

THE COST OF COASE

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INTRODUCTION

THE publication of "The Problem of Social Cost" in 1960 by Ronald Coase brought together two powerful intellectual currents, namely, the economic theory of externalities and the common-law tradition concerning torts and nuisance.¹ The sea is fertile but rough where two ocean currents meet, and the same can be said of the disputes provoked by Coase. Coase developed his argument through a series of concrete examples, such as the rancher and the farmer, the railroad sparks and the corn crops, etc. He steadfastly refused to articulate the general truths underlying the examples; for example, the famous "Coase Theorem" is abstracted from the paper but not stated in it. After two decades of debate the generalizations underlying the examples are still disputed.

In this paper I will not attempt the impossible task of offering the "true" or final interpretation of Coase's paper. Hermeneutics is left for others. Rather, I will state and prove those generalizations applicable to Coase's examples which follow from familiar assumptions of economic theory. It seems to me that these generalizations frequently conflict with Coase's examples in the sense that the immediate interpretation of his examples are inconsistent with the provable generalizations. The cost of Coase's paper is that readers are confused or misled about the generalizations which follow from familiar economic assumptions.

In the first section of this paper I characterize the dispute by developing one of Coase's examples. The second section formulates some general propositions about correcting externalities through the use of liability law, taxes, and transferable property rights. The third section addresses the

¹ I have received numerous comments on several drafts of this paper, and especially from Henry Hansmann and the participants in the public finance seminar at the University of Toronto.

² R. H. Coase, *The Problem of Social Cost*, 3 *J. Law & Econ.* 1 (1960).

TABLE 1
BALANCE SHEET SHOWING PRIMARY DATA

Row		TRAINS PER DAY			
		0	1	2	3
1	RR's gross profit (fares less operating costs)	0	100	150	125
2	Damage to nonmarginal fields	0	-60	-120	
3	Damage to marginal fields if cultivated	0	-60	-120	
4	Farmers' gross profit on marginal fields (no compensation)	10	-50	110	

problem of bargaining and the Coase Theorem. The formal development of the argument and the proofs, some of which are interesting in their own right, are relegated to the detailed Appendix.

I. RAILROAD AND FARMERS: THE PROBLEM

A famous example from nineteenth-century England developed by Coase concerns the crop damage caused by fires ignited by sparks emitted from railroad trains. We shall use this example to illustrate the scope of the controversy provoked by Coase. Tables 1-3 characterize the example quantitatively. The numbers in these tables are mostly reproduced from Coase, but it was necessary to supplement Coase's numbers in order to broaden the example's scope. Table 1 shows profits and losses experienced by the railroad and farmers. Crop damage is distinguished according to whether it occurs in nonmarginal or marginal fields. The marginal fields are located along the margins of the railroad tracks (fig. 1), but they are also marginal in an economic sense because the profitability of cultivating them depends upon the behavior of the railroad. By contrast, the nonmarginal fields are located far enough from the tracks so that cultivating them is profitable, regardless of the railroad's behavior.

The railroad decides how many trains to run each day and the farmers

TABLE 2
JOINT PROFITS

MARGINAL FIELDS	TRAINS PER DAY		
	0	1	2
Cultivate 1 + 2 + 4	10	-10	-80
Fallow 1 + 2	0	40	30

TABLE 3
POLICY OUTCOMES

POLICY	NO. OF TRAINS	CULTIVATE OR FALLOW	PROFITS BEFORE TAX OR SUBSIDY		
			RR's	Farmers'	Joint
1. Do nothing	2	F	150	-120	30
2. Liability	0	C	0	10	10
3. Tax on damages	0	C	0	10	10
	1	F	100	-60	40
4a. Bargaining: no liability	1	F	155	-115	40
4b. Bargaining: liability	1	F	15	25	40

decide whether to cultivate or leave fallow the marginal fields. The joint profits resulting from these decisions are shown in table 2. The resource allocation which is optimal in the sense of maximizing joint profits requires the railroad to operate one train per day and the farmers to leave the marginal fields fallow, yielding joint profits of 40.

In table 3 we see the outcomes resulting from different policies. If the government does nothing to reallocate costs, then the railroad will operate two trains per day and the farmers will leave the marginal fields fallow, yielding joint profits of 30. If the railroad is required to compensate the farmers for actual damage done to crops in the marginal and nonmarginal fields, then the farmers will cultivate the marginal fields and the railroad will run no trains, yielding joint profits of 10. These are the two rules of

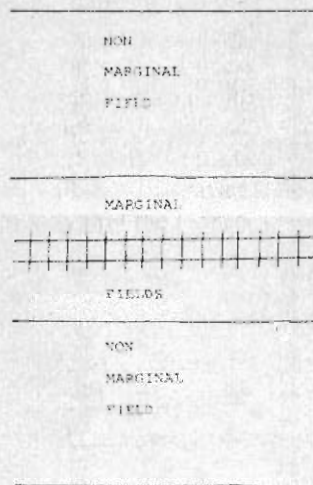


FIG. 1

RAINS PER DAY		
1	2	3
100	150	125
-60	-120	
-60	-120	
-50	-110	

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PER DAY	
1	2
10	-80
40	30

law discussed by Coase in the example of the railroad and the farmers. We have expanded this example in order to consider a tax remedy. If the railroad is taxed for the actual damage done to crops, and the taxes are *not* paid to the farmers as compensation, then there are two (Nash) equilibria. Either the farmers will cultivate the marginal fields and the railroad will run no trains, or the railroad will run one train and the farmers will leave the marginal fields fallow.

The preceding paragraph assumes that the railroad and the farmers do not bargain with each other or cooperate. If the parties can bargain and cooperate, then their best course is to maximize joint profits and split the surplus from cooperation. The proposition that resource allocation is efficient, regardless of the structure of liability law, provided that bargaining is frictionless, is one version of the Coase Theorem. We illustrate this claim in rows 4a and 4b of table 3. In these two rows the activities which maximize joint profits are undertaken, regardless of the liability law, but the law of liability does influence the distribution of the cooperative surplus. The railroad is better off under "no liability" (row 4a) and the farmers are better off under "liability" (row 4b). The exact numbers are obtained by computing what each party can earn on his own without cooperation (threat values) and adding to that amount one half of the surplus from cooperation. For example, consider the rule of liability. We see from row 2 that the railroad's and the farmers' noncooperative profits are (0, 10) respectively, the cooperative surplus is $40 - (0 + 10) = 30$, and so the payoffs in row 4b are $0 + 15$ and $10 + 15$, or (15, 25).

What goes wrong with the liability and tax remedies in this example? Can we expect these remedies to fail in the usual situation? Is the Coase Theorem a mere tautology or is it a conclusion deduced from the usual economic assumptions about human behavior? These are some of the questions answered in the next two sections.

II. THEOREMS ON REMEDIES UNDER COMPETITIVE ASSUMPTIONS

In this section we formulate and explain theorems about the existence, efficiency, and stability of the liability, tax, and property rights remedies for externalities. Throughout Section II we assume that there is no bargaining, collusion, or market power on the part of the parties. This assumption is relaxed in Section III. Mathematics is relegated to the Appendix.

Pigouvian Tax

How does a competitive market reach equilibrium? Economic theory usually imagines that an auctioneer adjusts prices until demand equals

supply. If demand exceeds supply, then the auctioneer shouts out a higher price. Consumers and producers respond by stating their demand and supply at the new price. If demand still exceeds supply, the auctioneer raises the price again. The market equilibrates through a series of such price and quantity adjustments.²

In this section we imagine that a tax is levied on pollution and that this tax is adjusted in a fashion similar to the auctioneer's adjustment of market prices. We name the government auctioneer after Pigou, as distinct from the Walrasian auctioneer who controls the prices of private goods.³ The Pigouvian auctioneer shouts out the tax-price of pollution. Polluters respond by stating how much pollution they will emit at that price, and pollutees respond by stating how much they would pay to reduce pollution. If the pollutees are willing to pay more than the tax to reduce pollution, then the auctioneer raises the tax. The pseudomarket equilibrates through a series of such price and quantity adjustments.

In order to have a concrete example, imagine that firms emit smoke and households suffer from it. When a tax-price is announced, the firms plan to pollute out to the point where the tax equals the marginal cost of smoke reduction. The households respond to the planned smoke level by adjusting their behavior so that they are less vulnerable to smoke, for example, they plan to rent homes farther from the factories. The households also reveal to the Pigouvian auctioneer how much they would be willing to pay for a marginal improvement in air quality. If the households are willing to pay more than the tax-price, then there is excess demand for clean air and the Pigouvian auctioneer raises the price of smoke. Thus our interpretation of pollution taxes is exactly parallel to the standard economic interpretation of market behavior.

We imagine that an auctioneer adjusts prices, including the tax price, upward when there is positive excess demand and downward when there is excess supply. It is easy to prove three fundamental theorems under the usual assumptions about convexity and continuity:⁴

PI. An equilibrium exists with the Pigouvian auctioneer setting the tax.

Furthermore, an equilibrium is efficient because the marginal benefit

² A sophisticated treatment of general equilibrium theorem is Kenneth Arrow & F. H. Hahn, *General Competitive Analysis* (1971).

³ Walras's account of general equilibrium theory is found in *Eléments d'économie politique pure* (1874, 1877), translated into English by William Jaffé as *Elements of Pure Economics* (1954). A. C. Pigou's discussion of externalities is in his *The Economics of Welfare* (4th ed. 1932).

