On and Off the Liability Bandwagon: Explaining State Adoptions of Strict Liability in Hazardous Waste Programs

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Abstract

We analyze factors in states' decisions to switch their approaches to hazardous waste liability policy from negligence standards to policies based on strict liability. Many, but not all, states have switched in recent years. We explain differences in the timing of states' adoption of strict liability into their "mini-superfund" programs using data on states' industrial activities, environmental programs, wealth and education, and political orientation. We test implications of a theoretical model in which states adopt the liability regime (strict *versus* negligence-based liability) that they see as having greater net benefits. We test this model by estimating a probit equation of the presence or absence of strict liability in a state hazardous waste cleanup program. We find that the likelihood of a state adopting strict liability is positively associated with the number of large manufacturing plants located in that state, but negatively associated with the number of large mining establishments. We also find that educational attainment of residents, state government resources, effectiveness of other state environmental programs, and political variables are significant determinants of the likelihood of strict liability adoption. Our findings suggest states may view strict liability as better suited to industrial waste sites than to mining pollution, that they may be partly motivated by a "deep pocket" mentality, or that they may anticipate engaging in "precaution targeting" (Tietenberg, 1989). Non-adopters may have fewer resources available to confront environmental problems, may not wish to discourage business activity, or may have other programs in place which effectively substitute (at least for a time) for strict liability imposed on parties responsible for hazardous waste releases.

Key Words: strict liability, toxic spills, liability policy, hazardous materials

JEL Classification Nos.: D78, H73, I18

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1. INTRODUCTION

Under both federal and state law, liability is triggered whenever the government or another party incurs response costs in dealing with the uncontrolled releases of toxic wastes into the environment. The federal program, dubbed Superfund[1], imposes liability on the current or prior operators of a contaminated site; on generators and transporters of the hazardous waste; and, under certain circumstances, even on other parties (Fogleman, 1992). Any "potentially responsible" party (PRP) is subject to strict liability for cleanup costs and damages at a contaminated site, without proof of negligence or intent.

Within a few years after the passage of the federal Superfund law, many similar state cleanup programs appeared. The state programs addressed the numerous hazardous waste sites that did not appear on the federal "priority list" (NPL), and so did not qualify for federally financed remediation (Barnett, 1994). Most of these state "mini-superfund" programs (EPA, 1989) have authorities and capabilities similar to those of the federal Superfund program, but are usually capable of listing many more sites than can practically be included in the federal program.

Liability provisions vary from state to state, and have often evolved considerably within states since the time of their inception. Many of the mini-superfund laws impose strict liability, so that parties held responsible for uncontrolled releases of pollutants need not have been negligent: they are liable *per se*.[2]

It turns out that many states have switched in recent years from negligence-based liability to a strict liability approach. In doing so, states may have been conforming to a general trend in public policy, responding to the public's demand for improved environmental quality,

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[1] The Comprehensive Environmental Response, Compensation and Liability Act, commonly known as Superfund, was passed in 1980, re-authorized in 1986 and further extended in 1991. Superfund instructs the U.S. Environmental Protection Agency to identify and list hazardous waste sites that pose a threat to human health and the environment, to name potentially responsible parties and force them to clean up (or to reimburse EPA for a cleanup already initiated by the agency). The EPA has generally interpreted Superfund to apply to closed and abandoned hazardous waste sites.

[2] The federal Superfund and state cleanup programs also include "joint-and-several" liability provisions, holding all parties responsible for the entire cost of cleanup at sites where it is not possible to ascertain which parties were responsible for the release. In this paper we only analyze the adoption of strict liability, whether it is adopted along with joint-and-several liability or not.

or reacting to changes in firms' operating environments which affected their level of usage or care in handling of hazardous wastes. Differences in the timing of states' responses -- *i.e.,* their adopting strict liability -- to such possible stimuli have created a natural experiment on the role of state-specific factors in a state's likelihood of adopting strict liability attributes in its mini-superfund program. In this paper, we explain differences in timing using data on states' industrial activities, environmental programs, wealth and education, and political orientation.

To provide a framework to guide and interpret our empirical analysis, we develop a theoretical model in which the state adopts the liability regime (strict *versus* negligence-based liability) that it sees as having the greater net benefits. The model allows for various factors to contribute more or less heavily to a state's costs and benefits, depending on the presence of specific constituencies and other political factors.

