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Regime Shift in Environmental Policies — The Cause of Local Regulation Uprisings

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Throughout US environmental regulation history, centralized regulation by the federal EPA has been the norm. More recently, however, state/local governments have taken a more active role by imposing more stringent environmental standards than the federal requirements. Some authors in the literature claim that this may be caused by the policy regime shift from the early command-and-control to incentive-based regulations. In this paper, we adopt both simultaneous-move and sequential-move regulation models, and consider both quantity and price policy regimes to see if and when this argument is valid. It is found that the policy regime shift theory holds only in a rather restricted sequential-move setting in which local EPAs lead the game. In addition, we further incorporate policy implementation/enforcement costs in our analysis. It is found that equilibrium policies of the central and local EPAs hinge crucially on these costs.

Keywords: environmental federalism, policy regime shift, policy enforcement
JEL classification: H23, H41, D64

1 Introduction

Beginning half a century ago, dating back to the 1960s, a spectacular federal environmental regulation has proliferated in the US, with the Congress enacting a whole range of environmental legislation, establishing and centralizing new responsibilities for the federal Environmental Protection Agency

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(EPA). Early prominent cases of such federal statues include the Motor Vehicle Pollution Control Act of 1965, the Air Quality Act of 1967, the Clean Air Act of 1970, the Federal Water Pollution Control Act of 1972, and the Superfund program starting in 1980. These congressional mandates kept most of the fundamental policy-making authority for federal agencies. With the spawning of federal environmental statutes later on, federal regulatory program expenditures have also grown substantially. As a result, most states relied on federal funding to run local environmental programs, and federal-state conflicts in environmental regulation were rare.

In the past few decades, however, things are quite different. State environmental agencies have become more active in setting new pollution standards, sometimes even aggressively over-riding federal regulations. As noted in Laskowski, Morgenstern, and Blackman (2005), the federal EPA in the early 1970s was often more knowledgeable than the states about environmental issues. Their staff had a mandate to ensure prompt implementation of newly enacted national environmental laws. Many states at that time simply did not have regulations comparable with these new federal regulations. Besides, state staff often lacked the authority and expertise to administer their environmental programs. During the past three or four decades, however, the states have developed needed laws and expertise. Some states are even stronger and more progressive in certain areas than the federal EPA by now.

Viewed more broadly, this trend occurred also in other policy arenas and countries as well. For example, Garcia-Valinas (2007) analyzes the decentralization process among different government levels in water resource policies in Spain. Luo et al. (2019) used the instrumental variable method to conduct empirical experiments to analyze environmental governance decentralization in China through data mining.

How can we explain this drastic change in central-local regulatory relationship in many countries around the world? Some authors (for example, Williams III (2012)) suggest that the decentralization in US environmental regulation may result from policy regime shifts. In this paper, we construct a central-local EPA interaction model to verify if this claim is well-founded. Conceivably this is an issue that is relevant to most countries with hierarchical governments with central-local environmental regulators.

We find that in the traditional command-and-control (e.g., emission caps) regulation regime, a social welfare maximizing federal/central agency will impose tighter emission caps than the state/local agencies to compen-

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sate for the spillovers effects of the pollutants, therefore leaving the local authorities nothing more to do. Whereas in the new incentive-based (e.g., emission tax) regulation era, local EPAs who prefer lower pollution tax than the central EPA may conversely set a tax rate just high enough to drive out the federal agency, and thus become the sole active regulators in the market. It is shown, however, that this case is rare and can only occur in a sequential-move tax/price game in which the local EPAs lead. Therefore, it is doubtful that policy regime shift can adequately explain the emerging of local environmental regulation.

2 Literature review

In the considerably small environmental federalism literature, many works, such as Potoski (2001), Wellisch (2000), Oates (1999, 2001), and Dwyer (1995), focus mainly on the so-called "race to the bottom" theory, which posits that decentralized regulation prompts local governments to compete for firm investments by lowering their emission standards below those of a centralized regime. Therefore, local environmental regulations will be set too lax compared to the nationally efficient level.

Some authors in the policy decentralization literature have investigated the federal-state relationship theoretically or empirically. For example, Chang, Sigman, and Traub (2007) consider a scheme of 'authorization' which grants the states the authority to implement/enforce federal policies under most federal environmental and health/safety laws. They find 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, thus leading to partial decentralization Boskovic (2013) also investigates the effects of environmental regulation decentralization air pollution regulation in the US. He found empirically that the transfer of regulatory authority from federal to state governments did generated a significant increase in air pollution observed at monitors in downwind states. Millimet (2013) provides a comprehensive survey of the empirical literature on environmental federalism.