⁴ A less explicit development of these theorems is in William J. Baumol, *On Taxation and Control of Externalities*, 62 *Am. Econ. Rev.* 307 (1972).

of clean air equals the marginal cost in equilibrium. Several alternative propositions about efficiency can be proved. The following formulation is especially useful:

P2. Equilibrium is efficient in the sense that no improvement can be made as measured by the cost benefit standard (hypothetical compensation or compensating variation).

An interesting fact proved in the Appendix is that the Pigouvian auctioneer always adjusts prices so that social value increases, as measured by the cost-benefit standard, providing income effects are small. In other words, social value increases as the economy moves along the disequilibrium path. The cost-benefit standard measures distance from the optimum, and the Pigouvian auctioneer acts to decrease this distance, from which our third proposition follows:

P3. If income effects are small locally, then the system is locally stable.

Propositions 1-3 imply that if the government taxes polluters for the actual cost of the pollution as recommended by Pigou, then taxes and prices will converge toward efficiency, under the usual competitive assumptions. Why does the railroad and farmers example fail to exhibit this property? An obvious reason is that in the example farmers are compensated for the market value of the crops destroyed on the marginal fields, not the loss of profits from leaving the marginal fields fallow. If the tax equaled the loss in profits on the marginal fields (10) and the nonmarginal fields (60 for one train, 120 for two trains), then the railroad would run one train and the farmer would leave the marginal fields fallow, as required for efficiency.

Some readers of Coase imagine that P1-P3 do not apply to choice of location. For example, it is said that taxing smoke from factories will cause residential housing to locate too close to the factory. But the location of residences is no different theoretically from the location of cultivated fields. What P1-P3 tell us is that the distance of cultivated fields from the railroad tracks will be efficient with Pigouvian taxes, and the same can be said about the distance of houses from stationary sources of pollution.

In passing we remark that the tax remedy is vulnerable to collusion. It is easy to see why. Suppose that there is no tax and that collusion between farmers and railroad is perfect. In that case the farmers and the railroad will maximize joint profits as required for efficiency. Now we impose a tax on sparks. The marginal cost of sparks to the joint enterprise increases by the value of the tax, so spark emissions will be reduced. But by assumption the joint enterprise was already taking efficient precautions. Thus the tax remedy is inefficient when polluter and pollutee collude, because it results in too little pollution.

Liability Remedy

Assume that there is an external bad and that efficiency requires costly preventive measures on the part of both injurer and victim. Assume that obstacles to private bargains prevent the parties from voluntarily reallocating the cost between them. If the law does nothing to reallocate costs, then the injurer's prevention will be nil. If the law holds the injurer strictly liable to the victim for the full damage, then the victim's prevention will be nil. Thus no liability and strict liability are symmetrical opposites, both of which are inefficient. This is the conventional economic analysis encountered in our example of the railroad and the farmers.⁵

Now consider an example which conflicts with the conventional analysis. A factory emits smoke which dissipates with distance from the plant. The smoke damages crops but not trees. The factory can prevent the externality by reducing or eliminating smoke, and landowners can prevent the externality by growing trees. If the rule of law is no liability, then there will be too many trees and too few crops near the factory, just as predicted by the conventional model. If the rule of law is strict liability, and if compensable damages equal loss in rental value of the land caused by smoke, then there will be an efficient mix of trees and crops, as we shall show. Thus strict liability for the loss in rental value is efficient and is not the symmetrical opposite of no liability.

It is easy to explain why strict liability for loss in rental value is efficient. The income from land ownership equals rent plus compensation. Compensation equals the fall in the competitive rental value of the land due to smoke. A landowner cannot increase his compensation by renting below the market. For example, lumbering is the activity which yields the highest return on land in the shadow of the smokestack, but the compensation will be the same whether the owner uses it for lumbering or for farming. An income-maximizing landlord will put his land to the highest-valued use, whether the rule of law is strict liability for loss in rental value or no liability. Furthermore, strict liability will cause the factory to internalize the cost of smoke. Thus, strict liability for loss in rental value will produce the efficient mix of trees, crops, and smoke.

What is the difference between the conventional economic model and our example? The difference comes down to the distinction between price making and price taking. Under strict liability, the pollutee's entitlement to be free from pollution can be purchased by the polluter at a price set by the court. If compensation is based upon damage to crops, then the pollutee can influence the price which the polluter must pay for the entitlement. If compensation is based upon the fall in rental value, then the

⁵ An explicit development of the conventional analysis is in John Brown's *Toward an Economic Theory of Liability*, 2 *J. Legal Stud.* 323 (1973).

pollutee cannot influence the price which the polluter must pay for the entitlement. In other words, the pollutee is a price maker in the supply of pollution rights under strict liability for damage to crops, and the pollutee is a price taker in the supply of pollution rights under strict liability for damage to rents. The destruction of crops is affected by the decision about what fields to plant, but the rental value of the land is determined by the market. In general, the victim supplies too little precaution when a decrease in precaution increases the price paid to him for the right to pollute. The victim's precaution is efficient when the price paid to him for the right to pollute is independent of his precaution.

Strict liability for damage to crops is inefficient because the pollutee behaves like a monopolist, whereas strict liability for damage to rents is efficient because the pollutee behaves like a competitor. This is the explanation which we offered for the difference between Coase's example and our example. The same point can be made by an analogy to taxation, rather than market structure. We may think of compensation as a subsidy (negative tax) paid to the farmer by the court. If compensation is based upon the fall in market rents, which the farmer cannot influence, then the subsidy is lump sum. A lump-sum subsidy does not distort the farmer's precaution. If compensation is based upon damage to crops, which the farmer can influence, then the subsidy distorts the farmer's precaution.

Now we turn to the task of formulating the underlying generalizations. We assume that polluters are strictly liable for the actual damage done to pollutees. We also assume that the measure of damage is a fall in competitive prices, such as land rents, which no individual pollutee can influence. We refer to this rule of law as "strict competitive liability." The following propositions can be proved about a model which has a Walrasian auctioneer for market goods and courts imposing strict competitive liability for external bads:

P1'. An equilibrium in prices exists with a Walrasian auctioneer and strict competitive liability.

P2'. An equilibrium is efficient by the cost-benefit standard with a Walrasian auctioneer and strict competitive liability.

P3'. Assume income effects are small locally. Then the system is locally stable with a Walrasian auctioneer and strict competitive liability.

These propositions imply that the allocation of resources will converge toward efficiency if markets are competitive and if courts hold injurers strictly liable for the actual damage from external bads, provided that individual victims cannot influence their compensation.

In our example adapted from Coase, if the railroad is liable, then farmers plant the marginal fields, which is inefficient. What goes wrong? The difficulty is that the computation of damages violates the competitive

assumption. Specifically, an individual farmer can influence the rate of compensation by cultivating the marginal fields or leaving them fallow. The Coase example envisions courts basing compensation upon damage to crops, which individuals control, and not on damage to rents, which the market controls. The example of the railroad and the farmers points out a problem with a liability remedy that builds monopoly power into the compensation schedule, but it does not imply a general problem with liability remedies.

What if the court wishes to compensate farmers as well as landlords, or to base compensation on damage to crops as well as rents? No difficulty arises so long as the court makes the correct distinction between temporary and permanent damage. If crop damage is unanticipated and uncompensated, then the railroad will cause profits from farming in a competitive market to be negative temporarily. This condition will persist until the amount of farming decreases enough to restore profits to their normal level. The courts may ease the pain of transition from one long-run equilibrium to another by ordering the railroad to compensate farmers for crop damage. However, this compensation must be temporary, for example, for damage done to marginal crops *last year only*. The court must not provide an incentive for continuing the inefficient practice of cultivating the marginal fields. By contrast, the damage to the rentier is permanent; for example, landlord losses equal the present value of the decline in annual rents for an infinite number of years. Strict competitive liability provides compensation for this permanent fall in rents.

Our discussion of the liability remedy focused upon strict liability. The analysis of a variety of other tort rules has been carried out elsewhere, with results similar to $P1'-P3'$. The point is that efficiency will be achieved under competitive conditions by mechanisms similar to those described in this section. For example, the rule of negligence is efficient if the standard of care is adjusted by the courts according to a mechanism similar to what we called the "Pigouvian auctioneer."⁶

Property Rights Remedy

Suppose that the government prints coupons authorizing the owner to emit one unit of smoke per coupon. No one is permitted to emit more smoke than his coupons allow. In this section we examine the competitive exchange of such pollution rights. We shall show that a competitive market will be efficient if the government adjusts the economy's endowment in coupons in a manner analogous to our Pigouvian auctioneer. In fact, the

⁶ See Robert Cooter, Lewis Kornhauser, & David Lane, *Liability Rules, Limited Information, and the Role of Precedent*, 10 *Bell J. Econ.* 366 (1979).

property rights remedy is the dual of the tax remedy, with government choosing the quantity of pollution rights rather than the tax-price of pollution.

