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How Should Standards Be Set and Met?: On the Allocation of Regulatory Power in a Federal System

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How Should Standards Be Set and Met?: On the Allocation of Regulatory Power in a Federal System*

C.-Y. Cynthia Lin

Abstract

Regulation often takes the form of a standard that can be met through the implementation of any of a number of different policies. This paper examines how the authority to set the standard and the authority to choose the combination of policies to meet the standard should be allocated between a central government and local governments. In the context of the United States, for example, should standards regarding such public goods as the environment or education be set and implemented by the federal government, by individual state governments, or by both? Because decisions about setting and/or meeting the standard can be non-contractible, an incomplete contracting approach is used. A central finding is that "conjoint federalism" (the central government sets the standard while the local governments meet the standard), which is the regulatory structure often used in federations such as the United States and the European Union, can be the least efficient form, while a reverse form of delegation, in which local governments choose their own individual standards which the central government then decides how to collectively meet, can be the most efficient.

KEYWORDS: regulatory federalism, delegation, incomplete contracts, environmental federalism

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1 Introduction

The issue of how best to distribute power between different tiers of a hierarchical government has been of interest to economists at least since the time Tiebout (1956), Olson (1969) and Oates (1972) published their pioneering works on the topic. Under what circumstances would it be optimal to distribute regulatory responsibility to both central (or federal) and local (or state) tiers of government? In the context of the United States, for example, should standards regarding such public goods as the environment or education be set and implemented by the federal government, by individual state governments, or by both? Likewise, in the context of the European Union, which regulatory decisions should be made by the European Commission, and which by individual member countries? In a firm, is it better for the boss to decide the production target and how to achieve it, or should the power to make one or both of these decisions be delegated to her subordinates? More generally, in any hierarchical organization, who should have the power to set and meet standards: the central authority, or the constituent units? In this paper I use an incomplete contracting paradigm to examine the efficiency of delegating regulatory power, and make a case for why, under certain circumstances, the form of delegation often used in such federations as the United States and the European Union should be reversed.

The key trade-off between centralized and decentralized systems of regulation that I model is thus the following: while the central government can better internalize externalities, local governments have better aligned preferences. Because of this trade-off, it is possible that the most efficient regulatory structure may involve delegation: the central government retains the power to either set or meet the standard, but not both, and delegates the power to make the remaining decision to the local governments.

The issue of how to distribute power between different tiers of government has been examined extensively by economists over the past few decades, and much of their work has focused on the same trade-off I have chosen between externalities and local preferences (see e.g. Alesina, Baqir & Hoxby, 2002, & references therein). The primary distinguishing feature of this paper is that, while most of the previous literature on federalism has been agnostic about the nature of the underlying contractual environment, I analyze the issue using an incomplete contracting paradigm. For example, although there is a thriving literature on multi-jurisdictional environmental regulation (see e.g. Bui, 1998; Oates 2001; Sarnoff, 1997; Sigman, 2004), little work has been done to date examining environmental federalism in the context of contractual incompleteness.

An incomplete contracting approach is needed because decisions about setting and/or meeting the standard can be non-contractible. The allocation of decision-making power matters precisely because the non-contractibility precludes individual states from coordinating with each other via contracts and side payments. If states could write contracts with each other, then they could internalize externalities and achieve the social optimum on their own, and there would be no need to allocate power to a central government. However, when contracts are incomplete, then the allocation of power matters because it determines which tier of government can make which decision.

Two sub-branches of the literature on contractual incompleteness impinge upon this paper. The first is that on firm boundaries. In particular, my model of the optimal governmental structure is an extension of Hart and Holmstrom's (2002) model of market structure and firm scope to a political context. In addition to that on firm boundaries, a second sub-branch of the incomplete contracting literature that relates to this paper is that on the allocation of authority (see e.g. Aghion & Tirole, 1997; Harris & Raviv, 2002; Marino & Matsusaka, 2002). Unlike the majority of this literature, this paper applies the question of authority allocation to governments as well as to firms.

