpleasant, but poses no health risk whatsoever. The social costs of pollution have risen from zero to some small amount. After a point, the pollution irritates the infirm, the aged, and the very young. The social costs have risen to a larger amount. Next, healthy adults suffer eye irritation. Then the weak have difficulty breathing. Later, the strong have difficulty breathing. Eventually we all start suffering severe health effects. The costs of pollution can be graphed as an increasing cost curve over quantity, as in Graph 3.



Graph 3. Pollution Costs

Now suppose that pollution can be measured and that the amount of pollution which the steel plant emits at full capacity of production is 100 units of pollution with the associated costs indicated in Graph 4. The costs can be in whatever units that are appropriate: thousands of dollars, millions of dollar, etc. For the sake of simplicity, we will just refer to the costs in one dollar increments. Notice that all the really harmful pollution is the last pollution emitted. The first 30 units did not impose any costs at all on society. All the pollution that caused over $4 of harm per unit was done by the last 10 units. If society could get the steel plant to cut back just 10 units of pollution, then most of the harm would be avoided.

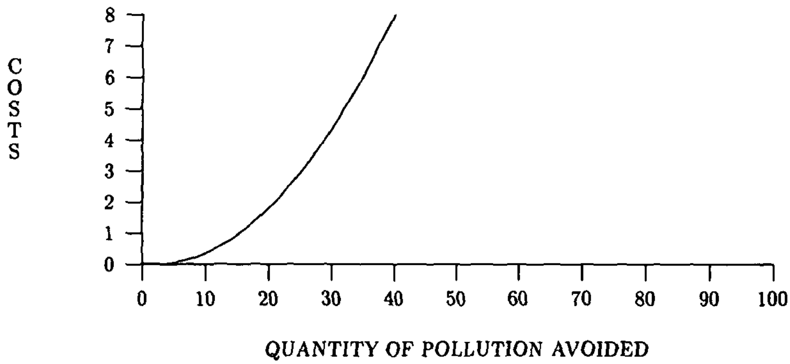
Now let us examine the costs of avoiding pollution. At first, it is very cheap to avoid pollution. In fact, it is virtually costless. The steel plant simply makes a conscious effort not to be wasteful. It turns off lights not being used, does not run the air conditioning so much, changes to energy efficient lights, recycles waste, encourages car pooling. There are a lot of little things that can be done that do not really cost anything. That does not solve the problem, however. The plant might have to switch to cleaner burning fuels that may cost significantly more. Then the plant buys scrubbers for its smokestacks. After that, more energy efficient equipment must be purchased. The costs are becoming more and more significant. After a point, it does not matter what the steel plant does, it cannot make steel and not pollute. The price of pollution avoidance becomes infinite. Graph 5 shows the costs associated with eliminating pollution. The first few units avoided are cheap and easy to do. The more pollution is eliminated, the more expensive it becomes to eliminate each successive unit of pollution. This is the marginal cost curve of pollution avoidance.



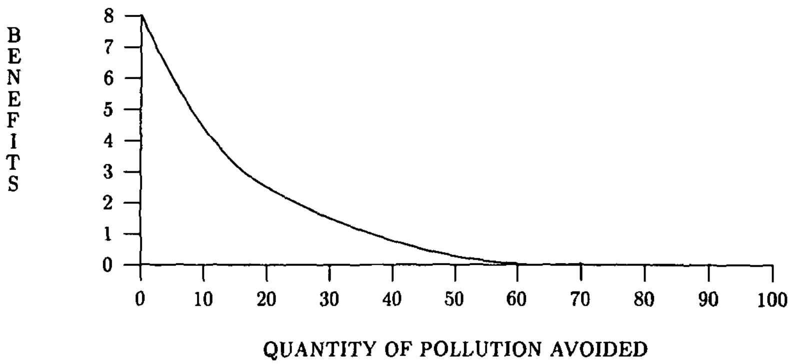
Graph 4. An Example of Pollution Costs

Next we must determine the benefits of pollution avoidance. The benefits of pollution avoidance are the costs of pollution which are avoided. Accordingly, the benefit of pollution avoidance is simply the reverse (or mirror image) of the costs of pollution. The cost of pollution in the steel plant example is Graph 4. The reverse of Graph 4 is Graph 6.

