A NOTE ON OPTIMAL CLEANUP AND LIABILITY AFTER ENVIRONMENTALLY HARMFUL DISCHARGES

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ABSTRACT

This note studies how liability for environmentally harmful discharges affects the incentives of firms to engage in cleanup after a discharge. It also considers how liability affects firms' investments in precautions to prevent discharges and consumers' purchases of the goods whose production leads to discharges. We show that making firms responsible for cleanup and strictly liable for any remaining harm leads in theory to the socially optimal outcome. We also discuss several factors that bear on the efficacy of this policy in practice (limited assets of firms, the chance of escaping liability, measurement of harm), and comment on an influential legal opinion that favors imposing liability equal to the cost of fully restoring natural resources damaged by a discharge.

I. INTRODUCTION

The damage caused by an environmentally harmful discharge often can be mitigated by various kinds of cleanup effort. By "cleanup effort" we mean any

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activity that reduces the harm after the discharge has occurred. For example, after an oil spill, oil can be removed from beaches, bird and animal rescue centers can be established, and fish can be restocked; or after toxic wastes have leaked from a storage facility, contaminated soil and groundwater can be treated and barriers can be constructed to reduce further diffusion of the waste.

The contribution of this note is to apply ideas from the economic theory of liability to the problem of environmentally harmful discharges when post-discharge mitigation of harm by cleanup activities is a significant issue. The standard model of liability treats the level of harm as fixed if an accident occurs. We add the possibility that the injurer can spend money to reduce the harm (by cleanup effort).[1] For completeness, we also consider how liability affects the incentives of firms to invest in precautions to prevent discharges (such as by converting from single-hulled to double-hulled supertankers), and the incentives of consumers to reduce the consumption of goods whose production leads to discharges (such as by purchasing clothing with natural rather than synthetic fibers, thereby reducing the use of chemicals and the number of associated waste-disposal accidents).

We first show (Section II) that making firms responsible for cleanup and strictly liable[2] for any remaining harm leads in theory to the socially optimal outcome: firms will appropriately clean up and take proper precautions, and consumers will purchase the correct amount of the goods whose production leads to discharges. We then discuss (Section III) several factors that bear on the efficacy of this policy in practice (limited assets of firms, the chance of escaping liability, measurement of harm), as well as an influential opinion of the U.S. Court of Appeals that favors imposing liability equal to the cost of fully restoring natural resources damaged by a discharge.

II. CLEANUP AND LIABILITY IN THEORY

Consider a model in which production of a good is associated with the risk of an environmental discharge and in which, if a discharge occurs, cleanup effort by the responsible firm can reduce the level of harm. Also, a firm can reduce the risk of a discharge by exercising precautions. Let

c = cost of producing a unit of the good, exclusive of the expense of precautions;
x = cost of precautions per unit of the good;
$p(x)$ = probability of a discharge per unit of the good; $p'(x) < 0$; $p''(x) > 0$;
y = cleanup expenditures if a discharge occurs;
$h(y)$ = harm due to a discharge, given y; $h'(y) < 0$; $h''(y) > 0$.

Assuming for simplicity that all consumers of the good are identical, let

z = production of the good per individual;
$u(z)$ = utility from consumption;
w = wealth;
and suppose that the total utility of an individual is $u(z) + w$.

We will assume as well that firms that produce the good are in a competitive market, so that the price of the good equals the cost of production plus any relevant cleanup and liability costs. Let

r = price of the good.

Social welfare is assumed to equal the utility of individuals less the total costs of production, including costs associated with discharges:

$$u(z) + w - z\{c + x + p(x)[y + h(y)]\}. \quad (1)$$

Let the optimal x, y, and z be denoted by asterisks.

It is clear from the form of (1) that y^* minimizes $y + h(y)$, so that y^* is determined by the first-order condition

$$-h'(y) = 1. \quad (2)$$

In other words, cleanup expenditures should be undertaken until the marginal reduction in harm from spending a dollar equals a dollar.

It also is clear from (1) that x^* minimizes $x + p(x)[y^* + h(y^*)]$, so that x^* is determined by

$$-p'(x)[y^* + h(y^*)] = 1. \quad (3)$$

That is, precautions should be invested in until the marginal reduction in expected harm and cleanup expenditures (at their optimal levels) equals a dollar.

Given x^* and y^*, z^* is determined by the condition

$$u'(z) = c + x^* + p(x^*)[y^* + h(y^*)]. \quad (4)$$

In other words, production of the good should occur until the marginal utility from the good equals the full cost of production, including the expected harm, the expected cleanup costs, and the costs of taking optimal precautions.