We test the model's adoption hypothesis by estimating a probit equation of the presence or absence of strict liability in a state hazardous waste cleanup program. The probit equation exploits differences in state-level economic, socioeconomic, and political variables to explain differences in the presence of a strict liability provision in a state's mini-superfund program. We find that the likelihood of a state incorporating strict liability into its mini-superfund program is positively associated with the number of large manufacturing plants located in that state, but is negatively associated with the number of large extractive or mining establishments. This suggests that, at least initially, states may have seen strict liability as a response better suited to industrial waste sites than to the types of pollution problems created by mining activity. This result is consistent with the notion that states may be at least in part motivated by a "deep pocket" mentality, and that they may anticipate engaging in precaution targeting (Tietenberg, 1989). Our analysis also finds that educational attainment of residents, state government resources, effectiveness of other state environmental programs, and political variables are significant determinants of adoption of strict liability.

This paper is organized as follows: Section 2 discusses the state mini-superfund programs. The theoretical and econometric models and variables are presented in Section 3. Section 4 presents the results and Section 5 concludes.

2. STATE MINI-SUPERFUND PROGRAMS

Since the early 1980s, many states have enacted laws and developed programs similar to the federal Superfund program providing for emergency response to, and long-term remediation at, hazardous waste sites. These statutes typically establish a financing mechanism to pay for initial feasibility studies and remediation activities; spell out the conditions under which monies from such funds are to be used; and confer authority to allow the regulator to force responsible parties to conduct the feasibility studies and cleanups, or to pay for them (EPA, 1989, 1990, 1991; Environmental Law Institute, 1993, 1995).

By 1989, thirty-nine states had cleanup statutes granting funding and enforcement authorities. By 1995, that number had climbed to 45. The five states without separate mini-superfund programs addressed their hazardous waste cases using other regulations.

Although the federal Superfund program is the law of the land, differences in the timing of the state programs give rise to the variability we analyze here. Another important difference between the Federal Superfund program and many state mini-superfund programs lies in the liability standards imposed on the responsible parties: Liability under the federal Superfund is strict, joint and several, but this is not necessarily the case for many of the state programs.[3] As of 1987 twenty-seven states had instituted strict liability. By 1995 this number had climbed to forty (see Figure 1).

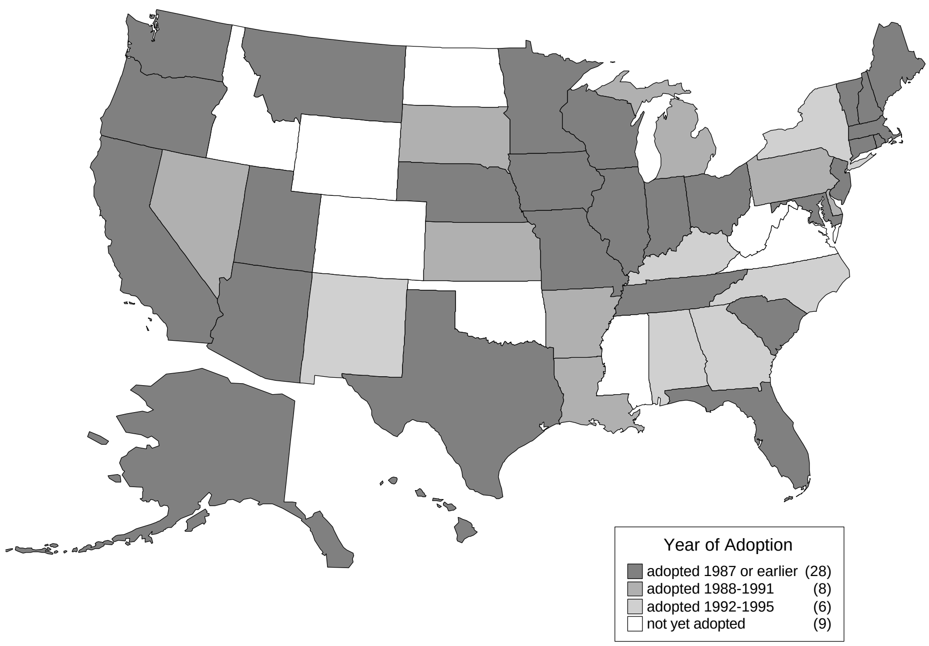

Figure 1: States' Adoption of Strict Liability

It has been argued that liability law is a valuable policy tool for responding to pollution problems. Tietenberg (1989) identifies three main advantages of liability law. First, by creating legal precedents that pollution damages will be borne by the polluter, liability law can create incentives for firms to handle hazardous substances carefully. Second, judicial remedies can effectively complement legislative and administrative remedies. Third, damage payment awards made through liability law can directly compensate those victims of exposure to toxics that are parties to the suit.