The few papers on environmental federalism that compare incentive-based and command-and-control regulations (e.g., Nordhaus (2006) and Wellisch (2000)) assume that regulation is entirely done by either the federal or the state governments. None of them nevertheless considers the case in which both federal and state levels may act to control the same pollu-

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tant. As far as we know, the earliest prior work that recognized the potential role of the policy regime shift is Williams III (2012). He forwards a seemingly compelling explanation as to why local agencies became more active in the environmental policy arena. This paper intends to evaluate his proposition that policy regime shift caused environmental regulation decentralization. Our model differs from his in two important aspects. Firstly, we construct both sequential- and simultaneous-move games, instead of only simultaneous-move Nash games. Secondly, we incorporate explicitly policy implememtation/enforcement costs in our model to capture the reality of policy formation.

This paper is organized as follows: The analytical framework is first laid out in the next section. In the third section we conduct a preliminary investigation without policy implememtation/enforcement costs. The fourth section then takes into account of the policy implememtation/enforcement costs, and solve for the Stackelberg equilibrium of our sequential-move policy game. The final section concludes and summarizes our findings.

3 The central-local government model

Consider a hierarchical government with two regulation levels in a country: one *federal/central* environmental protection agency (the central EPA) and n identical *state/local* regulators (the local EPAs). Firms in all local jurisdictions generate the same pollutant that causes external damage to every other state in the country. Let e_i denote the emission level of firms in local jurisdiction i. We assume that all firms possess identical pollution control technology, and thus have identical emission abatement costs

$$C(e_i),\ 0 \leq e_i \leq \bar{e} \quad \forall i,$$

which is twice-differentiable, decreasing, and strictly convex in its emission level e_i:

$$C'(e_i) < 0, \quad C''(e_i) > 0. \tag{1}$$

Here $\bar{e}(>0)$ denotes firms' natural unregulated emission level. Understandably, firms' pollution control costs $C(e_i)$ go down as they emit more pollutants. Therefore, state-i firm's marginal cleanup cost (MCC) is simply:

$$-C'(e_i) > 0.$$

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3.1 Pollution externality

External damages caused by the pollutants are assumed national, affecting all states at the aggregate level:

$$D(E), \quad E \equiv e_1 + \cdots + e_n,$$

which is twice-differentiable, strictly increasing, and convex:

$$D'(E) > 0, \quad D''(E) > 0. \tag{2}$$

It is well established in the environmental economics literature and textbooks that measures have to be taken by government regulators to curb the inefficiency. In our model, both the central and local EPAs may act to reduce firm emissions.

3.2 Independent government goals

We find out first what each EPA would do if it is the *sole regulator* of the pollutant in its own jurisdiction. In this case, it is assumed that each government cares only about its jurisdiction, and will hence strive for pollution efficiency in its jurisdiction only. This will then determine later how it will react to intervention of other regulatory authorities.

3.2.1 The central EPA

Consider the central government (the *central EPA*, denoted by F) first. As a national regulator, its policy goal is to minimize total national costs:

$$\min_{\{e_i\}} \ \mathrm{TNC}^0\left(e_1, \cdots, e_n\right) \equiv \sum_i C\left(e_i\right) + n \cdot D\left(e_1 + \cdots + e_n\right), \tag{3}$$

which yields the necessary first-order condition for optimal local emissions:

$$\forall\, i: \ -C'\left(e_i^*\right) = n \cdot D'\left(e_1^* + \cdots + e_n^*\right). \tag{4}$$

Plainly speaking, full efficiency requires that firms in all states have equal marginal cleanup cost, which must again equal to marginal *national damage*, and hence:

$$e_1^* = \cdots = e_n^*.$$

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Let this equated local emission level be s^*, and let their aggregate level be:

$$S^* \equiv n \cdot s^*$$

To achieve its objective, the central EPA F may set a state-level emission cap s^F:

$$s^F = s^*,$$

or, alternatively, may opt for a corresponding uniform emission tax t^F:

$$t^F = t^* \equiv -C'\left(s^*\right).$$

3.2.2 The local EPAs

Next we turn to the local EPA players. Each state i is supposed to minimize its total local costs:

$$\min_{e_i} \ \mathrm{TLC}_i^0\left(e_1, \cdots, e_n\right) \equiv C\left(e_i\right) + D\left(e_1 + \cdots + e_n\right) \tag{5}$$

which requires its local MCC being equal to local marginal damage:

$$-C'(e_i) = D'\left(e_1 + \cdots + e_n\right).$$

As we assume identical states, we will henceforth focus on symmetric-strategy equilibrium of the local EPAs, and the first-order condition above reduces to:

