Endogenous Decentralization in Federal Environmental Policies

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Abstract: Under most federal environmental laws and some health and safety laws, states may apply for "primacy," that is, authority to implement and enforce federal law, through a process known as "authorization." Some observers fear that states use authorization to adopt more lax policies in a regulatory "race to the bottom." This paper presents a simple model of the interaction between the federal and state governments in such a scheme of partial decentralization. Our model suggests that the authorization option may not only increase social welfare but also allow more stringent environmental regulations than would otherwise be feasible. Our model also suggests that the federal government may choose its policies so that states that desire more strict regulation authorize, while other states remain under the federal program. We then test this hypothesis using data on federal regulation of water pollution and of hazardous waste, which are two of the most important environmental programs to allow authorization. We find that states that prefer more environmental protection authorize more quickly under both policies. This evidence suggests that states seek authorization to adopt more strict policies instead of more lax policies compared to federal policies.

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States may voluntarily take control of implementation and enforcement of most U.S. environmental regulations, through a process known as "authorization." Authorization gives states "primacy," that is, substantial control over the effects of federal environmental policies. For example, the U.S. General Accounting Office (U.S. GAO, 1996) examined the stringency of water pollution permits issued by different states and found that, for similar size facilities, allowable pollution varied by more than one order of magnitude. Authorized states have considerable discretion over enforcement as well; it is rare for the federal government to impose penalties on facilities in an authorized state where enforcement actions have been deficient (Helland, 1998).[1] Some observers suggest that authorization allows states to pursue more lax policies and express fears of a regulatory "race to the bottom" that undermines federal policies (Flatt, 1997, p. 34; Crotty, 1987, p. 67). Thus, understanding this "cooperative federalism" is central to evaluating the effects of federal environmental policies in practice.

We present a simple model of the interaction between the states and the federal government with endogenous federal environmental policies and the option of authorization. Our model offers a more benign view of authorization than the "race to the bottom" scenario suggests. In our model, authorization allows higher levels of social welfare and stricter environmental policies than would otherwise be feasible. Our analysis also suggests some conditions under which states will want to seek authorization. We then test our hypotheses using data on two federal environmental policies: the Clean Water Act (CWA), which regulates water pollution, and the Resource Conservation and Recovery Act (RCRA), which regulates hazardous and solid waste. Our empirical analysis evaluates the factors that explain whether a state receives authorization under each of the laws early, late, or not at all.

[1] For example, in 1999, the U.S. Court of Appeals for the Eight Circuit ruled that the federal EPA could not take enforcement action over Harmon Industries' violations of the RCRA where the State of Missouri had already acted, even though the EPA found the state penalties to be lax (Harmon Industries, Inc. v. Browner, 191 F.3d 894 (8th Cir. 1999)).

Our principal empirical focus is on the role of preference heterogeneity in determining authorization. If, as some fear, authorized states use their discretion to weaken environmental protection, then we would expect the least "green" states to seek authorization first. Our model of authorization, however, suggests that the federal government may adopt policies designed to encourage authorization applications from states that prefer more environmental protection rather than less. We test this hypothesis empirically. We also test for a "U-shape" relationship in which states with median preferences are most content with centralized regulations, whereas those with preferences far from the median in either direction tend to authorize sooner.[2] We find that states with relatively "green" environmental preferences authorize sooner under both CWA and RCRA. This evidence is consistent with the more benign view of authorization suggested by our model.

In addition to exploring the role of environmental preferences, we test a few other hypotheses about the determinants of authorization. We find that states with greater potential to generate interstate externalities may authorize somewhat later, suggesting federal efforts to limit negative externalities among the states. We also find that the size and tax or legislative capacity of state governments, however, do not have a statistically significant effects on the speed of authorization.

The rest of this paper sets forth our analysis as follows. Section 1 gives background on authorization under the CWA and RCRA, as well as a discussion of the previous literature. Section 2 develops a model of authorization in which the federal government sets environmental policies endogenously, anticipating the effects on state incentives to seek authorization. Section 3 describes the variables we choose to represent the empirical determinants of authorization across states. Section 4 presents the results of duration models of the time until

[2]Studying state liquor control laws, Strumpf and Oberholzer-Gee (2002) test the hypothesis that greater preference heterogeneity across districts within a state increases the likelihood that the state chooses to decentralize its policy. We test a related proposition: the more a jurisdiction's tastes differ from the median, the more it wishes to control its policy.

authorization. Section 5 concludes with policy implications.

1 Authorization under CWA and RCRA

The CWA and RCRA are two of the most important environmental policies that allow authorization.[3] Under both of these acts, the federal and regional EPA offices act as the default administrator; a state must take the initiative to apply for authorization. If states can demonstrate to the EPA that they will adopt legislation that is at least as stringent as the federal standards and have the means to fund the implementation and enforcement of the policy, then they can receive authorization. The EPA's criteria for acceptance are public knowledge, so states only incur the cost of applying for authorization if they meet all of the requirements. The EPA usually requires amendments to a state's proposed implementation plan and holds public hearings on the application throughout the state before it grants authorization (Freeman, 2000; Helland, 1998). A search of the *Federal Register* did not turn up any instances of a state's application being denied.

Once the EPA grants authorization, the EPA finds it infeasible to retract and has never done so in practice, although the EPA is legally entitled to do so. For example, Arkansas refuses to impose federal discharge limits and monitoring requirements for municipal water pollution sources on the grounds that they are too strict, but the regional EPA office says that taking primacy back from Arkansas is "an unrealistic option" (GAO, 1996, p. 6). The EPA lacks a credible threat in large part because it lacks the resources necessary to take the delegated functions back from authorized states (Flatt, 1997, p. 16; GAO, 1995, pp. 20-22).

Some earlier studies consider the revealed preference for voluntary decentralization in

[3]The third major environmental program that allows authorization is the Clean Air Act (CAA). However, the CAA differs from the CWA and RCRA in that the default implementation responsibility lies with the states, which are required to develop State Implementation Plans; states opt-in for enforcement, but not implementation. Other federal environmental regulations, such as the Federal Insecticide, Fungicide and Rodenticide Act and the Safe Drink Water Act (1976), also allow authorization (ECOS, 2010), but are much smaller programs than RCRA and CWA in terms of costs.

various other policy contexts. Cutter and DeShazo (2007) study a policy in which California counties could devolve responsibility for enforcement of an underground storage tank program (under RCRA) to cities; they conclude that higher enforcement effort in delegated cities is the result of selection by both parties (the counties and the cities) and that predictions about the effect of decentralization should consider this selection. Meyer and Konisky (2007) find that a number of characteristics cause local communities to take control under a Massachusetts wetland protection program. These studies do not consider transboundary spillovers or the problem raised for the central government when it lacks an effective veto power over authorization.