The characterization of a competitive market for pollution rights is straightforward. The government issues a certain number of pollution coupons. It does not matter whether the coupons are initially given to polluters, pollutees, or auctioned to the highest bidder, so long as the owners of the coupons are free to exchange them. We assume that there are enough participants in this market for it to be competitive. In a competitive market, the right to pollute depends upon ownership of a pollution coupon and not on the identity of the owner. We are assuming that pollution coupons do not bear the names of individuals. For example, a factory owner who wants to emit pollution that will damage John Doe can use any pollution coupon. The factory does not need a coupon conferring the "right to pollute John Doe." Our competitive assumption requires that pollution rights be impersonal and that pollutees be numerous. Consequently, an individual pollutee cannot appreciably diminish the pollution which he suffers by refusing to sell his pollution rights. All pollutees will sell their rights to polluters. If the equilibrium price is positive, then the amount of pollution will equal the number of pollution rights created by the government.

The competitive price measures the amount that polluters are willing to pay to pollute, which equals the cost of reducing pollution. The government adjusts the quantity of pollution rights in circulation by a rule just like the one the Pigouvian auctioneer used to adjust the tax rate on pollution. If the pollutee's willingness to pay for a reduction of pollution is less than the market price, then the government issues more coupons. If the willingness to pay for a reduction in pollution is more than the price, then some coupons are removed from circulation. We call this behavior "quantity determination by the Pigouvian auctioneer."

The following theorems can be proved:

P1". An equilibrium exists, with the Pigouvian auctioneer setting the quantity of pollution rights and the Walrasian auctioneer setting prices.

P2". Equilibrium in the exchange of pollution rights with a Pigouvian/Walrasian auctioneer is efficient in the sense that no improvement can be made as measured by the cost-benefit standard.

P3". If income effects are small locally, then the system for exchanging pollution rights is locally stable with a Pigouvian/Walrasian auctioneer.

In our example of the railroad and farmers, we may imagine that government creates rights to emit sparks which it adjusts iteratively. In equilibrium the railroad will hold enough rights to operate trains at efficient intervals and farmers will cultivate at the efficient distance from

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the tracks. The initial allocation of pollution rights will influence the distribution of the surplus achieved by their exchange, as described in rows 4a and 4b of table 3. The efficiency of the equilibrium does not depend upon the initial allocation of rights. Efficiency is guaranteed by competitive exchange and the government's iterative adjustment of the quantity of pollution rights.⁷

Pollution rights are like coal in the ground, in the sense that in equilibrium the owners of the rights will be those who value them the most. The initial pattern of ownership does not affect efficiency. It does not matter whether the government auctions the coupons or gives them away. However, the quantity of coal in the ground is set by nature—whereas pollution rights are variable as a matter of policy. The government must create exactly the correct quantity of pollution rights to achieve efficiency. The Pigouvian auctioneer will do this by P2".

Information is needed to adjust the quantity of pollution rights in an efficient direction. We see from our propositions that the Pigouvian auctioneer requires the identical information to adjust either the endowment in property rights or taxes. (Furthermore, the "equilibrium price" of pollution rights in a government auction with recontracting is another name for the Pigouvian tax.) These facts offer no basis for choosing between the two mechanisms for controlling pollution. The difference between them is in the disequilibrium effects. Under the tax scheme, in each disequilibrium period the firms know the tax price of pollution in advance, but government is uncertain about the quantity of pollution. Under the property rights scheme, in each disequilibrium period the government knows the quantity of pollution in advance, that is, the quantity of coupons issued, but the firms do not know the price of pollution. Policy preference between these schemes turns on whether quantity or price uncertainty is more costly to society.

Before turning to a different topic, it is worth mentioning the connection between the competitive exchange of pollution rights and the "bubble" concept with which the Environmental Protection Agency has experimented. The idea of the bubble is that air quality for a plant or district is not allowed to fall below some given level. Extant polluters are given

⁷ The concept of a market for pollution rights was first analyzed mathematically by Arrow. Starrett showed that such markets may exhibit a nonconvexity. Coeter pointed out that the nonconvexity would not arise under realistic schemes for allocating the endowment in pollution rights. See K. J. Arrow, *The Organization of Economic Activity, Issues Pertinent to the Choice of Market versus Nonmarket Allocation*, in U. S. Congress, Joint Economic Committee, *The Analysis and Evaluation of Public Expenditures: The PPB System* (1969), 1:47-64; David A. Starrett, *Fundamental Nonconvexities in the Theory of Externalities*, 4 *J. Econ. Theory* 180 (1972); Robert Coeter, *How the Law Circumvents Starrett's Nonconvexity*, 22 *J. Econ. Theory* 499 (1980).

the right to continue polluting at the same level for some period of time, but any new polluter must buy pollution rights from someone else. Thus the air quality within the bubble is held constant. As characterized there is no provision for adjusting the number of pollution rights in circulation toward an optimum. If the pollution rights were adjusted iteratively until the market price paid by polluters equaled the pollutee's willingness to pay for pollution reduction, then the bubble scheme would correspond to our abstract model.⁸

The Coase Theorem is sometimes interpreted to mean that competitive exchange of pollution rights will be efficient regardless of the initial allocation of rights. This version of the theorem is confirmed by P2". However, the total endowment of pollution rights must be adjusted by government to achieve efficiency, as is done with the Pigouvian tax remedy. Most discussions of the property rights remedy envision a more limited role for government.

In Section III we consider what happens when pollution rights bear the names of individuals, so that there is an irreducible element of monopoly in their exchange. We also consider what happens when individuals can choose how many coupons to mint instead of the government making that determination.

Caveats

We have shown that tax, liability, and property rights remedies will solve the problem of externalities under competitive conditions. The competitive model is the natural starting point of an economic analysis because it is simple. Realism demands the relaxation of its assumptions. We shall not attempt a systematic examination of the consequences of relaxing the competitive assumptions, but we shall offer a few remarks.

A potential problem is nonconvexity in the production or consumption sets.⁹ It is easy to illustrate this problem by the example of the laundry and the smoky factory. If the two plants are located far apart, then the smoke will not interfere with the laundry. As the plants are moved closer together, smoke interferes with the laundry more and more, as illustrated in figure 2. The end points of the production frontier do not change because there is no interference when all resources are devoted to producing only one good, but the interior points collapse toward the origin as the plants are located closer together. Obviously a nonconvexity will be pro-

⁸ EPA's Widening Embrace of the "Bubble" Concept: The Legality and Availability of Intra-Source Tradeoffs, 9 Env'l L. Rep. 10027 (1979).

⁹ See Baumol, *supra* note 4; also see Starrett & Cooter, *supra* note 7.

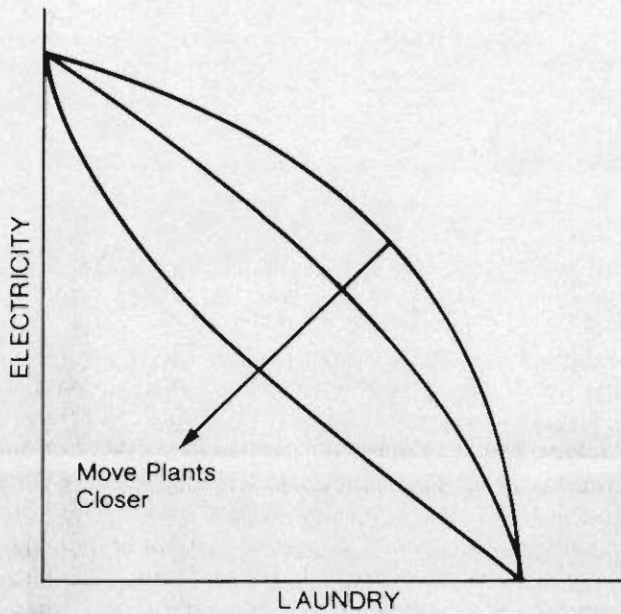


FIG. 2

duced if interference is large when the plants are close together. If the production or consumption sets display large nonconvexities, then our proofs of existence, efficiency, and stability will fail.

Another problem concerns imperfect information. For the tax or property rights remedy to work, the government must know the true damages suffered by victims. For the liability remedy to work, the courts must know the actual fall in rents caused by the pollution. Under each of these arrangements the parties have an incentive to provide distorted information to the government. It is not certain that government could obtain the needed facts.

There is also a problem concerning government motives. We have shown that the tax and property rights remedies will work if government behaves like the Pigouvian auctioneer. In fact government officials have little incentive to mimic the market. Our models suffer from the usual defect of assuming ideal government behavior without offering an account of incentives which would produce such behavior.

Finally, there are a host of second-best problems. How does insurance affect the liability remedy? What happens when compensation is partial, rather than complete? What happens to the tax remedy when some mar-

kets are monopolized? Can pollution rights be allocated without political chicanery? We must pass over these questions in order to consider the bargaining interpretation of Coase's Theorem.

III. BARGAINING AND THE COASE THEOREM

Coase gave his name to a fundamental theorem on externalities and tort law, but he left to others the job of stating exactly what the theorem says.¹⁰ The basic idea of the theorem is that the structure of the law which assigns property rights and liability does not matter so long as transaction costs are nil; bargaining will result in an efficient outcome no matter who bears the burden of liability. The conclusion may be drawn that the structure of law should be chosen so that transaction costs are minimized, because this will conserve resources used up by the bargaining process and also promote efficient outcomes in the bargaining itself.¹¹

It has been suggested that the Coase Theorem is a tautology, like the proposition "All husbands are married."¹² But a tautology conveys no information to someone who is competent in the language, whereas the Coase Theorem is the basis for a theory of externality and the evolution of property rights. Most discussions of the Coase Theorem do not treat it as an empty tautology; rather, it is taken to suggest a definite approach to policy and legislation—use the law to lubricate private bargaining. In order to account for the Coase Theorem's power, it must be regarded as being what its name proclaims, a theorem not a tautology.