$$-C'\left(\hat{s}\right) = D'\left(n \cdot \hat{s}\right). \tag{6}$$

Let $\hat{S}(\equiv n \cdot \hat{s})$ be the aggregate equilibrium emission level. To attain local efficiency, the local EPAs may either impose an emission cap s^S:

$$s^S = \hat{s},$$

or adopt an emission tax t^S equal to the local marginal damage:

$$t^S = \hat{t} \equiv -C'\left(\hat{s}\right),$$

It can be noted by comparing (4) and (6) and by assumptions (1)(2) that the central policies tends to be more stringent than the local ones due to pollution spillovers:

$$s^* < \hat{s}, \tag{7}$$

$$t^* > \hat{t}. \tag{8}$$

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4 Preliminary analysis

In this section, we model the central-local regulatory competition without policy implementation/enforcement costs, which will be incorporated into our analysis in the next section. For completeness, we will consider both quantity and price policy regimes in simultaneous-move as well as sequential-move games.

4.1 The simultaneous-move Nash game

In this subsection, we analyze both quantity and price competition equilibria in a Nash setting in which all central and local EPAs move simultaneously.

4.1.1 Quantity competition in emission caps

In early environmental regulation history, command-and-control is the standard way of pollution regulation. Central and local EPAs simply set limits on allowable emissions. Local firms then must comply with both requirements, and hence their emissions cannot exceed the tighter cap:

$$e_i \leq \min\left\{s^S, s^F\right\}.$$

Therefore, in equilibrium, a regulator (central or local) will either impose a *binding* cap or simply abstain, as policy enactment is usually politically troublesome and time-consuming. As such, there will only be one active regulator in the equilibrium.

Given condition (7), the Nash reaction functions of the central and local EPAs are, respectively:

$$s^F\left(s^S\right) = \begin{cases} s_{max}, & \text{if} \quad s^S \leq s^*, \\ s^*, & \text{if} \quad s^S > s^*, \end{cases} \tag{9}$$

$$s^S\left(s^F\right) = \begin{cases} s_{max}, & \text{if} \quad s^F \leq \hat{s}, \\ \hat{s}, & \text{if} \quad s^F > \hat{s}, \end{cases} \tag{10}$$

with $s_{max}(\rightarrow \infty)$ being a very large cap that will never be binding. The Nash equilibrium is then:

$$s^F = s^*,$$
$$s^S = s_{max},$$

which means that *the central EPA is the only active regulator in this game*, with local EPAs abstaining, as shown in Figure 1.

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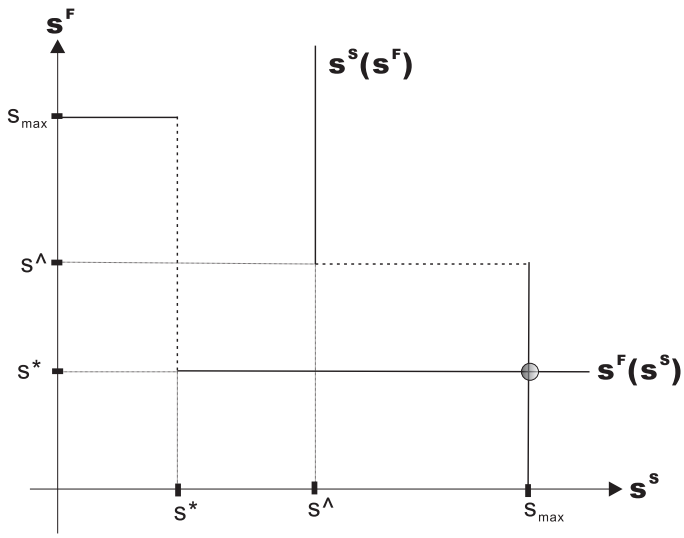


Figure 1: Nash equilibrium of the emission-cap competition (s^F and s^S)

4.1.2 Price competition in pollution tax/charge

In the policy regime of pollution tax, local firms have to pay taxes to both central and local authorities that obligate them to do so. Faced with pollution tax rate t^F and t^S set by respective regulators, firms have to pay the combined tax rates:

$$t = t^F + t^S,$$

and hence will choose an emission level equating their MCC with the combined rate:

$$-C(e) = t^F + t^S.$$

The Nash reaction functions of the central and local EPAs are now, given condition (8), respectively:

$$t^F\left(t^S\right) = \begin{cases} 0, & \text{if} \quad t^S \geq t^*, \\ t^* - t^S, & \text{if} \quad t^S < t^*, \end{cases} \tag{11}$$

$$t^S\left(t^F\right) = \begin{cases} 0, & \text{if} \quad t^F \geq \hat{t}, \\ \hat{t} - t^F, & \text{if} \quad t^F < \hat{t}, \end{cases} \tag{12}$$

