The Efficiency of Sharing Liability for Hazardous Waste: Effects of Uncertainty Over Damages

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I. Introduction

The environmental problems of the United States and the European nations have generated a dynamic body of literature in legal and economic research. One of the most significant branches of this research has been the analysis of strict liability versus ex post negligence standards, and the sharing of damages under each regime, when the level of prospective environmental damages can be estimated with certainty.\(^1\) These studies are crucial to policymakers in many countries, whether they are Americans considering the reenactment of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) statutes,
Western Europeans facing rapidly evolving environmental liability regimes, or Eastern Europeans searching for a solution to their countries’ environmental problems.

Yet, existing research has ignored the fact that tremendous uncertainty exists in calculating future environmental clean-up costs, and that this uncertainty might affect the choice of the appropriate liability regime. In this paper, we develop an industry equilibrium analysis for treatment storage and disposal facilities (TSDFs, more commonly referred to as “dumps”) to examine further the optimal choice of liability regime, particularly in the case where environmental damage costs are unknown.

Our main result is that taking into account the uncertainty of future environmental clean-up costs strengthens the case for sharing liability for these hazardous waste costs between generators and disposal sites. The intuition behind this result can be readily explained. Initially, our model looks at the case where TSDFs retain all of the liability for hazardous waste spills in the future (generators will have none). TSDFs will price their services, that is, make bids for waste, at prices that incorporate their best estimates of the uncertain costs of future clean-ups. In developing these cost figures, TSDFs can be thought of as estimating a “common value,” that is, the cost of rectifying any damage to natural resources and compensating for any permanent effects caused. Because of the magnitude of the uncertainty over the economic cost of future environmental problems, different TSDFs will forecast different valuations of these costs.

Those TSDFs that most underestimate their future clean-up liabilities will price their disposal services the lowest and therefore attract the most hazardous wastes. However, these are also the TSDFs taking the least care. Meanwhile, the TSDFs with high-liability cost estimates, and therefore higher prices for waste disposal, will attract too little waste. This adverse selection problem leads to an inefficient allocation of wastes.

We argue that extending liability from TSDFs to include generators alleviates this problem via an induced change in generators’ method for selecting TSDFs. If generators bear no liability for hazardous waste problems at TSDFs, they will select TSDFs purely on the basis of lowest price. If generators bear some liability, they will be induced to estimate the precautions taken by each competing TSDF and select the TSDF that offers the lowest total cost to the generator, where total cost includes both the direct TSDF price and the generator’s estimate of residual liability. Generators generally will have two sources of information to estimate their share of liability: exogenous information such as their own in-house evaluations; and endogenous information, that is, information contained in bids made by TSDFs. On this latter point, we show: that a generator can infer an estimate of damages of a TSDF from its bid (lower bids imply lower estimates of damages); that a generator will want to pool the information contained in all bids to make the best estimate of damages; and that an optimal selection rule will generally not always choose the lowest bid.

Our analysis yields other insights as well. First, the adverse selection argument tends

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4Although most of our discussion focuses on hazardous waste dumps, similar arguments could be made for nonhazardous solid waste facilities, for these facilities also have frequent problems with damage to surrounding natural resources. Indeed, with the recent emergence of national markets for household and municipal solid waste, the problems associated with competitive bidding that we highlight could be very prevalent.
to favor a negligence standard over a strict liability regime whenever damages are highly uncertain. The rationale for this is that strict liability causes the adverse selection problem by forcing providers of a service to estimate damages and price accordingly. Under a negligence standard, TSDFs no longer need to estimate damages, thereby eliminating a predominant reason for variation in prices. Second, our auction-theoretic model breaks new ground by showing how auctioneers can infer useful information from bids and how to select winners when price is not the sole variable influencing total cost. Third, our base-case equilibrium model of shared liability shows that the costs of shared liability are not as great as previous authors have suggested. And last, we argue that shared liability can ease the transition in industry structure necessitated by dramatic changes in costs.

The paper proceeds as follows. In Section II, we give a brief overview of the hazardous waste liability rules adopted in the United States. Section III describes the general structure of our model and the equilibrium attained under a strict liability standard when the TSDF alone bears all of the liability for environmental clean-ups and clean-up costs are known. We use this model as a benchmark in the remainder of the paper. Section IV extends this analysis to examine the effect of sharing environmental liabilities between the TSDF and the generator of the hazardous wastes, still assuming that the amount of the environmental liabilities is known. Section V drops the assumption that environmental damages are known. We first use a model of a competitive TSDF industry to illustrate the adverse selection problem that emerges and how extending liability to generators may improve efficiency. Although illustrative, this model cannot include the more interesting use of endogenous information. To examine the uses of endogenous information, we turn to auction theory, which allows us to explicitly consider how TSDFs incorporate damage estimates into their prices and how generators can use that information. Section VI briefly discusses other implications of our analysis for the hazardous waste industry and other industries. We conclude the paper with a summary and some extensions of our analysis to the oil tanker and garment industries.

II. American Hazardous Waste Laws: CERCLA and RCRA

In 1980, the United States Congress enacted CERCLA expressly "(1) to provide for clean-up if a hazardous substance is released into the environment or if such release is threatened, and (2) to hold responsible parties liable for the costs of these clean-ups." CERCLA authorized the Environmental Protection Agency (EPA) to remove, or to cause the removal of, any hazardous contaminant whenever there is a release or a

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“substantial threat of release” of any contaminant “which may present an imminent and substantial danger to the public health or welfare.” CERCLA also created a “Superfund,” or Hazardous Substance Fund, that Congress intended the EPA to use to study and clean-up contaminated sites, to recover costs of clean-up from responsible parties, and to order such parties to take remedial action.

CERCLA is retroactive and imposes strict liability on potentially responsible parties (PRPs). Liability under CERCLA is joint and several. To establish the liability of a PRP, the EPA must show that: “(1) the contaminated property or site is a facility; (2) a release or threatened release of a hazardous substance from the facility has occurred; (3) response costs have been incurred as a result of the release or threatened release; and (4) the party to be held liable falls within one of the four categories of PRPs enumerated [at § 9607 (a)].” The government is not required to prove causation, merely that the defendant’s hazardous waste is at the site in any quantity; there is no minimum threshold for liability. Defendants may avoid imposition of joint and several liability only if they can prove that the harm is divisible.

Divisibility has been difficult for defendants to prove. Some courts have rejected attempts to divide the harm based on the volume of waste contributed by each defendant, and have rejected arguments that a particular harm is traceable to a particular defendant if the hazardous wastes are commingled, and arguments based on a percentage of ownership of the site. Defendants unable to prove divisibility have three options. They can either clean up the site voluntarily or litigate the issue and allow the courts to impose joint and several liability. In either case, the defendant then has a
right of contribution against other PRPs. The third option is to settle with the EPA. Uncertainty over how the courts will allocate costs may make it difficult for defendants to decide which option to pursue. The RCRA regulates prospectively the disposal of solid waste, both hazardous and nonhazardous. The objectives of RCRA include promoting the reduction, reuse, recycling, or elimination of the generation of solid waste, as well as encouraging the proper handling and disposal of solid waste in the present to avoid future harm and clean-up costs. Significant provisions of RCRA ban land disposal and establish a “cradle-to-grave” approach to solid waste disposal regulations. Generators and transporters of hazardous solid waste, and the owners and operators of treatment, storage, and disposal facilities are all regulated.