It is helpful to keep in mind the distinction between them. A tautology is true by virtue of the definition of words. A theorem is true by virtue of its deduction from the assumptions of a theory. Tautologies are based upon linguistic conventions and theorems are based upon theoretical assumptions. The power of Coase's Theorem is explained by the fact that it is treated as if it were an economic theorem, that is, a proposition deduced from standard economic assumptions. The proof has never been con-

¹⁰ The theorem is suggested by arguments in his classic paper, *The Problem of Social Cost*, *supra* note 1. I am told that he stated the theorem explicitly in a seminar at the University of Chicago.

¹¹ For example this is a theme in Richard Posner's *Economic Analysis of Law* (2d ed. 1977).

¹² "In such a frictionless society, transactions would occur until no one could be made better off as a result of further transactions without making someone else worse off. This, we would suggest, is a necessary, indeed a tautological, result of the definitions of Pareto-optimality and of transaction costs which we have given." Guido Calabresi & A. Douglas Melamed, *Property Right, Liability, Rules and Inalienability: One View of the Cathedral*, 85 *Harv. L. Rev.* 1089 (1972); reprinted in *Economic Foundations of Property Law* (Bruce Ackerman ed. 1975); 31-48, esp. 34.

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structured, but there is widespread conviction that it could be constructed if sufficient care were taken in arranging the assumptions.

We shall argue that the central version of the Coase Theorem cannot be deduced from economic assumptions. The widespread belief to the contrary is symptomatic of confusion about bargaining. This confusion results in blindness toward certain outcomes of policy. We shall try to restore accurate vision by explaining the relations among liability law, bargaining, and the economic assumptions of rational behavior.

Bargaining Problem

The Coase Theorem identifies a set of conditions under which the legal assignment of liability makes no difference. The phrase "makes no difference" has two interpretations: (i) the allocation of resources is invariant, or (ii) the allocation of resources is efficient. There was a confused debate about invariance versus efficiency, but now there is agreement that the invariance version is untenable.¹³ It is the efficiency version which we shall consider.

There is no agreed-upon interpretation of the conditions suggested by Coase under which the rule of liability does not affect efficiency. One tradition of exegesis interprets Coase as requiring competitive markets, so that no one has any bargaining power. For example, Richard Zerbe has offered the following statement of the Coase Theorem: "In a world of perfect competition, perfect information, and zero transaction costs, the allocation of resources will be efficient and invariant with respect to legal rule of liability."¹⁴ We have already observed that the invariance interpretation is discredited, so the phrase "and invariant" should be deleted. The idea is that a complete set of markets can be achieved by liability law, even in the presence of externalities, and that these markets are efficient when competitive.

This form of the Coase Theorem is true. It is an application of proposition P2¹⁵ where we stated that competitive exchange of property rights achieves efficiency, regardless of the initial assignment of pollution coupons. However, the government must create exactly the right number of pollution coupons in order to achieve efficiency. The government's role in adjusting the total quantity of pollution coupons was shown to be the dual of the government's role in adjusting a Pigouvian tax. This activist

¹³ See comments by Bruce Ackerman, in *Economic Foundations of Property Law*, *supra* note 12, at 23.

¹⁴ Richard O. Zerbe, *The Problem of Social Cost: Fifteen Years Later. Theory and Measurement of Economic Externalities* 29 (Steven A. Y. Lin ed. 1976).

role of government is not what the commentators had in mind when discussing the Coase Theorem. Consequently, we shall not discuss any further the interpretation of the Coase Theorem which assumes competitive exchange.

Another interpretation of the Coase Theorem does not mention a requirement of competitive markets. For example, Polinsky has offered this compact statement of Coase's Theorem: "If transaction costs are zero the structure of the law does not matter because efficiency will result in any case."¹⁵ The meaning of transaction costs is not well-standardized in the literature. Calabresi says, "By transaction costs, I have in mind costs like those of getting large numbers of people together to bargain, and the cost of excluding freeloaders."¹⁶ The transaction costs of bargaining refer to the cost of communicating among the parties (including the value of time used up in sending messages), making side payments (the cost of the transaction, not the value of what is exchanged), and the cost of excluding people from sharing in the benefits exchanged by the parties. In the case of contingent commodities, the cost of obtaining information on the actions of the players is also treated as a transaction cost, so the inefficiencies from moral hazard and adverse selection are swept under the blanket of transaction costs. We shall not quarrel with the expansion of transaction costs to cover such diverse phenomena. Our objection is more fundamental.

The mechanism for achieving efficiency in the absence of competitive markets is bargaining. For example, Calabresi formulated the Coase Theorem as follows: "If one assumes rationality, no transaction costs, and no legal impediments to bargaining, *all* misallocation of resources would be fully cured in the market by bargains."¹⁷ This formulation apparently presupposes a general proposition about bargaining, namely, "Bargaining games with zero transaction costs reach efficient solutions."¹⁸

In order to evaluate this interpretation of Coase, we must explain the place of bargaining in game theory. A zero-sum game is a game in which total winnings minus total losses equals zero. Poker is an example. A zero-sum game is a game of pure redistribution, because nothing is created or destroyed. By contrast, a coordination game is a game in which the players have the same goal. For example, if a phone conver-

¹⁵ A. Mitchell Polinsky, *Economic Analysis as a Potentially Defective Product: A Buyer's Guide to Posner's Economic Analysis of Law*, 87 Harv. L. Rev. 1165 (1974).

¹⁶ Guido Calabresi, *Transaction Costs, Resource Allocation, and Liability Rules—A Comment*, 11 J. Law & Econ. 67 (1968).

¹⁷ Calabresi, *supra* note 16, at 68.

¹⁸ Donald H. Regan, *The Problem of Social Cost Revisited*, 15 J. Law & Econ. 427 (1972).

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sation is cut off, then the callers face a coordination problem. The connection cannot be restored unless someone dials, but the call will not go through if both dial at once. The players win or lose as a team, and winning is productive, so coordination games are games of pure production.

A bargaining game involves distribution and production. Typically, there is something to be divided called the *stakes*. For example, one person may have a car to sell and the other may have money to spend. The stakes are the money and the car. If the players can agree upon a price for the car, then both of them will benefit. The *surplus* is the joint benefits from cooperation, for example, consumer's surplus plus seller's surplus in our example of the car. If the players cannot agree upon how to divide the stakes, then the surplus will be lost. In brief, bargaining games are games in which production is contingent upon agreement about distribution.

The bargaining version of the Coase Theorem takes an optimistic attitude toward the ability of people to solve this problem of distribution. The obstacles to cooperation are portrayed as the cost of communicating, the time spent negotiating, the cost of enforcing agreements, etc. These obstacles can all be described as transaction costs of bargaining. Obviously, we can conceive of a bargaining game in which these costs are nil.

A pessimistic approach assumes that people cannot solve the distribution problem, even if there are no costs to bargaining. According to this view, there is no reason why rationally self-interested players should agree about how to divide the stakes. The distribution problem is unsolvable by rational players. To eliminate the possibility of noncooperation, we would have to eliminate the problem of distribution, that is, to convert the bargaining game into a coordination game. But it makes no sense to speak about a bargaining game without a problem of distribution.

Our example of selling a car illustrates the collision of these two viewpoints. The costs of communicating, writing a contract, and enforcing its terms are the transaction costs of buying or selling a car. These costs sometimes constitute an obstacle to exchange. However, there is another obstacle of an entirely different kind, namely the absence of a competitive price. The parties must haggle over the price until they can agree upon how to distribute the gains from trade. There is no guarantee that the rational pursuit of self-interest will permit agreement. If we interpret zero transaction costs to mean that there is no dispute over price, then we have dissolved the bargaining game.

The polar opposite of the optimistic bargaining theorem can be stated as follows: "Bargaining games have noncooperative outcomes even when the bargaining process is costless." This line of thought suggests the polar

opposite of the Coase Theorem: "Private bargaining to redistribute external costs will not achieve efficiency unless there is an institutional mechanism to dictate the terms of the contract." We have already discussed one institutional mechanism to achieve efficiency, namely a competitive market, which eliminates the power of parties to threaten each other. Another such institution is compulsory arbitration.

The conception of law which is the polar opposite to Coase is articulated in Hobbes and is probably much older. It is based upon the belief that people will exercise their worst threats against each other unless there is a third party to coerce both of them. The third party for Hobbes is the prince or leviathan—we would say dictatorial government—who has unlimited power relative to the bargainers. Without his coercive threats, life would be "nasty, brutish, and short."¹⁹ We shall refer to the polar opposite of the Coase Theorem as the Hobbes Theorem.

The Coase Theorem identifies the problem of externalities with the cost of the bargaining process, whereas the Hobbes Theorem identifies the problem with the absence of an authoritative distribution of the stakes. We shall argue that both theorems are false. However, they are illuminating falsehoods because they offer a guide to structuring law in the interest of efficiency.

