The Architecture of Federations: Constitutions, Bargaining, and Moral Hazard *

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Abstract

The paper studies a federal system where a region provides non-contractible essential inputs for the successful implementation of a local public policy project with spill-overs, and where bargaining between different levels of government may ensure efficient decision making ex post. Allowing financial relationships within the federation to be designed optimally, we ask whether the authority over the public policy measure should rest with the local government or with the central government. Centralization is shown to dominate when governments are benevolent. With regionally biased governments, both centralization and decentralization are suboptimal as long as political bargaining does not take place. With bargaining, however, the first best can often be achieved under decentralization, but not under centralization. At the root of this dichotomy is the alignment of decision making over essential inputs and project size under decentralized governance, and their misalignment under centralization.

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1 Introduction

The choice between centralized or decentralized political governance is arguably the most critical design element in federal systems. It is not surprising, therefore, that this issue has received considerable attention in the economic literature, starting with the pioneering work of Oates (1972). The main goal of the present paper is to study several empirically relevant – but previously disregarded – additions to the existing paradigm. In doing so, we are able to provide a novel argument why decentralization will often be beneficial. As in previous work, our starting point is a scenario in which a policy project that involves spillovers across the federation can be pursued in one of its regions. A federal constitution assigns authority over project choice either to the regional jurisdiction, or to a central decisionmaker, which may or may not be a benevolent government.

Models based on this standard setting usually posit that autonomous regional governments choose policies non-cooperatively. The failure to internalize spillovers on other regions then causes a suboptimal outcome under decentralization. Policy choice under centralization is hampered by other imperfections. Either the central authority is benevolent but subject to an exogenous requirement of policy uniformity. Or it is viewed as self-interested and composed of regionally biased federal politicians who, using agenda setting power, distort project choice away from the efficient level. Under this traditional approach, second best optimal governance then selects the regime that causes smaller distortions.

The present paper offers a different perspective of the tradeoffs at work. Our model uses the following building blocks. First, in a critical departure from most of the existing literature, we explicitly account for the possibility of negotiations between jurisdictions, and allow for an efficient outcome of the political bargaining process.[1] Bargaining over political projects across institutions is often observed in reality, regardless of whether decision power rests with the local or the central level of government.[2] Furthermore,

[1] To our knowledge, the only exception is Harstad (2006) which is discussed below.

[2] A good example of efficient inter-regional bargaining in a decentralized setting is Chernobyl. The remaining blocks of the Chernobyl nuclear power plant were finally shut down in December 2000 after intense negotiations between Ukraine and the EU. Under the terms of the accord, the EU provided almost one billion US dollars in compensation, and agreed to help build two modern replacement nuclear reactors. Another example are national tax policies in the EU. Although the tax authority

although transaction costs may often prevent efficient bargaining, a frictionless world provides a benchmark against which alternative views of political negotiations can be judged. This is true *a fortiori* as there is a lack of compelling arguments why these frictions should be more severe in the decentralization regime than under centralization. In the end, it may not matter much whether regional delegates come together in a federal assembly to bargain for a 'centralized' political outcome, or whether they meet as representatives of decentralized regions to negotiate political issues of mutual concern.

Second, in order to successfully reach a mutually beneficial agreement in reality, horizontal or vertical transfers are often called for. This leads us to illuminate the role of grant systems in the determination of optimal governance, and to endogenize the constitutional provisions which are taken in that respect. While Oates' original work emphasizes the role of Pigouvian grants and subsidies to resolve spillover problems, the more recent literature usually considers funding provisions as exogenously given at the constitutional stage, rather than being optimally set. In contrast, the present paper investigates optimal cost and output grant design in both institutional regimes.

Finally, pursuing and implementing significant political projects often involve a time and resource consuming process. This process involves several stages, and a whole range of measures are paramount for ensuring the final success. Many of these efforts are subject to moral hazard considerations: they are intangible in nature and therefore, cannot be made part of cost sharing arrangements among the member states in a federation. We argue that one important goal of efficient governance is to design authority and funding systems in a way as to resolve or at least alleviate moral hazard concerns.

As an example that illustrates these issues, consider the recently completed Canada Line Rapid Transit Project, a rail-based rapid transit line linking the Vancouver Airport to downtown Vancouver, BC. With its $ 1.9 billion (2006) capital cost, the transit line is one of the largest single public projects in the Vancouver area to date. On December 1, 2004 the local agency Greater Vancouver Transportation Authority (TransLink) gave its final approval to the completion of this project. Notably, although Translink

lies on the national (decentralized) level, member countries in 2006 agreed on exchanging information on capital flows in an attempt to crack down on tax evasion.

alone was put in charge of the Canada line, there had been prolonged negotiations involving agreements securing substantial funding contributions from both the federal and the provincial governments prior to the time of final approval.[3] Moreover, even before approval, Translink had already spent an estimated sum of at least $ 30 million on the project, primarily on the administration of the procurement process, property acquisition, community liaison, and public consultations.

The example exhibits the central features – mixed funding, political bargaining, and a costly planning process likely subject to moral hazard – that are often integral elements of public policy formation. All affected levels of government participate in the process through talks and negotiations. The final decision involves financial contributions through cost-sharing (matching) grants or other inter-governmental transfer mechanisms.[4] The way in which this cost-sharing arises is partly codified in the federal constitution, and it is logically distinct from the question of who has authority to implement a certain project. Finally, the support of the local authority is essential for a successful implementation: there are local citizens to convince, local laws to modify, local red tape to overcome; and local infrastructure to make compatible with the project size and design. The efficiency issue is to choose the system of governance and the project output and cost grants so that the local region will have the incentive to make these intangible investments into the success of the project optimally.

The theoretical framework we develop to study the above features is simple. There is a federation consisting of two regions. In the 'project' region a local public project of variable size becomes available. If implemented, this policy project causes spill-overs to

[3]To oversee procurement, design, construction, and implementation of the entire project from start to finish, TransLink created Canada Line Rapid Transit Inc. (CLCO, formerly RAVCO) as a special-purpose subsidiary. Apart from Translink itself, there are three other public funding sources: the federal government of Canada ($ 421 million), the provincial government of British Columbia ($ 387 million), and the Vancouver International Airport Authority ($ 251 million). In 2006, the Provincial government agreed to pay additional $65 million in exchange for design changes. Data Source: RAVCO Annual Report 2004 and Quarterly Report # 1, January – March 2005.