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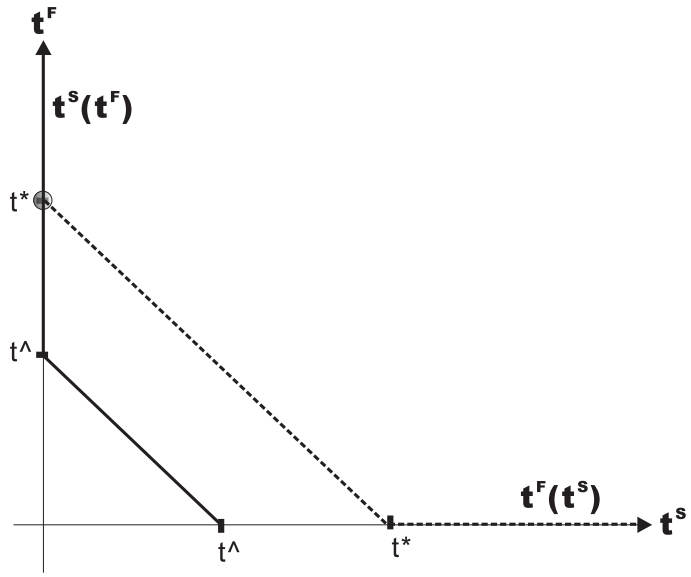


Figure 2: Nash equilibrium of the pollution-tax competition (s^F and s^S)

and the Nash equilibrium of the pollution tax competition game will be:

$$t^F = t^*,$$
$$t^S = 0,$$

which means that *the central EPA is again the sole regulator* in this tax game, setting the higher tax rate t^* it prefers. The local EPAs, meanwhile, stay silent, as shown in Figure 2.

Our analysis so far in this section shows that policy regime changes (from emission caps to pollution tax) will not affect the central-local relationship in environmental regulation: *The central EPA will always prevail and dominate whatever the policy regime is, not to be challenged by local EPAs, when they interact in a simultaneous way*.

4.2 The sequential-move game: central EPA as leader

Next we turn to the two-stage sequential-move models, in which central and local EPAs act sequentially, to see if and when local EPAs may become more aggressive than their central counterpart. In practice, we indeed have witnessed occasions in which either took the leadership role in real regulation

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cases. For transboundary pollution problems such as acid rain (SO_x) and green-house gases (CO_2), it is often the central EPA who took the initiatives in controlling the pollutants. Whereas for discharges that cause mainly regional externalities, it is usually the local EPAs that took the first step in emission regulation.

4.2.1 Quantity competition in emission caps

First we consider the case in which the central EPA announces its policy first (as the leader), followed by the local EPAs (the followers).

With the central EPA being the policy leader, it expects the local EPAs to act afterwards according to Nash reaction function (10). Therefore, it will simply choose $s^F = s^*$ to drive the local EPAs out of the policy arena. The Stackelberg equilibrium is hence:

$$s^F = s^*,$$
$$s^S = s_{max},$$

which is exactly the same as that in the simultaneous-move setting. The ideal emission cap s^* chosen by the central EPA is so high that it leaves no room for the local EPAs to intervene in the policy regulation.

4.2.2 Price competition in pollution tax/charge

In the alternative price regime, the local EPAs will react to the central EPA's pollution tax t^F according to their Nash reaction function (12). Knowing this, the central EPA will choose $t^F = t^*$, which is higher than the local EPAs' preferred rate $\hat{t}$, to deter their further intervention. As a result, the central EPA is again the sole active player in the equilibrium, still the same result as that in the simultaneous-move setting.

4.3 The sequential-move game: local EPAs as leader

In all cases so far, we found no instance in which local EPAs actively participate in environmental regulation. Finally, we consider the case in which the local EPAs act before the central EPA in the two-stage sequential-move setting. That is, the local EPAs determine their emission policy first (as a leader). The central EPA, after observing the announced local policies,

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then sets its national requirement (as a follower). Both players may, however, choose to abstain (or opt out) if they find it more appealing for their regulatory goals.

To explain how central and local regulators may change their regulation strategies when policy regime shifts, we again compare both quantity (in which EPAs set emission caps) and price (in which EPAs set emission tax) games.