In real situations faced by policymakers, transaction costs are positive. The Coase Theorem suggests that the role of law is to assign entitlements to the party who values them the most, so that the costly process of exchanging the entitlement is unnecessary. There are many similar versions of this proposition, for example, liability for accidents should be assigned to the party who can prevent them at lowest cost, or the cost of breach of contract should be assigned to the party who is the best insurer against nonperformance. If the party who values the entitlement the most cannot be identified, then it should be assigned to the party who can initiate an exchange at the least cost.²⁰

The Hobbes Theorem suggests that the role of law is to minimize the inefficiency that results when bargaining fails, by restricting the threats

¹⁹ In a state of nature men live in "continual fear, and danger of violent death; and the life of man [is] solitary, poor, nasty, brutish, and short." Thomas Hobbes, *Leviathan* 100 (Collier-MacMillan ed. 1973).

²⁰ "Suppose we are not sure whether rubber bumpers or wearing fluorescent clothing is the 'cheapest way' of handling the car-pedestrian accident problem. In this case it may become necessary to consider the following question: Is an erroneous placing of liability on car owners or an erroneous placing of liability on pedestrians more likely to be corrected in the market? Whether car owners (or car makers) can bribe pedestrians more cheaply than pedestrians can bribe car owners or makers, becomes the relevant issue." Calabresi, *supra* note 16, at 72.

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which the parties can make against each other. In the jargon of game theory, law increases the value of the noncooperative solution by eliminating elements of the payoff matrix with low value. This function is obvious in criminal law, where threats of violence against property or persons are punished. This function of law is also apparent in regulation of collective bargaining and strike activity. We claim that the same principle is at work where the threat is, say, to pollute a stream, to not perform on a contract, or to not take precautions against accidents.

For example, suppose that efficiency requires both the injurer and the victim to take precautions against accidents. According to the Hobbes Theorem, liability should be assigned to the party whose lack of precaution is most destructive. Put technically, liability should be assigned to the party for whom the excess of joint benefits over the private costs of precaution is largest. Alternatively, consider the problem of nonperformance on a contract by the promisor. According to the Hobbes Theorem, liability should be assigned to the promisee if excessive reliance by the promisee results in more net damage than insufficient precaution by the promisor against the events causing nonperformance. A detailed example from contract law will be developed in a subsequent section of this paper.

The Coase Theorem and the Hobbes Theorem have contradictory implications for the size of government. We can see this point most clearly by considering the policy implications in the ideal world of zero transaction costs. According to the Coase Theorem, there is no continuing need for government under these conditions. Like the deist god, the government retires from the scene after creating some rights over externalities, and efficiency is achieved regardless of what rights were created. According to the Hobbes Theorem, the coercive threats of government or some similar institution are needed to achieve efficiency when externalities create bargaining situations, even though bargaining is costless. Like the theist god, the government continuously monitors private bargaining to insure its success.

The Coase Theorem represents extreme optimism about private cooperation and the Hobbes Theorem represents extreme pessimism. Perhaps the Coase Theorem is more accurate than the Hobbes Theorem in the sense that gains from trade in bargaining situations are more often realized than not, or perhaps the Hobbes Theorem is more accurate from the perspective of lawyers who must pick up the pieces when cooperation fails. We shall not attempt an allocation of truth. The strategic considerations are not normally insurmountable, as suggested by Hobbes, or inconsequential, as suggested by Coase. An informed policy choice must balance the Coase Theorem against the Hobbes Theorem in light of the

ability of the parties to cooperate. Our next task is to develop a theory of bargaining, based upon standard economic assumptions, which facilitates thinking about the obstacles to cooperation.

Bargaining Model

Our concern is with games in which everyone has an interest in avoiding the worst outcomes, but the outcome which is best from one player's viewpoint is not best from another's. The objective of a skillful bargainer is to convince others that he intends to act in such a way that it is in their best interest to do what is in his best interest. He transmits information and makes side payments in order to maneuver his opponents into a position where perceived self-interest compels them to do what is to his advantage. Inefficient outcomes occur when the players miscalculate and fail to anticipate the moves that others will make; for example, "I think that your sincere threat is a bluff." In such cases everyone is rational in the Bayesian sense of maximizing expected utility, but the best move *ex ante* turns out to be a bad move *ex post*.

Dissimulation is part of bargaining skill, and the low cost of communication is what enables players to practice it. It is implausible to claim that no one would mistake a sincere threat for a bluff if they could communicate costlessly. Perfect information requires not only the declaration of intentions, it also requires the certification of their truthfulness. Certifying an intention is an act which destroys a player's freedom.²¹ Some examples are burning the bridges behind an advancing army, exchanging hostages, or signing a legal contract. The advantage of eliminating your freedom in a bargaining situation is that it makes you unable to compromise; that responsibility devolves upon your opponents. Typically, nature does not provide the means for certifying your intentions (for example, the rivers are in the wrong place), and the law denies those means by deliberate design. For example, in collective bargaining the law does not recognize contracts of the form, "Our union will strike unless management. . . ." If the law were to enable unions to certify their threats to strike, then it would enable them to destroy their ability to compromise. The laws governing collective bargaining are designed to facilitate compromise solutions, not inhibit them. Since the law is designed so that some threats cannot be certified, there is room for dissimulation, bluffs, and negotiating skill; there is also room for miscalculations and inefficiency.

In this section we develop an economic model of bargaining which captures many of the features just described. Specifically, the players are assumed to be rational in the Bayesian sense of maximizing subjectively

²¹ See Thomas C. Schelling, *Strategy of Conflict* (1960).

expected utility, and the equilibrium is a situation in which bargaining sometimes breaks down. This model will allow us to contrast the Coase Theorem and the Hobbes Theorem.

We can describe the model in the abstract language of bargaining theory. The players face a problem of agreeing upon how to divide the stakes in the game. If they reach agreement, then they enjoy the surplus from cooperation. If they cannot agree, then the surplus is lost. Bargaining proceeds through an exchange of offers and counteroffers for dividing the stakes. A bargaining strategy is a contingency plan for making offers. A strategy calls for a particular offer contingent upon the prior offers and counteroffers. Mathematically, a strategy is a sequence of functions in which the actual value of the offer at any point in time is a function of all the preceding offers and counteroffers.

To flesh out the model, assume that the law assigns a property right to individual farmers to be free from sparks. In other words, the government provides each victim with pollution coupons bearing the victim's name, and the injurer must hold one coupon for each unit of pollution to which a victim is exposed. The railroad could not emit one unit of sparks unless each farmer along the tracks sold one coupon to the railroad. There is an irreducible element of bargaining power in these situations because pollution rights are assigned to individuals by name.

In the event of noncooperation the farmers will cultivate the marginal fields, yielding joint profits of 10, and in the event of cooperation the farmers will leave the marginal fields fallow, yielding joint profits of 40. Thus the surplus from cooperation is $40 - 10 = 30$. For simplicity assume that the farmers can be treated as a single bargaining unit. Bargaining consists of exchanging offers and counteroffers for dividing the surplus or, equivalently, for dividing pollution rights and profits (the stakes). A strategy is a plan prescribing the offer to be made at each round of negotiations, given the prior history of offers and counteroffers.

Let us consider the problem of strategy from the railroad's viewpoint. The railroad plans to make concessions and expects the farmer to make concessions. If the railroad concedes too fast, then his share of the surplus will be low. If the railroad concedes too slowly, then the parties may fail to reach an agreement. Usually there will be a time limit on bargaining (for example, the crops must be planted by a certain date). If the railroad concedes too slowly relative to the farmers, then the date will arrive for planting the crops without an agreement and cooperation will no longer be possible. Thus the optimal strategy is found by trading off a higher payoff in the event of settlement against a lower probability of settlement.

The strategy chosen by a player depends upon his subjective probab-

ity distribution over his opponent's strategy. It is necessary to specify the mechanism for forming expectations. There are various economic models for the formation of expectations, but the model which is entitled to be called the most fundamental is a model of "rational expectations."²² This phrase means that expectations contain no systematic bias, that is, the subjective expectations correspond to the objective frequencies of the random event.

For example, consider a class of accidents for which there are many injurers and victims. The objective frequency is the actual frequency with which injurers or victims adopt a particular bargaining strategy, for example, the frequency with which railroads adopt a particular bargaining strategy when dealing with farmers. If the subjective expectations of the farmers correspond to the objective frequency of bargaining strategies among railroads, then the farmers' expectations are rational.

Rational expectations are the result of a learning process by which bias is corrected. There is a mechanism for learning in the legal setting. In our example the railroad and the farmers would probably seek legal counsel. The lawyers would be experienced with such bargaining situations. It is easy to see how bias would be eliminated from a lawyer's expectations. A lawyer expects a particular strategy on the part of his client to result in noncooperation a certain proportion of the time. If his expectations are disappointed, then he will revise them repeatedly until they are accurate. For example, if the railroad adopts the conciliatory strategy of demanding only 20 percent of the stakes, and the lawyer expects this strategy to produce cooperation in every case, but the farmers persist in rejecting the offer, then the lawyer will have different expectations the next time a similar case occurs.

The learning process which we have described will result in revision of the subjective probabilities until they correspond to objective frequencies. The process will cease when expectations are rational. Thus the equilibrium of the game is a situation in which subjective probabilities correspond to objective frequencies. The equilibrium can be called a "Bayesian Nash equilibrium."²³ It is Bayesian in the sense that each player's optimal strategy is derived from a subjective probability distribution over his opponent's move, and it is Nash in the sense that no one cares to revise his strategy given the distribution of the strategies of others.