[4]Since almost half of the population in British Columbia live in and around Vancouver, the benefits to the provincial government are obvious. The federal government's interest in the Canada Line can possibly be attributed to the fact that it is part of the city's preparations for hosting the 2010 Olympics. That the local authority would approve the project was not certain until the final vote in the Translink Board of Directors, a body composed of mayors and officials of all cities that are part of the Greater Vancouver Area. Indeed, there had been several rounds of voting, each of which was followed by a federal or provincial pledge for new funding. For a complete history of the project, see http://www.richmond.ca/discover/services/rav.htm.

a second 'composite' region that comprises a majority of the federation's inhabitants. Representatives from both regions initially sign a 'constitution' that allocates authority rights, and details cost matching and output grant provisions. In a decentralized regime, the project region has the authority to determine the project size. In a centralized regime, authority rests with the federal government which does not pursue the overall public welfare, but is composed of regionally biased delegates who take decisions by majority rule. Hence, the composite region decides on project size. We account for the essential role of regional involvement by assuming that after signing the constitution, the project region can make preparatory investments into the project, which are non-contractible and thus subject to moral hazard. The return accrues in the form of reduced project cost or increased project quality, positively depends on implemented project size, and is identical across governance structures. Before the final decision on project size is made, regions may bargain over this decision to ensure a Pareto improving outcome, taking into account the regime-dependent default outcome.[5]

We first show that a centralized system works efficiently in a benchmark scenario where the central government is benevolent, and if an appropriate grant design is chosen ex ante. Specifically, while the central planner always implements the ex-post efficient policy level, efficient investments call for a combination of (non-Pigouvian) cost grants and output grants. In the remainder, we then adopt the more realistic view that central decisions are politically motivated rather than benevolent. For a scenario where inter-regional bargaining over final policies is infeasible, an efficient outcome is then shown to be impossible under both centralized and decentralized governance. Grants serve the dual role of implementing optimal investments and optimal project decisions, which in equilibrium leads to inefficiently low investment levels. Also, decentralization always yields an excessive project size, and there is no clear cut ranking of governance structures.

As a final step, we explore the full model by allowing regions to negotiate the final project decision. With frictionless bargaining, the equilibrium project choice is made

[5]In the absence of moral hazard, political bargaining would always ensure an efficient outcome, regardless of the authority structure. But even without political bargaining, a constitutional Pigouvian grant easily resolves the externality problem, again rendering the choice of governance structure inconsequential. Hence, the choice between decentralization and centralization can be meaningfully addressed only if either subsidies are suboptimal and bargaining is inefficient, or if a moral hazard problem exists.

efficiently in either governance structure, irrespective of the grant system in place. This outcome does not imply, however, that investments are also chosen optimally. Investments affect the project region's payoff through two channels. As a direct effect, investments change for given default project size the project region's overall gross payoff (composed of default payoff, and its share of the bargaining surplus). In addition, an indirect or 'influence' arises because larger investments boost the project quality and therefore, increase the default project size under each governance structure. Since the sign and size of these effects depends on the constitutional grant provision, one may think that a proper grant design renders the choice of authority structure meaningless. In fact, this result is borne out with Pigouvian grants which lead decisionmakers to implement efficient policies (and where political bargaining does not arise). However, these grants are not optimal while a central result of the paper proves that with optimal grant design, decentralization will generally dominate centralized governance.

To understand this main finding intuitively, note that the project region will invest heavily if it believes that the project will be large (direct effect) and if it wants to induce a large project (influence effect). When the project region chooses both the investments and the project size they expect and want a large project if the grants are large, which aligns these two invesmtent motives. When the project region chooses investments but not the project size (centralization) a small grant (large grant out of the project region) leads the project region to expect a large project but to want a small one. Thus under centralization, unlike decentralization, grants can not generally be chosen to induce the project region to make its intangible investments optimally. In one word, Authority matters and decentralization dominates because in contrast to centralization, it brings the investing region 'on side' for the success of the local project.

2 Related Literature

The classical theory of federalism (Musgrave, 1959; Oates, 1972) argues that regional governments cater better to the needs of their constituency than a central government because of the latter's tendency towards a uniform provision of public services across the federation. Conversely, the advantage of centralization lies in the internalization of all

federation–wide spillover effects of local public decisions.[6] This traditional view offers important guidelines for an understanding of hierarchical government, yet it is based on two strong assumptions: first, that the central government acts as a benevolent entity who pursues the common good and, second, that its policies must be uniform across all jurisdictions.

These issues are addressed in the more recent 'new' literature on federalism, which adopts a political-economy view of central government and questions uniformity of provision as a defining feature (and a disadvantage) of centralized public goods supply.[7] In Besley and Coate (2003), the level of impure public goods under centralization is determined either by a minimum-willing coalition of regions, or by cooperative bargaining among the delegates from all regions. In the former scenario, public goods supply is inefficient because the ruling coalition ignores the well-being of minority districts. The latter scenario leads to problems of strategic delegation in that local citizens have an incentive to elect local representatives with above median preferences for their local public good.[8] In either case, centralization can be suboptimal even when polities are relatively homogeneous and the elected policy makers achieve a Pareto-optimal outcome ex post. In Lockwood (2002), regions can propose policy projects in a federal assembly. The projects to be realized are then selected in a sequential voting process. This paper finds that the equilibrium outcome depends on the degree (and the sign) of spill-overs which a regional project has on the majority of other regions. At the same time, however, the final allocation will be completely independent of the benefits to the home region in which it can be carried out.[9]

[6]This reasoning is silent on distributional aspects which might impede on the formation of a centralized federal state. In other words, inter-regional side payments are assumed feasible, and the optimal governance structure maximizes the total available surplus. While we adopt the same assumption, one should emphasize that another important strand of the literature on federalism disregards the feasibility of side payments. Among others, Casella (1992), Seabright (1996), and Alesina and Spolaore (1997) focus on the tradeoff between scale effects within federations, and the preference heterogeneity among regions.