[3] In 1987, 8 states had strict, but not joint-and-several, liability and 19 had both. By 1995, the number of states with strict, but not joint-and-several, liability, was 6, while states with both strict and joint-and-several liability numbered 34.

Tietenberg (1989) also examines the optimal strategy of the government when liability is imposed, arguing that under strict liability the government agency has an incentive to sue a particular firm only if the benefits of suing exceed litigation costs ñ a strategy termed "precaution targeting." This implies that firms likely to be targeted by the agency are those for which the recovery of the damages and cleanup costs is relatively certain; and those for which the size of the recovered damages and cleanup costs will exceed litigation costs. Larger and wealthier firms, and firms that by the very nature of their production processes handle large quantities of highly toxic chemicals, would seem to be potential candidates for precaution targeting, and may indeed be targeted at a different rate than smaller and less wealthy firms.[4]

Although the legislative history of Superfund is well documented (Barnett, 1994; Fogleman, 1992), little attention has been devoted to examining the factors that may drive state or federal governments to incorporate strict liability in their hazardous waste cleanup laws. In particular, it remains unclear whether lawmakers fully anticipate the possible adverse effects of imposing strict liability for uncontrolled hazardous wastes, such as the incentive for large and wealthy firms to subcontract risky operations to smaller and judgment-proof firms (Ringleb and Wiggins, 1990). Nor is it clear whether lawmakers are motivated more by public health concerns or by a desire to maintain a favorable business climate in their state.

Regarding strict liability, the wave of adoptions may have been caused by a gradual formation of support for the notion that strict liability is somehow a better way to handle incidents that carry response costs. Changes in litigation costs or judicial practice might explain this, or perhaps the CERCLA precedent could have been sufficient. The rise in state adoption of strict liability might also have stemmed from changes in underlying conditions that determine how safely firms operate: Changes in other environmental regulations, technologies or production processes could have affected firms' operating environments sufficiently that their average level of care in handling toxics, or in the amount of toxics they handle, changed. States may thus have been induced to try a different approach to liability law.[5]

These same factors could have also determined the development of other features of the state mini-superfund programs. Some of the state mini-superfund programs enable them to initiate cleanup when the responsible parties are uncooperative, and to seek to recover cleanup costs from those parties. In 1995, twenty-five states had laws containing provisions for punitive damages against recalcitrant responsible parties. State mini-superfund laws may also include provisions allowing private citizens -- as opposed to government agencies -- to

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[4] Tietenberg also shows that when strict liability is paired with joint-and-several liability at sites where more than one party has contributed to the releases, the agency can, and has an incentive to, target fewer parties which will absorb the entire amount of the damages. Many observers believe that the EPA was indeed targeting wealthy companies in its search for potentially responsible parties during the 1980s. Harper and Adams (1996) perform an event study of the returns to stocks of firms nominated potentially responsible parties to Superfund sites, finding support for the claim that the EPA was targeting wealthy companies in the 1980s.

[5] Recall that our goal is to identify factors explaining similarities in states' adoption responses to such possible stimuli; we do not investigate the stimuli themselves.

file civil actions requiring the responsible party to prevent further damage, or to take corrective action, if the citizens have been adversely affected by the release of a hazardous substance. Thirteen states had such provisions in 1987, with an additional four adopting similar laws by 1995.

In some states (15 in 1995), responsible parties must compensate persons who have been adversely affected by the release of the toxic substances. Compensation is usually limited to paying for alternative drinking water supplies or for temporary relocation.

In recent years many states have implemented property transfer programs, whereby the owners of certain types of property must certify that their property is free from hazardous waste before they transfer it to a second party (or else obtain state approval to do so). Such programs may also require that if the property is contaminated, the selling party must undertake remediation. Finally, most states have established cleanup standards and criteria for remedy selection, and have created procedures for public participation and involvement in the process, and for developing cooperative agreements with the EPA.