III. The General Model and the Efficient Benchmark

Lay-out of the Model

There will be various generators of hazardous waste, each of which produces a product(s) that is sold to consumers. Hazardous wastes are sent by generators to one of many TSDFs. Indeed, we will treat the TSDF industry as being competitive, albeit one with high fixed costs.

Generators can take various actions: They can reduce their generation of waste through pollution prevention activities; they can select TSDFs for minimum cost; they can monitor TSDFs for the degree of care being taken; and they can estimate the environmental costs associated with waste management at a TSDF. All of these activities are assumed to be costly, with details for costs spelled out below. We assume that consumers will purchase end products on the basis of cost and can take no avoidance actions for problems arising from TSDFs. TSDFs can take precautions to avoid damages from their disposal activities and can estimate the costs associated with any damage done. Both of these actions are costly. In addition, TSDFs have costs associated with their core waste management service; these costs will be assumed to be such that a TSDF has a typical U-shaped average cost curve (i.e., a high fixed cost component and a marginal cost that increases after some point).

In regard to prices, TSDFs will charge generators a per-unit price for wastes managed. This price will become part of generators’ costs of production, which in turn are reflected in prices charged to consumers for the final products.

All analysis will be conducted on a per-period basis, with the period taken to be a year. This neglects issues associated with intertemporal pricing and with the physical

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18Oswald, supra note 10, at 339. Of course, the defendant bears the risk that they will be unable to locate other PRPs or that the other PRPs will be insolvent. Id.

19PRPs who settle are shielded from contribution actions. Id. at 341. The remaining liability of nonsettling PRPs is reduced by the value of the settlement, not by the “fair share” of the settling PRPs. This encourages settlement and punishes those who litigate. Hyson, supra note 9, at 143.

20Butler, supra note 11, at 10135. (Discussing and evaluating for allocation methods and suggesting ways to improve cost allocation under CERCLA.)

2142 U.S.C. § 6902(a); Case, supra note 21, at 328.

2242 U.S.C. § 6924; Case, supra note 21, at 350.

23Case, supra note 21, at 328.


filling-up of dump sites. Given that much of hazardous waste management is now treatment, not storage, we believe that our focus on yearly rates of waste management is appropriate.

Equilibrium With Solo Strict Liability for TSDFs When Damage Costs Are Known

We begin by examining the case where TSDF’s bear full responsibility for all environmental damages arising out of disposal activities at their facilities. In effect, this means that generators can wash their hands of any responsibility for hazardous wastes once they are received at the dump. Initially, we assume that TSDF’s are strictly liable for all environmental damages caused by wastes stored in their facility. We call this liability regime solo strict liability. To keep the model as tractable as possible, we abstract away from the notion that damages arise from accidents. Instead, we will simply assume that the expected dollar cost of environmental damage is a linear function of the waste handled and the level of care taken:

Expected environmental damage at a TSDF = $D(q_i, c_i) = f(c_i)q_i$ (1)

where $c_i$ is the level of care (in dollars) at TSDF$_i$ and $q_i$ is the quantity of waste handled at TSDF$_i$. The function $f(\bullet)$ is assumed to be decreasing at a decreasing rate.

Besides the costs associated with liability and taking care, TSDFs have operating costs as well:

Operating Cost = $FC + VC(q_i)$ (2)

where $FC$ denotes fixed cost and $VC(q_i)$ denotes variable cost. We assume that $VC(\bullet)$ is increasing at an increasing rate.

We can now jointly determine the level of care of a TSDF and optimal level of input, $q_i$. Given our assumption on the competitiveness of the industry, the relevant conceptual experiment is to pose a price $p$ for the handling of waste and to calculate the optimal decisions for a representative TSDF:

TSDF’s Profits = $\pi(q_i) = pq_i - f(c_i)q_i - c_i - FC - VC(q_i)$ (3)

Taking the first derivatives for a profit maximum and rewriting yields

\[ p = f(c_i) + \frac{dVC}{dq_i} \] (4)

and

\[ \frac{-df}{dc_i} q_i = 1 \] (5)

Equation (4) is the standard “price equals marginal cost” condition for a competitive firm, where marginal cost is not only the traditional marginal cost but also the marginal

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environmental damage, \( f(c_i) \). Equation (5) states that the optimal level of care is when the marginal benefit of spending another dollar on care equals 1.

For equilibrium in the (competitive) TSDF industry, there must be zero economic profits; this means that price equals average total cost. Average total cost is given by

\[
\text{Average Total Cost for TSDF} = ATC = f(c^{*}) + \frac{c^{*}}{q_i} + \frac{FC}{q_i} + \frac{VC(q_i)}{q_i}
\]

Equation (6) describes a typical U-shaped average cost function. Taking \( c_i \) as given, there are three components to average total cost: a per-unit environmental damage cost \( f(c_i) \) that does not directly vary with \( q_i \); two average fixed costs that decline with \( q_i, c_i/q_i \) and \( FC/q_i \); and an average variable cost that is increasing in \( q_i \). To have (4) and (5) hold while at the same time price equals average cost means that the price must equal the minimum of a representative TSDF’s ATC curve when the TSDF chooses the level of care, \( c^{*} \), that is optimal for that price, which we denote \( c^{*} \). This price is the long-run equilibrium price for the TSDF industry; no matter what the level of demand, if entry and exit of TSDFs can occur, this price must eventually hold.

Figure 1 pictures a representative TSDF in long-run equilibrium.

It is straightforward to see the efficiency of solo strict liability when damage costs are known.\(^{27}\) In regard to care taken, each TSDF sees as its environmental damage cost the true social cost and therefore engages in an efficient level of care. More generally, each TSDF’s private marginal cost of handling waste includes all costs associated with the activity, so the TSDFs choose the optimal level of waste to handle. From the generators’ perspectives, the price for hazardous waste management will be weighed against the

\(^{27}\)We do not examine the problems that arise when TSDFs become insolvent. For an analysis of problems caused by insolvency, see Kornhauser and Revesz, “Policy Choices,” supra note 1. Our analysis is significantly different from Kornhauser and Revesz, though, because we explicitly model the behavior of TSDFs, particularly in regard to their equilibrium behavior.
marginal cost of reducing waste output (that is, pollution prevention). Because the price charged by TSDFs reflects all costs, the generators have incentives to reduce waste output by the efficient amount. Generators will also incorporate waste management costs into their own product prices; consumers therefore face prices that reflect all costs and therefore will consume efficient amounts of the end products.

IV. Sharing Strict Liability Between TSDFs and Generators When Damage Costs are Known

When damage costs are known, apportioning environmental liabilities between dumps and generators splits the total cost of environmental damage across all parties and therefore creates improper incentives: under shared but still strict liability, generators will produce less hazardous waste and final product prices will be higher than in a solo strict liability regime.28 TSDFs will, however, take too little care in the management of their facilities, and the TSDF industry will be composed of too many small TSDFs. Whether the total level of environmental damage is higher or lower than that under solo strict liability is ambiguous, for there is less waste being handled but it is handled with less care. The remainder of this section develops our basic model to illustrate these points.

Equilibrium With Shared Strict Liability When Damage Costs Are Known

Our analysis proceeds in two parts. First, we will take the level of care taken by TSDFs as a given and derive on that basis the full cost to generators of their hazardous waste output. This full cost is what generators will use to decide on their hazardous waste output (i.e., their pollution prevention activity), and it will also determine final product prices. Then we will analyze the level of care taken by TSDFs.

