
NATURAL RESOURCES JOURNAL

Volume 20
Issue 3 *Summer 1980*

Summer 1980

Environmental Policy Making: Liability for Externalities in the Presence of Transaction Costs

Peter J. Bird

ENVIRONMENTAL POLICY MAKING: LIABILITY FOR EXTERNALITIES IN THE PRESENCE OF TRANSACTION COSTS

PETER J. W. N. BIRD*

I. INTRODUCTION

The existence of a theoretical market solution to the problem of externalities has been generally accepted since the seminal contribution of Coase.[1] In the absence of transaction costs, the potential for bargaining between concerned parties has the effect of internalizing any externality. The burden of legal liability for external effects does not therefore affect the attainment of Pareto efficiency. Only when the assumption of zero transaction costs is removed does the question of liability enter upon the agenda. The relevance in such cases of market solutions, and the legal liability rules which they require, are the subjects of this paper. Emphasis is on environmental pollution, where externalities are in general negative.

It is shown in Section II that even without transaction cost effects, the market produces a Pareto optimal resource allocation only in a restricted subset of externality examples. In these cases, the introduction of transaction costs means that choosing particular rules of legal liability is necessary for Pareto efficiency. The criteria for choosing these rules are derived in Section III. These criteria are used in Section IV in a wider discussion of how to apportion liability for all types of externality. The paper concludes with a Section V, which argues that transaction costs should nevertheless have only a small role in designing rules for real world situations.

II. THE APPLICABILITY OF THE COASE RESULT

Since the appearance of Coase's results, several limitations have been noted in the literature. One line of criticism, developed by Dolbear,[2] Mishan,[3] and Randall,[4] relates to the supposed invariance

*Department of Economics, University of Stirling, Stirling, Scotland. The author gratefully acknowledges the helpful comments and suggestions of Alan Randall, Richard Zerbe, Ezra Mishan, and an anonymous referee on earlier drafts of this paper. Any errors are the author's.

1. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).
2. Dolbear, *On the Theory of Optimum Externality*, 57 AM. ECON. REV. 90 (1967).
3. Mishan, *The Postwar Literature on Externalities: An Interpretive Essay*, 9 J. ECON. LITERATURE 1 (1971).
4. Randall, *Market Solutions to Externality Problems: Theory and Practice*, 54 AM. J. AGRICULTURAL ECON. 175 (1972).

of the resource allocation to changes in liability. For a change in the laws of liability impinges upon the budget constraints of the concerned parties. This does not prevent the attainment of Pareto optimality, but the actual allocation of resources achieved is affected, including in the general case allocation to the externality generating activities. Only where the income effects are zero does the allocation of resources to the production of externalities depend upon the burden of liability.

For potential policy makers this restriction is of questionable significance. Even where the income effects are zero, the appropriate liability rule has to reflect non-efficiency considerations including distributional equity. That non-zero income effects mean that different liability rules generate different Pareto efficient allocations neither lessens nor complicates the practical problem. In either case, the liability rule has to be chosen according to the distributional and other critiera.

A second criticism of the Coasian position is that of Muney[5] and Regan.[6] They argue against Pareto efficiency of resource allocation and against the invariance to liability rules by pointing to the possibility of agents devoting resources to strategic actions such as threats and warnings. These activities constitute attempts to alter the climate in which transactions take place. Liability rules which encourage such actions allocate resources in a way which is Pareto inferior to situations where they are absent.

In this treatment, both criticisms are sidestepped. Distributional criteria are explicitly omitted from the discussion, not on grounds of irrelevance, but solely to isolate the efficiency considerations. Threats and warnings are subsumed in the discussion of transaction costs.

The most powerful critique is by Baumol and Oates,[7] who have shown that Coase's argument applies only for one specific type of externality problem–where the externality is depletable. They define an externality as existing whenever one individual's (say A's) utility or production function contains a variable, the value of which is chosen by others without regard to the effect on the utility or production function of A. Externalities can exhibit both depletability and exclusivity.