3. A MODEL OF STRICT LIABILITY ADOPTION

In this section we propose a model of the adoption of strict liability in hazardous waste law. We assume that a state adopts strict liability when it produces higher net benefits than the alternative(s).[6] We measure benefits as the reduction in the expected health damages incurred by the population exposed to accidental releases of toxics at contaminated sites where mitigation is subsequently undertaken. Formally,

$$B = \Delta r \cdot N \cdot Q \cdot V \tag{1}$$

where Δr is the mitigation-induced change in the risk of developing health problems, such as cancer or acute symptoms, per person exposed, per unit of volume of the toxic substance. N is the number of people exposed; Q is the quantity (volume) of toxic substance released; and V is the (dollar) value of a statistical life, or the average willingness to pay to avoid the symptoms caused by exposure to the toxic release.

The liability regime should affect the costs of mitigation. These include litigation and administrative costs from the state's attempts to force responsible parties to mitigate; plus any unrecoverable share of mitigation costs that fall to the state. State costs are assumed to be proportional to the quantity released: $C=aQ+pcQ$, where a is the average administrative and litigation cost per unit of volume of the chemical, p denotes the fraction of all mitigation costs which the state must absorb, and c is the average total cost of mitigation per unit of volume released.

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[6] That government agencies act rationally when developing environmental regulations or making cleanup decisions at Superfund sites -- doing so to optimize a specified objective function -- has been previously proposed and empirically estimated by Magat et al. (1986) to explain the stringency of allowable effluent levels as per the Clean Water Act, the decision to cancel or re-register pesticides (Cropper et al., 1992), and cleanup strategies at individual Superfund sites (Gupta et al., 1996).

In this stylized model, the net benefits of the liability system are thus equal to $NB = Q \cdot (\Delta r \cdot N \cdot V - a - pc)$. We posit that the state adopts strict liability if $Q_S \cdot (\Delta r_S \cdot N \cdot V - a_S - p_S c_S) > Q_A \cdot (\Delta r_A \cdot N \cdot V - a_A - p_A c_A)$, where the subscripts *S* and *A* denote strict liability and the alternative liability regimes, respectively.

In our empirical work we proxy the size of the exposed population using the state's actual population and its total area. (In effect we are accounting for the state's population density, a measure of exposure risk.) We further assume that the quantity of uncontrolled toxics grows with the extent of manufacturing and mining activity within the state, proxied here by the numbers of establishments involved in those activities. We allow firms' contributions to total uncontrolled toxics to vary with their scale (small or large) and type (manufacturing or mining, since mining is also known to create highly toxic wastes). These variables, plus a state's composition of manufacturing activity across industrial sectors, should also help capture the toxic-exposure risk faced by the residents, both before and after remediation.

Economic theory (see Tolley et al., 1994 and Viscusi, 1993) holds that the value of a statistical life *V* (or willingness to pay to avoid illness, if the consequences of exposure are limited to disease, as opposed to cancer or death) is increasing in income and education. Hence, among the determinants of net benefits, we include variables measuring the educational attainment and income of state residents.

The administrative-and-litigation cost parameters a_S and a_A are likely to vary with the general wealth of the state, and with the resources and the administrative structure of the state agency in charge of the mini-superfund program: The wealthier is a state, we believe, the larger will be its environmental program and accompanying administrative costs, and the greater will be its willingness to sue for recovery of cleanup costs. The probabilities p_S and p_A that the state will have to absorb unrecovered costs may be positively affected by the prevalence of small firms in the state, as such firms are more likely to have resources insufficient to handle the full costs of cleanup at their sites.

In practice, we approximate the log net benefits NB_j from adopting liability regime *j* as:

$$NB_j = \beta_0^j + \beta_1^j \log LMFG + \beta_2^j \log SMFG + \beta_3^j \log LMINE + \beta_4^j \log SMINE \qquad (2)$$

$$+ \beta_5^j \log MEDHHINC + \beta_6^j NOHSDP + \beta_7^j HIGHSCH + \sum_{j=1}^{K} \beta_{7+i}^j X_i + \varepsilon_j$$

where *j* = {*S* (strict liability), *A* (alternative regime)}, LMFG and SMFG are counts of large and small manufacturing firms, and LMINE and SMINE are the numbers of large and small mining outfits in the state. MEDHHINC is state median household income, NOHSDP is the fraction of state residents 25 years old or older who lack a high school diploma, and HIGHSCH is the percentage who have completed high school, excluding the college-educated.