Other empirical studies have explored the effects of authorization in the federal context. Helland (1998) finds an insignificant effect of authorization on the probability of inspection of paper and pulp facilities under the CWA. Sigman (2005) presents evidence that when states obtain authorization under the CWA, the water quality in downstream states worsens. Outside the environmental area, Morantz (2007) finds authorized states enforce federal employment safety laws less aggressively than the federal government.

Finally, some studies have examined the factors that explain the decision by states to seek authorization under federal environmental laws, which is the focus of our analysis. In particular, political scientists have studied the relationship between authorization and the strength of a state's commitment to environmental protection.[4] These prior studies have produced mixed results on this question. Some have found a positive relationship between past efforts by a state to protect the environment and authorization under various environmental laws (Crotty, 1987, p. 65), including the CWA (Wassenberg, 1986, pp. 132-33). Lester and Bowman (1989, p. 749), on the other hand, find a negative relationship between authorization under RCRA and environmental interest group strength. Woods

[4]Lowry (1992, pp. 67-68) investigates whether various factors affect authorization under the CWA but does not examine a state's commitment to environmental protection as a factor.

(2005, pp. 269-70) finds a statistically significant and negative relationship between state initiatives to protect the environment and primacy under the CWA and the Clean Air Act. Hunter and Waterman (1996, pp. 127-28) find no correlation between political support for the environment and primacy under the CWA. Each of these prior studies by political scientists, however, rely only on variations among the states to explain their decisions to seek authorization. Our methodology and data allow us to exploit variation not only among the states but also over time to explore the factors that make authorization more likely at any given point in time. Sigman (2003) reviews the literature on authorization and provides less formal tests of some of the hypotheses tested formally here.

1.1 The Clean Water Act

Under the Water Pollution Control Act of 1948, individual states had sole responsibility for setting, implementing, and enforcing standards, while the federal role was oversight. Over time, this arrangement became viewed as problematic for a number of reasons. One reason was that "states varied enormously in their commitment to pollution control objectives" (Freeman 2000, p. 173). The 1972 Federal Water Pollution Control Act (which later became known as CWA) gave the federal government control over establishing minimum effluent limits (restrictions on quantities, rates and concentrations of chemical, biological, and physical pollutants that can be discharged into navigable waters) and issuing permits under the National Pollutant Discharge Elimination System (NPDES). Industrial facilities and sewage treatment works need an NPDES permit to discharge pollutants into navigable waters. The 1972 act also included a provision allowing authorization. Once a state obtains the right to issue NPDES permits, it follows the guidelines it has established under its authorizing legislation, rather than the federal standards.[5]

[5]The CWA allows partial delegation. In 1972, the only section of the CWA for which states could be authorized was base NPDES permitting. As new sections were added to the CWA, state authorization became available for them as well. Currently, states can receive authorization under five sections of the

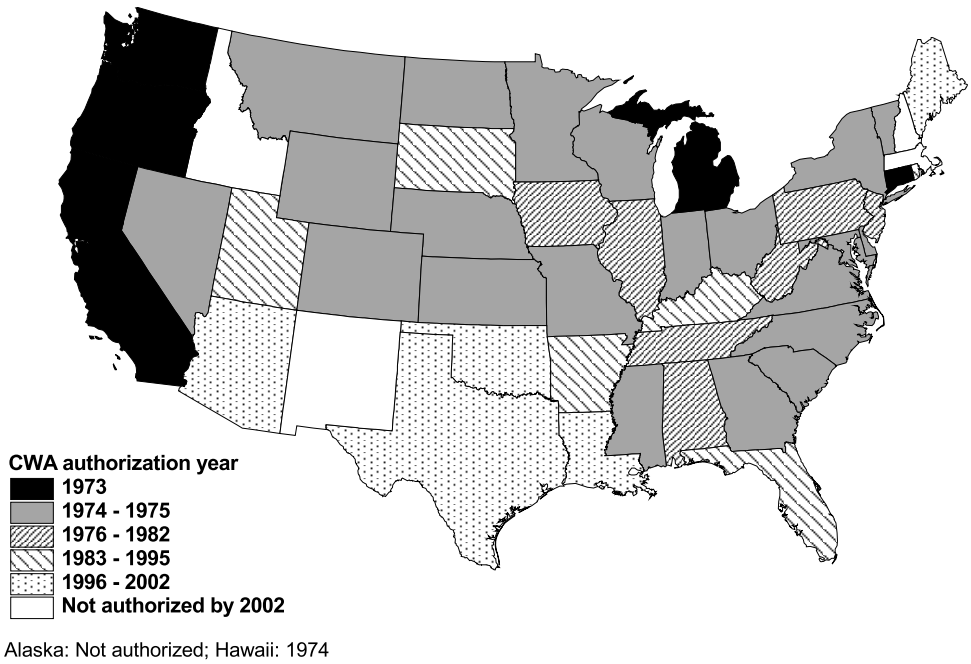

Figure 1: Year of base CWA authorization

Forty-five states have authorization over NPDES and general permitting; New Mexico, Alaska, Massachusetts, New Hampshire, and Idaho are not currently authorized. Figure 1 maps the year of authorization by state. Over half of the states were authorized under the base NPDES policy in the first three years.

1.2 The Resource Conservation and Recovery Act

RCRA first emerged as amendments to an older law (1965 Solid Waste Disposal Act) in 1976. Congress substantially strengthened RCRA with the Hazardous and Solid Waste Amendments (HSWA) in 1984. The EPA first allowed state delegation under the base RCRA program in 1982. This base program governs the permitting of hazardous waste facilities and establishes requirements for safe recycling, composting, storage, and disposal

CWA: base NPDES permitting, general permitting, regulation of pretreatment programs and standards for sewage treatment works, NPDES permits for federal facilities, and the management of biosolids (sewage sludge) disposal. All authorized states have responsibility for at least base NPDES permitting.