The difference between the concepts of depletability and exclusivity was elaborated by Head[8] (who used the terms "jointness" and

5. Muney, *The Coase Theorem: A Re-examination*, 85 Q.J. ECON. 718 (1971).
6. Regan, *The Problem of Social Cost Revisited*, 15 J.L. & ECON. 427 (1972).
7. W. BAUMOL & W. OATES, THE THEORY OF ENVIRONMENTAL POLICY (1975).
8. Head, *Public Goods and Public Policy*, 17 PUB. FINANCE 197 (1962).

"non-appropriability"). A good (or "bad") is undepletable if consumption by one individual leaves unaffected the amount available for consumption by others. By contrast, consumption by one person of a depletable good reduces by the same amount the quantity available for others. The common case of a mixed externality, which displays elements of both these opposites, has been shown by Holtermann[9] to be analyzable in terms of the polar cases. Exclusivity refers to the extent to which it is possible to prevent individuals from enjoying a positive externality or from avoiding a negative externality. Head shows that depletability and exclusivity are conceptually distinct.

Baumol and Oates demonstrate that Coase's theorem is inapplicable for an undepletable (and also therefore for a mixed) externality. Consider a negative externality. There is a cost to society when the externality is supplied, hence the Pareto optimal supplier price is negative. The marginal benefit to society of one person consuming the externality is zero, since it is undepletable. The Pareto optimal consumer price is therefore zero. No market price can be simultaneously negative and zero, and therefore the market cannot generate a Pareto optimal resource allocation. A simple explanation of this result is that the payment of the bribe to the consumer removes any incentive for him or her to relocate so as to avoid the externality, which might well represent a Pareto superior alternative.

Coase's theorem applies only when externalities are depletable. The example in his original article—the rancher's cattle on the farmer's crop—was depletable and exclusive. For a depletable, nonexclusive externality, consider the case of pollution of the sea from an oil rig. Many fish are killed, constituting a cost to the fishing industry. Irrespective of the legal liability, where transaction costs are absent the market can attain a Pareto optimal allocation. When the law favors the fishers, any bribe paid to an individual fisher corresponds to the social benefits to the other fishers of that one fisher suffering the loss. When the law favors the oil company, any bribe a fisher pays corresponds to the social cost to the rest of the fishing industry of the individual fisher's increase of catch.

Even where externalities are depletable and the market can produce a Pareto optimal solution, this will not necessarily be attained in situations where transaction costs exist. Bargaining a Pareto improvement is not possible if transaction costs are so great as to destroy the net mutual advantage of the bargain. And even where transaction costs are low enough to allow bargaining, the resultant

9. Holtermann, *Externalities and Public Goods*, 39 ECONOMICA 78 (n.s. 1972).

allocation is trivially Pareto inferior to the same allocation when achieved not with bargaining, but rather because of the rules of legal liability. An appropriate distribution of the burden of liability is of obvious importance to policy makers in a world of all-prevalent transaction costs.

III. TRANSACTION COSTS AND LIABILITY RULES

The problem of choosing a liability rule is concretized in the example of the oil rig and the fishing industry. Aside from distributional value judgments, the optimal choice of policy, either of allowing the oil company to pollute or of installing abatement devices, depends upon the relevant costs. To the fishing industry, the relevant cost is the value of the fish lost; to the oil company, it is the cost of the new equipment. Depending upon the relative magnitudes of these costs, one or the other of the situations is superior.

To the policy maker interested in attaining Pareto optimality, the problem is how to allocate the burden of liability. The answer in a world of perfect information is trivial: liability should be such that no bargaining is necessary to achieve efficiency. If the company's cost of abating pollution is greater than the value of the fish lost, then the company should legally be entitled to pollute. A Pareto efficient outcome is thereby achieved, and no transaction costs are incurred. As a guide in the real world, however, this consideration alone is empty of content. Not only are the relevant costs of pollution usually unknown in advance, but they always vary, not only in different instances of similar pollution problems, but also through time. The law would have to be different in different locations and to be frequently revised. If a law is to be regarded as universal (at least for the same industry) and unchangeable (at least for reasonable time periods), what should it be?