Finally, the X's are variables capturing the administrative structure of the agency responsible for the state program, state expenditure per capita, and state expenditures on environmental programs. We take information on administrative structure from the typology developed in Ringquist (1993).[7]

In its purest form, the theoretical model (2) assigns equal weight to every dollar of costs and benefits. In practice, however, it seems reasonable to allow for differences in the relative weights of some of the cost-benefit categories, to account for differences across states in interest group pressure, in attitudes of residents towards the quality of the state's environment, and in the attitudes of the state agencies towards the environment. To do so, we expand the basic net benefit equation, (2), to include additional variables, such as the strength of other environmental programs in the state (Ringquist, 1993); membership within the state in major national environmental organizations (Hall and Kerr, 1992); political variables such as the percentage of republican representatives in the state houses; and a dummy for the state governor's party of affiliation. These all proxy for pro-business or pro-environment attitudes within the state.

Because the net benefits of adoption of strict liability are not observed, we do not estimate (2) directly. Instead, we estimate probit models that explain the presence/absence of strict liability in state *i* in year *t* (ranging from 1987 to 1995), assuming that strict liability is present when NB_S-NB_A>0, and is absent otherwise. Under the assumption that the error term ε_S-ε_A has variance equal to one,[8] we estimate the *differences* between the coefficients b^j of the two regimes.

4. RESULTS

To estimate our probit model of strict liability we compiled state-level annual data from 1987 to 1995. The dependent variable is a dummy for the presence/absence of strict liability in the state mini-superfund programs, as reported in EPA (1989, 1990, 1991) and ELI (1993, 1995). These documents are also the source of data on the number of "final NPL" sites in the state.

Ideally, we would have liked to obtain the numbers of manufacturing and mining firms by *asset* size. Unfortunately, such information is not available at the state level, and we were forced to resort to counts of plants by number of employees. We experimented with different definitions of "small" and "large" firms. In this paper, we report results based on classifying as "small" establishments with fewer than 20 employees. We obtain qualitatively similar results when we use either 50 or 100 as the cut-off for defining small establishments. Although establishments with fewer than 20 employees account for only about one percent of

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[7] Ringquist's classification of state agencies for environmental quality regulation and enforcement consists of: (i) public health agencies; (ii) agencies completely dedicated to environmental protection (*mini-EPAs*); (iii) agencies entrusted with taking care of both natural resources management and environmental protection (*super-agencies*). A final category comprises administrative structures like California's, where the various environmental responsibilities (e.g., for toxic substance control, water, etc) are delegated to different state agencies. Ringquist's characterizations assisted us in forming prior expectations about the likely effects of these categories, but in practice 'agency type' was not a significant explanatory factor, and we omit it from further discussion.

[8] This assumption is standard in probit models (see Maddala, 1983).

total value of shipments from manufacturing firms, they are very numerous: On average, there are two such establishments for every one with more than 20 employees.

Our data on the strength of other environmental programs in the state come from Ringquist (1993), who develops a scoring system to rate the air and water programs of each of the states. Data on the percentages of state budgets spent on environmental programs and on participation of state residents in environmental organizations are drawn from Hall and Kerr (1992).

The data set has a panel structure, with 51 states and 9 years of observations per state, for a total sample size of 459. We present descriptive statistics for the variables used in our probit analyses of strict liability adoptions in Table 1.

The results of several specifications of the probit equations explaining the presence/absence of strict liability are reported in Table 2a. Specification (A) is our basic model, containing only population, area, and the number of manufacturing and mining plants by size. Equation (B) adds variables which we believe to affect the benefits of the state program. In our theoretical development we selected membership in environmental organizations, educational attainment, and income variables. However, we found in earlier runs of the model that median household income and the environmental membership rates--which are collinear with education--were not statistically significant. Therefore here we include as "benefits shifters" only the two educational attainment variables described earlier.

Model (C) addresses the possible effects of states' resource constraints on their ability, or willingness, to adopt strict liability, using state expenditures per capita, and percent of state budget spent on environmental programs as proxies for state resources.[9]

Equation (D) adds measures of the performance of other state environmental programs (specifically, their air and water programs, evaluated on scales from 1 to 10 and 1 to 13, respectively, as ranked in Ringquist, 1993). It also includes a variable describing the seriousness of the state's hazardous waste problem, captured by the number of sites in the state that are listed on the Superfund National Priorities List.