If firms that cause environmental discharges are made responsible for cleanup and strictly liable for any remaining harm, they will undertake the socially optimal amount of cleanup if a discharge occurs and invest in socially optimal precautions to prevent discharges. Moreover, consumers will purchase the socially optimal amount of the good whose production gives rise to discharges.

To demonstrate this, observe that if a discharge occurs, a firm's expenses will be its cleanup costs, y, plus its liability for harm, $h(y)$, so it will choose y to minimize $y + h(y)$, meaning that it will select y^*. Because the firm knows that it will choose y^* and bear costs of $y^* + h(y^*)$ if a discharge occurs, it will select its level of precautions to minimize its unit costs $c + x + p(x)[y^* + h(y^*)]$, so it will choose x^*. Consequently,

$$r = c + x^* + p(x^*)[y^* + h(y^*)]. \tag{5}$$

Since individuals will choose z to maximize

$$u(z) + w - rz, \tag{6}$$

their selection of z will satisfy

$$u'(z) = r, \tag{7}$$

which is to say that (4) will be satisfied. Hence, x^*, y^*, and z^* will result.[3]

III. CLEANUP AND LIABILITY IN PRACTICE

Although the preceding section shows that a policy of holding firms responsible for cleanup and strictly liable for remaining harm functions well in theory, a number of additional factors need to be considered to evaluate the efficacy of this policy in practice. We discuss three such factors in this section, as well as a leading legal opinion regarding liability for environmental discharges.

A. Limited Assets of Firms

In many circumstances firms may not have assets sufficient to pay for the consequences of environmental discharges resulting from their operations. A small pesticide company, for instance, could misuse a carcinogenic chemical and thereby generate cleanup costs and residual harm far exceeding its resources. If a firm's assets are less than the cleanup costs and harm that its operations could cause, the conclusions of Section II no longer hold; rather, the firm will take insufficient precautions to prevent discharges, will not clean up adequately if a discharge occurs, and will price its products too low (leading to socially excessive purchases).

To alleviate these difficulties, governmental regulation of cleanup effort and of investment in precautions may be desirable. For example, the government might require oil firms to store dispersants to be employed in the event of an oil spill, or stipulate that chemical transporters use trucks designed to withstand rupture if they roll over. In fact, the government does rely on a variety of regulations to reduce and mitigate environmental risks.[4] To the extent that these regulations appropriately balance the costs and benefits of investments in precautions and efforts to clean up, they may provide a useful supplement to liability. However, regulations will not solve the problem of inadequate product prices and socially excessive consumption, since even if firms invest optimally in precautions and undertake proper cleanup, they may be unable to pay for the harm that nevertheless eventuates.

B. Chance of Escaping Liability

Firms sometimes can escape liability after causing an environmentally harmful discharge, perhaps because the discharge is difficult to discover or because the injurer is difficult to identify. When firms can escape liability, their expected outlays for cleanup and residual harm fall, leading to inadequate incentives and inappropriately low product prices.

Courts can seek to counter the effects of escaping liability by increasing the magnitude of liability. If the level of liability is set equal to the harm multiplied by the inverse of the probability of being found liable (for example, multiplied by three if the chance of liability is one-third), then expected liability will equal harm, and the analysis in Section II will apply.[5] In practice, it often will be evident whether there is, or is not, a need to increase the level of liability to make up for the chance of escaping liability. When a supertanker runs aground and spills oil in a harbor, presumably it would have no chance of escaping liability, so there is no reason to impose liability in excess of harm. But when a truck dumps toxic wastes along an infrequently traveled road in the middle of the night, it would have a high chance of avoiding liability, so that a significant damage multiplier would be appropriate (although its precise magnitude may be difficult to establish). If an enhanced level of liability is desirable, it might be achieved through the imposition of punitive damages or civil or criminal fines.

C. Measurement of Harm

Although the analysis in Section II presumed that harm could be measured accurately, reliable estimation may be particularly difficult in the context of damages to natural resources. Notably, it is not clear how to ascertain the value of animals and scenic areas that do not have market value. One approach to measurement, known as "contingent valuation," relies on surveys of individuals' hypothetical willingness to pay.[6] For instance, individuals might be asked how much they would pay to preserve the life of 1,000 birds of some type; their answers would provide the basis for setting the level of liability for the death of these kinds of birds, as well as for deciding how much to spend to protect them.