4.3.1 Quantity competition in emission caps

Since the central EPA intends to set a more stringent emission limit than the local ones ($s^* < \hat{s}$, by (7)), all leading local EPAs will abstain and relinquish the regulatory power to the central EPA:

$$s^F = s^*,$$
$$s^S = s_{max}.$$

The finding here is not new still, just the same as what we have obtained in all previous models. And the Williams III (2012) conclusion does not hold in all these settings.

4.3.2 Price competition in pollution tax/charge

Now we consider this last case of emission tax sequential game. Since the central EPA prefers a higher tax rate than the local EPAs ($t^* > \hat{t}$, by (8)), it can always choose the tax rate

$$t^F = t^* - t^S \tag{13}$$

in the second stage to make the combined rate equal to t^*. Knowing this, the local EPAs is indifferent about the rate t^S it chooses in the first stage.

The local EPAs, however, may not just quit and leave the regulation arena. Even though local firms will be taxed eventually at the combined rate t^*, it still matters to the local governments where the tax revenues go. Although tax payment by local firms are considered pure transfer within state jurisdictions, payment by local firms to the federal government is arguably a fiscal loss to local governments. Therefore, local governments conceivably would prefer to retain it rather than to render it to the central government.

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Table 1: Equilibrium summary of the six model settings.

Equilibrium	Nash Game	Central EPA leads	Local EPAs lead
Emission Caps	Central EPA active	Central EPA active	Central EPA active
Pollution Tax	Central EPA active	Central EPA active	*Local EPAs active*

To preserve the largest possible tax revenues in local treasury, the local EPAs will announce the maximal rate

$$t^S = t^*, \tag{14}$$

and hence leave no room for central EPA to impost further tax. As a result, the federal EPA will not impose further emission tax beyond the state requirement:

$$t^F = 0.$$

4.3.3 Section summary

The equilibrium policies we obtained in the subsections of this section can be more clearly summarized in the table below:
These findings are also briefly stated as two propositions below. The first proposition confirms that, in most cases, the central EPA will be the only active regulator.

Proposition 1. In all forms of policy regulation competition that the central and the local EPAs may engage in, except for the sequential-move tax game in which the local EPAs lead, the central EPA will always be the sole active regulation and will thus enact nationally efficient policies, with the local ones abstaining. ■

The following proposition, on the other hand, elaborates on the only circumstance that the local EPAs will dominate in the regulation competition.

Proposition 2. In the sequential-move tax rate game in which the local EPAs lead, the leading local EPAs will set nationally efficient tax rates preferred by the central EPA in the first stage in order to block the central EPA's intervention in the subsequent stage. Hence the local EPAs will be the only active regulations. ■

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Our findings in this section may serve to explain why the central EPA has always been the major (quite often the only) regulator in the old times, when emission standards/caps were ubiquitously used as the regulation instrument. Since non-binding or lax local policies have no effect in this regime, the local EPAs have no reason to engage in regulation competition.

In recent decades, however, environmental economists have triumphed in persuading politicians and policy makers to switch from direct control (i.e., caps) to incentive-based price instruments (tax/subsidy or permits). We show here that when the local EPAs lead in the price competition game, they will become ever more active in setting local policies, eventually overriding the central ones. This may explain why devolved (decentralized) authority became the mainstream in the 1990s, when US shifted from traditional quantity policy regime to incentive-based (tax or permit) regime in environmental regulation.

To be noted, however, that among the models we consider, the *sequential-move competition led by local EPAs* is the only one that accords with the policy trend we observe in US. In all other model settings, the local EPAs simply have no role to play at all. Therefore, whether policy regime shift can be promoted as the main cause for local uprising is questionable.

5 Costly policy implementation and enforcement

Next we add new features to the sequential-move model in previous section for a more complete and realistic analysis. In a real-world policy-setting process, there are costs associated with policy implementation and enforcement, to be borne by all central and local regulators.

For the central regulator, there are costs associated with implementing the optimal policy. This is assumed to be a one-time fixed cost

$$K,$$

which includes costs of designing policies, negotiating with congress in democratic processes, dissolving industry resistance, as well as policy legislature, etc.

Furthermore, once a policy is enacted, it needs to be enforced for planned effects. The costs of enforcement will notably depend on firm emission level:

$$F(e), \quad F' > 0, \quad F'' > 0,$$

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which comprise expenses for emission monitoring and violator prosecution.