Notice that the benefits of avoiding the first 10 units of pollution are very great. That is because it is the last 10 units of pollution which actually are being avoided. Pollution is reduced from the top, like water from a bucket, not from the bottom. The next 20 units of pollution avoided are substantial. After that, the benefits of avoiding pollution are rather small. After avoiding 70 units of pollution, there are no benefits to further reductions in pollution. That is because the first 30 units of pollution are harmless. This graph illustrates the fact that even if all pollution *could* be eliminated, it should not be avoided because it would be a waste of time and resources. The question is, how much pollution should be avoided? That can be determined by overlaying the marginal cost curve of pollution avoidance onto the marginal benefit curve.

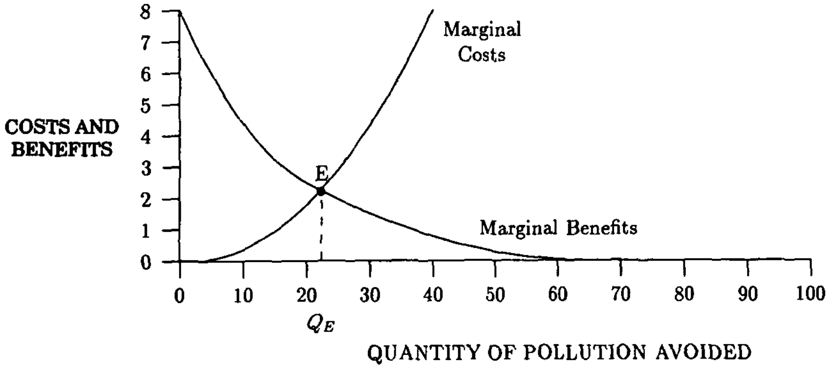


Graph 5. The Cost of Pollution Avoidance



Graph 6. The Benefits of Pollution Avoidance

Our steel plant example is illustrated in Graph 7. Here, society would want the steel plant to avoid about 23 units of pollution. The benefits from avoiding the pollution exceed the costs of avoiding the pollution up to 23 units of pollution avoided. Clean up costs beyond 23 units of pollution exceed the benefits. It is inefficient to clean up more than 23 units of pollution.

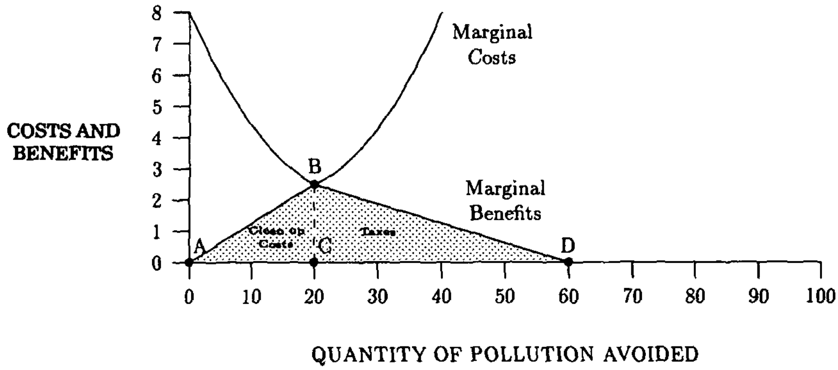


Graph 7. The Pollution Avoidance Market

Think of it this way. The marginal cost of pollution control at the 23rd unit of pollution is about $2.30. Suppose society were given a choice: either have the pollution beyond the 23rd unit cleaned up or be paid $2.30 per unit of pollution. Society would rather take the money. The benefits of cleaning the pollution up are less than $2.30 per unit. It is better to get $2.30 per unit than less than $2.30. This leads us to a theory for direct pollution taxes.