[7]See the discussion in Oates (2005), who provides an excellent survey of the recent literature on federalism. For an early contribution which abolishes a benevolent planner, see Ellingsen (1998). In his model, a pure public good is provided either in a decentralized fashion, or by a majority region that pursues its own interests under exogenous cost sharing rules.

[8]Inman and Rubinfeld (1997) have coined this latter scenario as *cooperative federalism*. For a similar argument on strategic delegation, but in a tax competition framework, see Persson and Tabellini, 1992.

[9]Several papers in the recent literature analyze federal systems with a hybrid organizational structure. The central government composed of individual regions directs public policies via majority vote.

This previous literature treats cost sharing rules as exogenous.[10] Moreover, decentralization is characterized by the total lack of cooperation with other regions in the federation, i.e., any political negotiations among regions in a decentralized system are ruled out. To our knowledge, the only other paper that explicitly studies political bargaining in decentralized settings is by Harstad (2007) and quite different in focus. The author considers a model where regions do not provide public inputs (investments) but have private information on their valuation of the project. The main result is that a mutual commitment to policy harmonization (uniform policies) may be advantageous in inter-regional negotiations because is reduces delay in bargaining.

In its emphasis on the role of specific investments prior to project realization, and in stressing the relevance of (re-)negotiations, our paper is also closely related to the literature on property rights and incomplete contracting (Grossman and Hart, 1986; Hart and Moore, 1990). There are two main differences. First, we allow not only for an assignment of authority rights but also for monetary grant provisions at a contractual prestage. By adding monetary elements which are prevalent in reality, initial contracting opportunities are less incomplete than usually assumed in the literature. Second, the standard property-rights model posits that agents without property rights (authority on our framework) realize a zero default. In contrast, externalities in our federalism setting naturally arise even when negotiations are unsuccessful and when as a consequence, the region with authority rights chooses a project design that she finds privately optimal. This public-goods character of the project is in line with the approach in Besley and Ghatak (2001) who show that because of this additional externality and in contrast to the central tenet from property-rights theory, the agent who benefits most from the project should be assigned authority rights.[11]

In addition, regions are allowed to top up these provisions (which can be interpreted as federal mandates) by individual choice. See Cremer and Palfrey (2000), Fernandez and Rogerson (2003), Alesina et al. (2005), and Hafer and Landa (2005). A general finding emerging from these papers is that a majority of regions prefers such a dual system over a pure centralized or a pure decentralized regime. See also Rubinchik-Pessach (2005) for a similar approach.

[10] In most settings, a switch from decentralized to centralized governance changes the financing rules of public projects, with cost sharing only assumed to be feasible under centralization.

[11] Setting and results of both papers differ significantly. Besley and Ghatak do not consider monetary (grant) schemes. They also confine attention to a binary project choice and assume that both agents always prefer project realization. Hence, the authority structure does not affect the default project size which in our setting, would make centralization and decentralization indistinguishable. Furthermore, in contrast to the present paper, marginal investment returns are assumed to depend on the authority

The remainder of the paper proceeds as follows. Section 3 introduces the model, and Section 4 analyzes a benchmark scenario with benevolent central government. Section 5 compares the outcomes under centralization and decentralization when negotiations on project size is disregarded, while Section 6 incorporates political bargaining. Section 7 concludes.

3 The Model

We set up a federal system that is comprised of two jurisdictions, $j = A, B$. Region A can pursue a public project x of variable size which may cause an externality on the other, composite, region B. The model has three stages: at a constitutional prestage (stage 0), the regions select an authority structure (centralization, decentralization) with regard to the implementation of the policy x, and in addition agree on a grant system that is detailed below. In a next stage (stage 1), region A undertakes two types of public investments. The first investment (labeled as a) increases the expected benefit of the policy measure x that is pursued subsequently. For instance, if the project is a new airport that benefits both regions, its social value may be enhanced by investments in the surrounding infrastructure (streets, public transportation), in noise abatement, or in improving the planning procedure as an intangible asset. Secondly, the region may also undertake investments e which decrease the expected costs of the policy project x: it may spend effort in finding the most cost-efficient suppliers, or invest in research to find out the most cost-efficient design. After these investments are made, uncertainty on value and costs of the policy measure is resolved at the beginning of stage 2. In Section 5 where the possibility of political bargaining among regions at this stage is left aside, the political institution with authority now chooses x which is then implemented in stage 3. Alternatively, regions A and B may be able to renegotiate the policy level by mutual consent, a scenario that is analyzed in Section 6 below.

Regions are governed by local governments, who by assumption act in the best interest of their respective constituencies.[12] Also, two distinct behavioral assumptions regard-

structure, and are larger for the agent in control. This feature in combination with regime-independent default projects yields the main result according to which the agent with higher stakes should have authority, regardless of the relative importance of each agent's investments.

[12] This behavioral postulate serves to simplify the analysis. Of course, this assumption is very natural

ing the central government will be explored. We first assume a benevolent planner who maximizes global welfare as is presumed in Oates' (1972) pioneering work. Subsequently, and more realistically, the central government is viewed as a federal assembly that is composed of delegates from both jurisdictions, who pursue the interests of their home regions.

Let $x \in [0, \bar{x}]$ be the size or scope of the policy project, e.g., the quantity or quality of public goods provided, the capacity of an airport, or the rigidity of environmental standards. We denote the value-enhancing investments of region A by $a \in R_0^+$. Likewise, cost-reducing investments are indicated as $e \in R_0^+$. The corresponding investment outlays are $\phi(a)$ and $\psi(e)$, respectively. In stage 2, after investments have been made and uncertainty has been resolved, a project of size x generates a total gross benefit measured in monetary terms by $V(x, a, \theta)$ across the federation. At the same time, it causes total implementation or opportunity costs $C(x, e, \theta)$. The variable θ is a random shock and distributed according to a continuous cumulative distribution function $F(\theta)$ on the support $[\underline{\theta}, \bar{\theta}]$. Benefits and costs of the 'status quo' policy $x = 0$ are normalized to zero. Throughout the paper, we also impose