The particular regulatory structure that is often used for many regulations in such federations as the United States and the European Union is "conjoint federalism", where the central government sets a standard that individual states must then implement policies to meet. For example, air quality regulation in both the U.S. and the EU stipulates that standards be chosen by the central authority and implemented by individual states (Farrell & Keating 1998; Europa, 2004).[1] Similarly, the U.S. Elementary and Secondary Education Act (also known as the "No Child Left Behind Act") stipulates that a test-based accountability system be set by the federal government and met by each state (Elmore, 2002; U.S. Department of Education, 2004). Likewise, under the Planning and Compulsory Purchase Act in the United Kingdom, the British government determines the number of new houses that are needed in each part of the country, while local planning authorities must prepare and implement the actual development schemes (Her Majesty's Stationery Office, 2004; "Building in Britain", 2004).

Although conjoint federalism is commonplace, it is not clear that it is the optimal regulatory structure. Beginning in 1969, conjoint federalism supplanted state control for many environmental regulations in the United States as a result of federal research in pollution, mounting public concern with envi-

[1]Indeed, the term "conjoint federalism" was used by Farrell and Keating (1998) to describe the U.S. ozone regulatory structure. I borrow this term from their paper.

ronmental issues and the ineffectiveness of state pollution control efforts (Keleman, 2004). Conjoint federalism thus appears to have arisen out of a desire to involve the federal government in environmental regulation, although the particular form of involvement (i.e., via setting the standards) might not have been taken into consideration and therefore may not have been optimally chosen. The novelty of this paper is to posit that there are several ways in which the different tiers of government can be involved in environmental regulation, and that there may be alternative regulatory structures involving the federal government that may be better than conjoint federalism. The prevalence of conjoint federalism suggests that while those who designed the regulatory structure were correct that the federal government should be included, they perhaps did not fully optimize on the particular allocation of decision-making authority. Indeed, states backlashed against conjoint federalism in the early 1990s because it was inflexible and constrained state autonomy (Keleman, 2004).

One central finding of this paper is that under certain circumstances, a case can be made for a reverse form of delegation, in which the federal government retains the power to meet the standard but delegates the power to set individual standards to the states. The results therefore suggest that social welfare may be increased by reversing the form of delegation often used in regulatory decision making.

2 A Model of Delegation in Regulation

2.1 The Two Stages of Regulation

A common form of regulation involves the setting and meeting of standards for a particular good in question. This good, which I term "output", is the good regulators care about and can represent, for example, ambient air quality, student achievement, the number of widgets produced, or, more abstractly, performance. Let q_i denote the output in state i.

In order to produce the output good, policies must be implemented. I call these policies "inputs". There are two different types of input policy that can be implemented to produce output: type-a and type-b. These two types may represent, for example, two different types of technology, emissions reductions from two different types of sources, two different policy instruments, or investment in human versus physical capital. In the case of ozone smog regulation, since ozone is formed in ambient air by two different types of pre-

cursors, each input type may correspond to a policy for reducing emissions of a different type of precursor.[2] The input policy choice of each state i is given by the vector (a_i, b_i) of two types of input.

I model regulation as a two-stage process. In the first stage, a standard is set: that is, the output q_i is chosen for each state i. In the second stage, the standard is met: that is, the input policy mix (a_i, b_i) is chosen for each state i in order to implement the set of output standards $\{q_i\}_i$ chosen in the first stage.[3] I assume that, irrespective of who makes the choice, policies are always chosen to comply with the standard dictated in stage 1.

There are generically many combinations of the two types of input policy that can be implemented in order to meet any given output standard. However, the particular choice of type-a and type-b input policy levels will be governed by the following trade-off: while the type-b input policy is privately less costly to implement, the type-a input policy induces more positive spillovers and thus is the socially less costly input type. As a consequence, a non-cooperative Nash equilibrium[4] input policy choice would allocate more input toward type-b than a coordinated choice would. My distinction between these two types of input is needed to allow for the possibility that, even after the output standard is chosen, it matters whether or not the input policy choice is made in a coordinated fashion.[5]

There are many reasons why the effects of a policy may spill over from one state to another. For example, if the policy generated and disseminated knowledge and other forms of human capital, then such human capital could easily spill over to other states. Similarly, if the input policy abated emissions of a transboundary pollutant, then any policy that abated the pollutant in one state would result in lower quantities of that pollutant in another state.