²² The idea that expectations about macroeconomics should be rational has been developed into an elaborate theory. The first paper in this tradition is apparently John F. Muth, *Rational Expectations and the Theory of Price Movements*, 29 *Econometrica* 315 (1961).

²³ John Harsanyi, *Games with Incomplete Information Played by "Bayesian Players,"* 41 *J. Management Sci.* 320 (1968), esp. at pt. 2.

Let us summarize our bargaining model. Bargaining occurs in a context of uncertainty about how opponents will react to offers and counteroffers. The basic approach in economics to choice under uncertainty involves a two-step process: first, form your best expectations about the likelihood of each possible outcome from acting, and second, calculate your maximal move. The two-step process is called expected utility maximization with Bayesian probabilities. The fundamental problem in game theory is that one player's expectations about another's move depend upon the other player's expectations about the first player's move. How can the two-step process be applied simultaneously by everyone? The paradox is resolved by specifying expectations in the first step which are confirmed in the second step. Rational expectations have this characteristic because the subjective expectations correspond to objective frequencies. When expectations are rational, each player's strategy is optimal against the distribution of an opponent's strategies, but not necessarily optimal against a particular opponent drawn randomly from the distribution. The optimal strategy balances an increased share of the stakes associated with a harder strategy against a higher probability of noncooperation.

The error in the bargaining version of the Coase Theorem is to suppose that the obstacle to cooperation is the cost of communicating, rather than the strategic nature of the situation. Bargainers remain uncertain about what their opponents will do, not because it costs too much to broadcast one's intentions, but because strategy requires that true intentions be disguised. The error in the Hobbes Theorem is to suppose that bargainers increase their demands without regard to the reduction in probability of settlement. In equilibrium when expectations are rational, players do not adopt strategies which always lead to noncooperation, nor do they adopt strategies which always lead to cooperation.

An interesting question is whether lowering transaction costs will increase the frequency of cooperation. A natural interpretation of transaction costs in this model is the cost of transmitting offers and counteroffers. Lowering transaction costs will reduce the incentive to settle early. Noncooperation occurs when the deadline on bargaining is reached before settlement. Consequently, lowering transaction costs will delay settlement and make noncooperation more likely. Thus, lowering transaction costs results in fewer settlements in this model, which is counter to the Coase tradition.

Policymakers require a detailed account of how observable variables influence the probability of settlement. A list of relevant variables might include cost of transmitting information, payoff while awaiting resolution of the dispute, discount rate (time preference), risk aversion, and spitefulness. A model connecting these variables to the probability of cooperation

would tell a policymaker whether the Coase Theorem or the Hobbes Theorem is a better guide in a particular situation. This paper is not the place to develop such a theory.²⁴ Instead, we shall consider in detail a recent court decision on a contract dispute.

Before leaving the discussion of the abstract bargaining model, we should mention its relationship to some familiar bargaining theories. There have been many attempts in bargaining theory to eliminate uncertainty and insure cooperation in every case. This approach postulates that a rational player will accept a payoff based upon his bargaining strength, which is gauged by his power to hurt others.²⁵ It is unreasonable for anyone to expect a payoff greater than his bargaining strength warrants and unnecessary to accept less, according to these theories. The scheme for distribution is, "To each according to his threat point."²⁶ It is an appealing picture, reminiscent of ritual combat among animals in which the victory goes without a fight to the contender who would win if the fight were to occur. Unfortunately these stipulated solutions have not gained a strong hold upon reality. Litigation drags on for months, strikes occur, nations persist in wars, hostages are killed, common resources are wasted, etc. Apparently the stipulated solutions were never meant to be predictive or descriptive.²⁷

Austin Instrument v. Loral

In order to give concrete meaning to our argument, we shall consider an example of an appellate decision which fits the Hobbes Theorem better than the Coase Theorem.

In 1971 the Court of Appeals of New York extended the concept of duress in deciding the case of *Austin Instrument, Inc. v. Loral Corporation*.²⁸ Loral had been awarded a general contract from the Navy for the

²⁴ Robert Cooter & Steve Marks, *Bargaining in the Shadow of the Law: Model of Strategic Behavior* (1981).

²⁵ I have in mind the Nash-Zeuthen solution and the Shapely value. For a discussion see R. Duncan Luce & Howard Raiffa, *Games and Decisions* (1957). A different kind of stipulated solution is presented by J. C. Harsanyi, *The Tracing Procedure: A Bayesian Approach to Defining a Solution for n-Person Noncooperative Games*, 4 *Int'l J. Games Theory* 61 (1975).

²⁶ The phrase is due to John Rawls.

²⁷ "Certainly it [Nash's solution] is not a prediction of what actually happens in bargains—it is easy to cite empirical cases where an agreement is not reached and the players end up at the [inefficient] status quo point. Nash contends that his solution is a 'fair' division which purportedly should reflect the 'reasonable expectancies' of 'rational bargainers.'" Luce & Raiffa, *supra* note 25, at 128.

²⁸ *Austin Instrument, Inc. v. Loral Corporation*, 316 N.Y.S.2d 528 (1970); *Austin Instrument, Inc. v. Loral Corporation*, 324 N.Y.S.2d 22 (1971).

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production of radar sets, and Austin was one of its subcontractors. A year later Loral was awarded a second contract from the Navy and solicited a bid from Austin to construct some of the component parts. This second bid was solicited at a time when Austin had not completed delivery on items prescribed in its first contract with Loral. Austin threatened non-performance on the remainder of its first contract unless Loral awarded the second contract on terms that favored Austin, including a retroactive price increase on the remaining items from the first contract. Austin was not the lowest bidder on some items covered by the second contract. Loral needed the items from the first contract to meet its delivery deadline with the Navy and escape the penalty clauses for late delivery in its general contract. Loral could have challenged Austin and sued for breach of contract in the event of nonperformance. Instead, Loral capitulated to Austin's demands but made clear in a letter to Austin that it did so under duress. Deliveries proceeded on schedule, but after receiving all of the items specified in the two contracts with Austin, Loral withheld its last payment and both parties sued.

The New York Supreme Court decided the case in favor of Austin on the grounds that Loral had access to the traditional legal remedy for breach of contract. In that court's view Loral had not established that the normal legal remedy for breach would be inadequate or ineffectual. However, the Court of Appeals reversed the lower court's ruling and found in favor of Loral. The higher court held that duress was established by the fact that the threatened party could not obtain the goods from another source in the event of default.

We can understand the higher court's finding in terms of Hobbesian bargaining theory. If Loral had responded to Austin's initial threat by a counterthreat, namely the threat to sue for breach of contract, Austin might have capitulated and the outcome would have been efficient. But if Austin did not capitulate, then the outcome would have been costly to both parties. A judge following the Hobbes Theorem would want to reduce the destructiveness of noncooperation. This end was accomplished by allowing Loral the option of postponing its challenge until after Austin completed performance, as permitted by the rule of duress. The structure of the law was chosen to eliminate the worst consequences of nonperformance.

The skeleton of the situation is portrayed in the payoff matrices in tables 4 and 5. If the lower court's ruling had stood, then the parties would play the game of default pictured in table 4. If Austin does not perform, the damage to joint profits is -200 , plus an additional -100 in legal costs if there is a suit. If Austin performs on the first contract, but is not awarded the second contract, then joint profits are highest ($+300$). If

TABLE 4
JOINT PROFITS IN DEFAULT GAME

AUSTIN	LORAL		
	Sue if Austin Defaults	Do Not Sue & Do Not Give Austin Second Contract	Do Not Sue and Give Austin Second Contract
Nonperformance	-300 (non-cooperative)	-200	...
Performs on 1st contract	...	+300 (cooperative)	...
Performs on 1st & 2nd contracts	+200

NOTE.—Numbers are illustrative.

Austin is awarded the second contract, then joint profits fall (+200) because Austin cannot produce the items in the second contract at lowest cost.

In the game of duress depicted in table 5, we assume that Austin has already fulfilled the first and second contracts. The remaining uncertainty is whether Loral will make the last payment on the second contract and whether Austin will sue if Loral does not perform. Loral's payment or nonpayment is purely redistributive. Austin's decision to sue would reduce joint profits (+200) by the cost of legal fees (-100), as shown.

The cooperative solution to a bargaining game maximizes the joint profits. In the game of default, the cooperative solution requires Austin to perform on the first contract and Loral not to award the second contract to Austin, yielding joint profits of +300. In the game of duress, the cooperative solution requires Austin not to sue, yielding joint profits of +200. Profits are lower in the game of duress because Austin builds parts under the second contract, for which it is not the lowest-cost supplier.

TABLE 5
JOINT PROFITS IN DURESS GAME

AUSTIN	LORAL	
	Nonperformance	Performance
Sue	100 (noncooperative)	...
Not sue	200 (cooperative)	200 (cooperative)

NOTE.—Numbers are illustrative.

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The noncooperative solution occurs when the parties act upon their worst threats. In the game of default, noncooperation occurs if Austin does not perform on the first contract and Loral sues, yielding joint profits of -300. In the game of duress, noncooperation occurs if Loral does not perform and Austin sues, yielding joint profits of +100.

We have seen that the game of default has a higher cooperative and a lower noncooperative solution than the game of duress. A court concerned with efficiency would prefer the game of default if it were optimistic about cooperation in two-party bargaining, and it would prefer the game of duress if it were pessimistic. Apparently, the Court of Appeals was pessimistic and chose the game of duress, as commended by the Hobbes Theorem.