In column (E), the probit equation is further expanded to include proxies for political attitudes toward, or support of, business in the state. Finally, equation (F) attempts to capture the composition of manufacturing in the state, using as predictors of the adoption decision the number of firms in the two-digit SIC industrial sectors that tend to top the lists of emitters reported in the Toxic Release Inventory (TRI).[10]

In all of our specifications, the independent variables, considered jointly, are significant determinants of the presence or absence of strict liability. This provides empirical support for the theoretical model of adoption, equation (2). The joint significance of our

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[9] The administration structure variables described earlier were never significant predictors of a state's adoption decision, and are thus omitted from the specifications reported in this paper.

[10] The paper and allied products industry and the rubber and plastic industry are among five industries that release the largest amounts of toxics. However, since the number of establishments in these industries was not found to influence adoption of strict liability, we excluded them from this specification.

regressor variables is demonstrated, for each of the specifications, in Table 2b, which reports the results of likelihood ratio tests that compare the fitted models from Table 2a against a "baseline" model with only an intercept term (and all slope coefficients constrained to zero).

Table 1: Descriptive statistics

Label	Description	mean	std. dev.
AREA	*total area of the state (square miles)*	72824.32	90071.97
POPUL	*state population (thousands)*	4945.76	5460.24
MINESTAB	*number of mining establishments in the state*	583.55	1091.20
MFGESTAB	*number of manufacturing establishments in the state*	7143.69	8456.48
SMFG	*number of manufacturing establishments with fewer than 20 employees in the state*	4763.28	5747.49
SMINE	*number of mining establishments with fewer than 20 employees in the state*	466.80	912.28
AIRPGM	*score assigned to the state air program (1=worst, 10=best)*	4.88	2.61
H2OPGM	*score assigned to the state water program (1=worst, 13=best)*	7.72	2.48
ENVORG	*members of three major environmental organizations per 1000 residents*	8.49	3.54
EXPEND	*state expenditure per capita (1987 dollars)*	10096.00	11701.00
PCTENVEXP	*percentage of state budget on environmental programs*	1.86	1.19
NPLFINAL	*sites in the state on final NPL list*	22.21	24.87
NOHSDP	*percent of adults 25 years and older that lack high school diploma*	23.77	5.54
HIGHSCH	*percent of adults 25 years and older whose highest educational attainment is completing high school*	30.60	3.64
PCTREPLO	*percent republicans in the lower state house*	0.43	0.16
PCTREPUP	*percent republicans in the upper state house*	0.42	0.16
REPGOV	*dummy for republican governor*	0.49	0.50
STRICT	*state program imposes strict liability*	0.68	0.47

Table 2a: Probit equations: presence/absence of strict liability in state mini-superfund program
(T statistics in parentheses)