For concreteness, consider air quality regulation. Once set, a given standard for ambient air quality can be met through a combination of two types of policy: a policy that reduces smokestack emissions from power plants (type-

[2]Even more abstractly, one input type may correspond to emissions reduction while the other corresponds to emissions relocation.

[3]Regulations that specify standards that can be achieved in a variety of ways are sometimes termed "performance-based regulations" (Coglianese, Nash & Olmstead, 2002).

[4]Throughout this paper, I will use the terms "non-cooperative" and "Nash equilibrium" interchangeably.

[5]If the spillover were to occur with the output rather than the inputs, then the choice of inputs is completely determined by the choice of outputs. In this case, there is only one choice to be made – the choice of output – and there is no need for delegation where the input and output choices are separately allocated between the state and federal governments. Since the allocation of the two separate decisions is the focus of this paper, I model the spillover as occuring with the inputs.

a), and a policy that reduces tailpipe emissions from cars (type-b). Fowlie, Knittel and Wolfram (2008) find that the cost of reducing NO_x emissions from cars is approximately one-fifth the cost of reducing NO_x emissions from power plants. Power plants are more expensive to regulate but, because smokestack emissions can be blown from one state to another, the benefits from smokestack regulation in one state can spill over to the other state. In contrast, cars are cheaper to regulate, but, because low-lying tailpipe emissions are less likely to get blown across state boundaries, the tailpipe regulatory policy in one state does not affect any other state.[6] Thus, while it may be privately less costly to abate emissions from cars than it is to abate emissions from power plants, it may be socially more costly to do so.

2.2 Decentralization Scenarios

In my model, governmental power encompasses the right to make decisions and the ability to enforce them. There are two types of power: one for each of the two stages of regulation. **Output power** is the right and ability to set, measure, monitor, and enforce the standard for output q_i in stage one. **Input power** is the right and ability to choose, measure, monitor, and enforce the (conditional) input policies (a_i, b_i) to meet the standard in stage two.[7]

The two types of power can be separately allocated to different tiers of government. Under **state (S) control**, the state governments have both output power and input power. Under **federal (F) control**, the federal government has both output power and input power. Under **conjoint federalism (C)**, the federal government has output power and the state governments have input power. Under **reverse conjoint federalism (R)**, the state governments have output power while the federal government has input power.

2.3 The Incomplete Contracting Framework

The primary feature that distinguishes this paper from previous work on regulatory federalism is that I operate in a paradigm of contractual incompleteness. In particular, I assume that neither decisions about the input policies (a_i, b_i)

[6] In this stylized example, I assume that cars themselves do not travel across state borders and that car manufacturers tailor their cars to meet the regulations set by each state. I also assume that it makes no difference to the profits of car manufacturers how the state-by-state tailpipe regulations are set.

[7] I sometimes refer to the stage-two input policy choice as a "conditional" input policy choice, since the choice is conditional on the stage-one output standard.

nor decisions about the output good q_i are contractible among individual states either ex ante or ex post. Under these assumptions, the distribution of the two types of power is important because it determines which tier of government can decide the levels of input and output that will be implemented.

There are several possible reasons why decisions about input and output may be non-contractible by individual states. First, because both the effectiveness of the input policies and the level of the output good may be affected by exogenous and often unpredictable stochastic factors and other unforeseen contingencies, the transactions costs of writing complete Arrow-Debreu state-contingent contracts that specify the appropriate input and output choices for every possible state of the world may be prohibitively high. These stochastic factors would include weather for the case of air quality and cohort effects or parental involvement for the case of education.

A second reason why states cannot contract on input and output is that, even if they were written, contracts between individual local governments may not be enforceable. For example, if the "states" in my model were individual countries, then no contracts between these sovereign states could be enforced.