The Coase Theorem and the Hobbes Theorem are both too flexible and vague to permit construction of a decisive example in which they are contradictory. No doubt a true believer in the Coase Theorem could find a way to explain the higher court's decision. However, the Hobbes Theorem is the more immediate, less forced explanation.

In passing we mention that other cases of duress have been decided according to the Hobbesian theory. A case in point is *Harris v. Watson*, which was decided in 1791, considered a leading case by Williston.²⁹ The master of a ship offered his seamen a five-guinea bonus to exert themselves to save their ship from danger, but he refused to pay after the danger had passed. Lord Kenyon ruled that there was no obligation to pay, because "if sailors were in all events to have their wages, and in times of danger were entitled to insist on an extra charge on such a promise as this, they would in many cases suffer a ship to sink, unless the captain would pay any extravagant demand they might think proper to make." The judge reasoned that sailors would from time to time act upon their worst threat and sink ships if masters could not void contracts created under duress. This is another example where the game of duress has a less destructive noncooperative outcome than its alternative, so the courts defined the law to give players access to the game of duress.

Conclusion

"The Problem of Social Cost" brought together two divergent intellectual traditions, and its poignant examples continue to be a valuable instrument for teaching the economic analysis of law. But this classic has its costs. The examples are often misleading about the underlying

²⁹ *Harris v. Watson*, Peake 102, 170 Eng. Rep. 94 (1791); discussed in Grant Gilmore, *Death of Contract* C. 25 (1974); Gilmore refers to Williston, *Contracts* § 130 (1920).

generalizations. In this paper we showed that the tax remedy, liability remedy, and competitive market for pollution rights have desirable microeconomic properties. Specifically, an equilibrium exists and it is both stable and efficient. We showed that strict liability is efficient even when remedies are bilateral, provided that compensation is independent of the individual victim's behavior; for example, compensation equals the fall in rental value of land. We also showed that the Pigouvian tax remedy and the competitive exchange of liability rights are dual remedies, that is, the government follows the same procedure and uses the same information to adjust the tax rate or the quantity of liability rights in order to achieve an efficient equilibrium. The competitive exchange of liability rights is efficient regardless of their initial allocation, as stated in the competitive market interpretation of the Coase Theorem, but the role of the government in this remedy is no less than in the Pigouvian tax remedy.

We also considered the bargaining interpretation of the Coase Theorem, which states that externalities will be cured by private bargains, even in the absence of competitive prices, provided that there are no obstacles to the bargaining process. Inspired by Hobbes, we formulated the polar-opposite theorem: Externalities will not be cured by private bargains unless someone coerces the parties to agree about the price. The Coase Theorem and the Hobbes Theorem are illuminating falsehoods. The Coase Theorem is false because the final obstacle to private noncompetitive bargains is the absence of a rule for dividing the surplus, not the cost of bargaining. In fact, it is cheaper to engage in strategic behavior when communication is inexpensive. The Hobbes Theorem is false because bargainers moderate their demands in order to increase the likelihood of agreement. The Coase Theorem is illuminating because it suggests that liability rights should be allocated by the court in the way that they would be if cooperative agreements were always achieved. The Hobbes Theorem is illuminating because it suggests that legal rights should be structured to eliminate the most destructive noncooperative outcomes, that is, the cells in the payoff matrix with low value should be inaccessible to the players.

In order to explain our view of Coase's Bargaining Theorem, we developed a bargaining model in which strategic behavior sometimes results in noncooperative outcomes. In our model the equilibrium is rational in the sense that every individual is maximizing his expected utility, and everyone's expectations are accurate, but noncooperative outcomes still occur. Noncooperative outcomes occur because each player's strategy is best against opponents on average, but not best against every individual opponent. Reducing the transaction costs of bargaining in this model does not generally increase the probability of cooperation.

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Coase created a new field out of poignant examples. After twenty years we ought to get clear about the underlying generalizations.

APPENDIX

AI. FIRMS AND HOUSEHOLDS

Notation is as follows:

$p = (p_1, p_2, \dots, p_N)$, vector of prices;

$p_s = \tau$, tax on smoke;

$y = (y_1, y_2, \dots, y_N)$, supply vector;

$y_s = -s$, supply of clean air, or minus smoke, an element of y ;

$x = (x_1, x_2, \dots, x_N)$, net demand vector;

$f(y) \leq 0$, continuously differentiable production set;

$u(s, x)$, continuously differentiable utility function;

$I = \alpha(\pi + \tau s)$, income of a household, equal to its share of profits and taxes on smoke;

$v(s, p, I)$, indirect utility.

Optimization by households and firms:

$$E(s, p, v) \equiv \min_x p \cdot x \mid u(s, x) \geq v \Rightarrow \text{demand } E_p = x(s, p, v),$$

where $v = v(s, p, I)$,

$$\pi(p) \equiv \max_y p \cdot y \mid f(y) \leq 0 \Rightarrow \text{supply } \pi_p = y(p).$$

Define excess demands:

$$i \neq s: Z_i(s, p, I) \equiv E_{pi} - \pi_{pi},$$

$$i = s: Z_s(s, p, I) \equiv E_s - \tau.$$

AII. TAX REMEDY

Pigouvian auctioneer's rule R :

$$p_i(0) > 0 \text{ all } i,$$

$$\dot{p}_i(t) = kp_i Z_i \text{ all } i, \text{ where } k > 0.$$

Define equilibrium: Set of prices $p(t)$ such that $\dot{p}(t + \Delta) = 0$ for all $\Delta \geq 0$.

P1. An Equilibrium Exists for Pigouvian Rule R

Proof. We shall construct a mapping with a fixed point. Express all prices as price relatives, $p_i/\sum p_i$, so that $p \in S_N$ where S_N is the unit simplex with N sides. Pick any positive price vector $p \in S_N$. The prices determine supply $y(p)$ and profits $\pi(p)$. Supply and profits determine smoke and income to households: $s = -y_s(p)$ and $I = \alpha[\pi(p) + \tau s]$. Prices, smoke, and income determine demands: $x = x(s, p, I)$. Supply and demand determine excess demand: $Z = y - x$. Excess demand and

prices determine new prices by the rule R . The mapping is from the compact, convex set S_N into itself. It is continuous for continuously differentiable E and π .

Definition. The cost-benefit standard of social value of a change in smoke, prices, and income from (s^*, p^*, I^*) to (s, p, I) is the income equivalent given by $\bar{W} = E(s, p, v^*) - E(s, p, v)$, where $v = v(s, p, I)$, and $v^* = v(s^*, p^*, I^*)$.

P2. Equilibrium Is Efficient in the Sense That No Improvement Can Be Made as Measured by the Cost-Benefit Standard of Social Value

Proof. 1. The cost benefit measure of value is, by adding and subtracting [], equal to

$$\begin{aligned}\bar{W} &= [E(s^*, p^*, v^*)] - E(s, p, v) + E(s, p, v^*) - [E(s^*, p^*, v^*)], \\ &= I^* - I + E(s, p, v^*) - E^*, \\ &= \pi^* + \tau^* s^* - \pi - \tau s + E(s, p, v^*) - E^*.\end{aligned}$$

2. We wish to minimize \bar{W} with respect to p and s . The starred items are constants, so we minimize W where

$$W = E(s, p, v^*) - \pi(p) - \tau s,$$

with first order conditions

$$\begin{aligned}E_p - \pi_p &\leq 0 \quad \text{strictly equal for } p_i > 0, \\ E_s - \tau &\leq 0 \quad \text{strictly equal for } \tau > 0.\end{aligned}$$

3. By rule R an equilibrium is a condition where

$$\begin{aligned}0 &= p \cdot Z = p \cdot (E_p - \pi_p), \\ 0 &= p_s Z_s = \tau(E_s - \tau).\end{aligned}$$

Definition. The system is locally stable if it returns to the original equilibrium after any small disturbance.

P3. Assume That Income Effects Are Small. Then the System Is Locally Stable

Proof. By P2 we know that the equilibrium p^* , with resulting smoke $s^* = \pi^*$, maximizes W . Differentiate W fully:

$$\frac{dW}{dt} = (E_p - \pi_p) \cdot p + (E_s - \tau)s \text{ evaluated at } v = v^*,$$

$$= \sum_i \bar{Z}_i k p_i Z_i \text{ by rule } R, \text{ where } \bar{Z}_i \text{ is the compensated demand relative to } v^*.$$

By assumption, income effects are small, so near the equilibrium we have $\bar{Z} \approx Z$, implying $dW/dt > 0$ for nonequilibrium values. Hence W is a Lyapunov function and the system is stable.

Definition. Let x_{n+1} and y_{n+1} measure nearness to CBD for a household and a firm, where P_{n+1} is the increase in rent from moving a little nearer to CBD. Hence y_{n+1} is an argument in $f(y)$, and $u(\cdot)$ includes both x_{n+1} and y_{n+1} as arguments.

P4. Propositions 1-3 Also Apply to the Choice of Location

Proof. This is merely a reinterpretation of variables using the preceding definition.

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AIII. LIABILITY REMEDY

Households: Each household assumes that compensation for smoke damage is based upon harm as computed by a measure which no individual household can influence. Thus smoke, prices, and compensation C are taken as given by households

$$\begin{aligned} E(s, p, v) &\equiv \min_x p \cdot x \mid u(s, x) \geq v \Rightarrow E_p = x(s, p, v), \\ &v = v(s, p, I), \\ I &= \alpha\pi + C. \end{aligned}$$

Compensation Rule \bar{R} : Compensable smoke damage equals the damage which the typical household suffers,

$$C = E(s, p, v) - E(0, p, v).$$

C may be interpreted as the fall in rent that is suffered by identical households.