Given whatever level of care TSDFs undertake, there will be a long-run equilibrium price, $P_E$, that TSDFs charge generators for waste handling, along the lines of Figure 1. For each unit of waste created, generators will therefore pay $P_E$. Generators will also bear some liability for damages that occur at TSDFs handling their waste. Total damages at each TSDF will be $f(c)q_E$, where $c$ is the assumed level of care taken and $q_E$ is the equilibrium level of waste handling at each TSDF. In what follows, we will assume that courts allocate $a\%$ of this damage to the TSDF and $(1-a)\%$ to the generators. Furthermore, each generator bears the total generator liability in proportion to their output of waste to that TSDF.29 The total costs at a representative TSDF are then

$$TSDF's \ total \ costs = a(f(c)q_E) + c + FC + VC \quad (7)$$

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28We continue to assume that all actors are solvent. We also assume that all actors have rights of contribution against each other. For further analysis of the relative efficiency of contribution and no contribution rules, see Kornhauser and Revesz, “Sharing Damages,” supra note 1 at 860–861. Note that our results differ from Kornhauser and Revesz. Those authors construct a model wherein joint and several liability results in more hazardous waste production by generators. Our model offers different predictions than theirs because, among other things, our analysis treats TSDFs as optimizing entities that choose an optimal output level, whereas Kornhauser and Revesz assume passive TSDFs.

29We recognize that this is only one of several possible allocation rules that could be used to share this liability. The proportions used could be based on the respective parties’ contributions to the environmental problem’s occurrence. This “proportional share” rule has the virtue of being close to the one currently employed by some courts in allocating CERCLA liabilities. See Kornhauser and Revesz, “Sharing Damages,” supra note 1 at 843. For an analysis of alternative apportionment rules between waste generators under strict liability, see id. at 856–860. Those authors also conclude that in a strict liability regime, a proportional allocation rule between waste generators is inefficient.
and average total cost at the minimum point will be

\[ \text{minimum ATC for TSDF} = a f(c) + \frac{c}{q_E} + \frac{FC}{q_E} + \frac{VC}{q_E} \]  

(8)

Note that the minimum of (8) will necessarily occur at the same output as the minimum of (6), as long as care levels are the same. This level of ATC will be the long-run equilibrium price for waste handling charged to generators.

Generators’ cost per unit of waste output is then given by

\[ \text{per unit cost to generators} = a f(c) + \frac{c}{q_E} + \frac{FC}{q_E} + \frac{VC}{q_E} + \left(1 - a\right) \frac{f(c)(q_E)}{q_i} \]  

(9)

where \( q_i \) is the generator’s waste output. The last term of (9) is interpreted as follows: The numerator is one generator’s proportional share of all generators’ liability at a TSDF, and the denominator expresses this on a per unit basis for one generator that has output \( q_i \). Equation (9) reduces to

\[ \text{per unit cost to generators} = f(c) + \frac{c}{q_E} + \frac{FC}{q_E} + \frac{VC}{q_E} \]  

(10)

which is identical in form to equation (6), the long-run equilibrium price charged by TSDFs under solo strict liability. If TSDFs take the same care under shared liability (which will not be the case, as we will soon show), then generators will bear exactly the same per unit cost for waste handling whether the liability regime is solo or shared strict liability. Generators would then take the same (efficient) effort at reducing hazardous waste output and would price their products the same.

The crux of this argument is that generators assume that their liability from TSDF activity will be governed by how TSDFs operate in equilibrium. Thus, although any one generator imposes liability on other generators and the TSDF, that generator must anticipate that other generators will impose liability on it, and that the TSDF will charge for any liability it bears. Most importantly, any generator must realize that its own waste output decisions will not affect the total environmental damage and hence total liability at any TSDF it uses. If a generator increases its own waste output to a TSDF and thinks that by so doing it will bear only a portion of the increase in total liability, it will be wrong: The TSDF will respond to an increase by one generator with a reduction in amounts accepted by other generators, for otherwise its marginal cost will exceed the price being received. This, in turn, increases the first generator’s proportional liability to such a degree that the generator ends up bearing all of the additional liability created by its action.

This analysis is no different from standard analysis for a competitive industry. One buyer can neither change the price set in a competitive industry nor can it cause any one firm to increase its output beyond its profit-maximizing level. We see no reason to believe that the hazardous waste management industry performs differently.

But what about the level of care taken by a TSDF? Although generators would like TSDFs to take optimal care, for they end up bearing both costs of care and all resulting liability (either directly or through the price TSDFs charge), TSDFs have incentive to take too little care. TSDFs bear all the costs of taking care but receive only a% of the resulting benefits. If generators could contract directly with TSDFs to take optimal care, there would be no problem. However, there may be substantial transactions costs
involved in writing such contracts. Alternatively, generators could monitor the level of
care being taken by TSDFs to insure that they take appropriate precautions. However,
care will likely be a "hidden action," observable only at a cost, and this would discourage
adequate monitoring.

Let us assume for now that generators cannot costlessly monitor TSDFs’ care levels.
Then TSDFs will all take a level of care $c' < c^*$. The representative TSDF’s average total
cost function will then be given by

$$ATC_i = \alpha f(c') + \frac{c'}{q_i} + \frac{FC}{q_i} + \frac{VC(q_i)}{q_i}$$

and the minimum of this ATC curve will determine the equilibrium price charged to
generators for waste handling.

We first note that the minimum of (11) will occur at a lower level for $q_i$ than does the
minimum of (6); TSDFs are therefore inefficiently small. This can be seen by differentiating (11) with respect to $q_i$ and setting the derivative equal to zero:

$$\frac{dATC_i}{dq_i} = \frac{-c'}{q_i^2} + \frac{-FC}{q_i^2} + \frac{dAVC}{dq_i} = 0$$

$$\Rightarrow q_{i_{\text{min}}} = \left(\frac{c' + FC}{dAVC/dq_i}\right)^{1/2}$$

where $AVC = VC/q_i$. Decreasing $c'$ therefore decreases the output at which ATC
reaches a minimum. Intuitively, the cost of care $c'$ is of fixed cost nature; reducing fixed
costs means that the optimal size of the firm falls.

The next significant result is that the lower care levels taken by TSDFs lead to higher
total per unit cost of hazardous waste management for generators. There are two
reasons for this. First, when TSDFs are too small, the long-run equilibrium price
charged by TSDFs is higher than otherwise. Second, generators end up bearing all care
costs and liability either directly through their own actions and liabilities, or indirectly
through the price they are charged by the TSDF. The sum of these is greater than under
solo strict liability because TSDFs take too little care with shared liability. More formally,
the per unit cost to generators will now be

$$\text{per unit cost to generators} = f(c') + \frac{c'}{q'_E} + \frac{FC}{q'_E} + \frac{VC}{q'_E}$$

following the logic for equation (9).

Neither $c'$ nor $q'_E$ are at the levels implied by equation (6) and Figure 1, and those
levels—$c^*$ and $q_E$—are ones that would minimize (14). Generators therefore end up
paying more in total for hazardous waste management under shared liability. They
therefore will reduce their waste output by more than under solo strict liability, incurring
more cost for pollution prevention. Their final product prices will also be higher,
and consumers will therefore purchase less of their end products, again as compared to
a solo strict liability regime.

A shared liability regime therefore causes a different, and less efficient, allocation of
resources. There are, however, at least three reasons to believe that the inefficiency
created by shared liability will be smaller than that described above: (1) ex ante regu-
latory statutes (e.g., RCRA) can set care standards for TSDFs even under a strict liability regime; (2) generators can monitor TSDFs; and (3) TSDFs could indemnify generators.