Assumption. *All functions $V(\cdot), C(\cdot)$, $\phi(\cdot)$ and $\psi(\cdot)$ are non-negative. Moreover, $V(\cdot), \phi(\cdot)$ and $\psi(\cdot)$ are increasing in their arguments, whereas $C(\cdot)$ is increasing in x and θ and decreasing in e. For any a, e, θ, all functions satisfy (subscripts denote derivatives)*

a) $\lim_{x\to\bar{x}} V(x, a, \theta) - C(x, e, \theta) < 0$ *and* $V(x, a, \theta) - C(x, e, \theta) > 0$ *for some* $\theta < \bar{\theta}$ *and some* $x > 0$. *Also,* $V_{xx} \leq 0$, $C_{xx} > 0$.

b) $V_{ax} > 0$ *and* $\lim_{x\to\bar{x}} V_a(x, a, \theta) \to \infty$; $C_{xe} < 0$ *and* $\lim_{x\to\bar{x}} -C_e(x, e, \theta) \to \infty$.

c) $V_{aa}(\cdot) \leq 0$, $\phi_{aa}(\cdot) > 0$, $\phi(0) = \lim_{a\to 0} \phi_a(a) = 0$ *and* $\lim_{a\to\infty} \phi_a(a) = \infty$.

d) $C_{ee} \geq 0$, $\psi_{ee}(\cdot) > 0$, $\psi(0) = \lim_{e\to 0} \psi_e(e) = 0$ *and* $\lim_{e\to\infty} \psi_e(e) = \infty$.

if individuals in a region have identical preferences. With heterogenous voters, regional representatives may be elected in an intraregional voting process. Voters will elect a politician who represents, e.g., the preferences of the regional median voter. Analyzing intraregional heterogenity would be straightforward in the present context and is therefore left out in our analysis.

According to a), the socially efficient project size is unique, strictly positive in some states θ and always less than the maximal size $\bar{x}$, irrespective of investments. Part b) states that the return on cost-decreasing and value-enhancing investments increases in the project size. Specifically, the marginal return on investment increases without bounds. The convexity and Inada conditions in c) and d) ensure the optimality of some positive but finite investment levels.

For simplicity, we parameterize the regional shares of total benefits from the project. Region A reaps a gross return of $V^A = \beta V(\cdot)$ while the return of the composite region B is $V^B = (1-\beta)V(\cdot)$. Thus, the parameter $\beta \in [0,1]$ measures the relative spillovers of the policy pursued in the project region A on region B.[13]

Our special focus is on the interplay between the governance structure and grant assignments both of which are chosen at stage 0. Throughout the paper, grant payments can be contingent on the project level x and on its respective costs, $C(x,\cdot)$. On the other hand, the investments (a,e) as well as the state θ and the project gross value $V(\cdot)$ are assumed to be non-contractible. Investments may be intangible assets which are hard to verify, or they may represent a bundle of measures so complex that it is impossible to really describe them contractually. Likewise, the gross value of the policy is a benefit which is idiosyncratic to either region, and thus cannot be observed by an enforcing party (such as a Federal Supreme Court).

To keep the analysis transparent, we let regional preferences be described by quasi-linear utility functions. Monetary side payments thus enter additively, and utilities are fully transferable. Governance structure and grant system will then at stage 0 be chosen so as to maximize total expected surplus, and distributional issues do not enter the analysis.[14] Specifically, regions can set up the following grants which are often used in reality.

[13]For example, suppose x is a pure public good and all individuals in the economy have identical valuations. Then, $V(\cdot)$ is the sum of individual utilities in the overall economy, and β represents the fraction of individuals living in A while $(1-\beta)$ indicates the fraction of individuals who live in B. The case where there are no externalities corresponds to $\beta = 1$. The case of negative externalities, $(1-\beta) < 0$ can (with appropriate adjustments) be analyzed analogously and is therefore disregarded in our formal analysis.

[14]They can be can be accounted for by initial inter-regional lump-sum transfers. While size and direction of these transfers depend on the governance structure in force prior to the stage 0, and on the ex-ante bargaining strength of either region, we can be agnostic about these issues because they do not affect our analysis.

(i) Cost-matching grants. These grants are described by a parameter α that reflects the fraction of implementation costs $C(\cdot)$ to be borne by region B. If some x is implemented, region A thus receives a grant of size $\alpha C(x, \cdot)$ which is disbursed by the other region.[15]

(ii) Output grants. Region A may be eligible for grant payments that are contingent on the project size x. Indicating t as a payment per unit x, A receives an output grant of size tx when a policy x is implemented.

In summary, agents play the following stage game under perfect information.

Stage 0: Political representatives from each region decide on the governance structure and on a grant system, comprised of output and cost-matching grants. (In addition, there may be a non-contingent lump-sum payment made from one region to the other.)

Stage 1: Region A can undertake cost-reducing investments e and and value-enhancing investments a into a policy measure, x.

Stage 2: Uncertainty is resolved. Representatives from A and the composite region B may negotiate the size of policy measure x using Nash bargaining, in exchange for side payments. Default payoffs depend on whether region A (decentralization), or region B (centralization) has authority over implementing the project.

Stage 3: Policy x is implemented, grant payments are made, and the game ends.

As a benchmark for future comparison, it is useful to compute the socially optimal policy level $x^*(\cdot)$ to be chosen at stage 3. At that date, region A has already expended (a, e) and θ has been revealed. Accordingly, the efficient project size solves

$$x^*(a, e, \theta) = \arg\max_{x \in [0, \bar{x}]} S(x, a, e, \theta) \equiv V(x, a, \theta) - C(x, e, \theta). \tag{1}$$

Under our previous assumptions, $x^*(a, e, \theta) > 0$ for a nonempty set of realizations θ, which is then uniquely determined by the first-order condition

$$V_x(x^*, a, \theta) = C_x(x^*, e, \theta). \tag{2}$$

[15] Alternatively, grants may be paid by the central government and refinanced via general taxation that is imposed on either region. While the actual grant parameter may differ from α if region A bears a part of the federal revenues, α in our model is then a measure for the *effective* payments flowing to region A net of financing costs.