With these new model features, the central EPA has to make a binary participation decision first as to whether to invest K in policy implementation. Upon participation, it then, in the next stage, determines the optimal central policy to enforce:

$$\min_{\{e_i\}} \ \mathrm{TNC}^1\left(e_1, \cdots, e_n\right) \equiv \sum_i C\left(e_i\right) + \sum_i D(E) + \sum_i F\left(e_i\right), \quad (15)$$

which yields the interior first-order condition:

$$\forall i: \ -C'\left(s^*\right) = n \cdot D'\left(n \cdot s^*\right) + F'\left(s^*\right). \quad (16)$$

Compared with the no-cost case, the optimal central policy is tighter due to costly policy enforcement. Now the emission cap s^* becomes lower, and the corresponding optimal tax rate t^* becomes higher:

$$t^* = n \cdot D'\left(n \cdot s^*\right) + F'\left(s^*\right). \quad (17)$$

Similarly for the local states, policy implementation and enforcement involves real expenditures. As the political ecosystems differ in central versus local governments (due maybe to different jurisdiction sizes), we assume that local regulators face a somewhat lower implementation cost than the central EPA:

$$K_i (< K).$$

However, policy enforcement process would be identical regardless of regulator identities (central or local), and hence the local enforcement costs are the same as the central costs:

$$F_i\left(e_i\right) = F\left(e_i\right).$$

Quite like the central EPA, local EPAs first have to decide whether to participate in the policy game by expending the policy implementation cost K_i. If so, local EPAs then move on to the second-stage enforcement choice:

$$\min_{e_i} \ \mathrm{TLC}_i^1\left(e_1, \cdots, e_n\right) \equiv C\left(e_i\right) + D(E) + F\left(e_i\right), \quad (18)$$

which gives us the interior condition:

$$-C'\left(\hat{s}\right) = D'\left(n \cdot \hat{s}\right) + F'\left(\hat{s}\right). \quad (19)$$

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Similar to the central authority case, local regulation becomes tighter with the extra policy enforcement costs: local optimal emission cap $\hat{s}$ is lower, and the desired local emission tax $\hat{t}$ goes higher:

$$\hat{t} = D'\left(n \cdot \hat{s}\right) + F'\left(\hat{s}\right). \tag{20}$$

As the existence of policy enforcement costs tightens emission regulation in both central and local levels, the former still tens to be more stringent than the latter, by conditions (16)(19):

$$s^* < \hat{s}, \tag{21}$$

$$t^* > \hat{t}. \tag{22}$$

5.1 The sequential-move emission cap game

We first investigate the quantity control regime of environmental regulation, in which both central and local authorities use emission caps as the policy instrument. The same logic in the preliminary analysis applies here. Since polluting firms are bound by the lower emission limit:

$$e_i = \min\left\{s^S, s^F\right\},$$

only one (either central or local) cap can be binding,[1] and hence only one authority level will be active.

In the absence of regulation costs, the federal authority is shown earlier to be the sole regulator in the emission cap game. Now with costly regulation, the federal authority will choose to engage in the policy war if and only if there are social gains from its action:

$$\mathrm{TNC}^1\left(s^*\right) + K < \sum_i \left[\mathrm{TLC}_i^1\left(\hat{s}\right) + K_i\right],$$

which means

$$\sum_i \left[C\left(s^*\right) + D\left(S^*\right) + F(s^*)\right] + K < \sum_i \left[C\left(\hat{s}\right) + D\left(\hat{S}\right) + F\left(\hat{s}\right)\right] + \sum_i K_i,$$

[1] The case of $s^S = s^F$ is not possible with the existence of policy implementation costs.

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or equivalently:

$$K - \sum_i K_i < \sum_i \left[C\left(\hat{s}\right) + D\left(\hat{S}\right) + F\left(\hat{s}\right) \right] - \sum_i \left[C\left(s^*\right) + D\left(S^*\right) + F\left(s^*\right) \right].$$

That is, the efficiency improvement (RHS, > 0) is greater than the excessive policy implementation costs (LHS). More specifically, if policy implementation exhibits *economy of scale*, as is the usual case:

$$K < \sum_i K_i$$

then we have

$$K - \sum_i K_i < 0 < \sum_i \left[C\left(\hat{s}\right) + D\left(\hat{S}\right) + F\left(\hat{s}\right) \right] - \sum_i \left[C\left(s^*\right) + D\left(S^*\right) + F\left(s^*\right) \right],$$

and the central EPA will certainly act and set:

$$s^F = s^*.$$

Knowing what the central EPA will do, the local EPAs, though as policy leaders, will abstain in the first stage.

5.2 The sequential-move pollution tax game

Finally, we turn to the price regulation regime, in which all regulators use tax as the de facto policy instrument. In this scenario, both central and local regulators may be involved when they all actively impose positive emission taxes (i.e., $t^F > 0$, $t^S > 0$). If this actually happens, assignment of enforcement duty can be arbitrary and clumsy. We assume that, whenever federal policy is in effect, the central EPA is responsible for its enforcement. Otherwise, there exists only local regulation, and it is the local governments' duty to enforce it locally.