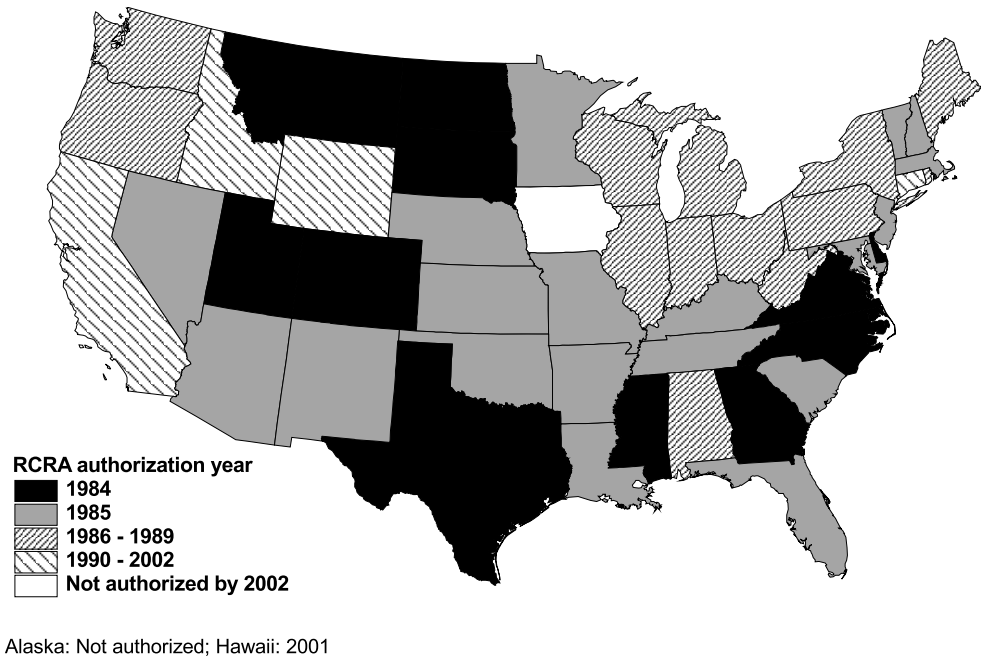

Figure 2: Year of initial RCRA authorization

of waste. Permits issued under RCRA are more standardized than NPDES permits, as they rely more heavily on federal technology standards. Thus, authorization under RCRA gives states less discretion than under CWA to adjust emission limits. Authorization still provides control over the inspection of facilities and enforcement.

Figure 2 maps the years that states first received RCRA authorization. Two states, Alaska and Iowa, are not currently authorized under any part of RCRA. As with the CWA, this paper focuses on the initial decision to seek authorization under the base RCRA policy. The vast majority of the states (80%) received authorization in the first 4 years.

Certain states are authorized under RCRA but not under the CWA and vice versa. The correlation between the time to authorization under the two laws is only 0.04. The number of sections for which a state is authorized under the CWA and the percentage of RCRA for which it is authorized have a correlation of 0.20. These low correlations suggest the importance of policy-specific factors to authorization.

2 A Model of Endogenous Federal Regulation

To illustrate the possible role of authorization in federal environmental policy, we present a simple model of the interaction between the federal and state governments. In evaluating the effect of the authorization option on environmental regulations, it is important to consider what policy the federal government would adopt in the absence of this option. Our model allows us to determine federal policy as an endogenous variable and thereby reveals how the option of authorization may not only increase social welfare but also allow more stringent environmental regulations than would otherwise be feasible. In particular, the authorization alternative may make it possible for the federal government to regulate in circumstances that would otherwise prevent any federal regulation.

2.1 Pure Decentralization

First, suppose that each state may choose its own regulatory policies for a particular pollutant. For simplicity, assume that there are only two types of states, L and H. Let R_i represent the amount of pollution allowed by the regulatory policies imposed in a state of type i. R_i reflects not only the state's formal regulatory standards but also the effective stringency of its policies, including policy implementation, pollution monitoring, and enforcement.[6] The two types differ only in terms of the pollution levels they would choose; all states are identical in all other respects. Type L would choose R_L^*, and type H would choose R_H^*, where $0 < R_L^* < R_H^*$. Let h represent the fraction of states that are type H, so that $1-h$ represents the fraction that are type L, where $0 < h < 1$.

If we assume that each state maximizes the welfare of its own residents, then R_i represents

[6] Thus, our model does not distinguish between standard-setting and enforcement, but subsumes both functions into a single overall stringency. For studies that distinguish these activities in the context of a federal system, see CBO (1997), Lin (2010), and Hutchinson and Kennedy (2008). The latter consider strategic standard-setting by the federal government when states will control enforcement and may "free ride."

the optimal level of pollution from that perspective. Under this normative interpretation of our model, each state would be minimizing the sum of the costs its residents would bear from pollution and the costs they would bear from pollution abatement. Otherwise, we can adopt a purely descriptive interpretation of our model, in which case the policy chosen by each state merely reflects the political pressures applied by its constituents.

Let $U_i(R_i)$ represent the utility enjoyed by each state of type i as a result of its own regulatory policy R_i, where:

$$U_i(R_i) = -(R_i - R_i^*)^2. \tag{1}$$

Thus, type i suffers a cost that increases as the R_i imposed on its polluters deviates further from its optimum R_i^*. The marginal cost of this deviation also increases as R_i deviates further from R_i^*.

2.2 Interstate Negative Externalities

Suppose that the federal regulator seeks to maximize national utility, which we define as the mean of the state utilities. National utility does not simply equal the average of the U_i functions, however, because the pollution allowed in each state imposes an external cost on the other states. Let this external cost equal aR_i for each state of type i, where a is a parameter representing the relative importance of this negative externality and $a > 0$. Assume that this cost reduces national utility without affecting the U_i functions.

Thus, because the federal regulator takes this negative externality into account, it prefers a different R_i for type i than a state of type i would prefer for itself. In particular, rather than choosing R_i to maximize U_i, the federal regulator would prefer the R_i that internalizes this externality and thus maximizes U_{iN}, where:

$$U_{iN} = U_i(R_i) - aR_i. \tag{2}$$

That is, the federal regulator would like to choose R_H and R_L to maximize national utility U_N, where:

$$U_N(R_H, R_L) = hU_{HN}(R_H) + (1-h)U_{LN}(R_L). \tag{3}$$

Under a policy of pure decentralization, each state of type i would adopt R_i^*, and national welfare would be:

$$U_N(R_H^*, R_L^*) = -a\bar{R}.$$

where $\bar{R}$ denotes the mean R_i^*:

$$\bar{R} = hR_H^* + (1-h)R_L^*. \tag{4}$$

Pure decentralization would be optimal only if $a = 0$. Given that $a > 0$, we can show that the federal regulator would prefer instead that each state of type i adopt R_{iN}, where:

$$R_{iN} = R_i^* - a/2 \tag{5}$$

assuming that

$$R_L^* > a/2, \tag{6}$$

so that we have an interior solution. Assume that inequality (6) holds, so that even the most stringent policies that we consider would allow some pollution.