The answer suggested by Randall[10] is to relate it to transaction costs of producers and consumers. The law should favor that party with the higher transaction costs. The rationale for the proposal is thus. If transaction costs are higher than the net social benefit (exclusive of these costs) of a bargained adjustment, adjustment will not take place. On balance, therefore, more Pareto efficient bargains are deterred by a law hostile to the party with higher transaction costs than by a law favorable to it. The law should, therefore, in absence of further knowledge about the relative costs of the pollution, favor the party with the higher transaction costs.

10. Randall, *supra* note 4.

Such an argument is wrong, as is demonstrated by Zerbe.[11] If there is a net benefit to a bargain between polluter and pollutees, then either party will be prepared to initiate it. Either the pollutees can bribe the polluter not to pollute, or the polluter, by offering to abate, can extract the bribe from the pollutees. Only when the transaction costs exceed the net benefit from the bargain, irrespective of who initiates the deal, will a Pareto efficient bargain not take place. Consequently, the arguments above imply nothing about the preferred distribution of liability.

Choice of a rule is nevertheless possible, but it must be based upon assumptions about the transaction costs of particular bargains, not of the parties to the bargains. The law should favor the polluter or the pollutee, depending upon whether the transaction costs of bargains to prevent pollution are smaller or greater than those to allow pollution.

The result can be derived thus. Let the cost to the polluter of modifying the process to exclude the discharge be represented by P, and let the total cost of the pollution to the fishing community be R. Then the net social cost of the pollution, denoted X, equals R-P. The efficient policy is to allow pollution, or to insist upon control devices, depending upon whether X is lesser or greater than zero. The two possible states of the law, where the burden of liability favors either the polluter or the pollutee, are denoted respectively as L and $\bar{L}$. For each state of the law, X can assume either positive or negative values. Four possible states of the world therefore exist, summarized as $L(X > 0)$, $L(X \leqslant 0)$, $\bar{L}(X > 0)$, and $\bar{L}(X \leqslant 0)$. These are known respectively as states 1, 2, 3, and 4. Only in states 1 and 4 is bargaining possible; in states 2 and 3, the law is in line with the Pareto efficient outcome.

With each bargain in states 1 and 4 are associated transaction costs or legal costs. In state 1, the fishing industry can bribe the polluter to install control devices; let the transaction costs for this be f_1. Alternatively, a bribe can be obtained by the polluter, by offering abatement and incurring transaction costs p_1. In state 4, there are three possibilities. The polluter can pay a certain sum, and incur transaction costs p_4, for the fishing industry to waive its rights. Again, the fishers themselves can initiate the transaction, with transaction costs of f_4. A third possibility arises in this case: the polluter can ignore the law and engage in polluting activity. The fishers then sue for damages, and the polluter is liable for penalty and legal costs of p'_4.

11. Zerbe, *The Problem of Social Cost: Fifteen Years Later*, in THEORY & MEASUREMENT OF ECONOMIC EXTERNALITIES 29 (S. Lin ed. 1976).

For convenience, it is assumed that transaction costs fall on the originator of the transaction only, and legal and penalty costs upon the polluter; *a priori* this appears justified, but the argument is unchanged however transaction costs are distributed.

For transaction and legal costs, the following assumptions are made. In state 4, p'_4 is less than p_4; it is cheaper voluntarily to pay compensation than to be forced to do so by a court of law. (This is the basis of all out-of-court settlements.) In state 4 and state 1, p_4 is less than f_4 and p_1 is less than f_1. Justification for this is given by Mishan,[12] whose arguments imply that the cost to the fishing industry of initiating bargains would be higher on account of its larger problems of coordination and its smaller access to resources. Whether bargaining will actually take place depends upon the magnitudes of these transaction costs. In state 1, it will take place if p_1 is less than X; in state 4, there will be a bargain if p_4 is less than $-X$.

The assumption made about the policy maker, who wishes to choose an optimal legal state, is that the expected social benefit from choosing one rule rather than another is maximized. It is assumed that the policy maker has a prior probability density function $f(X)$ for the value of X and knows the certain, constant values of p_4 and p_1. The expected social benefit (ignoring all distributional implications) from the rule $\bar{L}$ rather than L (i.e., placing the legal burden on the polluter) can then be determined. To do so we have to consider, for each of states 3 and 4, whether transaction costs will be high enough to deter the bargains.