The first point—standards of care—is an obvious one, given that the inefficiency caused by shared liability is focused on the care taken by TSDFs. The state can mandate a care level that mimics the optimal level \( c^* \). The care standard could be enforced with either fines or criminal penalties. Such standards will be favored by generators, for although they will increase prices charged by TSDFs, they reduce the total cost of waste management by improving the level of care taken.

Generators can also simply monitor the care taken by TSDFs. However, this cannot be expected to solve the inefficiency in its entirety for two reasons. First, monitoring will be costly. Second, there will be a free-rider problem because monitoring by one generator creates positive externalities for others. Thus, generators will have incentives to engage in too little monitoring.

Indemnification could well be the cheapest, and certainly the most complete, solution. If TSDFs were to offer indemnification contracts to generators, the efficient outcome of solo strict liability would be achieved. Because TSDFs would bear all liability, they would undertake optimal care, and this would induce them to grow to efficient size. Generators would pay higher prices to TSDFs but would again enjoy lower total costs for waste management. This indemnification option is clearly feasible, for such indemnification contracts have been offered by major waste management companies.

To this point in the analysis, then, we must conclude that there are inefficiencies caused by shared liability but that these may be substantially reduced by relatively low-cost remedies. In the next section, we complement this conclusion by presenting an important benefit of shared liability.

V. Shared Strict Liability for TSDFs and Generators when Damage Costs are Unknown

The Winner’s Curse Problem in Hazardous Waste Management

Thus far our analysis, like other analyses of liability regimes for hazardous waste management, presumes that TSDFs know the dollar value of the environmental problems resulting from their activity. This is a very tenuous assumption. TSDFs may be able to "guesstimate" the probability of an accident or a leak occurring at their facility, but even if they are accurate in this calculation there will be tremendous uncertainty over the economic cost of such an occurrence for at least two reasons. First, there will be scientific uncertainty over the likelihood that an environmental accident will result in the exposure of humans or natural resources to harmful wastes, and, if such exposure occurs, whether it will cause physical damage. Furthermore, TSDFs will need to calculate the economic cost of any exposure. This requires placing a value on natural resources lost or damaged and on any detriment to human health (including, of course,

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50This also increases the efficient size of TSDFs, thereby rectifying that problem as well. Ex ante regulatory statutes can also be used to mandate financial standards for TSDFs thereby reducing the risk of insolvent dumps analyzed by Kornhauser and Revesz. See e.g., Kornhauser and Revesz, “Apportioning Damages,” supra note 1. Furthermore, if the state can determine \( c^* \) accurately, a strict liability regime could be designed to mimic the efficiency properties of a negligence regime. See Kornhauser and Revesz, “Sharing Damages,” supra note 1 at 858–859.

51Of course, there may be substantial transactions costs in writing and enforcing these contracts. As Kornhauser and Revesz point out, these transactions costs as a practical matter may limit the usefulness of indemnification. See Kornhauser and Revesz, “Policy Choices,” supra note 1.
the loss of any human lives). One only needs to look at surveys of contingent valuation studies to see how much uncertainty prevails in this latter area.32

In estimating the cost of these environmental problems, TSDFs are estimating a “common value”—the value of natural resources and human health.33 This is similar to the problem faced by bidders in, say, oil lease auctions, where everyone is trying to estimate the common value of the oil beneath a tract of land. As auction theory explains, in such a situation the winner of the auction will tend to be the one who most overestimates the value of oil to be recovered.34 In the hazardous waste arena, the common-value problem will cause those TSDFs who most underestimate the cost of environmental damages to be the “winners” of the bidding process and, therefore, the ones who process the most hazardous waste.

Elaborating on this argument, uncertainty will cause TSDFs to vary in their estimates of the environmental damage function \( f(c_i) \), with some TSDFs underestimating its value, and others overestimate it. With solo strict liability, TSDFs will take care according to their estimate of \( f(c_i) \) and equation (5); underestimating TSDFs will naturally take too little care, and overestimating TSDFs will take too much. An underestimating TSDF will, therefore, view its marginal cost as being lower than the true marginal cost for two reasons: (1) Even at the optimal care level, \( c^* \), the TSDF views damages as being lower than they really are; and (2) such a TSDF will take less care than \( c^* \) and will, therefore, cause the true marginal cost of its activity to increase. The opposite holds true for an overestimating TSDF (they view their marginal cost as being higher than the true marginal cost).

If hazardous wastes were distributed equally across these two classes of TSDFs, two inefficiencies would result. First, there would be a nonoptimal allocation of resources in regard to care, with some TSDFs underinvesting in care and others overinvesting in it. Second, given that some TSDFs are taking too little care, it would be more efficient to shift some of their waste to the TSDFs that are taking too much care.

But with solo strict liability, the inefficiency is even worse, for competition for waste will not yield an equal allocation of waste; instead, an underestimating TSDF will attract more waste than an overestimating TSDF. Figure 2 illustrates this aspect of the problem.

In Figure 2, we retain our assumption that the hazardous waste industry is competitive. In this competitive market, at the equilibrium market price for handling waste each TSDF accepts an amount of waste such that its private marginal cost equals that price. The curve marked \( MC_{\text{UNDER}} \) depicts the (privately believed) marginal cost for a TSDF that underestimates the \( f(c_i) \) function. Given its beliefs, such a TSDF will take on \( q_1 \) waste to be handled. But this is an inefficiently high quantity of waste for that TSDF. If the TSDF took the optimal level of care, the efficient quantity would be \( q_3 \), determined by equating price and the true marginal cost when optimal care (\( c^* \)) is taken. But the underestimating TSDF will take less care than that, \( (c_i < c^*) \), so that the efficient quantity of waste for it to handle is only \( q_2 \) (determined by the equation of price and the true marginal cost at the lower care level \( c_i \)).

Of course, the reverse argument holds for an overestimating TSDF: Their (privately

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33In a common value auction, the value of the item being sold is uncertain but is the same to all bidders. See Randall S. Thomas and Robert G. Hansen, “Auctioning Class Action and Derivative Lawsuits: A Critical Analysis,” 87 Northwestern University Law Review 423, 446 (1993).

34Id. at 447.
believed) marginal cost function induces them to take on too little waste, especially because such TSDFs will be engaging in too much care.

Thus, the effect of allowing environmental costs to be uncertain is an adverse selection problem, with "bad dumps driving out the good dumps." Too much waste ends up being handled by those TSDFs that are taking too little care. With all liability resting on the TSDFs, generators have no reason to be concerned, for they bear no liability for the costs that are being inaccurately estimated. Indeed, generators have every incentive to search out those dumps that most underestimate environmental costs and therefore offer the lowest prices.

**Does Shared Liability Solve the Problem?**

Our argument is not based on irrational or nonequilibrium behavior by TSDFs. TSDFs will spend resources to ascertain the true damage function, $f(c)$, but, given uncertainty, there will be a distribution of estimates of this critical function. Given that TSDFs make "rational mistakes," competitive forces worsen the problem by sending more waste to the TSDFs that most underestimate costs.

Sharing liability for damages between TSDFs and generators can alleviate this problem by inducing generators to select TSDFs on the basis of price and expected environmental damages instead of on the basis of price alone. Generators will use two types of information in selecting TSDFs, exogenous and endogenous. We will deal with exogenous information here and treat endogenous information in the following section on auctions.