Define $S^* \equiv S(x^*(a,e,\theta),a,e,\theta)$ as the maximum surplus in stage 3 and note that S^* is independent of β and strictly increasing in (a,e) if $x^*(\cdot)>0$. In stage 1, the socially optimal investment outlays (a^*,e^*) to be undertaken by region A maximize the ex-ante expected overall surplus in the economy, i.e.,

$$(a^*,e^*) \in \arg\max_{a,e\geq 0} \; E_\theta\left[S(x^*(\cdot),a,e,\theta)\right] - \phi(a) - \psi(e). \tag{FB}$$

Again, our assumptions ensure that (a^*,e^*) satisfies the corresponding first-order conditions which, using the envelope theorem, read

$$E_\theta\, V_a(x^*(\cdot),e^*,\theta) = \phi_a(a^*) \quad \text{and} \quad -E_\theta\, C_e(x^*(\cdot),e^*,\theta) = \psi_e(e^*) \tag{3}$$

As expected, marginal expected investment returns (evaluated at the conditionally optimal policy level) are equalized to marginal investments costs at the optimum.

In what follows, indicate the first-best project size in a state θ as $x^{FB}(\cdot) = x^*(a^*,e^*,\theta)$. Also, let $a^*(e)$ (and $e^*(a)$, respectively) be the conditionally optimal level of a for any given e (and the conditionally optimal level of e for any given a, respectively). We can now start an equilibrium analysis for different assumptions on government behavior.

4 Benevolent Central Planner

To start with, consider a centralized governance structure in which a benevolent government P has authority over the policy measure x. Denoting as $S^j(\cdot)$ the gross surplus of region j and recalling that distributional issues are irrelevant in our setting, this planner chooses x in stage 3 so as to maximize

$$S(\cdot) = S^A(\cdot) + S^B(\cdot) = V(x,a,\theta) - C(x,e,\theta). \tag{4}$$

Clearly, the resulting policy level $x^*(e,a,\theta)$ is efficient for any (a,e) and in any state of the world θ. We can now investigate the investment decisions of region A in stage 1. For any constitutional grant assignment (t,α), the region chooses a and e to maximize the net surplus of its inhabitants (P stands for Benevolent Planner),

$$U_P^A(\cdot) = E_\theta\left\{\,\beta V(x^*,a,\theta) + tx^* - (1-\alpha)C(x^*,e,\theta)\right\} - \phi(a) - \psi(e). \tag{5}$$

Maximization of this program yields the following first-order conditions for the region's equilibrium investments:

$$E_\theta \{ \beta V_a(x^*, a, \theta) + [\beta V_x(x^*, \cdot) + t - (1-\alpha) C_x(x^*)] \frac{dx^*}{da} \} = \phi_a(a), \quad (6)$$

$$E_\theta \{ -(1-\alpha) C_e(x^*, e, \theta) + [\beta V_x(x^*, \cdot) + t - (1-\alpha) C_x(x^*)] \frac{dx^*}{de} \} = \psi_e(e). \quad (7)$$

The first terms in (6) and in (7), respectively, represent the (positive) marginal direct effect of investments on A's payoff. The second term in both conditions indicates an indirect effect which arises because region A has preferences over but cannot directly choose the project size: since the central government's selection of $x^*(a, e, \theta)$ depends on region A's effort, the region indirectly affects the central policy. Notice that the indirect effect is positive if and only if $x^A(\cdot) > x^*(\cdot)$, and vice versa: If region A is eligible for large grant payments, it is interested in a larger policy than P will provide, and higher investments are a tool to achieve this goal.

To further assess conditions (6) and (7), suppose first $\alpha = t = 0$, a situation where A receives no monetary support from the other regions in the federation. Then, the indirect effect in either condition is negative whenever $\beta < 1$ because $x^*(\cdot)$ is increasing in a and e, and $V_x(x^*, \cdot) - C_x(x^*(\cdot) = 0$ by the definition of $x^*(\cdot)$. In absence of grant payments, the region aims to reduce the policy level x through reduced investments because it bears the entire costs while receiving only a fraction β of the accompanied social benefits. In addition, the direct effect in (6) is smaller than the social marginal return from value-increasing investments for any $\beta < 1$. For these reasons, the region unambiguously underinvests not only in benefit enhancement, despite being full residual claimant for its cost savings, also in cost reduction when $\alpha = t = 0$.

We can now ask whether cost or quantity grants can remedy this underinvestment problem. The answer is positive, by the following arguments. Note that the indirect effect increases in t without bounds because $x^*(\cdot)$ remains unaffected. Hence, for any arbitrary α, some $t^*(\alpha)$ renders the indirect effect strictly positive and satisfies (6) for $a = a^*(e)$. Next, consider (7) for $t = t^*(\alpha)$. Again, the indirect effect is positive which implies that A overinvests in cost-reducing activities for $\alpha = 0$. At the same time, increasing α while fixing $t = t^*(\alpha)$ reduces e arbitrarily.[16] As a result, there must

[16]We cannot rule out some $\alpha > 1$ to be optimal here, in order to prevent an overshooting of A's cost-reducing investments.

exist some combination $(\alpha^*, t^*(\alpha^*))$ which implements the fixed points $a = a^*(e)$ and $e = e^*(a)$, and we have

Proposition 1. *Consider centralization with a benevolent government. Then, some constitutional policy* $(\alpha^* > 0, t^* > 0)$ *implements a first-best outcome. Moreover, under the optimal grant design, region A would prefer a policy size larger than the one chosen in equilibrium.*

Centralization is an efficient governance structure if grant design is optimized and if the central government maximizes social welfare. Moreover, both cost and output grants are necessary to sustain a first-best outcome.[17] These findings have intuitive appeal. With a benevolent central government, grants serve no role in achieving an ex-post efficient policy outcome: given the preferences of the federal decisionmaker, x^* prevails regardless of constitutional grant provisions. Rather, the purpose of grants is to fine tune the project region's incentives to invest in cost reduction and benefit enhancement, which quite naturally requires a properly designed combination of output and cost grants.

The Proposition also conveys that optimal grants are so sizable that region A prefers a larger project than the one actually implemented by the central government. To see why, consider 'small' grants for which region A would prefer a project size less or equal to $x^*(\cdot)$. Inspecting (6) and noting that the indirect effect is non-positive, shows that with positive externalities $\beta > 0$, the region will still underinvest in value increasing measures as it reaps only a fraction of the associated benefits. Remedying this non-internalization problem requires larger grants: the region A would then prefer a project size in excess of $x^*(\cdot)$, which renders the indirect effect positive. In simple terms, large grants boost the project region's investment incentives because a larger project size implies larger absolute grant payments.