With the two-stage Stackelberg framework presented in previous sections, we now solve for the sub-game perfect equilibrium of the policy game.

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We start backwards with the social cost minimization problem of the central EPA in stage 2.

Given local policy t^S and corresponding s^S satisfying (20) in stage 1, the central EPA will intervene and set

$$t^F = t^* - t^S$$

only if:[2]

$$K \leq \mathrm{TNC}^1\left(s^*\right) - \sum_i \mathrm{TLC}_i^1\left(s^S\right).$$

Otherwise it will consider intervention not worthy and hence abstain. Therefore, there will exist a local tax threshold $\bar{t}$ and corresponding emission $\bar{e}$:

$$-C'(\bar{e}) = \bar{t}$$

satisfying

$$K = \mathrm{TNC}^1(e^*) - \sum_i \mathrm{TLC}_i^1(\bar{e}),$$

above which the central EPA will abstain. As such, the optimal stage-2 central EPA strategy will be:

$$t^F = \begin{cases} t^* - t^S, & \text{if} \quad t^S < \bar{t}, \\ 0, & \text{if} \quad t^S \geq \bar{t}, \end{cases} \tag{23}$$

as shown in Figure 3(left panel), and the final tax rate $\tilde{t}$ will be:

$$\tilde{t} = t^F + t^S = \begin{cases} t^*, & \text{if} \quad t^S < \bar{t}, \\ t^S, & \text{if} \quad t^S \geq \bar{t}, \end{cases} \tag{24}$$

as shown in Figure 3(right panel).

Back up in stage 1, expecting the central EPA to behave as described in (23), the local EPAs will choose local tax rate t^S to make final equilibrium tax rate $\tilde{t}$ as close as to their desired level $\hat{t}$ (as defined in (20)) as possible. Depending on the value of the threshold $\bar{t}$, there can be two possible cases.

[2]Note that local policy implementation costs K_i incurred in stage 1 (if $t_S > 0$) are left out here as forgone sunk social costs for the federal player in stage 2. In addition, enforcement burden $F(\cdot)$ is deemed pure transfer (shifting from local to central level) and cancels out in the national perspective.

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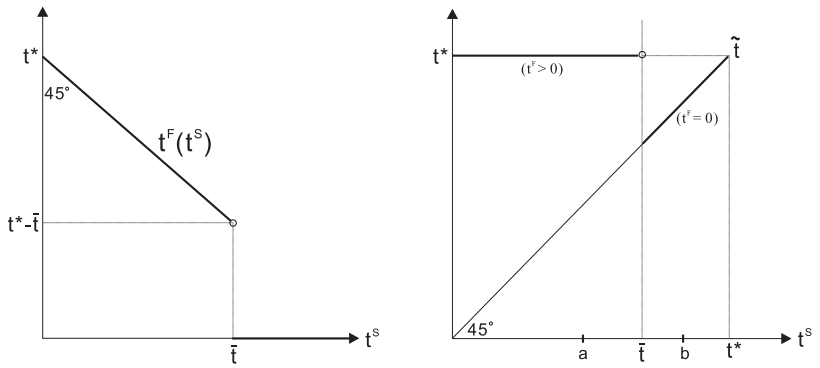


Figure 3: Federal choice t^F and final tax rate $\tilde{t}$ as a function of t^S

- Case 1: $0 < \hat{t} < \bar{t} < t^*$.

  The local EPA's preferred tax rate $\hat{t}$ is lower than the threshold $\bar{t}$, such as point a in the right panel of Figure 3. In this case, local EPAs will set

  $$t^S = \bar{t}$$

  to drive the central EPA out of the game. This is true because, if $t^S < \bar{t}$, the central EPA will step in, and the final tax rate $\tilde{t} = t^*$ is way too high for the local EPAs. On the other hand, if the local EPAs set a tax rate t^S above $\bar{t}$, the central EPA will surely abstain, but the final tax rate $\tilde{t} = t^S > \bar{t} > \hat{t}$ becomes too high unnecessarily.
- Case 2: $0 < \bar{t} \leq \hat{t} < t^*$.

  The preferred local tax rate $\hat{t}$ is higher than the threshold $\bar{t}$, such as point b in the right panel of Figure 3. In this case, the local EPAs can simply choose their ideal tax rate

  $$t^S = \hat{t}$$

  and the central EPA will stay out anyway.

It can be noted that, in both cases, the central EPA will abstain:

$$t^F = 0,$$

and the local EPAs are the sole regulators who get to keep all the pollution tax revenues.