Variable	A: basic model	B: add shifters of benefits	C: state budget constraints	D: st. env. qual., performance	E: political variables	F: high-polluting industries
intercept	-3.5957 (-3.117)	-3.6693 (-2.017)	-2.7906 (-1.410)	-0.2293 (-1.618)	2.2769 (0.608)	9.6971 (1.756)
log(population)	0.7303 (1.873)	0.9532 (2.332)	0.4701 (0.801)	0.9265 (1.336)	1.0519 (0.985)	0.2638 (0.909)
log(area)	0.1741 (2.037)	0.0870 (0.945)	0.0182 (0.169)	-0.1414 (-0.984)	0.3426 (1.451)	0.1476 (0.1477)
log(manufacturing. establishments 20+ emp)	-0.0683 (-0.247)	0.1258 (0.380)	0.4272 (1.139)	0.8038 (1.752)	1.6070 (2.332)	
log(manufacturing establishments <20)	-0.0960 (-0.058)	-0.4446 (-0.997)	-0.8682 (-1.651)	-1.3512 (-2.291)	-3.0247 (-3.420)	
log(mining establishments 20+ emp)	-0.9233 (-5.143)	-0.6483 (-3.356)	-0.8421 (-3.688)	-1.2542 (-4.456)	-1.4419 (-3.476)	-1.9941 (4.701)
log(mining <20)	0.2562 (1.161)	0.0709 (0.424)	0.2983 (1.520)	0.4472 (1.880)	0.2547 (0.820)	0.5257 (1.547)
log(chemical establishments 20+ emp)						1.7252 (4.803)
log(chemical establishments <20)						0.1784 (0.279)
log(primary metal 20+ emp)						1.6746 (4.859)
log(primary metal <20)						-2.2130 (-4.508)
log(transportation equipment 20+ emp)						2.1029 (4.100)
log(transportation equipment <20)						-1.0817 (-2.429)
log(all other manuf. 20+ emp)						-1.1092 (-1.011)
log(all other manuf. <20)						-1.2630 (-1.152)
less than high school (percent)		-0.0607 (-3.744)	-0.0563 (-3.154)	-0.0811 (-3.520)	-0.1734 (-4.448)	-0.1448 (-4.033)
completed high school (percent)		0.0637 (2.557)	0.0389 (1.463)	0.0685 (2.074)	0.1036 (2.212)	0.0700 (1.442)
log(state expenditure per capita)			0.5869 (2.076)	0.4026 (1.072)	0.8224 (1.231)	0.3200 (0.524)
percent state budget on env. programs			0.0370 (0.504)	0.2446 (2.755)	0.3220 (2.548)	0.3448 (2.328)
log(final NPL sites)				-0.2524 (-1.447)	-0.3006 (-1.111)	-0.2681 (-0.977)
state air program score				0.2454 (4.466)	0.4123 (4.398)	0.3784 (4.584)
state water program score				-0.2530 (-5.307)	-0.3468 (-4.650)	-0.3734 (-4.887)
percent republicans in lower state house					-5.3577 (-3.216)	
percent republicans in upper state house					1.6640 (1.161)	
republican governor					0.2698 (1.236)	
n	442	433	419	414	289	391
log Likelihood	-220.40	-20.7.60	-195.25	-164.86	-101.97	-109.58

Table 2b: Probit equations:presence/absence of strict liability in state mini-superfund program: Likelihood Ratio tests

Value of the LR test statistic	A: basic model	B: shifters of benefits	C: state budget constraints	D: st. env. qual., performance	E: political variables	F: high-polluting industries
Null hypothesis: All slope coefficients 0	109.62	128.32	132.78	183.94	147.94	258.02
degrees of freedom 0.01 critical level	6 16.8	8 20.1	10 23.2	13 27.7	16 32.0	19 36.2

The regression results suggest that, controlling for the level of industrial activity in a state, bigger states, whether by population, area, or both, are no more likely to adopt strict liability than are other states.

As regressions (C)-(F) show, the availability of resources to the state does influence the likelihood of adopting strict liability. States with a greater share of environmental expenditures in their budgets are more likely to adopt strict liability, even controlling for state expenditure per capita.

It is not only a state's wealth that determines its likelihood of adopting strict liability. As one would expect, the extent of industrial and extractive activities in a state and the presence of substantial chemical-intensive sectors are important predictive factors.

The most robust and interesting finding is that "mining" states are decidedly less likely to adopt strict liability than are other states, especially in the presence of numerous large mining establishments. This result may be due to the success of the oil-and-gas-extraction and mining industries in lobbying against such regimes. It also suggests that perhaps states' experiences with their manufacturing sectors, as opposed to the mining and extractive sectors, have been their primary motivation to adopt strict liability. (As an alternative explanation, we conjecture that in some cases it may be easier to establish negligence in mining activities--so states where hazardous waste problems are created primarily by extractive industries will be less inclined to adopt strict liability. We do not have sufficient evidence to reject or confirm this interpretation.)

Regarding the effects of manufacturing activity, only in the more complete specifications do the coefficients on the numbers of small and large manufacturing establishments become statistically significant. All else unchanged, the number of large manufacturing plants *raises* the likelihood of a state's adopting strict liability, while the number of small plants *lowers* this probability. Perhaps following the example of the federal Superfund program, and because of the greater difficulty of recovering cleanup costs from smaller firms, states may indeed be inclined to go after the "deep pockets" of the larger firms located within its borders. The possible existence of economies of scale in this kind of litigation may also work to create this effect. These results can also be explained by states' possibly finding that large firms, handling greater amounts of chemicals and hazardous wastes, have contributed proportionally more than small firms to the formation of toxic sites in the past, and are expected to continue doing so in the future. To the extent that this is true, this finding suggest that states may incorporate strict liability into their hazardous waste cleanup laws if they anticipate they will need or wish to engage in "precaution targeting."