If contingent valuation or alternative methods of estimating harm to natural resources are not employed, and instead only readily measured components of harm are taken into account, then the level of liability—and thus incentives and product prices—will be too low. On the other hand, if contingent valuation is employed but is subject to substantial error, and especially to overstatement of harm, then undesirable risk and the possibility of excessive liability will result. Moreover, the use of contingent valuation is likely to increase administrative costs associated with the resolution of legal disputes because it increases the scope for disagreement about the magnitude of liability. The preceding advantages and disadvantages of using contingent valuation to measure the full extent of environmental harm have led to considerable controversy and debate.[7]

D. State of Ohio Opinion

In an influential decision—*State of Ohio v. U.S. Department of the Interior*, 880 F.2d 432 (D.C. Cir. 1989)—the United States Court of Appeals for the District of Columbia Circuit addressed the issue of liability for environmentally harmful discharges. The Court endorsed a rule that, in effect, imposes liability on dischargers for complete restoration—the cost of restoring a natural resource to its original condition. But optimal cleanup does not generally entail complete restoration of a natural resource because, beyond a certain point, further restoration typically becomes more expensive than the additional benefits.[8] Moreover, the analysis in Section II shows that the level of liability should equal the harm that remains from a discharge after appropriate cleanup has been undertaken, not the (higher) cost of fully restoring the natural resource.[9] Thus, the Court's ruling is likely to cause dischargers to spend excessively on cleanup, to take unreasonable precautions, and to charge inappropriately high prices for their products.

The Court did recognize, however, that if the cost of completely restoring a natural resource far exceeds (is "grossly disproportionate" to) the resulting increase in the value of the resource, the discharger's liability might be less than the cost of complete restoration.[10] This somewhat lessens the inefficiencies of the complete restoration rule, but does not result in the policy identified here as desirable: responsibility for cleanup and strict liability for residual harm.

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NOTES

1. Complementary discussions of the control of environmental discharges include Burrows, Rowley, and Owen (1974), Cohen (1986; 1987), Epple and Visscher (1984), Goldberg (1994), and Segerson (1989; 1990). None of these articles, however, focuses on and formally models how liability affects an injurer's incentive to clean up after a discharge.

2. Firms that cause discharges often are held strictly liable for harm. See, for example, Grigalunas and Opaluch (1988, p. 511):

> Various pieces of environmental legislation provide strict liability for damages from spills of oil or hazardous substances. These include the Outer Continental Shelf Lands Act Amendments of 1978, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, CERCLA's recent amendments, the Superfund Amendments and Reauthorization Act of 1986 and the Water Quality Act of 1987 as amended. [footnotes omitted]

However, firms are not always free to decide on the level of cleanup (see Section III).

3. A rule that makes firms causing discharges liable for harm if and only if they fail to take appropriate precautions or to engage in appropriate cleanup—a form of negligence rule—also can induce them to behave socially optimally in terms of precautions and cleanup. However, for well-known reasons, such a rule will lead to socially excessive consumption of goods whose production gives rise to discharges (because the prices of goods sold by firms that behave non-negligently will not reflect any residual harm).

4. See generally Gibson (1993).

5. Setting liability according to this principle creates an incentive for a firm to identify itself—by engaging in cleanup effort—as having caused a discharge. Consider, for example, a discharge that would result in $1 million of harm in the absence of cleanup and only $200,000 of harm if $100,000 is spent on cleanup. With an appropriate multiplier to make up for the chance of escaping liability, the discharger's expected liability will be $1 million if it does not identify itself and does not clean up. But if, instead, the discharger spends $100,000 on cleanup, and thereby inevitably discloses its identity, it will bear total costs of only $300,000—the cleanup costs plus $200,000 in liability costs for the residual harm. (The residual harm should not be multiplied because, given the discharger's decision to clean up, there is no chance of escaping liability.)

6. See, for example, Mitchell and Carson (1989).

7. See generally Note (1992).

8. In saying this we are abstracting from the effects of "loss aversion," which would result in individuals' placing special value on restoration. See generally Kahneman, Knetsch, and Thaler (1991).

9. If the cleanup is undertaken by an entity other than the discharger (say by the government), then, consistent with the analysis in Section II, the level of liability should equal the cost of cleanup plus the residual harm—still an amount generally less than the cost of full restoration.

10. In footnote 7 of the opinion, the Court suggested by way of example that if the cost of complete restoration is larger than three times the harm to the resource, such a cost would be grossly disproportionate to the value of restoration, and should not be fully imposed on the spiller.

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