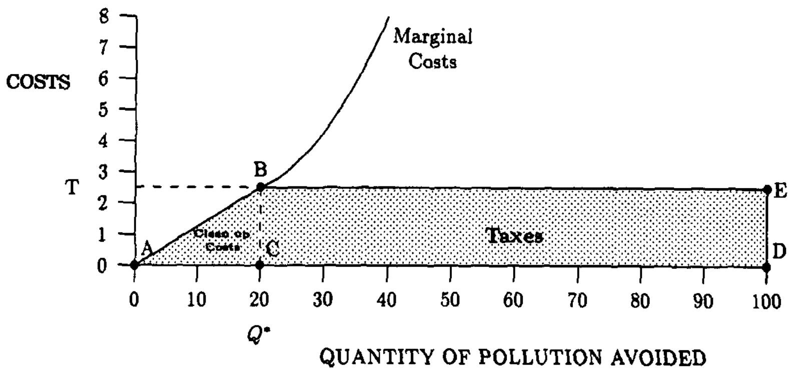
V. DIRECT POLLUTION TAXES

In a perfect world where everyone knew all relevant information with absolute certainty, the government could require polluters to clean up pollution where the benefit of pollution avoidance exceeded the costs and to pay a tax equal to the marginal benefit of pollution avoidance where the cost of clean up exceeded the benefit. Using the example above, exactly 23 units of pollution would be cleaned up. As Graph 8 illustrates, under this perfectly precise tax scheme, the firm would pay the amount Δ ABC in clean up costs. Then the firm would pay a tax in the amount of Δ BCD exactly equal to the marginal benefit of pollution avoidance beyond the 23rd unit of pollution.



Graph 8. Pollution Avoidance and Taxes Under Perfect Information

Unfortunately, we do not live in a perfect world and we do not know all relevant things with absolute certainty. We do not know the shapes and positions of the marginal benefit curve nor of the marginal cost curve. What then is society to do? Fortunately we do live in an adjustable world. The government can estimate what the marginal costs and benefits are and then set a tax on pollution. Industry either pollutes and pays the tax or spends the money to avoid the pollution. It operates as illustrated in Graph 9.



Graph 9. Firm Behavior Under Arbitrary Pollution Taxes

The government sets a tax, say, at $2.50 per unit. The manufacturer either pays the tax or cleans up the pollution. The manufacturer will clean up or avoid pollution where it is cheap and easy to do so. The manufacturer pays Δ ABC in clean up costs. Where it is expensive to clean up, the manufacturer elects to pay the set tax. The firm pays □ BCDE in taxes. The manufacturer and the government know how much tax is owed because air pollution can be monitored and measured.

If the manufacturer makes a mistake and doesn't clean up enough pollution, then it pays the tax which is higher than the avoidance costs. The manufacturer will adjust its behavior in the next period and clean up more pollution because that is cheaper than paying the tax. If the manufacturer makes a mistake and cleans up too much pollution relative to the tax rate, it will adjust its behavior, suspending the more expensive clean up programs, electing to pay the smaller tax. Perfect information is not required. Firms adjust their behavior over time in reponse to clear economic signals in an uncertain world.

If the government decides that more pollution needs to be avoided, then it simply raises the tax. On the other hand, if industry is paying substantial sums of money for trivial gains in pollution avoidance, and pollution levels are low, then the government can reduce the tax as appropriate. The important thing about direct pollution taxes is that industry can elect to clean up pollution or pay the tax. The marginal cost of a unit of pollution is defined and understood. No one is spending billions of dollars to avoid non-existent health risks. The strength of the taxation system is in the explicit definition of costs imposed in combination with the flexibility of choice on the part of industry to minimize compliance costs given a realistic and objective value of pollution and pollution avoidance.

CONCLUSION

Property law is simply a legal expression of the fundmental economic requirements for an optimal economy. Pollution is a violation of an optimal economic system. Pollution controls, regulation, and abatement generally promote efficiency and optimality. The abatement of pollution, as any activity, can be pursued inefficiently. By understanding the economics of pollution and pollution control, society can achieve any desired level of pollution avoidance at the least cost.