[17] If the region invests only in value enhancement, the instruments α and t substitute each other, and using only one of them is sufficient for implementing a efficient outcome. Conversely, with only cost reducing investments, an output grant t always achieves efficiency whereas in general, a cost grant α does not as it causes the direct and indirect effects to move in opposite directions.

5 Federalism without Political Bargaining

From now on, we drop the assumption of a benevolent central government. The present Section 5 investigates a federal system where regions do not negotiate with each other to determine the final policy. Under centralization, federal policies are selected in a simple majority vote process among regions from different regions. Under decentralization, the project region A decides.[18] In each regime, we allow for efficient grant design and compare findings to those in absence of constitutional grant promises.

5.1 Decentralization

If project region A decides on x, the regional government chooses the project size to maximize regional welfare.[19] Under a grant system (α, t), region A will in stage 3 implement a policy x^A which maximizes its continuation utility

$$S^A(x, a, e, \theta, \alpha, t) = \beta V(x, a, \theta) + tx - (1-\alpha)C(x, e, \theta) \tag{8}$$

in each state θ. The corresponding first-order condition for an interior solution $x^A > 0$ reads

$$\beta V_x(x^A, a, \theta) + t = (1-\alpha)C_x(x, e, \theta). \tag{9}$$

One can easily check that $x^A(\cdot)$ is strictly increasing in (a, e) and in t, and strictly decreasing in α. For the Pigouvian cost subsidy $\alpha = 1 - \beta$ and $t = 0$, region A implements the ex-post efficient policy $x^*(\cdot)$. Conversely, without any grant assignment, $\alpha = t = 0$, $x^A(\cdot) < x^*(\cdot)$ whenever spillovers are present, $\beta < 1$. In anticipating of its subsequent project choice, region A invests at stage 1 so as to maximize (D stands for Decentralization)

$$U_D^A(\cdot) = E_\theta \{ \beta V(x^A, a, \theta) + tx^A - (1-\alpha)C(x^A, e, \theta) \} - \phi(a) - \psi(e). \tag{10}$$

[18] This latter regime differs from the setting in Oates (1972) because regions can undertake non-contractible investments. Hence, we address the issue whether in our extended setting, corrective grants still implement an efficient outcome under decentralization.

[19] While intra-regional heterogeneity is disregarded for simplicity, we could easily incorporate it by assuming regional decisions to be taken by majority voting under some given financing rule. Then, the median voter theorem applies and regional policies are determined by the preferences of the individual with median preferences (see, e.g., Besley and Coate, 2003; Alesina et al., 2005). Besley and Coate (1997) show that this result extends to mutidimensional policy spaces in two candidate elections, which can arise endogenously in their model. As is well-known, such democratic processes will not maximize regional welfare in an utilitarian sense if median preferences differ from mean preferences.

Using the envelope theorem, the equilibrium investments (a^D, e^D) are then implicitly determined by the first-order conditions

$$E_\theta\, \beta V_a(x^A, a, \theta) = \phi_a(a) \tag{11}$$

and

$$-\, E_\theta\, (1-\alpha) C_e(x^A, e, \theta) = \psi_e(e). \tag{12}$$

If region A receives no grants, the level of its cost-reducing investments is optimal for the (suboptimally small) policy x^A that is subsequently implemented. In contrast, value-increasing investments will be suboptimal relative to x^A, because region A disregards the effect of its investment on the other region for $\beta < 1$. Only for $\beta = 1$ where spillovers are absent, both types of investments are chosen efficiently and $x^A(\cdot) = x^*(\cdot)$, with the consequence of a first-best outcome.

Consider now cost and output subsidies. The most prominent examples of such grant systems are corrective 'Pigouvian' grants that help regional decisionmakers to internalize external effects, and yield an efficient policy, here, $x^*(\cdot)$. Our setting features a continuum of Pigouvian grant systems, specifically, the pure cost grant $\alpha^P = 1 - \beta$ and the pure output grant $t^P = E_\theta\, (1-\beta) V_x(x^*, \cdot)/x^*(\cdot)$. But more generally, each combination $(\alpha, t)^P$ satisfying $t(\alpha) = (1-\alpha) C_x(x^*(\cdot), \cdot) - \beta V_x(x^*(\cdot))$ at equilibrium investment levels for given grant parameters, implements the ex-post efficient project size $x^A(\cdot) = x^B(\cdot) = x^*(\cdot)$. Throughout the paper, we find that Pigouvian subsidies are optimal only in special circumstances, and that cost and output grants are not mere substitutes to each other. Specifically, output subsidies often dominate cost subsidies, but a combination of both grant types is sometimes desirable.

Even with an optimal grant design, efficient policies $x^*(\cdot)$ are incompatible with the goal of achieving efficient value-enhancing investments $a^*(e)$. Specifically, condition (11) immediately reveals that for any arbitrary policy x^A , investment incentives are always smaller than efficient (given x^A) whenever $\beta < 1$. This is not true for cost-reducing investments, though. Here, $\alpha = 0$ and an output grant inducing $x^A = x^*(\cdot)$ guarantees efficient cost reduction $e^*(a)$, as is easily seen from (12). Note also that under the second-best grant design, the regions will never use a cost subsidy $\alpha > 0$. Any cost-matching grant distorts A's incentives to invest in cost reduction, simply because the region no longer bears the full project costs. In contrast, a positive output

grant is desirable, inducing region A to choose a larger project size and to internalize the project externality to some degree. We can state

Proposition 2. *Consider decentralization without ex-post bargaining. An optimal federal constitution comprises output grants $t^* > 0$ but no cost-matching grants, $\alpha^* = 0$. Moreover,*

(1) a first best outcome prevails if the region undertakes only cost-reducing investments. Moreover, the optimal subsidy is a Pigouvian output grant.

(2) With spillovers ($\beta < 1$), a first-best outcome is infeasible if the region undertakes value-increasing investments, or both investments. Under the optimal grant, the region implements a policy $x^A(\cdot) \geq x^*(\cdot)$, it underinvests in value enhancement, and it invests optimally (given x^A) into cost reduction.

Proof: see the Appendix.