This policy for each state would maximize U_N. Under the normative interpretation of our model, national utility would represent national welfare. Under the purely descriptive interpretation, national utility simply reflects the political pressures applied by constituents in all of the states, including the pressure applied by residents of each state who bear the cost of pollution emitted in other states.

2.3 The Uniform Federal Policy

Suppose that political or legal constraints or information asymmetries prevent the federal government from discriminating among states based on type. Thus, the federal regulator must apply a uniform policy to all states, as assumed under the pure form of the Oates Decentralization Theorem (Oates, 1972). In particular, suppose that the federal regulator only has the option of imposing a single policy R_N nationwide. In this case, the federal regulator can reduce the cost of externalities but only by losing the flexibility advantages of pure decentralization. A uniform policy nationwide is costly as long as states are not all identical.

If the federal regulator must impose a single policy R_N nationwide, then we can show that the federal regulator would choose R_N^*, where:

$$R_N^* = \bar{R} - a/2. \tag{7}$$

We can show that national welfare under policy R_N^* would be greater than it would be under pure decentralization if and only if:

$$h(1-h) < \frac{a^2}{4(R_H^* - R_L^*)^2}. \tag{8}$$

Thus, if a is sufficiently large relative to the difference between the two types, then inequality (8) holds, and the gain from reducing external costs outweighs the costs of imposing this uniform policy on heterogeneous states.

If a is sufficiently small relative to this difference, however, then inequality (8) is reversed:

$$h(1-h) > \frac{a^2}{4(R_H^* - R_L^*)^2}, \tag{9}$$

and the costs of the uniform policy outweighs its benefits. Under the normative interpre-

tation of our model, any uniform policy would reduce national welfare compared to pure decentralization if inequality (9) holds. Under the descriptive interpretation, any uniform policy would be politically infeasible in this case.

2.4 The Role of the Authorization Option

Now suppose instead that the federal regulator has another possible option. In particular, suppose the federal regulator can impose R_N as federal policy on one type while costlessly authorizing the other type to choose its own policy. By providing this alternative to pure decentralization and the uniform federal policy, the authorization option can provide some of the benefits of federal regulation without all the costs of the uniform policy. Suppose the federal regulator can choose either type H or type L to regulate.

In either case, if the federal regulator chooses to regulate type i and to authorize type j to adopt its own policy, then national utility would be unambiguously better than it would be under pure decentralization. Although type j would still choose R_j^*, the federal government could now impose $R_N = R_{iN}$ on type i, which is the nationally optimal policy for that type.[7] This policy would increase national utility compared to pure decentralization even if inequality (9) holds, so that the federal government would prefer pure decentralization over any uniform policy. Thus, the authorization option may make federal regulation possible when such regulation would otherwise be infeasible.[8] This federal regulation would reduce total pollution and (under the normative interpretation of our model) improve national welfare.

Furthermore, we can show that the federal regulator would prefer to regulate type L and

[7]The increase in national utility (from improving R_i) under this policy compared to pure decentralization would equal $(1-h)a^2/4$ if the federal government were to regulate type L and would equal $ha^2/4$ if the federal government were to regulate type H instead.

[8]Crotty (1987, p. 54) describes authorization as an important element of the political compromise that allowed the federal government to enact environmental laws in the face of hostility to federal preemption of state power in this area.

authorize type H rather than imposing R_N^* nationwide as long as:

$$1 - h > \frac{a^2}{4(R_H^* - R_L^*)^2}. \tag{10}$$

Similarly, we can show that the federal regulator would prefer to regulate type H and authorize type L rather than imposing R_N^* nationwide as long as:

$$h > \frac{a^2}{4(R_H^* - R_L^*)^2}. \tag{11}$$

Thus, if either inequality (10) or inequality (11) holds, then under the normative interpretation of our model, the authorization alternative would increase national welfare compared to the uniform federal policy R_N^*. Moreover, each condition is less demanding than inequality (9). Thus, even when uniform federal regulation is a feasible option, the authorization alternative may yield higher national welfare than uniform federal regulation.

The federal government may choose to regulate type L and authorize type H. We can also show that:

$$R_{LN} < R_N^* < R_H^*. \tag{12}$$

In this case, as feared by critics, authorization would allow type H states to adopt policies more lax than the federal policy R_{LN}. The alternative to authorization, however, would not be to impose that same federal policy R_{LN} on type H states. The federal regulator chooses R_{LN} only when anticipating authorization for type H states. In the absence of the authorization option, the federal regulator would choose a more lax federal policy (R_N^*), if such a policy is feasible at all. In any event, the authorization option allows the federal regulator to apply a more stringent policy to type L states than would otherwise be possible.

The federal government may choose instead to regulate type H and authorize type L. Unlike the authorization scenario commonly feared by critics, this authorization policy allows

the type L states to adopt more stringent policies than the policy adopted by the federal regulator (R_{HN}). Furthermore, even if R_N^* is feasible as an alternative, because $R_N^* < R_{HN}$, authorization allows the federal regulator to apply policies that are more tailored to type H states (albeit more lax) than the federal policy that would apply in the absence of the authorization option. Finally, we can also show that:

$$R_L^* < R_N^* \tag{13}$$

if and only if:

$$h > \frac{a}{2(R_H^* - R_L^*)}, \tag{14}$$

which is a more demanding condition than inequality (11). Thus, if inequality (14) holds, then even the uniform policy that the federal regulator would adopt in the absence of the authorization option (R_N^*), if such a policy is feasible, would be more lax than the policy applied by type L states under authorization (R_L^*). In this case, even if R_N^* is feasible, authorization would allow type L states to apply more stringent policies than the federal government would otherwise impose on them.

If all of these three options for federal regulation are feasible, then the federal regulator would prefer at least one of these options over pure decentralization: The federal regulator would prefer to impose R_N^* nationwide as long as a is large enough relative to the difference $R_H^* - R_L^*$ to ensure that neither inequality (10) nor inequality (11) holds. That is, the federal regulator would prefer the uniform policy only if the negative externalities among states are sufficiently large relative to the difference between type L and type H states.

If the difference $R_H^* - R_L^*$ is instead large enough relative to a that either inequality (10) or inequality (11) holds, however, then the federal regulator would prefer to authorize one of the types to choose its own policy rather than impose R_N^* nationwide. In particular, we can show that under these circumstances, the federal regulator would prefer to regulate L

and authorize H if:

$$h < \frac{1}{2} \tag{15}$$

but would prefer to regulate H and authorize L if:

$$h > \frac{1}{2} \tag{16}$$

instead. That is, the federal regulator would seek to regulate the more common type and authorize the less common type, because by regulating the more common type, the federal regulator can obtain the larger reduction in external costs and thus the larger improvement in national utility.