Firms: Maximize profit net of compensation,

$$\pi(p, v) \equiv \max_y p \cdot y - C(s) \mid f(y) \leq 0.$$

Auctioneer's Rule R' :

$$P_s = \tau = 0 \text{ (no Pigouvian tax),}$$

$$p_i(0) > 0 \text{ for } i \neq s,$$

$$\dot{p}_i(t) = kp_i x_i \text{ for } i \neq s, k > 0.$$

P1'. An Equilibrium in Prices Exists under Rules \bar{R} and R'

Proof. We require only a slight modification in the mapping to use the same proof as in P1. Let v be the relative utility $v = u/\sum u$, so that $v \in S_H$. Begin with utilities v and prices p . Together they determine a supply vector y (including smoke s), compensation C , and profits $p \cdot y$. Smoke s , prices p , compensation C , and profits $p \cdot y$ determine demand x . Smoke and demand determine a new relative utility allocation v . Demand and supply determine new prices p by R' . Thus the mapping is from $S_N \times S_H$ into itself. The mapping is continuous for continuously differentiable π , E , and v .

P2'. An Equilibrium Is Efficient under Rules R and R' by the Cost-Benefit Standard

Proof. The first-order conditions for a cost benefit maximum are the same as in the proof to P2. It only remains to show that these conditions are satisfied in equilibrium under liability rule \bar{R} . In equilibrium we have

$$0 = p_i z_i = p_i (E_{pi} - \pi_{pi}) \text{ for } i \neq s,$$

$$0 \geq f_s - E_s \text{ by liability rule } \bar{R}.$$

P3'. Assume That Income Effects Are Small: Then the System Is Locally Stable

Proof. Same as for P3.

AIV. COMPETITIVE MARKET IN POLLUTION RIGHTS

Allocating pollution rights:

\bar{s} = endowment in coupons authorizing pollution;

$$Z_s \equiv x_s + s - \bar{s} \leq 0,$$

$\pi \equiv p \cdot y$, profits under polluter's rights;

$I = \alpha\pi - p_s s$, household income under pollutee's rights.

Pigouvian auctioneer's rule R for quantity adjustments:

$$p_i(0) > 0, \text{ all } i;$$

$$\dot{p}_i(t) = kp_i Z_i, \text{ all } i \neq s, \text{ where } k > 0;$$

$$\dot{s}(t) = -kp_s z_s, \text{ where } k > 0.$$

Competitive Market Assumption: Households assume that s is unaffected by an individual's buying or selling pollution rights.

P1". An Equilibrium in Prices Exists under Auctioneer's Rule R "

Proof. Same as P1.

P2". If Pollution Rights Are Scarce ($p_s < 0$), Then an Equilibrium Is Efficient under Rule R If and Only If \bar{s} Is Efficient, Regardless of Whether the Rule of Law Is Polluter's Rights or Pollutee's Rights

Proof. Households solve

$$\min_x p \cdot x \mid u(s, x) \geq v.$$

By assumption x_s does not affect utility directly. Under the competitive assumption, x_s does not influence s for any individual, so x_s does not influence utility indirectly. Consequently the minimization problem is solved at $x_s = 0$, which implies that $s \leq \bar{s}$ in equilibrium. If $p_s > 0$, then by Rule R in equilibrium $z_s = s - \bar{s} = 0$. Since actual pollution equals the endowment in pollution rights, it follows that efficiency is achieved *only if* \bar{s} is efficient. By repeating the proof to P2 it follows that efficiency is achieved in equilibrium if \bar{s} is efficient.

P3". Assume That Income Effects Are Small: Then the System Is Locally Stable

Proof. Same as for P3.

Comment. From Sections AIII and AIV we see that the government cannot avoid choosing either the price τ or the quantity \bar{s} of pollution. The same efficiency results can be achieved under the property rights approach as under the Pigouvian tax by adjusting the endowment \bar{s} .

AV. BILATERAL MONOPOLY IN EXCHANGE OF POLLUTION RIGHTS: BARGAINING

Defining the Stakes

Noncooperative outcome is the equilibrium utility and profit allocation when property rights are not exchanged. *Cooperative outcome* is the equilibrium utility and profit allocation when property rights are exchanged until efficiently allo-

cated. *Stakes* equal the cooperative outcomes as

Bargaining Process

Bargaining consists in stakes. *Strategy* is a sequence depends upon the previous demands are at least as *Assume ranking of strategy* and "b" is hard

Bargaining rule 'R': Co not too hard and nonconcness indexes,

a

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Value of game:

$m(a, b)$ = proportion of $0 \leq m \leq 1$.

$V(m, w, u^H)$ = household traits u^H . Note that in ex

V =

$p(b, w)$ = subjective probabilities w .

Value of game to household

$$V^H = \int_0^{1-a} p(b, w) V$$

Bayesian Nash equilibrium (u^F) be the probability of firms, respectively. Let opponents' moves. Let c tively. An equilibrium $(j$

Comparative statics: developed in Robert Co Law: Model of Strategic costs increases the probability broken off. This result i

²⁰ Robert Cooter and St Strategic Behavior," J. Le.

cated. *Stakes* equal the change in welfare between the noncooperative and cooperative outcomes as measured by the cost-benefit standard \bar{W} .

Bargaining Process

Bargaining consists in a sequence of offers and counteroffers for dividing the stakes. *Strategy* is a sequence of offer functions, in which the offer at any time t depends upon the previous history of bargaining. A *harder strategy* is one in which demands are at least as great under any contingency as for the softer strategy. Assume ranking of strategies by hardness, where "a" is hardness of household's strategy and "b" is hardness of firm's strategy.

Bargaining rule 'R': Cooperative outcome occurs when the pair of strategies is not too hard and noncooperation occurs otherwise, or by normalizing the hardness indexes,

$$a + b \leq 1 \iff \text{cooperation,}$$

$$a + b > 1 \iff \text{noncooperation.}$$

Value of game:

$m(a,b)$ = proportion of stakes won by household in event of cooperation where $0 \leq m \leq 1$.

$V(m,w,u^H)$ = household's utility given m , observable traits w , and unobservable traits u^H . Note that in event of cooperation

$$V = v(s^*, p^*, I^*) \text{ where } I^* = \alpha\pi + m.$$

$p(b,w)$ = subjective probability that firm adopts strategy b given observable traits w .

Value of game to household is

$$V^H = \int_0^{1-a} p(b,w) V[m(a,b), w, u^H] db + [1 - P(1-a, w)] V(o, w, u^H).$$

Bayesian Nash equilibrium or rational expectations equilibrium: Let $r(u^H)$ and $r(u^F)$ be the probability density function on unobservable traits of households and firms, respectively. Let $p(b,w)$ and $q(a,w)$ be the subjective probabilities on opponents' moves. Let $a(u^H, w)$ and $b(u^F, w)$ solve $\max V^H$ and $\max V^F$, respectively. An equilibrium (p^*, q^*) satisfies

$$p^*[b(u^F, w)] = r(u^F)$$

$$q^*[a(u^H, w)] = r(u^H).$$

Comparative statics: The comparative statics of this model of bargaining are developed in Robert Cooter and Steve Marks, "Bargaining in the Shadow of the Law: Model of Strategic Behavior."³⁰ It is shown that an increase in transaction costs increases the probability of cooperation, assuming that negotiations are not broken off. This result is contrary to the Coase Theorem approach.

³⁰ Robert Cooter and Steven Marks, "Bargaining in the Shadow of the Law: Model of Strategic Behavior," J. Legal Stud., forthcoming.

THE COST OF COASE

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INTRODUCTION

THE publication of "The Problem of Social Cost" in 1960 by Ronald Coase brought together two powerful intellectual currents, namely, the economic theory of externalities and the common-law tradition concerning torts and nuisance.¹ The sea is fertile but rough where two ocean currents meet, and the same can be said of the disputes provoked by Coase. Coase developed his argument through a series of concrete examples, such as the rancher and the farmer, the railroad sparks and the corn crops, etc. He steadfastly refused to articulate the general truths underlying the examples, for example, the famous "Coase Theorem" is abstracted from the paper but not stated in it. After two decades of debate the generalizations underlying the examples are still disputed.

In this paper I will not attempt the impossible task of offering the "true" or final interpretation of Coase's paper. Hermeneutics is left for others. Rather, I will state and prove those generalizations applicable to Coase's examples which follow from familiar assumptions of economic theory. It seems to me that these generalizations frequently conflict with Coase's examples in the sense that the immediate interpretation of his examples are inconsistent with the provable generalizations. The cost of Coase's paper is that readers are confused or misled about the generalizations which follow from familiar economic assumptions.

In the first section of this paper I characterize the dispute by developing one of Coase's examples. The second section formulates some general propositions about correcting externalities through the use of liability law, taxes, and transferable property rights. The third section addresses the

* I have received numerous comments on several drafts of this paper, most recently from Henry Hansmann and the participants in the public finance seminar at the University of Toronto.

¹ R. H. Coase, "The Problem of Social Cost," 3 *J. Law & Econ.* 1 (1960).