A third reason why contracts might be incomplete is that, especially for public goods, input and output are subject to what Williamson (1971) termed "strategic misrepresentation risk" and therefore might not be verifiable. In the context of air quality regulation, for example, one possible argument for the non-verifiability of the input policy is as follows. Input policies, such as those stipulating reductions in power plant emissions, need to be enforced. Because the input boss is endowed with enforcement authority, he can essentially enforce whatever emissions reductions he wishes, and can neglect to enforce any reductions imposed upon him from outside. Indeed, owing to spillovers in input policies, if state governments had input power, meaning that states rather than the central government each had its own enforcement authority, then each state government would likely have an incentive to mislead the other state governments about the extent and success of its policies. Even if Ohio and Maine wrote a contract that specified the amount of smokestack emissions reductions that would take place in each state, Ohio might claim to have complied without Maine ever being able to verify that it did, for Ohio could easily mislead Maine about how much abatement it achieved. Similar arguments could be made for why the quality of an educational input policy to train teachers may not be verifiable.

The argument for the non-verifiability of output is similar. Output must be monitored or measured. Since the quality of the environment or of schools is difficult to measure or monitor with certainty, its level can be obscured by the government with output power from all other governments. Thus, output

is not contractible.

I choose the incomplete contracting framework for two main reasons. A first reason why I assume contracts are incomplete is to provide a possible justification for the existence of a federal government. If contracts were complete, then individual state governments could coordinate by contracting on input and output levels and then dividing the surplus through transfers or side payments; as a consequence, there would be no need to allocate any power to a central government and therefore no need for a federal government at all. It is precisely because contracts are incomplete and coordination is no longer possible that one might consider creating a central government and allocating power to it.

A second reason for contractual incompleteness is that my assumptions on the non-contractibility of input and output seem reasonable in the context of public goods regulation. High transactions costs, the lack of enforcement, and non-verifiability are all possible reasons why input policies, and, to a lesser extent, output goods, are non-contractible among states.

2.4 Welfare

Assume there is one federal government and two state governments.[8] The federal government suffers from an agency problem: the preferences of the federal government differ from those of the local constituents. To model the agency problem in its most general form, I allow both the benefit function and the cost function used by the federal government to differ from the true benefit function and cost function, respectively. As a result of the agency problem, the federal government's choices of input and output are inefficient.

There are many possible reasons why the federal government's preferences may not reflect social welfare.[9] First, voting rules might create a divergence between federal and local preferences. For example, if preferences of governments reflect those of the median voter among their constituents, and if states were heterogeneous, then the median voter in the entire nation would not be the same as the median voter in each state. Since their median voters would differ, state and federal governments would have different preferences. Voting institutions such as the electoral college system may also create incentives for

[8] My model can of course be generalized to any organization consisting of a central authority and constituent units.

[9] I assume in this paper that the preferences of the state governments are perfectly aligned with local welfare. The same arguments still apply even if this assumption were relaxed, as long as the preferences of the state governments are better aligned with local preferences than those of the federal government are.

the federal government to care about some states more than others. A second reason why the federal government may fail to maximize social welfare is that, for equity reasons, it may prefer to use the same benefit function for all states. For example, it may be constrained, perhaps by legislation, to value education or the environment in both states equally. A third source of an agency problem is the need for the federal government to balance domestic with foreign policy objectives. Owing to possible trade-offs between national and international interests, the federal government may not be able to fully attend to domestic concerns. A fourth reason why the federal government might not use the true benefit functions is an information problem: the federal government is unable to correctly measure what the true benefits are, as such information may be local or private information to the states, and therefore uses an incorrect estimate of them. Thus, voting rules, equity concerns, international objectives, and informational asymmetries are all potential sources of an agency problem.

One strength of my model is that it is agnostic about the actual mechanism underlying the agency problem; my results therefore do not hinge on the verity of any particular agency story, but rest only on the assumption that *some* story exists that makes the state government's preferences better aligned with local welfare than the federal government's preferences are. Thus, the model is general enough to capture the reduced-form implications of any of a number of agency stories.