Note that both inequality (11) and inequality (16) make inequality (14) more likely to hold. In this sense, inequality (14) — and thus inequality (13) — is likely to hold if the federal regulator chooses to regulate type H and authorize type L. Thus, authorization is likely to allow more stringent policies for type L than the federal government would otherwise apply to those states.

2.5 Implementation of the Authorization Alternatives

The discussion in Section 2.4 assumed that both of the authorization alternatives are feasible despite the constraint that requires the same federal policy to apply to all states. Consistent with this requirement of formal equality, the authorization policies adopted under the CWA and the RCRA allow all states to apply for authorization. Although a successful application must propose a state policy at least as stringent as the EPA's policy, states granted authorization may in fact deviate from the proposed policy, and as discussed in Section 1, the EPA has never rescinded authorization. Thus, the EPA typically does not actually punish an authorized state for lax implementation or enforcement of the proposed policy. In this sense, authorization under these statutes resembles the authorization assumed in our model,

which allows states to adopt policies that deviate from the federal policy, even those that are less stringent than the federal policy.

To implement the authorization policies outlined in our model, however, federal policies must deter authorization for the type of state that the federal regulator prefers to regulate. The federal government may be unable to observe a given state's type perfectly or may face political constraints in denying authorization to an applicant state on the basis of inferences regarding type. We next discuss how the federal regulator can induce the two types to separate without any explicit discrimination between types.

Here we introduce the costs associated with authorization, which include the costs that a state government bears when it implements and enforces its own environmental policy. In the absence of authorization, the federal government would bear these implementation costs, which we denote C_I, where $C_I > 0$. In this sense, C_I is a price paid by a state that authorizes to the rest of the country. As that state in effect transfers C_I to others within the country, however, C_I does not represent a cost in terms of national utility. Another cost imposed on a state that authorizes is the fixed cost of applying for authorization, which we denote C_A, where $C_A > 0$. Unlike C_I, the authorization application process imposes costs that reduce national utility. The federal government in effect sets C_A by determining the substantive and procedural requirements for authorization. The federal government also controls C_I by deciding how much federal funding to offer to subsidize implementation and enforcement by authorized states.[9] For now, assume that not only C_A but also C_I is the same for all states.

Together, the two costs imposed by authorization, $C_I + C_A$, may induce the two types of states to separate as long as one type has more to gain from authorization than the other. Suppose the federal regulator first chooses both $C_I + C_A$ and R_N, then each state decides

[9] Crotty (1987, p. 55) and the GAO (1995, p. 11) cite the availability of federal funding as an important incentive for states to seek authorization.

whether to apply for authorization. If

$$(R_N - R_i^*)^2 > C_I + C_A \tag{17}$$

then type i gains from authorization and such a state will apply. Otherwise, the state will not apply. For at least some parameter values, the federal regulator can choose $C_I + C_A$ and R_N to induce its chosen type to apply while deterring applications from the other type.

For example, the federal regulator can induce type H to apply while deterring type L by choosing $R_N = R_{NL}$. Type H would then stand to gain more than type L from authorization, because $R_{NL} < R_L^* < R_H^*$. Thus, R_N would then be more costly for type H than for type L. The federal regulator can separate the types as long as it can choose $C_I + C_A$ such that the gain for type H is greater than $C_I + C_A$ while the gain for type L is less than $C_I + C_A$. Insofar as authorization requires $C_A > 0$, however, the cost of authorization in terms of national utility would make this alternative less attractive to the federal regulator.

For some parameter values, the federal regulator can also induce type L to apply while deterring type H by choosing $R_N = R_{NH}$. If:

$$a < R_H^* - R_L^* \tag{18}$$

then R_{NH} will be closer to R_H^* than to R_L^*, so that type L will have more to gain from authorization than type H. If instead inequality (18) does not hold, then the federal regulator would have to set R_N above R_{NH} in order to deter type H from authorization while still inducing type L to apply. In particular, the constraint

$$R_N > \frac{R_H^* + R_L^*}{2} \tag{19}$$

would bind. In either case, the federal regulator can separate the types as long as it can

choose $C_I + C_A$ such that the gain for type L is greater than $C_I + C_A$ while the gain for type H is less than $C_I + C_A$.

Insofar as authorization requires $C_A > 0$ or $R_N > R_{NH}$, authorization becomes less attractive to the federal regulator. In this sense, the federal regulator is most likely to regulate type H and authorize type L when inequality (18) holds. In this case, inequality (16) implies inequality (14), and inequality (13) would therefore hold. Thus, when the federal regulator authorizes type L, this policy seems likely to allow type L states to apply more stringent policies than would otherwise be imposed by the federal regulator.

2.6 Other considerations

Results from the simple model can generalize to a context with greater heterogeneity across states. In particular, we are interested in the heterogeneity observed in our data. We next set forth some hypotheses to test in our empirical analysis.

In our simple model, the federal regulator chooses between authorizing type H and authorizing type L based on the value of h, that is, the probability of each type. In a more complex model, the federal regulator would also consider many other factors that may outweigh the probability of each type. For example, we have assumed that the external cost imposed by each state on other states is simply proportional to the level of pollution allowed by that state, so that the marginal external cost is constant. If the marginal external cost were to increase with the level of pollution, however, then this increase may militate in favor of federal regulation of type H rather than type L. Thus, we may expect "greener" preferences to make authorization more likely.

We could also introduce heterogeneity among states in terms of the external costs they impose on other states. If one type happens on average to impose greater marginal external costs than the other, then this factor would militate in favor of federal regulation for the type expected to generate larger negative externalities. Thus, we may expect states that

impose the largest negative externalities on other states to be the least likely to authorize.

States may also be heterogeneous in other ways within each type. For example, they may vary in terms of how costly authorization would be for the state government. To the extent that C_I or varies among the states, those states with higher costs would be less likely to apply for authorization. States may also vary in terms of the costs they bear when policies deviate from their preferred policies. Those states that bear the greatest costs from a given deviation would be more likely to seek authorization. These sources of heterogeneity imply that the federal regulator may not be able to separate types perfectly using only C_A and R_N as instruments, which would make authorization less attractive to the federal regulator.