In presence of externalities, decentralization fails to achieve efficiency whenever value-increasing investments play a role. The reason for this deficiency is intuitive. While grants can control the project size that is selected by region A, they cannot tackle the externality that arises because A does not reap the full social return of its value-increasing activities. This causes a trade-off between larger investments if $x^A(\cdot)$ is raised above $x^*(\cdot)$, and the reduction in allocative efficiency which goes along with it.[20] Since this tradeoff does not arise for cost-reducing investments and $\alpha = 0$, the optimal grant system yields an equilibrium policy which is never smaller but possibly *larger than efficient*. Grant payments in the decentralization regime should thus exceed those of a Pigouvian subsidy in order to ensure a second-best outcome.

Interestingly, the efficiency outcome for cost-reducing investments *requires* the regions not to use cost matching grants in their constitution. The explanation is simple. Any cost grant counterbalances the region's incentive to invest in cost reducing measures for any given project size, because it now shares the marginal benefits of its actions with the other region. Accordingly, despite its preponderance in reality, cost matching

[20] In contrast to centralization with benevolent government where grants leave the final policy choice unaffected, grants under decentralization serve the dual purpose of fine tuning investments, and affecting the project size.

grants are no useful instruments in an economic scenario with moral hazard element, and in which there is no ex post interregional bargaining on project size.[21]

Our results so far show that with a benevolent central government, centralized authority on project implementation strictly dominates decentralization, even if optimal corrective grants are available. Another interesting issue is whether the unambiguous ranking of benevolent centralization in the tradition of Oates, and decentralization with a regional planner continues to hold for non-optimal subsidy levels. Some answers are given in

Proposition 3. *Without a grant policy, $t = \alpha = 0$, decentralization may dominate centralization with a benevolent planner. Also, for any Pigouvian grants $(\alpha, t)^P$ inducing $x^A = x^*$, both regimes are economically identical and region A underinvests in both cost reduction (unless $\alpha = 0$) and value enhancement.*

Proof: See the Appendix for an example where decentralization dominates for any degree of spillovers, $\beta < 1$, given $(\alpha, t) = (0, 0)$. The second statement immediately follows from inspection of the respective first-order conditions.

When grants are not optimally set, a benevolent central government is not necessarily desirable. As Proposition 3 shows, decentralization may dominate, notwithstanding the fact that regional government takes neither the external effects of its investment choice *nor* those of its policy selection into account. Intuitively, with small or no grants, the project region would prefer a smaller policy than the one actually chosen by the central planner. Its only tool to achieve this goal is a reduction in investments, a motive which is absent in the decentralization regime where region A is in control of policy choice. Investments under decentralization will thus be more efficient, and decentralization can be preferable overall even though project size is too small. The Proposition also says that interestingly, Pigouvian grants render both governance structures economically identical. Since these grants align the desired outputs of central and regional government, they also trigger identical investment responses.

[21] The same logic immediately applies to the case of centralization. In contrast, Section 6 below shows that the argument becomes invalid in a setting where regions can negotiate the project size.

5.2 Centralization

We now envision the central government as a federal assembly, composed of representatives from both regions. These delegates pursue their own idiosyncratic interests which, as said before, coincide across all individuals within each region for simplicity. This setup encompasses parliamentary systems in which political decisions are taken by some form of majority vote in a federal assembly (e.g., as in the UK, Germany or Canada), as well as a Presidential systems in which some elected decisionmaker is assigned for making these decisions (as, e.g., in the US or in France).

Decisions are taken via majority rule so that the region with more delegates in the assembly can enforce its preferred policy. If region A is the majority region, the outcome clearly coincides with the one under decentralization. To make the subsequent analysis meaningful, let us thus suppose that delegates from the composite region B form the majority.[22] If region B has authority in the democratic process, it will in stage 3 choose a policy x^B to maximize

$$S^B(a, e, \theta, \alpha, t) = (1 - \beta)V(x, a, \theta) - tx - \alpha C(x, e, \theta), \tag{13}$$

and the corresponding first-order condition for interior solutions reads

$$(1 - \beta)V_x(x^B, a, \theta) - t = \alpha C_x(x^B, e, \theta). \tag{14}$$

In contrast to the decentralization regime, $x^B(\cdot)$ now strictly decreases in t and α because region B dislikes grant payments. As under decentralization, for $\alpha = 1 - \beta$ and $t = 0$, the implemented policy is ex-post efficient. Anticipating x^B, region A then chooses it investments at stage 1 so as to maximize (C stands for Centralization)

$$U_C^A(\cdot) = E_\theta \{ \beta V(x^B, a, \theta) + tx^B - (1 - \alpha)C(x^B, e, \theta)\} - \phi(a) - \psi(e). \tag{15}$$

Accordingly, the equilibrium investments (a^C, e^C) are implicitly determined by the first-order conditions

$$E_\theta \, \beta V_a(x^B, a, \theta) + [V_x(x^B, a, \theta) - C_x(x^B, e, \theta)]\frac{dx^B}{da} = \phi_a(a), \tag{16}$$

[22] Alternatively, we could assume that all federal citizens, or the representatives in the federal assembly, elect a federal policymaker. All subsequent results also apply to each of these alternative settings.

$$- E_\theta\,(1-\alpha)C_e(x^B,e,\theta) + [V_x(x^B,a,\theta) - C_x(x^B,e,\theta)]\frac{dx^B}{de} = \psi_e(e). \qquad (17)$$

Unlike the decentralization regime, an indirect effect appears in these optimality conditions. While a larger investment of region A again boosts project size, this choice x^B is now made by the other region, and affected by region A's investments.[23] The indirect effect is positive and enhances investment incentives only if $V_x(x^B,\cdot) - C_x(x^B,\cdot) > 0$,[24] which is satisfied if grants to region A are larger than Pigouvian so that $x^B < x^*$. Otherwise, for small grants so that x^B exceeds x^*, A wants to induce a smaller x^B which renders the indirect effect negative and reduces investments.

Given these considerations, regions at the constitutional stage now face the following tradeoff. Substantial grants which trigger a small policy level x^B make the direct investment effect small but allow the indirect effect to be positive, or vice versa. Whenever value-enhancing investments play a role, this tradeoff cannot generally be resolved in favor of large or small grants. Rather, the induced policy can either be larger or smaller than efficient, depending on the specific functional forms. We can state the following results.