The aggregate benefit to residents of state i of output q_i is $V_i(q_i) = v_i \ln(q_i)$, where $v_i > 0 \ \forall i$. Benefits are measured in terms of money equivalents. Because I use the sum over all states of the aggregate benefits to each state i as my welfare criterion, I call $V_i(q_i)$ the "true" benefit function for state i.[10]

For each state i, the federal government uses the "federal" benefit function $V_{F,i}(q_i) = \eta_i v_i \ln(q_i)$ as the aggregate state benefit instead of the "true" benefit function $V_i(q_i)$, where $\eta_i \geq 0$. One can interpret the parameters $\eta = (\eta_1, \eta_2)$ as the vector of weights that the federal government puts on the states' benefit functions in its own objective function. Different mechanisms underlying the agency problem would be manifested in different values of this weight vector. If $\eta = (1, 1)$, then there is no agency problem; the federal benefit functions reflect the true benefit functions. If $\eta = (1, 0)$, then the federal government does not care about the benefits to state 2, while if $\eta = (0, 1)$, then the federal government does not care about the benefits to state 1. If $\eta = (0, 0)$, then the federal government does not care for output benefits at all.

[10] I remain agnostic about how the benefit functions from individual citizens are aggregated to the state level.

While each state reaps benefits from its own output, it also incurs the costs of the input policy that is chosen to meet the standard for this output. For each state i, the input policy mix (a_i, b_i) imposes a cost given by $C(a_i, b_i) = c_a a_i + c_b b_i \ \forall i$, where $c_a > 0$ and $c_b > 0$.[11] Owing to an agency problem, the federal government uses a possibly incorrect cost function given by $C_F(a_i, b_i) = \theta_a c_a a_i + \theta_b c_b b_i \ \forall i$, where $\theta_a, \theta_b \geq 0$.

Owing to spillovers in the input policies, each state i's output q_i is a function of not only the input policies in state i but also the input policies in state j so that $q_i = f_A \cdot (a_i + \alpha_i a_j) + f_B \cdot (b_i + \beta_i b_j)$, where f_A and f_B are constants, $f_A > 0$, $f_B > 0$ and $f_A + f_B = 1$, where the *type-a effective input spillover* $\alpha_i \in [0, 1]$ is a measure of the extent of the spillover to state i from state j's choice of type-a input, and where the *type-b effective input spillover* $\beta_i \in [0, 1]$ is a measure of the extent of the spillover to state i from state j's choice of type-b input. I assume that, for each type of input, input does not completely spill over for both states, where by "complete" spillover I mean a spillover equal to one: $1 - \alpha_i \alpha_j \neq 0$ and $1 - \beta_i \beta_j \neq 0$. With a linear production function, the two input types are perfect substitutes. With air quality regulation, for example, policies that regulate emissions from different sources may be perfect substitutes: reducing the emissions of a pollutant from cars has the same effect on air quality as reducing emissions of the same pollutant from power plants.

The utility U^i for each state i is simply the benefits it accrues from its output minus the input costs it incurs to achieve it: $U^i = V_i(q_i) - C(a_i, b_i)$. Thus, while each state only incurs the cost of its own input, its benefits depends on the input levels of both states through their effect on that state's own output. I assume that each state i will always act so as to maximize its own utility U^i.

Since each state government's utility function correctly reflects the aggregate utility of its citizens, total welfare W is given by the sum of the utilities of all the states: $W = \sum_i U^i = \sum_i [V_i(q_i) - C(a_i, b_i)]$. A social planner would use total welfare W as her objective function. In contrast, because the federal government uses its own benefit and functions for the output good in place of the true benefit and cost functions, the federal government's objective function U^F is given by $U^F = \sum_i [V_{F,i}(q_i) - C_F(a_i, b_i)]$. I assume that the federal government will always act so as to maximize U^F, even though the benefits of

[11] I assume that states always incur the costs of their own policies regardless of who makes the policy choice. If the federal government chooses the input policies, this assumption is reasonable if, for example, the federal government levies taxes from each state to pay for the policies it implements in the state.

output and the costs of input accrue to the citizens of the individual states.

Let the welfare W under decentralization scenario X be denoted as W^X, where $X \in \{S, F, C, R\}$. Let the welfare difference between decentralization scenario X and decentralization scenario Y be denoted as $\Delta^{XY} \equiv W^X - W^Y$.