We can also introduce a larger number of types. Once we introduce a third type, for example, then the incentive to authorize may not be monotonic in environmental preferences. Suppose, for example, we add a type M to our model, where $R_L^* < R_M^* < R_H^*$. If the differences $R_H^* - R_M^*$ and $R_M^* - R_L^*$ are large enough relative to a, and states are more likely to be type M than type L or type H, then the federal regulator may prefer to set $R_N = R_M^* - a/2$ and authorize both type L and type H to adopt their own policies. This case suggests that the probability of authorization may also be a U-shaped function of environmental preferences.

Finally, in our model, the opportunity to authorize arises only once. We can also introduce multiple periods into our model with multiple opportunities to authorize and parameters that change over time. In each period, the federal regulator may change R_N and C_A, and states that have not already obtained authorization may decide whether to apply for authorization. The state's decision whether to apply in each period would depend on its preferences and costs at time t.[10]

[10]Both the states and the federal regulator may also consider their expectations regarding the values that all relevant parameters may take in the future. The federal regulator, in particular, may value the option of regulating states in the future, and this option value would tend to militate against authorization at the margin.

3 Empirical implementation

Equation (17) provides the basis for an empirical analysis of this model. It suggests that a state's decision to apply for authorization at time t depends on the centralized alternative to authorization R_{Nt}, the costs associated with authorization $C_{It} + C_{At}$, and the state characteristics that determine the states' private optimum R^*_{it}. Because these variables can change over time, we employ a duration model with time-varying covariates for our empirical analysis.[11]

As the principal determinant of the state's private optimum R^*_{it}, we focus on measures of environmental preferences in the state, with the idea that states with "greener" preferences likely desire stricter controls (lower R^*_i). To measure the level of concern about the environment, the estimated equations principally use the adjusted League of Conservation Voters (LCV) score averaged for the state's Congressional delegation each year. The LCV score is the percentage of times a legislator voted with the LCV's position on environmental legislation in a particular year. Groseclose et al. (1999) present a method to adjust these scores for the changing slate of legislation, creating an estimate of the legislator's parameter that is consistent over time; Groseclose (2010) generously provides up-to-date adjusted LCV scores. The LCV score has been used frequently in the empirical literature to indicate environmental preferences (e.g., Gray and Shadbegian, 2004) because it is available for all states annually since the 1970s. Levinson (2000) reports that a state's average LCV score has a high positive correlation with several major cross-sectional environmental scores. For our purposes, the LCV score has the advantage of representing the views of the most influential voters because it results from a political process.

Alternatively, we include dummy variables indicating whether a state ranked in the bot-

[11] Our empirical work examines only the decision to seek authority. We do not study the choice of R^* by authorized states because it is challenging to identify the effects of authorization separately from its determinants.

Table 1: Descriptive statistics

	CWA dataset		**RCRA dataset**	
	Mean	Standard deviation	Mean	Standard deviation
Adjusted League of Conservation Voters (LCV) score	42.0	14.4	46.4	15.6
Environmental group membership per 1,000 (1993)	.924	.568	.924	.568
State population (millions)	4.5	4.6	4.8	5.2
Personal income per capita (thousand 2005$)	20.2	3.4	23.5	3.7
State land area	.072	.087	.072	.087
Coastal state	.460	–	–	–
Number of permitted facilities (CWA or RCRA)	18.3	39.2	10.5	23.4
Ideological distance from president	.261	.127	.353	.190
Tax capacity index	99.0	15.0	98.0	22.4
State employees per 1,000 people	16.9	5.6	17.2	6.0
Index of legislature's professionalization (1986–88)	.221	.144	.221	.144
Year	1977	5.3	1985	2.3

Note: Standard deviations are shown for continuous variables only.

tom or top thirds of the distribution of LCV score in a given year. These dummy variables can capture nonlinearity in the relationship between LCV score and authorization, such as the U-shape hypothesis discussed in Section 2.6. They also adjust the LCV scores for variation in legislation over time, much as the Groseclose et al. (1999) adjustment does, but with fewer assumptions.

As another measure of green preferences, we use environmental group membership in the state. The variable is membership in the World Wildlife Fund, Nature Conservancy, Natural Resources Defense Council, and 7 smaller organizations per 1,000 residents (Wikle, 1995). For this variable, we have a single cross-section for the year 1993. This variable is not our preferred measure because it is not available over time and may reflect the frequency of views far enough in the extreme of the distribution that they are not decisive politically.

Descriptive statistics for the adjusted LCV scores, environmental group membership, and other covariates are shown in Table 1 separately for the CWA and RCRA datasets. To weight each state equally, we first calculated the means of the variables over all of the years each

state is in the dataset (a state is only in the dataset until it authorizes), and then we present statistics calculated from these state means. The levels of variables differ between the CWA and RCRA datasets because a given state is in each data set during different periods. Most states were candidates for CWA authorization only in the 1970s and for RCRA authorization only in the 1980s.

We also examine other possible determinants of the authorization decision. Similarity between the state's preferences and that of the federal government may affect the desire of states to control their environmental programs. This hypothesis is addressed by looking for authorization in states that deviate most from median environmental preferences. We also consider the match between broad political preferences at the federal and state levels. Poole (1998, 2010) provides an ideological score (liberal-conservative) on a single scale for both the President and members of Congress, based on the positions they take on legislation. Our "ideological distance" variable is the square of the difference between the President's score and the average score for the state's Congressional delegation in a year.

Our model emphasizes the importance of interstate spillovers as a motivation for the federal government to retain control over state programs. We consider two variables that might indicate the extent of spillovers. First, almost all watersheds in interior states are upstream of another state, so interior states may generate more interstate externalities under the CWA than coastal states. As a result, the CWA equations include a dummy variable that equals one for states on the coast and zero otherwise. Second, the potential for spillovers is greatest in border regions (Kahn, 2004; Helland and Whitford, 2003). States with larger land areas have a smaller share of border regions and may be less likely to generate interstate externalities or to experience harm from spillovers.

The equations also include variables for the personal income per capita and population of the state. Both of these measures are included to control for the availability of resources that might reduce the opportunity cost of scarce state resources and thereby facilitate the

state taking control of environmental programs. More populated and wealthier states may have better organized state governments and thus shorter times to authorization. We would like to separate these effects from the effects of environmental preferences, with which they may be correlated. In Table 1, income is much higher for the RCRA than the CWA dataset, largely reflecting the later period of the RCRA dataset.