The first case is where the net social cost of pollution is positive (state 3) and exceeds the transaction costs of bargaining to prevent it (p_1). The expected social benefit of rule $\bar{L}$ is then equal to the magnitude of the transaction costs so avoided, multiplied by the probability of the situation occurring. With our notation, this is equal to $p_1 \int_{p_1}^{\infty} f(X)\mathrm{d}X$.

In the second case, the net social cost of pollution is positive (state 3) but less than the transaction costs (p_1) for the bargain to allow pollution. Thus the expected social benefit of rule $\bar{L}$ is just the mathematical expectation of the net social loss that is avoided by preventing the polluter from polluting. This is given by $\int_0^{p_1} Xf(X)\mathrm{d}X$.

The third and fourth situations are the opposite of the first two. Thus, suppose the pollution has a net social benefit (state 4), but this is disallowed by rule $\bar{L}$ and is less than the cost of bargaining to allow

12. Mishan, *supra* note 3. *See also* Mishan, *The Economics of Disamenity*, 14 NAT. RES. J. 55 (1974).

it (p_4). The rule then produces an expected social loss equal to the expectation of the social benefit which is missed. The expression for the loss is $\int_0^{-p_4} Xf(X)\mathrm{d}X$. Finally, when the transaction costs (p_4) are not so high as to deter bargaining to allow beneficial pollution (state 4), the expected loss from $\bar{L}$ is the transaction cost incurred (p_4), multiplied by the situation's probability: this is expressed as $p_4 \int_{-\infty}^{-p_4} f(X)\mathrm{d}X$.

The four expressions so derived combine algebraically to give the total expected social benefit for rule $\bar{L}$. Thus:

$$\text{Expected social benefit} = p_1 \int_{p_1}^{\infty} f(X)\mathrm{d}X + \int^{p_1} Xf(X)\mathrm{d}X + \int_{-p_4}^{0} Xf(X)\mathrm{d}X - p_4 \int_{-\infty}^{-p_4} f(X)\mathrm{d}X \qquad \text{(Equation 1)}$$

What can be said about the sign of this expression? In general, nothing, unless more is posited about the shape of $f(X)$. In the special case where the probability density function is symmetrically distributed with zero expectation, however, it can be shown that the sign of the expression will be positive or negative, depending upon whether p_1 is greater or less than p_4. This is most easily illustrated by the diagram in Figure 1 and an analogy.