With respect to exogenous information, generators are likely to have independent information on the $f(c)$ function, for they have their own solo strict liability under CERCLA for accidents that occur at their own sites (e.g., while accumulating waste before it is shipped to a TSDF or for past disposal activities on their property). Furthermore, generators will, under a shared liability regime, have strong incentives to investigate potential TSDFs to see what techniques are being used and what level of care
is being taken. Although TSDFs have obvious incentives to overstate their care levels, it is reasonable to expect that a generator can at least imperfectly observe the true care level. Armed with its own private information and what it believes TSDFs to be doing, a generator will, under shared liability, select a TSDF on the basis of expected total cost—this being the sum of the dollar price charged and the generator’s estimate of its share of liability created by the TSDF. Referring back to Figure 2, this means that underestimating TSDFs will be less likely to be chosen and, therefore, will be unable to expand their output to what they see as their privately optimal level. Economic efficiency is increased because less hazardous waste flows to TSDFs that take too little care.

There is, however, an offsetting cost to sharing the liability that remains, which is the effect we discussed in the first part of Section IV. The TSDFs that face less than 100% liability will take too little care because they bear only a portion of the benefit of care but all of the cost. Thus, sharing liability with generators forces a trade-off between less of an adverse selection/hidden knowledge problem but more of a moral hazard/hidden action problem.35 We do not claim here that alleviating the adverse selection problem outweighs the creation of a moral hazard problem, just that the alleviation of adverse selection is a benefit to be weighed against a cost.

This analysis using a competitive industry model is rather cursory, however, for it cannot tell us how, with solo strict liability, one TSDF gets more or less waste than another—it simply assumes that if a TSDF chooses an output level, it can attract that much waste input. Further, with shared liability, the model is incapable of describing in any detail how an underestimating TSDF will be turned down by generators, and how such a TSDF might react to being rejected (such rejection would obviously contain valuable information).

For these reasons, we elect to use auction theory to model more realistically the nature of TSDF selection by generators. In doing so, we replace the decision by TSDFs about output level that is implicit in Figure 2 with the decision by TSDFs about their bid, or price, for a fixed quantity of waste. Because only one TSDF will win an auction, it becomes easy to discuss the efficiency of the resulting allocation of waste. And most importantly, the auction approach allows us to consider how a generator can infer the care level of a TSDF from its bid and how a TSDF will base its own bid on the knowledge that it will win the auction only if its bid is the most attractive.

**An Auction-Theoretic Approach**

*Introduction.* Suppose that a generator will bear some of the liability caused by accidents at TSDFs. In such a case, the generator will clearly want to consider the care taken by TSDFs who submit bids for waste management services in addition to the dollar amount of the bids themselves. If care levels of each TSDF are known by the generator, selection based on “total cost” would be easy: We could envision the generator adding the expected accident costs and the dollar cost of the bid to calculate the total cost associated with each bid. It would then select the TSDF offering the lowest total cost bid.

Efficient selection becomes more difficult if care levels of TSDFs are not known by the generator. The generator will still want to select on the basis of total cost, but the liability portion of total cost is not known. We wish to consider the possibility of the generator inferring the liability associated with a TSDF from that TSDF’s bid and, more

importantly, from the bids of all the other TSDFs competing in the auction. Intuitively, a TSDF submitting a relatively low bid should be assumed to be taking little care and thus having high liability. Use of information contained in the entire distribution of bids is warranted if the underlying reason for differing care levels is uncertainty over a common damage function—a reasonable assumption, as we discussed above.

If such a selection scheme based on estimated total cost using information contained in all the bids could be profitably implemented by generators, it could also result in greater economic efficiency, relative to selection based on bids alone. Because generators will be concerned with liability only under a shared liability regime, any efficiency gain would be an argument for shared liability.

To show how sharing liability will lead generators to a selection mechanism that does not always accept the low bidder, and to show that this is not only profit enhancing for the generator but is efficient for society as well, we will develop a discrete example. In this example, there will be one generator that requests bids from two TSDFs for handling the generator’s waste. We begin with the base case, which is where TSDFs bear all liability, and show that there will sometimes be a misallocation of waste—that in some states of the world, the winning TSDF will be taking too little care, and that social costs would be lower if the other TSDF had won the auction. Then we consider what would happen if damages were shared between the TSDF and the generator. We show that in some states of the world, the generator will find it profitable to reject the low bidder and instead offer the job to the high bidder at a mutually agreeable price. Such a transfer of responsibility will also be shown to be socially efficient. Although we rely on a discrete example to make our points, we believe that the example is indicative of general effects.

**Assumptions and Base-Case Analysis (Solo Liability with TSDF).** The timing of actions in the model are as follows. The two TSDFs first receive an informational “message” on damage costs. Given their message, each TSDF must decide on a level of care and commit to that care level. Next, the TSDFs each submit a bid to the generator. The generator then selects the winner, and the waste is processed at the level of care chosen previously by the winning TSDF.

In regard to damages and the messages: Damages are a common value, assumed to be the same for each TSDF but unknown *ex ante*. Each TSDF independently receives one of three messages: m₁, m₂, or m₃. If D denotes damages, then there is a joint probability density, f(mᵢ, D), which TSDFs would use to estimate damages conditional on the message they received. We will not need to specify this function. We will, however, assume that the messages are ranked in order of the severity of damages, so that expected damages given m₁ are lowest and expected damages given m₃ are highest.

From an informational point of view, two messages contain more information than one, for they are independent random variables. Note that there are six combinations of the two messages that could be received. Without specifying numerical values for damage costs, probabilities, and care costs, we will assume that Table 1 below gives the socially efficient action for each message combination—the action that minimizes total social cost. We consider only two actions, either “no care” or “care.” To take one example, if the two messages (m₁, m₂) were received, then a TSDF “taking care” would have lower expected total cost than a TSDF “taking no care.”

The actions laid out in Table 1 are only for comparison purposes, for actions by TSDFs have to be taken given only the one message that each TSDF receives. Without specifying numerical assumptions, we will assume that in the case where the TSDF bears
all liability for damages, they will find it in their interest to take care if they receive message \( m_2 \) or \( m_3 \) and to take no care if they receive message \( m_1 \). Note that this is consistent with our assumption on \( m_1 \) indicating the lowest damages.

It should immediately be noted that the case of \((m_1, m_3)\) is of interest. For efficiency, a TSDF should take care given the information contained in both messages, but only one of the TSDFs has received a message that will induce it to take care. If, as we should expect, the TSDF receiving message \( m_1 \) turns out to be the low bidder, it will be taking an inefficient level of care.

To analyze this more formally, we turn to the auction rules and optimal bidding. For clarity, we assume a second-price, sealed-bid auction, where the low bidder wins but receives as payment the second-lowest bid.

Equilibrium bids are given as

\[
b(m_1) = E(cost|m_1, m_1, \text{no care}) \tag{15}
\]

\[
b(m_2) = E(cost|m_2, m_2, \text{care}) \tag{16}
\]

\[
b(m_3) = E(cost|m_3, m_1, \text{care}) \tag{17}
\]

with \( b(m_1) < b(m_2) < b(m_3) \).

Derivation of these equilibrium bids follows closely Milgrom and Weber (1982). In other words, the bid given message \( m_i \) is the expected cost given \( m_i \) and that the other bidder receives \( m_i \), and given the level of care that was chosen when message \( m_i \) was received.