The size of the task confronting the authorized state is represented by the number of permitted facilities under the relevant statute. A larger number of facilities means higher monitoring and enforcement costs C_I. As these costs increase, states may choose to authorize later. On the other hand, a larger number of facilities could indicate that a state has a larger stake in obtaining authorization, which would militate in favor of rapid authorization. In Table 1, the average number of regulated facilities per state is small for both programs because many states authorized before a lot of permits had been issued; the large standard deviations reflect much higher numbers of permits by end of the period.

Finally, we include several measures of the overall legislative and administrative capacity of the state government, which may reduce opportunity costs and thereby facilitate management of these environmental programs. The state's ability to finance regulatory activities is measured by its "tax capacity," an index based on twenty-seven common state tax bases.[12] This well-established measure provides a summary of revenue available to state policy-makers that is comparable across states with different current tax structures. The number of full-time equivalent state employees provides an indication of the size of the state government and perhaps its ability to address new tasks. The variable derives from the Census Bureau's regular *Census of State Governments*.[13]

[12]The Advisory Council on Intergovernmental Relations (ACIR) calculated the measure periodically until ACIR was disbanded. Berry and Fording (1997) fill the missing years through 1991. We predict values for the small number of state-years in our data after 1991. The tax capacity index captures the relative status of the states only, not aggregate trends. Not surprisingly, this variable is highly correlated with state income.

[13]This variable seems a better measure of the state's ability to administer a program than revenues or spending; the latter measures may include components not directly related to the available resources, such as debt service and intergovernmental transfers.

Some equations also include a variable to measure the "professionalization" of the legislature (Squire, 1997). This index considers the legislature's time in session, legislative staff levels, and legislators' salary, based on data from 1986–88. The index ranges from .042 (New Hampshire) to .659 (New York). A more professional legislature is likely to be more prompt in taking up the legislation necessary to secure authorization than a less professional legislature.

Each estimated equation includes dummies for the EPA region. The ten regional EPA offices undertake implementation and enforcement when states are not authorized and oversight when they are. The dummies may thus capture heterogeneity across the regions in the "centralized" alternative to authorization, as well as more general geographic heterogeneity.[14]

4 Empirical Results

This section presents the estimates of states' "hazard" rates for initial authorization of the base policies under the CWA and RCRA. The first states authorized in 1973 under the CWA and in 1984 under the RCRA, so these mark the start of the "at-risk" period in our analysis. The analysis extends through 2002, the most recent year that any state authorized under either program.[15]

The models presented below are estimated using a multi-period discrete-choice model that allows a very flexible specification of the baseline hazard rate (Meyer, 1990; Cameron

[14]Several possible covariates were excluded from the empirical specification of the model because of endogeneity concerns. The state budget for environmental regulation is one example. If a state is preparing to apply for authorization or has already received authorization, it will have to increase the resources devoted to environmental policy. Thus, the path of this variable will depend upon the duration.

[15]Although a state applies for authorization some time before it actually receives it, we use the time until the state receives authorization as the dependent variable because it is more readily available. The delay is usually short, within the year that we use as the period for our analysis. For example, Florida submitted its application for authorization under the CWA on November 21, 1994 and it was accepted on May 1, 1995 (*Federal Register*, 1995). Texas submitted its CWA authorization application on February 2, 1998 and it was approved on September 14, 1998 (*Federal Register*, 1998). We cannot use cross-state variation to understand the time between application and acceptance because all states are subject to the same federal process.

and Trivedi, 2005).[16] The model estimates determinants of the likelihood of authorization by a state in a given year. Thus, a positive coefficient reflects a higher hazard rate and a shorter expected time to authorization.

The estimates for the hazard rates for initial CWA authorization are in Table 2, and those for RCRA authorization are in Table 3. For both sets of equations, the parameters representing a third-degree polynomial in time are statistically significant, indicating that the probability of authorizing depends upon time in a non-linear way. The first three columns in each table focus on the effects of environmental preferences, and the last two add other covariates.

4.1 CWA Authorization

In the first column of Table 2, the coefficient on the adjusted LCV score is positive, suggesting faster authorization of "greener" states, but is not statistically significant. In column (2), the high LCV dummy (top third of the distribution) is positive and significant at 5%, whereas the low LCV dummy (bottom third) is not significant. If all high LCV states were switched to the middle group, the median predicted probability of authorization for these states would fall from 5.1 percent each year to 1.8 percent each year. This pattern is consistent with the case in our model in which the federal government discourages authorization by states whose anticipated stringency is below a certain threshold. This model would suggest monotonicity — but possible nonlinearity — in the relationship.

In column (3), an alternative measure of green preferences, environmental group membership, also has a coefficient with a positive point estimate. This coefficient is statistically

[16] This approach "stacks" states at risk of authorizing in any year and estimates a binary response model for whether the state authorizes in that year. Based on a proportional hazard model, the binary response model estimated has a complementary log-log binary form (Cameron and Trivedi, 2005). We tried including a gamma-distributed heterogeneity across states, using the Stata routine by Jenkins (2004). However, tests never rejected the absence of this heterogeneity. For many specifications, the model with heterogeneity did not converge.

Table 2: Semi-parametric discrete-choice hazard models: CWA authorization

	(1)	(2)	(3)	(4)	(5)
Adjusted LCV score	.019	–	–	–	–
	(.013)				
Bottom third LCV score	–	.150	–	.152	.249
		(.443)		(.495)	(.514)
Top third LCV score	–	1.055*	–	1.000*	.904†
		(.426)		(.461)	(.489)
Conservation group membership	–	–	.834†	–	–
			(.474)		
State population	–	–	–	.061	.093
				(.053)	(.086)
Personal income per capita	–	–	–	-.109	-.161
				(.085)	(.104)
State land area	–	–	–	-5.01	-4.41
				(3.71)	(3.64)
Coastal state	–	–	–	1.422*	1.251†
				(.631)	(.697)
Number of permitted facilities (100s)	–	–	–	.115†	.107
				(.067)	(.069)
Ideological distance from president	–	–	–	.043	.105
				(.879)	(.895)
Tax capacity	–	–	–	–	.0066
					(.0100)
State employees	–	–	–	–	.050
					(.053)
Legislative professionalization	–	–	–	–	.444
					(2.15)
Log likelihood	-128	-126	-128	-120	-119

Notes: All equations include a cubic in time and dummies for the EPA regions.
Observations: 486 state-years.
Standard errors in parentheses.
†significant at 10%; *significant at 5%

significant at the 10% level. A one standard deviation increase in environmental group membership increases the median annual hazard of authorization from 4.9 percent to 7.6 percent. Thus, this coefficient provides additional support for the hypothesis that greener states expect greater benefits from authorization.[17]

Column (4) tests the robustness of the basic result that high LCV score states authorize earlier by including additional explanatory variables. The pattern of coefficients on the LCV dummies remains the same: The high LCV dummy remains statistically significant at the 5% level in column (4).