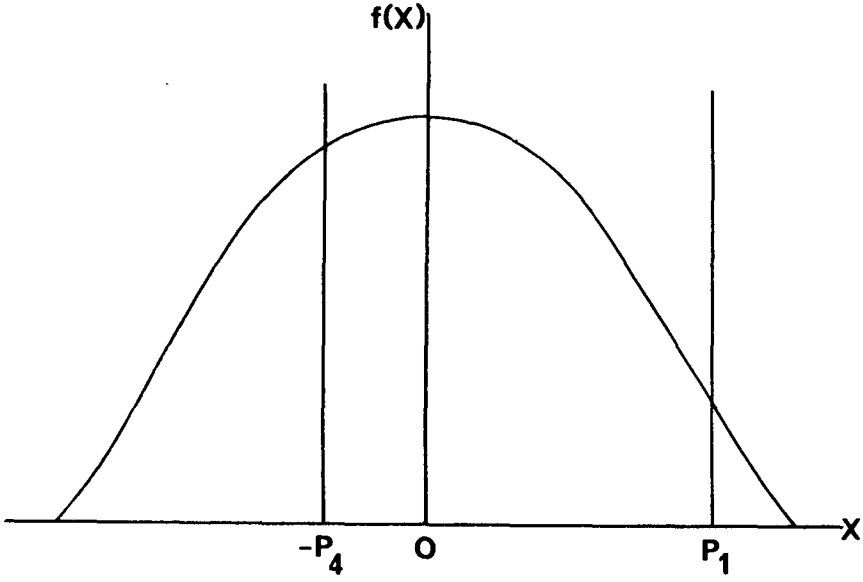

FIGURE 1

The expected social benefit of the rule $\bar{L}$ can be interpreted as the first moment about the vertical axis through zero of a transformation of the uniform lamina made by the area under the density function $f(X)$. Let all the area to the right of p_1 be concentrated in the line through p_1; similarly, let the area to the left of $-p_4$ be concentrated in the line through $-p_4$. The first moment of the transformed lamina corresponds to the expected social benefit of rule $\bar{L}$. Clearly it will be positive or negative, as p_1 is greater or less than p_4.

The results of the argument can thus be summarized. If the prior probability distribution of the net social cost of the pollution is symmetrical with zero expectation, then the preferred rule is to allow pollution or not to, depending upon the relative costs of transactions. If transactions to stop pollution (p_1) are more expensive than those to allow pollution (p_4), then the rule that maximizes social benefit is the rule that places the burden of liability on the polluter.

The above prescription is limited in its application, as two examples make clear. Suppose that the transaction costs of either type of bargain are large relative to the potential gains from the bargains, as depicted in Figure 2. Here the expected gain from any rule is zero. All bargains are ruled out by high transaction costs, and the justification for any rule disappears. Given the absence of bargaining transactions in the real world, there is a strong case for supposing that

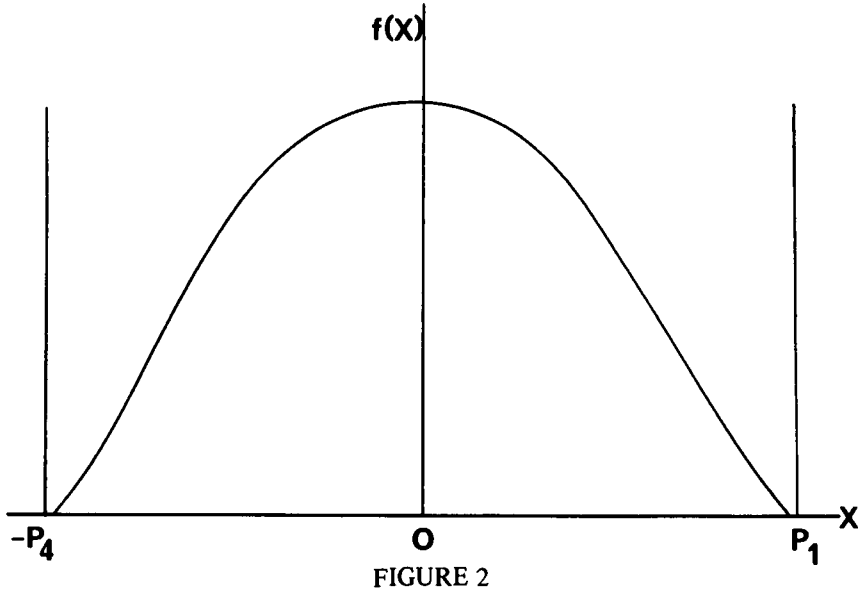

FIGURE 2

transaction costs are such as to make this the most likely situation.

The second problem occurs when the assumption is violated that the prior probability distribution for the social benefit is symmetrical with zero expectation. A non-zero expectation is of course strong grounds for favoring a particular rule. But even with zero expectation, a non-symmetrical probability density function invalidates the justification for the prescription. Consider Figure 3. In this case it is apparent that although p_1 is greater than p_4, the expected gain from preventing pollution is negative. And although it could be objected that the ignorance of policy makers about the likely costs associated with pollution is best represented in a symmetric probability density function, there is good reason to suppose that Figure 3 is realistic. In an industrial example, costs of abating pollution are usually small and are limited to the total value of a factory's production, while the costs of the pollution are potentially massive, albeit with very small probabilities. In such a situation, a rule that prevented pollution could mean that many Pareto efficient bargains were invalidated by what were low transaction costs, while a few large gains from stopping pollution outweighed the higher transaction costs of doing so. (The vehemence of opposition to nuclear power plants indicates a potential example of this phenomenon.) A rule that removed the legal liability from polluters seems in such cases to be superior.