To see why these are equilibrium bids, consider the TSDF that receives message \( m_1 \) and takes no care (itself the optimal decision given \( m_1 \)). Given that this TSDF received \( m_1 \), the possible combination of the two messages are \((m_1, m_1), (m_1, m_2), \text{and} (m_1, m_3)\). If \((m_1, m_1)\) is the case, then both bids will be \( b(m_1) \) and each TSDF has a 50% chance of winning (ties are chosen randomly). But \( b(m_1) \) is by construction equal to expected cost given \((m_1, m_1)\), so expected profits are zero. If \((m_1, m_2)\) occurs, then the TSDF with \( m_1 \) wins (it has the lower bid) and receives as payment \( b(m_2) \). This will be a profitable sale, for the TSDF is taking the cost-minimizing level of care (see Table 1) and will receive as payment \( b(m_2) \), which is the expected cost given an assumption of \((m_2, m_2)\).

Expected cost given \((m_2, m_2)\) will be higher than expected cost given the actual messages received \((m_1, m_2)\), so the price received exceeds expected cost. If, however, \((m_1, m_3)\) occurs, then the TSDF with \( m_1 \) wins but will lose money: Although he receives

<table>
<thead>
<tr>
<th>Message Combination</th>
<th>Efficient Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m_1, m_1 )</td>
<td>No care</td>
</tr>
<tr>
<td>( m_1, m_2 )</td>
<td>No care</td>
</tr>
<tr>
<td>( m_2, m_2 )</td>
<td>Care</td>
</tr>
<tr>
<td>( m_1, m_3 )</td>
<td>Care</td>
</tr>
<tr>
<td>( m_2, m_3 )</td>
<td>Care</td>
</tr>
<tr>
<td>( m_3, m_3 )</td>
<td>Care</td>
</tr>
</tbody>
</table>

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Liability for hazardous waste

TABLE 1. Efficient action given both messages

\[
\begin{array}{ll}
\text{Message Combination} & \text{Efficient Action} \\
\hline
m_1, m_1 & \text{No care} \\
\hline
m_1, m_2 & \text{No care} \\
\hline
m_2, m_2 & \text{Care} \\
\hline
m_1, m_3 & \text{Care} \\
\hline
m_2, m_3 & \text{Care} \\
\hline
m_3, m_3 & \text{Care} \\
\end{array}
\]
b(m₃) as payment, b(m₃) is conditioned on taking care, and the winning TSDF is not taking care.³⁶

Now consider whether the TSDF receiving message m₁ should raise or lower its bid from b(m₁). By lowering its bid, it would win all the time when the other TSDF receives m₁ instead of only half the time, but because expected profit is zero in this case, there is no gain from bidding lower. In those cases when the other TSDF receives m₂ or m₃, the TSDF being considered already wins with its bid of b(m₁). Also, price is determined by the bid of the other TSDF (b(m₂) or b(m₃)). Thus, again, there is no gain from bidding lower.

What about raising its bid conditional on m₁? Raising it above b(m₁) but below b(m₂) means that this TSDF loses all the (m₁, m₂) sales instead of only half of them. They are zero expected profit sales, so there is no gain or loss. Raising the bid to b(m₂) or greater, but less than b(m₃), means that the (m₁, m₂) sales will also be lost (only half of them if the bid is exactly b(m₂)). But these are profitable sales, so raising the bid in this range reduces profits. Last, consider raising the bid to b(m₃) or greater. This clearly reduces profits, for now all of the profitable (m₁, m₃) sales would be lost.

Conditional on m₁, b(m₁) as given is therefore an optimal bid. The same analysis can be performed for b(m₂) and b(m₃), showing that they too are optimal bids.

The inefficiency of this result is that in case (m₁, m₃), the TSDF that received message m₁ wins the auction. But that TSDF is not taking care, and care should be taken when the information set is (m₁, m₃). From the standpoint of efficiency, it would be better if the TSDF that received m₃ were awarded the sale, for it is taking an appropriate level of care.

Next we turn to an auction where the TSDF shares liability with the generator. The question, of course, is whether this regime reduces the inefficiency of the solo liability regime.

**Auction With Shared Liability.** With shared liability, the costs borne directly by the TSDF fall so that, with the same auction rules, their bids would fall. Of course, the reduced price paid by the generator would be offset by the liability that they bear directly. But two other effects of sharing liability need to be noted. First, as we show below, the generator will have incentive to change the auction rules to avoid cases where the low bidder is taking an inefficient level of care. This effect yields a greater efficiency for the shared liability regime as compared to solo liability. Second, the TSDFs may find it optimal to reduce their level of care, for they now bear only a portion of the liability.

In our example, with solo liability the TSDFs took care if they received message m₂ or m₃. With shared liability, the TSDFs may find it optimal to take care only if m₃ or even not at all. This moral hazard effect is one of the costs of a shared liability regime. In our example, it will not appear by assumption, for our goal is to illustrate how sharing liability can alleviate the adverse selection problem. We return later to discuss the trade-off between less adverse selection but more moral hazard.

To analyze the shared liability auction, we begin by assuming an arbitrary sharing of the liability—say, 75% with the TSDF and 25% with the generator. This allocation is

³⁶It need not be the case that expected cost given (m₁, m₃) and no care exceeds b(m₃). We implicitly assume that not taking care when care should be taken raises cost significantly. The assumption is not critical. What is important, however, is that the overall expected profit with a bid of b(m₃) be nonnegative. This requires that any loss on the (m₁, m₃) sale be at least offset with the profits from the (m₁, m₂) sales.
determined in the real world by courts.\textsuperscript{37} To focus only on the adverse selection problem, we will assume that TSDFs still find it optimal to undertake care when messages $m_2$ and $m_3$ are received but not when $m_1$ is received.

Proceeding, we will assume again that a generator request bids in a second-price, sealed-bid auction. For now, the generator will be committed to accepting the lowest bid. As before, equilibrium bids conditional upon the three messages are:

\begin{align}
b(m_1) &= E(cost|m_1, m_1, \text{no care, 75\%}) \\
b(m_2) &= E(cost|m_2, m_2, \text{care, 75\%}) \\
b(m_3) &= E(cost|m_3, m_3, \text{care, 75\%})
\end{align}

where the 75\% denotes that this expected cost to the TSDF assumes 75\% liability. Note also that $b(m_1) < b(m_2) < b(m_3)$. Because the proof for equilibrium is exactly analogous to the full-liability equilibrium, we will not repeat it.

The interesting case that now presents itself is when one bidder receives message $m_1$ and the other receives $m_3$. In that case, the low bidder will be the one who received $m_1$, and he would win the auction and receive $b(m_3)$ because that is the second-lowest bid. The problem is that the winning bidder, because he received $m_1$, is taking no care. Although that is of no direct concern to the generator in the solo liability regime, it becomes a direct concern to the generator under the shared liability regime. Besides paying $b(m_3)$ to the winning bidder, the generator will also now pay 25\% of any damages resulting from accidents at the TSDF. Because the TSDF is taking an inefficient level of care—when the joint message set is $(m_1, m_3)$, care is the efficient response—the total expected cost will be higher than it could be.

Because the generator sees all the bids as a result of being the auctioneer, a cost-reducing strategy presents itself. The generator knows that the joint message set is $(m_1, m_3)$ because the two bids received are $b(m_1)$ and $b(m_3)$. The generator also knows that given $(m_1, m_3)$ total cost would be lower if care were being taken, and that the bidder who received message $m_3$ will take care. If the generator could accept the bidder who received $m_3$ instead of the one who received $m_1$, at a price not too much higher than what it would have to pay the bidder with $m_1$, then the generator would be better off.