The *marginal private cost of producing output via type-a input* for each state i is given by $MPC^A \equiv \frac{c_a}{f_A}$, while the *marginal private cost of producing output via type-b input* is given by $MPC^B \equiv \frac{c_b}{f_B}$.

Because type-a input spills over from one state to another, the marginal private cost of producing output via type-a input differs from its marginal social cost. I define the *marginal social cost of producing output via type-a input* in state i as $MSC_i^A \equiv \frac{1-\alpha_j}{1-\alpha_i\alpha_j}\frac{c_a}{f_A}$ and the *marginal social cost of producing output via type-b input* in state i as $MSC_i^B \equiv \frac{1-\beta_j}{1-\beta_i\beta_j}\frac{c_b}{f_B}$. Unlike the marginal private costs, the marginal social costs are not symmetric across the two states.

Because the federal government uses its own cost function when making its decisions, what it perceives to be the marginal social cost of producing output via the two types of input may be incorrect. I define the *marginal federal cost of producing output via type-a input* in state i as what the federal government uses in its decision in place of the true marginal social cost. This value is given by $MFC_i^A \equiv \frac{1-\alpha_j}{1-\alpha_i\alpha_j}\frac{\theta_a c_a}{f_A}$. The *marginal federal cost of producing output via type-b input* in state i is $MFC_i^B \equiv \frac{1-\beta_j}{1-\beta_i\beta_j}\frac{\theta_b c_b}{f_B}$.

I assume it is privately (weakly) more costly to implement the type-a policy, but socially (weakly) more costly to implement the type-b policy: $MPC^A \geq MPC^B$ and $MSC_i^A \leq MSC_i^B \ \forall i$. If the state governments have input power, then the inputs would be chosen in a non-cooperative Nash equilibrium. If $MPC^A > MPC^B$, then each state would allocate all its conditional input to the privately less costly type-b input. In contrast, the socially optimal conditional input levels would be chosen cooperatively, yielding cost-effective input levels which achieve a given target output vector at minimum total cost. If $MSC_i^A < MSC_i^B$, then all the conditional input in state i would be allocated to the socially less costly type-a input. As a consequence, because giving states power yields a Nash equilibrium, an externality arises when states have input power, and also when they have output power. These externalities make the states' decisions inefficient.

For each stage of regulation, therefore, there is a trade-off between the externality that makes local control inefficient and the agency problem that makes central control inefficient. There are thus four types of regulatory inefficiency: an **input choice externality** that arises when states have input

power**,** an **output choice externality** that arises when states have output power, an **input agency problem** that arises when the federal government has input power, and an **output agency problem** that arises when the federal government has output power.

3 Analyzing the Model

In order to best establish the intuition behind my results, I begin with the simplest case of a unique one-sided spillover. In particular, I assume not only that type-a input is the only type of input that spills over (i.e., the spillover is "unique"), but also that the input only spills over from state 2 to state 1, but not vice versa (i.e., the spillover is "one-sided"): $\alpha_1 \in (0,1]$, $\alpha_2 = 0$ and $\beta_i = 0 \ \forall i$.

Proposition 1 *With a unique one-sided spillover, and if* $\theta_a = 1$ *and* $\theta_b > \frac{c_a f_B}{c_b f_A}$*, then:*
(i) reverse conjoint federalism dominates state control,
(ii) federal control dominates conjoint federalism,
(iii) state control weakly dominates conjoint federalism, and
(iv) state control strictly dominates conjoint federalism if there is an agency problem.

The intuition is as follows. If $\theta_b > \frac{c_a f_B}{c_b f_A}$, then there is no input agency problem: when the federal government has input power, it chooses the cost-effective input levels. For (i), reverse conjoint federalism dominates state control because while state control suffers from both an input choice externality and an output choice externality, reverse conjoint federalism suffers from an output choice externality; the difference between the two is the input choice externality. For (ii), federal control dominates conjoint federalism because while conjoint federalism suffers from both an input choice externality and an output agency problem, federal control only suffers from an output agency problem: again, the difference between the two is the input choice externality. For (iii) and (iv), while both state control and conjoint federalism suffer from an input choice externality, conjoint federalism also suffers from an output agency problem. With a linear production function, there is no additional output choice externality under state control when the states have input power.