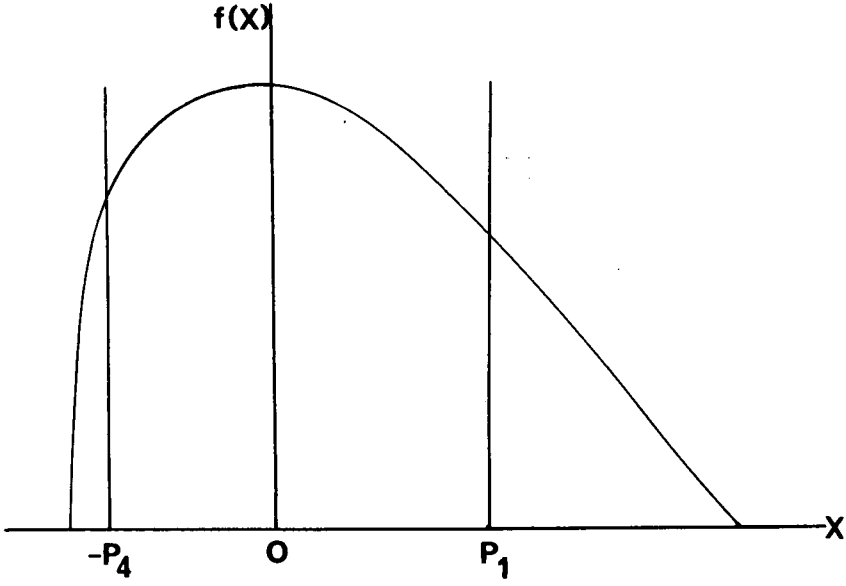

FIGURE 3

IV. LIABILITY RULES FOR EXTERNALITY TYPES

Analysis with the model above suggests that where a market solution is possible the choice of legal liability depends upon the relative magnitudes of transaction costs. One feature of the model is that the transaction costs of bargaining are both independent of the scale of the transactions and known with certainty. To consider liability rules for the different categories of externality, it is necessary to investigate further these assumptions.

The assumption that transaction costs are independent of the magnitudes of transactions provides the simple expression for expected social benefit in Equation 1. Otherwise, transaction cost functions $p_1(X)$ and $p_4(X)$ would appear under the integral signs in Equation 1. As a consequence, determination of the sign of the expected social benefit would require full knowledge not only of the complete transaction cost functions, but also of the exact form of the probability density function $f(X)$, rather than just of its symmetry or asymmetry.

The transaction costs of a bargain can be divided into three components: the cost of coordinating as a bargaining unit the parties on each side of the bargain; the actual cost of negotiation; and the cost of enforcing the agreement. There is no justification for asserting that any of these is a function of the amount transacted. *Private* costs may well be functions of the amount of transactions—the legal practice of charging percentage commissions is an excellent example. But most of a commission payment constitutes a transfer payment; the *social* cost of a transaction is independent of its amount and depends only upon the actual resources employed.

The second assumption of the model is that transaction costs are known with certainty. This assumption is much less defensible, but without it probability density functions for transaction costs would be included under double integral signs in Equation 1, and no simple conclusions could be derived. When uncertainty is extended to more than one parameter of the expected social benefit function, it is obvious that no general rules for the distribution of liability can be derived. If no limits are imposed upon the area of policy makers' uncertainty, then no rules can be given to optimize the expectation of the result of their decisions.

Such pessimistic conclusions suggest that it is the paradigm used that is at fault. An attractive alternative is the "trial and error" procedure. One such is Baumol and Oates' proposal[13] to enforce

13. W. BAUMOL & W. OATES, *supra* note 7, ch. 10.

standards by adjusting pollution charges as necessary. But the model developed here does retain prescriptive power if there is a theory about the *difference* between transaction costs for the two types of bargain. The actual magnitude of the transaction costs can remain unknown; but if, say, p_1 is greater than p_4, then although the possibility cannot be excluded that all transaction costs are so high as to make Figure 2 the accurate depiction, there is nevertheless a case for recommending $\bar{L}$ law. It is shown below that prima facie grounds do exist for asserting such a difference in transaction costs. Therefore, appropriate rules of liability can be suggested for the various types of externality.