In fact, such a transaction is feasible, and, furthermore, \textit{ex ante} knowledge on the part of the bidders that the generator may not always accept the low bidder will not affect the bidding equilibrium. To see this, note that the bidder who received $m_3$ bids

\begin{equation}
b(m_3) = E(cost|m_3, m_3, \text{care, 75\%})
\end{equation}

and that this is also the price that the winning TSDF would receive. Suppose that the generator rejects the low bid ($b(m_1)$) and instead awards the contract at the same price of $b(m_3)$ to the other bidder, the one who received $m_3$ and who takes care. Suppose further that the generator offers the contract to this TSDF at a price equal to its bid—$b(m_3)$. This is an acceptable offer to that TSDF, because $b(m_3)$ is the TSDF’s expected cost conditional on the joint message being $(m_3, m_3)$, which is a worse joint message than actually occurred—$(m_1, m_3)$. The rejection of the low bid and the acceptance of the higher bid is therefore “win-win” for all three parties involved—the high

bidder, who will be awarded the sale at a profitable price; the generator, who pays the same price to the TSDF but will now have less residual cost due to care being taken; and, interestingly enough, the low bidder, who would lose money on the contract because he is taking an inefficient level of care.

One last issue remains to be resolved, however: Will the change in auction rules lead to a new bidding equilibrium if the generator’s behavior is known in advance? One should expect that a policy of sometimes rejecting the lowest bid in favor of a higher bid would lead bidders to submit higher bids. In a first-price auction this would definitely occur; in that case, we would have to determine the new equilibrium to see whether the generator is truly better off.

In the second-price context we have assumed, this problem does not present itself so long as certain conditions are met. To demonstrate the stability of the bidding equilibrium, we will examine the incentives for bidders to deviate from the equilibrium depicted in equations (18) to (20). Conditional on m₁, b(m₁) is still optimal: Raising the bid would only cause some profitable sales to be lost. For a bidder who received m₃, there is only the effect that they will win some sales when the joint message is (m₁, m₃), but this is no reason to bid differently. A bidder who receives m₂ might consider changing their bid to b(m₃), in hopes of “fooling” the generator into believing that the joint message was (m₁, m₃) and into accepting the higher bid. Although winning such sales would be profitable, there is also a cost to the change of bid, in that sales that would have been won with a bid of b(m₂) would now be lost. Thus, a cost/benefit calculation needs to be done by a bidder with m₂ to determine whether it is profitable to change their bid from b(m₂) to b(m₃). If the benefit from switching to b(m₃) from b(m₂) is low enough, then the bidder with m₂ will prefer to stay with b(m₂). This benefit will be low if at least one of two conditions are met. First, if the probability of event (m₁, m₂) is low relative to the probability of event (m₂, m₃), then the expected gain from a bid of b(m₃) will be low relative to the cost, which is the loss of profitable sales in event (m₂, m₃). Whether this first condition is met is a function of nature—the event probabilities. The second condition that ensures maintenance of equilibrium is controllable by the generator: the probability of the higher bid being accepted when the two bids are b(m₁) and b(m₃). If the generator only occasionally takes the higher bid in these circumstances, then the TSDF with message m₂ that is thinking of bidding b(m₃) instead of b(m₂) will face little chance of gain but a large chance of loss (sales that could have been won with b(m₂) in the (m₂, m₃) events.

Thus, if the generator deviates only occasionally from its normal rule of taking the lowest bid, or if nature cooperates with the right event probabilities, then the original equilibrium in (18) to (20) remains unchanged. Of course, the generator and society gain every time the generator refuses a bid of b(m₁) in favor of b(m₃). This, therefore, completes our demonstration of how sharing liability can improve efficiency.

We should note again that our analysis has assumed away the moral hazard aspect of the problem: that the TSDFs have incentive to take less care under shared liability than under solo liability. The inclusion of the moral hazard effect can offset the gains from a better allocation of waste across TSDFs. Such a trade-off is not unusual; in oil lease auctions, for instance, royalty rates (sharing of revenues) have desirable revenue-enhancing properties, but they also create moral hazard effects in that production may be shut down prematurely. Or, taking another example, product guarantees are desirable in that they alleviate informational asymmetry, but they cause moral hazard on the part of consumers (misuse of the product or failure to maintain properly, for instance).

We expect that a more complete analysis would yield the conditions under which
sharing liability is optimal when both adverse selection and moral hazard are present, and we expect that such an analysis would yield the optimal sharing proportion. This is beyond our scope, however, as we are simply pointing out that sharing liability can have the beneficial effect of reducing adverse selection. The inefficiency of sharing liability due to moral hazard is well known, but the adverse selection effect is not.

VI. Other Implications of Uncertain Damages

Strict Liability Versus Negligence When Damage Costs are Unknown

A strict liability regime leads TSDFs to estimate environmental damages and to take care according to these estimates. With uncertainty, this necessarily results in some TSDFs taking too little care, whereas others take too much. Competitive forces such as those in auctions make it more likely that the TSDFs who take too little care will receive a disproportionate quantity of waste.

As we showed above, sharing liability between TSDFs and generators alleviates this adverse selection problem. Replacing strict liability with a negligence regime could also reduce the adverse selection. Under a negligence standard, the optimal care policy of TSDFs will typically be to meet what the standard requires: Doing more yields no benefit, and doing less means taking on liability when that liability could be discontinuously eliminated by meeting the standard. Estimating environmental damages is, therefore, unnecessary, for they will not be part of the expected costs of the TSDF; more important, bids of the TSDF in an auction context will reflect only the nonliability costs of performing the service. A standard low-bid auction would then select the TSDF with the lowest private cost, which would be an efficient outcome.

Negligence standards may not alleviate adverse selection if TSDFs are uncertain about the appropriate standard. With a vague standard, TSDFs will take different levels of care because they all estimate different standards—a result similar to that attained under strict liability. And an auction will tend to select that TSDF that believes the standard to be the least stringent; in this case, efficiency could be improved by using the information contained in all the bids to select the TSDF taking the closest-to-optimal care level.

The Impact of Sharing Liability on Property Transfers

Enactment of RCRA and CERCLA greatly changed the economics of the hazardous waste management industry, with particular implications for industry structure. These laws imposed large fixed costs on TSDFs—not only do facilities have to be engineered to more exacting and costly specifications, but they need to be monitored on an ongoing basis. Also, TSDFs can anticipate additional compliance and litigation activity, thereby creating the need for larger compliance monitoring and legal staffs. The implication of increases in fixed costs is an increase in the optimal size of a TSDF. We should expect, therefore, to see some consolidation in the hazardous waste industry through mergers and acquisitions.

A major impediment to this consolidation would be transaction costs caused by uncertainty over the liability assumed by purchasers of existing TSDF properties. Auction theory shows that uncertainty creates exchange-blocking transaction costs by making the expected price in a common-value auction lower than the true expected value of the property. Existing owners of TSDFs may, therefore, find it more attractive to retain ownership of their properties rather than to sell them to a new owner who could consolidate their operations. This would be inefficient.
These transaction costs will differ according to the liability regime. One obvious way to minimize the transaction cost is to exempt new owners from liability for existing problems. Indeed, CERCLA’s 1986 amendments attempted to do this by creating the “innocent purchaser defense.” Furthermore, sellers of properties can (and do) indemnify purchasers for certain existing problems. In practice, neither of these solutions works perfectly: One remaining issue will always be the determination of whether an environmental problem is new (subject to new owner’s liability) or preexisting (exempt).