Another interesting result stems from the inclusion of the air- and water-program scores. Successful air programs (those programs that were given high scores) are consistently associated with an increased likelihood that a state has adopted strict liability (equations (D), (E), and (F)), whereas the coefficient on the state *water* program scores is consistently negative. There are two possible interpretations for this result, both based on the widespread concern about groundwater and surface water contamination. In the first place, it is possible that states with aggressive and successful water programs may see no additional benefit in adopting strict liability. Alternatively, a state environmental agency may be *forced* to implement an aggressive water program to address contamination of surface and ground water it would not be able to effectively address within the existing, negligence-based hazardous waste cleanup program.

We find it harder to interpret the positive sign of the score for the state air program. Toxic waste sites generally involve contamination of soil and water, rather than releases into the air, and there would seem to be only a minimal overlap of enforcement and administrative capabilities and competence between toxics and air programs. The best explanation we can provide for the positive sign of the score for the state air program is that this variable is a proxy for an energetic and aggressive pollution control agency.

The number of toxic waste sites already listed in the NPL, one of our proxies for the extent of the hazardous waste problem in a state, is negatively associated with the inclusion of a strict liability provision in a state program. However, the coefficient of this regressor is never statistically significant.

Of the variables correlated with values people have for environmental quality or their own health, we find that as the educational attainment of residents improves, a state program is more likely to include a strict liability provision. First, the *lower* the percentage of a state's population failing to complete high school, the greater the likelihood of that state adopting strict liability. Similarly, as the percentage of the population with a high school diploma increases, so does that state's support for strict liability.

Of the political-affiliation variables, the percentage of Republicans in the lower state house is negatively and significantly associated with that state's adoption of strict liability. The composition of legislator party affiliations for states' upper houses, and the affiliation of the governor, are not significant determinants of the presence of strict liability. This finding holds no matter which subsets of these three regressors we include in the model. It is consistent with Republicans' general stated preferences for "business" ahead of "the environment," in the sense that a strict liability standard makes it easier for the state to recover cleanup costs against firms responsible for hazardous waste contamination.

Finally, the results in column (F), where manufacturing is broken down into the extent of this activity within sectors that are prominent on TRI lists, such as the chemical, primary metal and transportation industries, suggest that most of the patterns identified in the other regressions continue to hold when the composition of the industry is accounted for. Notably, adoption of strict liability is positively associated with the presence in a state of large plants in these sectors. This mirrors the large-plant effect that emerged, finally, in the broad specification (E). Other manufacturing sectors, *i.e.*, those not prominent in the TRI, appear to have no additional effect on a state's likelihood of adopting strict liability.

5. CONCLUSIONS

We have developed a simple theoretical model of the adoption of strict liability in state hazardous waste laws, which posits that states adopt strict liability when they see it gives greater net benefits than the alternative. After proxying for the components of net benefits using population, area, manufacturing and mining activity, educational attainment, state wealth, success in other environmental programs, and political variables, we fit probit models explaining the presence/absence of strict liability in a state over each of the nine years between 1987 and 1995.

We find that the kinds of a state's industrial activities, the share of its resources it spends on the environment, the educational attainment of its citizens, the party affiliations of its lawmakers, and the quality of its other environmental programs all play a discernible role in its decision to adopt strict liability. The presence of a strong mining industry tends to discourage a state from adopting strict liability, possibly because approaches based on a negligence standard have proved sufficient to date, or possibly because of effective lobbying by these firms.

One of the most striking results is that states with large numbers of relatively large manufacturing plants tend to be more likely to adopt strict liability. This effect may indicate that states are in part motivated by a "deep pocket" mentality, or foresee the need to engage in "precaution targeting," and that litigation costs with large firms may be lower, all else the same, under a strict liability standard than under a negligence standard.

States with higher educational attainment or a greater devotion of their available resources toward the environment have a greater propensity to adopt strict liability. We also find that the performance of state water quality programs is negatively correlated with the presence of strict liability in hazardous waste laws, while air quality programs are positively correlated with it. This may be an indication that good water-quality programs can substitute for strict liability laws.

To summarize, we have uncovered some of the determinants of the adoption of strict liability provisions in state hazardous waste cleanup programs. We have not yet uncovered whether strict liability has had a deterrent effect against uncontrolled releases of toxics, as some observers have argued. We hope to address this question in future research.

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