Consider first undepletable externalities. For them there is no competitive market solution. The criteria derived cannot therefore contribute to the choice of liability rule. A rule can be chosen only if the policy maker's prior probability distribution for the net social cost of the pollution has a non-zero expectation.

Depletable externalities can be exclusive or non-exclusive. In the former situation, all possible Coasian bargains are of a one polluter-one pollutee nature and are independent of each other. Prima facie there is no reason to argue that transaction costs can be other than such that p_1 and p_4 are equal. A liability rule therefore can be chosen only by zero-expectation policy makers in the asymmetric example of Figure 3.

Estimation of transaction costs presents most difficulties in the case of depletable, non-exclusive externalities. Are transaction costs for bargains which allow the oil company to pollute likely to be greater or less than for bargains which stop the pollution? The prima facie answer is found by consideration of two phenomena that are noted in the public goods literature—the "free rider" and the person who "holds out." Each involves the transmission in the market of false signals. Free riders understate their preference for a public good, intending to use free what is provided by the payments of others. The hold out problem is caused by one individual overstating his preferences, and thus obtaining reward for his consent, in a situation where unanimity of consent is necessary. It is argued here that for depletable, non-exclusive externalities, the free rider problem is present and the hold out problem absent. Consequently, transaction costs are higher for bargains to stop pollution than to allow it.

At first sight, it might appear that the free rider and the hold out problems are symmetric. This view is mistaken. The free rider problem is a function only of the non-exclusivity of an externality. Regardless of the depletability, if a good can be consumed irrespec-

tive of who has paid for it, there is an incentive for individuals to understate their references. By contrast, holding out arises only where an externality is undepletable. For if the externality can be depleted, an individual's power to hold out can be negated by another person absorbing the external effects. Suppose there is $\bar{L}$ law: oil companies have to bribe the fishing industry to be allowed to pollute. The oil destroys £1000 worth of fish, and abatement would cost £2000. The oil company might offer £150 each to ten fishers, who together would absorb the loss of fish. One fisher holds out for, say, £600. In this case, however, an eleventh fisher can accept the offer of £150 and fish around the rig, all the external effects thus being absorbed. The holder out would be frustrated; since the externality had been totally depleted, there would be no claim against the company.

The problem of free riders arises where an externality is non-exclusive; the hold out possibility occurs only for undepletable externalities. Where externalities are depletable and non-exclusive, it follows that only the free rider problem is relevant. In such cases, it is to be expected in consequence that transaction costs to prevent pollution are greater than the costs to allow it. The $\bar{L}$ law, with the burden of liability being placed on the polluter, is therefore appropriate.

Prescriptive conclusions can thus be obtained. Where externalities are undepletable, there is no efficiency basis for choosing between states of the law. For depletable, exclusive externalities, again there is no efficiency advantage in either law, unless the probability distribution for net social benefit is asymmetric. For depletable and non-exclusive examples of externalities, there is a clear basis for choosing the $\bar{L}$ law. In the absence of specific information about social benefits and costs, a law that attributes liability to the polluter is therefore to be preferred.

V. CONCLUDING REMARKS

The environmentalist's law, that favors the victim of pollution against the polluter, has been given some theoretical justification. For depletable externalities, this originates from the important asymmetries between "free riding" and "holding out" that have been described, and from the physical nature of several externality problems. For a large class of pollution examples, however, where the externality is undepletable, no market can achieve a Pareto optimal allocation. In these cases market solutions are useless if efficiency is to be the criterion for the allocation of liability.

In a real world context, much of the argument for the environmentalist's law disappears. Very high transaction costs remove the justification for any rule, and the possibility of asymmetry in pollution costs could be used to support laws that favor the polluter. Accordingly, the efforts of policy makers should be directed towards more careful assessment of the likely costs and benefits of polluting activities and of the distributional and ethical dimensions. Beside these factors, the possibility of market solutions and the relative magnitude of transaction costs are of a doubtful relevance.