The coastal dummy is significant and positive, which means that states on the U.S. coasts are more likely to authorize sooner. The median predicted hazard rates would fall from 4.8 percent to 1.2 percent for these states were they not on the coast. This coefficient is consistent with our hypothesis that the federal government prefers authorization when negative externalities are less of a concern and therefore facilitates authorization by coastal states. On the other hand, states with greater land area (and thus a small share of their land near borders) are slower to authorize, but the coefficients are not statistically significant at the 10% level.

The number of permitted facilities in the state has a statistically significant (at the 10% level) and positive effect on the hazard. Thus, states with programs that are potentially more costly to run authorize earlier. One possible explanation is that these states have more of a stake in authorization and therefore apply sooner.

The ideological distance between the President and the state's congressional delegation does not have a statistically significant coefficient in any of the equations for CWA. (This variable also fails to have a statistically significant effect on RCRA authorization in Table 3.)[18]

[17] Our results may not be surprising, given the limited resources provided to the EPA to implement programs in states that are not authorized (GAO, 1995, p. 22).

[18] In earlier versions of the paper the equations included another variant of this measure, a dummy variable

Column (5) adds variables to reflect state government's legislative, bureaucratic, and financial resources. None of these variables — tax capacity, the size of state government, or the legislative professionalism index — yields a statistically significant coefficient. The coefficients on all three, however, have the expected positive point estimates.[19]

LCV scores and conservation group membership are correlated with party affiliation and with political ideology. For example, the correlation by state between adjusted LCV score and Poole (1998)'s liberal-conservative dimension is -.69 (Poole's left-wing scores are negative). To test whether ideology rather than green preferences is driving the results, we also estimated the equations with the average ideology score of the Congressional delegation included as an explanatory variable (not shown). The ideology variable was not statistically significant and did not much change the point estimates on either the LCV score variables or environmental group membership for either CWA or RCRA.

4.2 RCRA Authorization

Table 3 contains discrete-choice models for the hazard rate for initial RCRA authorization. The only covariate from Table 2 that is not included in the RCRA models in Table 3 is the coastal indicator variable. Interior states are no more likely to generate interstate externalities than coastal states under RCRA.

In column (1) in Table 3, the adjusted LCV score has a positive coefficient that is statistically significant at the 5% level. A one standard deviation increase in this score would increase the median annual hazard of authorization from 22 percent to 41 percent. This result is consistent with the hypothesis that states authorize faster if they desire stricter

for whether the dominant party in the state legislature was the president's party. This dummy variable also did not have a statistically significant coefficient.

[19] To test whether states with more resources were more willing to take on large programs, we also estimated equations with an interaction between the tax capacity variable and the number of NPDES facilities. The interaction had a substantively small and statistically insignificant coefficient. A similar interaction was also insignificant in the RCRA equations below.

Table 3: Semi-parametric discrete-choice hazard models: RCRA authorization

	(1)	(2)	(3)	(4)	(5)
Adjusted LCV score	.038*	–	–	.037†	.051*
	(.017)			(.019)	(.020)
Bottom third LCV score	–	-.340	–	–	–
		(.439)			
Top third LCV score	–	.047	–	–	–
		(.527)			
Conservation group membership	–	–	.431	–	–
			(.502)		
State population	–	–	–	-.033	-.157
				(.067)	(.097)
Personal income per capita	–	–	–	-.017	-.011
				(.062)	(.073)
State land area	–	–	–	-1.37	3.89
				(2.93)	(4.04)
Number of permitted facilities (100s)	–	–	–	.876	.199
				(1.24)	(1.30)
Ideological distance from president	–	–	–	.015	.879
				(1.00)	(1.14)
Tax capacity	–	–	–	–	.0043
					(.0091)
State employees	–	–	–	–	-.0169*
					(.0053)
Legislative professionalization	–	–	–	–	.236
					(2.39)
Log likelihood	-86	-89	-89	-86	-81

Notes: All equations include a cubic in time and dummies for the EPA regions.
Observations: 184 state-years.
Standard errors in parentheses.
†significant at 10%; *significant at 5%

standards. In column (2), the dummy variables for state's relative LCV ranking do not yield statistically significant coefficients, although the point estimates are consistent with a monotonic relationship. The environmental group membership variable in column (3) has a positive coefficient, which is again consistent with the greener states authorizing first, but this coefficient is not statistically significant.

In column (4) of Table 3, the adjusted LCV score remains statistically significant at the 10% level with the basic set of state characteristics included. The results for other determinants of RCRA authorization differ from the results for CWA, perhaps indicating that the sources of voluntary decentralization are fairly specific to the particular policy. None of the other explanatory variables are statistically significant in column (4).

When state government capacity variables are added in column (5), the LCV coefficient is again statistically significant at the 5% level and somewhat larger in magnitude. The coefficients on population and the number of state employees per capita are both negative (and the latter is statistically significant at the 5% level), which is surprising, as these variables indicate states that have more resources to manage their RCRA programs. Perhaps these states adopt independent legislation to strengthen environmental protection rather than seek authorization under the federal policy; authorization under RCRA may give them less discretion than they desire.

5 Conclusion

This paper studies the factors that cause states to seek control of their environmental policies. In our simple model, the federal government adopts policies that anticipate the incentives created for states to seek authorization. We present a relatively benign account of the effect of the authorization option, which may increase social welfare and allow stricter environmental policies than would be possible otherwise. With endogenously set federal policies, autho-

rization may look attractive either to states that desire relatively tight pollution controls or to those that desire relatively weaker controls, depending on the parameters.

Using econometric models of duration, we then explore the determinants of the speed with which states authorize, focusing particularly on the role of environmental preferences. Our results suggest that states with greener environmental preferences authorize sooner under both the CWA and RCRA. Our main finding suggests that states seek authorization in order to adopt stricter rather than weaker environmental policies than the federal government. Our result is consistent with other studies in the empirical literature, which often fail to find evidence that decentralization in the United States harms the environment (List and Gerking, 2000; Millimet, 2003; Levinson, 2003). Thus, our analysis suggests that this form of cooperative federalism may improve efficiency, by giving states flexibility to respond to their local conditions while allowing the federal government to limit free riding and to provide a minimum level of environmental quality. Our results do not lend support to concerns that states authorize primarily to undermine federal controls.

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