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In summary, in the Stackelberg equilibrium, the leading local EPAs will always be active in stage 1 and impose emission tax:

$$t^S = \begin{cases} \bar{t}, & \text{if} \quad 0 < \hat{t} < \bar{t} < t^*, \\ \hat{t}, & \text{if} \quad 0 < \bar{t} \leq \hat{t} < t^*. \end{cases} \tag{25}$$

Subsequently in stage 2, the central EPA will abstain:

$$t^F = 0.$$

In the end, the equilibrium tax rate will always be inefficiently lower (sub-optimal) than the case without policy costs. The findings of this section is summarized in the following proposition.

Proposition 3. When policy implementation exhibits economy of scale, the central EPA is more likely to take on the major role in environmental regulation. In contrast, the local EPAs can only be active when they are leaders in a sequential-move pollution tax game with policy enforcement costs. ■

6 Conclusion

We find in this paper that, when quantity (command-and-control) policy is the *de facto* instrument used by all government agencies, the central EPA will always dominate in the policy arena as the only active regulator, no matter whether they move simultaneously or sequentially. In these cases, local agencies will be silent and refrain from setting any emission standards at all. Only when the central and local EPAs compete in a sequential-move manner with price (the incentive-based tax policy), the local ones will be active, with the central EPA abstaining from imposing pollution tax. It is thus questionable if the policy regime shift in US can serve to explain the emergence of aggressive local environmental regulations, as suggested by Williams III (2012).

Further with the incorporation of more realistic features, like policy implementation and enforcement costs in our model, our conclusions become even more robust. It is our hope that these findings will contribute to explain the observed trend of decentralized regulation in the past few decades in many countries around the world.

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References

Boskovic, Branko (2013), "Air Quality, Externalities, and Decentralized Environmental Regulation," PhD thesis, University of Toronto.

Chang, Howard, Hilary Sigman, and Leah G. Traub (2007), "Endogenous Decentralization in Federal Environmental Policies," NBER Working Paper, No. 13238.

Dwyer, John (1995), "The Practice of Federalism Under the Clean Air Act," *Maryland Law Review*, 54(4), 1183–1225.

Garcia-Valinas, Maria Angeles (2007), "What Level of Decentralization Is Better in an Environmental Context? An Application to Water Policies," *Environmental and Resource Economics*, 38(2), 213–229.

Laskowski, Stanley, Richard Morgenstern, and Allen Blackman (2005), "Environmental Decentralization in the United States," Resources for the Future, Discussion Paper, No. 5–42.

Luo, Zhigao, Xinyun Hu, Mingming Li, Jirui Yang, and Chuanhao Wen (2019), "Centralization or Decentralization of Environmental Governance — Evidence from China," *Sustainability*, 11(6938), 1–20.

Millimet, Daniel (2013), "Environmental Federalism: A Survey of the Empirical Literature," IZA Discussion Paper, No. 7831.

Nordhaus, William (2006), "After Kyoto: Alternative Mechanisms to Control Global Warming," *American Economic Review*, 96(2), 31–34.

Oates, Wallace (1999), "An Essay on Fiscal Federalism," *Journal of Economic Literature*, 37(3), 1102–1149.

——— (2001), "A Reconsideration of Environmental Federalism," Resources for the Future Discussion Paper, No. 1–54.

Potoski, Matthew (2001), "Clean Air Federalism: Do States Race to the Bottom?" *Public Administration Review*, 61(3), 335–342.

Wellisch, Dietmar (2000), *Theory of Public Finance in a Federal State*, Cambridge, UK: Cambridge University Press.

Williams III, Roberton (2012), "Growing State-Federal Conflicts in Environmental Policy: The Role of Market-Based Regulation," *Journal of Public Economics*, 96(11), 1092–1099.

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環境政策制度改變與地方管制之崛起

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本文探討環境政策之制度性變化與地方環保管制崛起之關係。文獻中有些作者 (如 Williams III (2012)) 認爲美國在過去數十年間地方管制逐漸變爲強勢, 甚至凌駕在中央聯邦管制規定之上的原因是由於環保政策在過去由傳統的排放從量管制轉爲汙染稅之類的從價管制之故。我們設立了各種同時行動和循序行動的賽局, 並發現在六種同時/循序和從量/從價的組合中, 中央政府幾乎都是唯一的政策設定者。只有在地方政府領頭的從價政策競爭中, 地方政府才有可能超越中央而成爲活躍的政策設定者。因此環境政策規範之改變並無法做爲解釋地方管制勢力崛起的主要決定性因素。

關鍵詞: 環境政策, 地方競爭, 制度改變
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