Proposition 2 *With a unique one-sided spillover, if* $\theta_a = 1$ *and* $\theta_b > \frac{c_a f_B}{c_b f_A}$*, and if the federal government puts no weight on the benefits to at least one of the states (i.e., if* $\exists i$ *s.t.* $\eta_i = 0$*), then* $W^R > W^S > W^F > W^C$*.*

The federal government's objective function may put little weight on the benefits of the public good to at least one of the states as a result of the electoral college, for example, or during a Republican administration in the U.S. In this case, the output agency problem is so severe that output power should be allocated to the state government: therefore reverse conjoint federalism and state control dominate federal control and conjoint federalism. Conditional on the allocation of output power, input power should be allocated to the federal government because there is no input agency problem; therefore reverse conjoint federalism dominates state control and federal control dominates conjoint federalism. Although putting zero weight on one state's benefits is an extreme form of the output agency problem, the result that reverse conjoint federalism is second-best efficient when the agency problem is sufficiently severe hold more generally for less extreme cases as well.

I now generalize my simple base-case model to allow for two-sided spillovers from each input type.

Proposition 3 *If* $\theta_a = 1$ *and* $\theta_b > \frac{1-\alpha_j}{1-\alpha_i\alpha_j}\frac{1-\beta_i\beta_j}{1-\beta_j}\frac{c_a f_B}{c_b f_A}\forall i$, *then federal control weakly dominates conjoint federalism. If, in addition,* $\exists i$ *such that* $MSC_i^A < MSC_i^B$, *then federal control strictly dominates conjoint federalism.*

The intuition is as follows. Under the assumptions on θ_b, there is no input agency problem. Federal control weakly dominates conjoint federalism because while both scenarios suffer from an output agency problem, conjoint federalism also suffers from an input choice externality. In this case, the cooperative conditional input choice yields a corner solution in which all the input is allocated toward the type-a input, while the Nash equilibrium conditional input choice yields a corner solution in which all the input is allocated toward the type-b input. Thus, except in the knife-edge case in which $MSC_i^A = MSC_i^B$ so that all conditional input choices satisfy the cooperative first-order condition, the Nash equilibrium choice is not cost-effective, the input choice externality is therefore non-zero, and federal control is more efficient than conjoint federalism when the production function is linear.

Proposition 4 *If* $\theta_a = 1$ *and* $\theta_b > \frac{1-\alpha_j}{1-\alpha_i\alpha_j}\frac{1-\beta_i\beta_j}{1-\beta_j}\frac{c_a f_B}{c_b f_A}\forall i$, *and if the federal government does not value the benefits of at least one state (i.e.,* $\exists i$ *s.t.* $\eta_i = 0$*), then both state control and reverse conjoint federalism are infinitely more efficient than both federal control and conjoint federalism.*

Again, the intuition is that when the output agency problem is so severe, output power should be allocated to the state governments.

4 Concluding Remarks

Regulation often takes the form of a standard that can be met through the implementation of any of a number of different policies. This paper examines how the authority to set the standard and the authority to choose the combination of policies to meet the standard should be allocated between a central government and local governments, when neither setting nor meeting the standard is contractible.

According to the results, while delegation via reverse conjoint federalism can be the most efficient distribution of power, delegation in its more typical form of conjoint federalism can also be the *least* efficient. Thus, contrary to common practice, it may be best to allow individual units to each choose set its own standard and then to have the central authority decide how each unit should meet its standard. For example, states should each decide their own air quality standard or test score standard, but the federal government should be the tier that decides how to regulate emissions sources and how to improve schools in order to meet these standards. The federal government's role should be that of a facilitator.