Reducing the liability of TSDFs directly holds more promise for reducing the transaction costs of exchanging assets. Moving from a strict liability rule to a negligence standard, for example, would most likely reduce uncertainty over the environmental liabilities of a TSDF. With a negligence standard, a purchaser could first assess the care levels of the TSDF and determine whether negligence had occurred; if not, the difficult estimation of damages need not be done.

Sharing liability between generators and TSDFs could also reduce the effect of uncertainty over the liability of TSDFs on consolidations. If the liability allocation rules are known, or can be reasonably estimated, then the total amount of any liability assumed by purchasers will be lower than it would be under solo strict liability. The total transaction costs of consolidation (in the form of a lower price) would then be lower as well. Of course, these transaction costs are simply shifted via shared liability to generators. This will increase transaction costs incurred on exchange of generators’ assets. However, this shifting is likely to be desirable because the TSDF industry is the one most in need of restructuring.

VII. Summary and Extensions

This paper argues that the costs of shared liability in the hazardous waste arena are less than previously thought and that there is a significant benefit created by shared liability. In regard to cost, we show that shared liability will not lead to overgeneration of waste so long as hazardous waste facilities are not assumed to be passive “dumps.” The significant benefit of shared liability arises because under shared liability there will be less adverse selection by generators of hazardous waste facilities that underestimate the risks and damages from their activity.

It is important to consider the conditions that make sharing of liability and the resultant reduction in adverse selection an efficient institutional arrangement. Indeed, because the law does not always force the sharing of liability, one should presume that it is not always efficient to do so. We point to four conditions that are critical for liability sharing to be an efficient regime. First, suppliers (staying within the supplier/purchaser paradigm) must face uncertainty over a portion of their cost that is both economically significant and common to all suppliers. Second, there should be relatively little variation in other costs of suppliers (besides the common, uncertain portion), so that variation in bids reflects to a great extent variation in estimates of the common cost. Third, buyers must be serving as de facto auctioneers, so that they see bids from different suppliers and can compare levels of care by inferring individual care levels from bids. Fourth, moral hazard issues cannot overwhelm any benefits from less adverse selection.

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38**Germany has adopted a form of this rule for new owners of businesses in former East Germany. See Thomas, supra note 3.**
These conditions will not always be present. We can, however, point to two areas where the conditions are likely to be met and where the legal system is in flux.

One such area concerns liability for spills by oil tankers, covered under the Oil Pollution Act of 1990 (OPA). The OPA makes ship owners and operators liable for the costs of removing the oil and for damages to the natural resources and property.\(^\text{39}\) Initially, legislation was introduced that would have extended this liability to the oil companies that owned the oil being shipped in the tankers. However, in the final version approved by Congress, OPA did not extend this liability to cargo owners.\(^\text{40}\)

We would argue that some liability should be extended to the oil companies to prevent them from choosing those tanker companies who underestimate the risks of oil spills. Again, the essence of the argument is that oil companies, by seeing all the bids from tanker companies, are in a naturally favorable position to determine the tankers that are underestimating the risk of an environmental accident. Shared liability would increase the efficiency of the resulting selection of tankers.

Another possible application of our model arises in the garment industry. In recent years, the growth of the garment industry has spurred intense competition among independent contractors to provide the lowest cost product to garment companies and retailers. Some of these independent contractors have cut their costs by employing impoverished immigrant groups.\(^\text{41}\) As a result, the American garment industry has seen a growing use of sweatshops that violate federal labor laws in many ways: paying substandard wages; failing to pay overtime; engaging in numerous health and safety violations; and using underage child labor.\(^\text{42}\) To combat the problem, state and federal authorities have tried to investigate apparel contractors suspected of violating various labor laws, but with limited success.\(^\text{43}\)

Frustrated federal authorities have changed their enforcement strategy to focusing on the garment companies and retailers that hire the law breaking contractors. The

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\(^{39}\)This liability is unlimited in cases where the shipper has acted with gross negligence. 33 U.S.C. § 2702 (1990). The regulatory provisions of OPA also require ship owners and operators to obtain certificates of financial responsibility (COFRs), and exposes them to unrestricted liability under state law. Alan Kovski, “U.S. Coast Guard Takes Criticism For Spill Rules,” The Oil Daily, Nov. 7, 1991, at 1; Oil spill insurance: Coverage proves expensive, scarce, American Political Network, Inc., Greenwire, July 7, 1994, available in Lexis, News library, Curnws file. The COFRs are proof that the ship owners and operators have enough financial resources to pay for the increased liability of an oil spill under the Oil Pollution Act of 1990. “API says U.S. Coast Guard oil tanker rule too costly,” Reuters, Limited, July 1, 1994, available in Lexis, News library, Curnws file.

\(^{40}\)The Congressional conference committee cut out the provision of the House bill that would have extended liability to the cargo owners. H.R. 1465, 101st Congress, 1st Session, S 1002 (a) (2).


\(^{42}\)Stuart Silverstein, “Survey of Garment Industry Finds Rampant Labor Abuse; Workplace: The Random Inspections Turn Up Numerous Violations of State and Federal Laws,” L.A. Times, April 15, 1994, at D1 (noting a recent study of 69 randomly selected garment manufacturers in California that found that 92.8% violated health and safety standards, 72.5% kept faulty records, 68% did not pay overtime, 50.7% did not pay the minimum wage, 30% paid workers in cash, 14.5 fostered illegal work in the home, and 2.9% violated child labor laws).

\(^{43}\)Lee, supra note 51, at A1. These efforts have been met with limited success because the worst infractions occur at small garment contracting companies that merely close up shop and set up a business under a new name in response to investigators cracking down on them. “Labor Department Set to Go After Stores Selling Garments From Sweatshops,” L.A. Times, September 9, 1994, at D1. The fact that both the employers and employees involved benefit from the illegal activity compounds the problem. Lee, supra, at A1. Additionally, the common use of contractors and subcontractors in the garment industry makes it difficult to find the responsible parties thus opening legal loopholes for employers.
Department of Labor has decided to place liability for contractors’ violations on both retailers and manufacturers. This strategy has already met with several successes.

44“Labor Department Set to Go After Stores Selling Garments From Sweatshops,” L.A. Times, September 9, 1994, Business section, at D1. This effort utilizes the little used 1938 hot-goods provision of the Fair Labor Standards Act, which allows the department to seek injunctions prohibiting the interstate transportation goods produced in violation of federal labor law. Id.; 29 U.S.C. § 215 (1988). First, the hot-goods provision is used to block shipments from the law violating garment manufacturers to retailers. L.A. Times, supra, at D1. Second, the same clause is also being used to prevent retailers from selling any received goods that have been illegally produced. Id. Once a retailer has been warned about illegal manufacturers, the retailer is liable for any future dealings. Id.

45For example, in November of 1994, Chorus Line Corp., one of Southern California’s biggest garment manufacturers, signed a consent judgment in agreeing to pay $74,000 in back wages to 202 employees at seven of its contractors and to insure that its contractors refrain from further labor standards violations. Stuart Silverstein and George White, “Garment Maker Vows to Halt Salary Abuses; Labor: Chorus Line Corp. Signs Pact Saying That It Will Make Its Contractors Refrain From Violating Federal Wage and Other Standards,” L.A. Times, Nov. 4, 1994, Business, at D2.