Although reverse conjoint federalism is uncommon, some regulatory structures do resemble this form. For the regulation of crime in the United States, the federal government aids the states in meeting the criminal laws, or "output standards", they each set on their own by providing, as an "input policy", the Federal Bureau of Investigation's fingerprint service (Zimmerman, 1992). Similarly, while states set individual child support laws, the U.S. federal government implements policies to address, enforce and collect interstate child support payments when parents live in different states (Zimmerman, 1996). Reverse conjoint federalism also appears to describe the underlying philosophy of the World Trade Organization (WTO). For example, Article 20 of the General Agreement on Tariffs and Trade (GATT) allows member countries to each set their own health and safety standards, but the WTO sets the code of practice for preparing, adopting and applying these standards (WTO, 2004a). Similarly, member countries can each decide their own trade policies and practices (output), while the WTO reviews and meets these policies (WTO, 2004b). Because input needs to be enforced and output needs to be monitored or measured, input and output in these examples are subject to strategic misrepresentation risk and are therefore non-contractible. Moreover, in the case of the WTO, input and output are also non-contractible because contracts between countries are not enforceable.

The results therefore suggest that social welfare may be increased by

reversing the form of delegation often used in regulations in such federations as the United States and the European Union. These results may have important implications for the issue of optimally distributing governmental power in the provision of public goods as well as for any problem of organizational choice in the presence of interjurisdictional externalities.

5 Appendix: Proofs

Proof of Proposition 1. With a unique one-sided spillover, $\theta_b > \frac{c_a f_B}{c_b f_A} \Longleftrightarrow MFC_i^A < MFC_i^B \forall i \Rightarrow$the federal government makes the cost-effective input choice. If, in addition, $\theta_a = 1$, then the federal government makes the efficient output choice as well when $\eta = (1,1)$. Thus, (i) $\Delta^{RS} = \alpha_1 \nu_2 > 0$, (ii)$\Delta^{FC} = -\nu_2 \ln(1-\alpha_1) > 0$, (iii) $\Delta^{SC} = 0$ when $\eta = (1,1)$, and (iv) $\Delta^{SC} > 0$ when $\eta \neq (1,1)$.

Proof of Proposition 2. With a unique one-sided spillover, $\theta_b > \frac{c_a f_B}{c_b f_A} \Longleftrightarrow MFC_i^A < MFC_i^B \forall i \Rightarrow$the federal government makes the cost-effective input choice. If, in addition, $\theta_a = 1$, then the federal government makes the efficient output choice as well when $\eta = (1,1)$. If $\exists i$ s.t. $\eta_i = 0$, then (i) $\Delta^{SC} = \Delta^{RF} = \Delta^{SF} = \Delta^{RC} = \infty$, (ii) $\Delta^{RS} = \alpha_1 \nu_2 > 0$ and (iii) $\Delta^{FC} = -\nu_2 \ln(1-\alpha_1) > 0$. This means that $W^R > W^S > W^F > W^C$.

Proof of Proposition 3. $\theta_b > \frac{1-\alpha_j}{1-\alpha_i \alpha_j} \frac{1-\beta_i \beta_j}{1-\beta_j} \frac{c_a f_B}{c_b f_A} \forall i \iff MFC_i^A < MFC_i^B \forall i \Rightarrow$the federal government makes the cost-effective input choice. If, in addition, $\theta_a = 1$, then the federal government makes the efficient output choice as well when $\eta = (1,1)$. Thus, $\Delta^{FC} = \sum_i \left[-\nu_i \ln\left(MSC_i^A - MSC_i^B \right) \right] \geq 0$ since $\nu_i > 0$ and $MSC_i^A \leq MSC_i^B \ \forall i$. The inequality is strict if $\exists i$ such that $MSC_i^A < MSC_i^B$.

Proof of Proposition 4. $\theta_b > \frac{1-\alpha_j}{1-\alpha_i \alpha_j} \frac{1-\beta_i \beta_j}{1-\beta_j} \frac{c_a f_B}{c_b f_A} \forall i \iff MFC_i^A < MFC_i^B \forall i \Rightarrow$the federal government makes the cost-effective input choice. If, in addition, $\theta_a = 1$, then the federal government makes the efficient output choice as well when $\eta = (1,1)$. Thus, $\lim_{\eta_i \to 0} \Delta^{SC} = \lim_{\eta_i \to 0} \Delta^{RF} = -\lim_{\eta_i \to 0} \Delta^{FS} = \lim_{\eta_i \to 0} \Delta^{RC} = \infty$.

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