Proposition 4. *Consider centralization without ex-post bargaining. If the region undertakes only cost-reducing investments or if $\beta = 1$, efficiency prevails with the same grant policy $(t^* = t^P, \alpha = 0)$ that is optimal under decentralization. Otherwise, the outcome remains inefficient and the optimal project choice may be larger or smaller than $x^*(\cdot)$. Finally, centralization and decentralization cannot be welfare ranked in general.*

Proof: For $\alpha = 0$ and the Pigouvian output grant $t = t^P$, project size is $x^B = x^*$ and condition (17) holds at $e = e^*(a)$. To establish the second result, observe that the indirect effect in (16) is non-zero only if $x^B \neq x^*$. Hence, $x^B = x^*$ is incompatible with $a = a^*(e)$ unless $\beta = 1$. Moreover, in contrast to decentralization, the optimal x^B can be smaller than x^*: while raising x^B above x^* boosts the direct investment effect in (16), the now negative indirect effect may dominate. □

In sum, neither democratic centralization nor decentralization generate an efficient

[23] In long form, the indirect effect is $[\beta V_x(x^B,a,\theta) + t - (1-\alpha)C_x(x^B,e,\theta)]dx^B/di$ for $i = e, a$. Since x^B is given by (14), this can be simplified to the expressions stated in (16) and (17).

[24] Verify that that x^* is always in between x^A and x^B. Specifically, $x^A > x^* > x^B$ holds for large grants, while the reverse is true if grants are small.

outcome when value-enhancing investments are feasible. Both governance modes yield different economic outcomes when the second-best efficient grant schemes are in place. While performance is identical under Pigouvian grants where $x^A = x^B = x^*$, we found that $x^A > x^*$ to be optimal under decentralization while $x^B < x^*$ may be optimal in a centralized setting.[25] For this reason, a clearcut welfare comparison must remain elusive when inter-regional bargaining is prohibited and central decisionmaking is political rather than benevolent.

6 Federalism with Political Bargaining

This Section introduces a novel and important element of real-world politics.[26] We allow politicians from different regions to negotiate the final policy outcome after uncertainty on benefits and costs has been resolved. Because the policy project is associated with spillovers, there are benefits from such a policy coordination prior to the final decision on x. Taking recourse to Coase (1960), renegotiations can be expected to produce an efficient outcome when all involved parties have complete information, which is ensured in our framework. Therefore, rational politicians will in stage 2 enter negotiations and agree on the ex-post efficient policy $x^*(a, e, \theta)$. This is true regardless of the institutional setting in place; in particular, and in contrast to the existing literature, political negotiations are assumed to be feasible in the decentralization regime.[27]

For concreteness and in line with the property-rights literature (see, e.g., Hart, 1995), we assume that the unfolding bargaining process between the regional representatives results in the generalized Nash-bargaining solution. Thus, in equilibrium each region obtains its governance- and transfer-dependent disagreement payoff, plus a fixed share

[25] Decentralization unambiguously dominates centralization if the optimal x^B is larger than x^* (which means the indirect investment effect under centralization is negative). However, if the indirect effect is sufficiently sizable, it is optimal to have $x^B < x^*$, because the positive indirect effect causes more efficient investments.

[26] This is done in a way which borrows from Lülfesmann (2002) who, however, considers a more restricted model. His paper does not analyze the case of a benevolent central government, focuses on value-increasing investments, and disregards output grants.

[27] As said before, we disregard transaction costs that may render an efficient outcome infeasible. Imposing transaction costs would not alter our qualitative results unless they differ across regimes, which often seems implausible. After all, there is no compelling reason why the possibility to renegotiate is linked to the authority structure as set in the constitution.

of the bargaining gain which becomes available when $x^*(\cdot)$ rather than the respective disagreement policy is implemented. The shares reflect a region's relative bargaining strength and are parameterized as $\gamma \in [0,1]$ for region A and $(1-\gamma)$ for region B, respectively.[28]

In what follows, this setting is first explored for the regime of decentralized governance. Then, we investigate democratic centralization where decisions again require a majority of delegates in the federal assembly.

6.1 Decentralized Politics with Bargaining

Under decentralization, region A can autonomously decide on its policy projects. Nevertheless, gains from trade can be realized if the region enters negotiations with the government in B after investments have been expended and the state of the world has become clear. To establish disagreement payoffs, suppose first that negotiations with region B fail. Then, region A will in stage 3 again implement a project of size

$$x^A(a,e,t,\alpha,\theta) = \arg\max_x \ \beta V(x,\cdot) + tx - (1-\alpha)C(x,\cdot). \tag{18}$$

Accordingly, a switch from policy $x^A(\cdot)$ to policy $x^*(\cdot)$ increases total surplus by an amount $\Delta_{DP} = [V(x^*,\cdot) - C(x^*,\cdot) - (V(x^A,\cdot) - C(x^A,\cdot))] = S^*(a,e,\theta) - S(x^A,a,e,\theta)) \geq 0$ which represents the bargaining surplus under decentralized politics (DP). Frictionless negotiations will in equilibrium be successful and region A appropriates a share γ in Nash bargaining. In stage 1, region A therefore maximizes

$$U^A_{DP}(\cdot) = E_\theta\left[S^A(x^A,a,e,\theta,\alpha,t) + \gamma(S^*(a,e,\theta) - S(x^A,a,e,\theta))\right] - \phi(a) - \psi(e). \quad (DP)$$

Using the envelope theorem, the associated the first-order conditions for equilibrium investments (a^{DP}, e^{DP}) are[29]

$$E_\theta\left[(\beta-\gamma)V_a(x^A,\cdot) + \gamma V_a(x^*,\cdot) - \gamma[V_x(x^A,\cdot) - C_x(x^A,\cdot)]\frac{dx^A(\cdot)}{da}\right] = \phi_a(a) \tag{19}$$

[28] While one may argue that these bargaining weights are related to the size, political, or economic importance of regions, we remain agnostic with respect to the determinants of bargaining strength, and also abstract from the possibility of 'renegotiation design' that is sometimes discussed in the literature (see, e.g., Aghion et al., 1994).

[29] We require program (DP) (as well as program (CP), see below) to be well behaved. This is the case if the investment cost functions $\phi(\cdot)$ and $\psi(\cdot)$ are sufficiently convex.

and

$$E_\theta \Big[-(1-\alpha-\gamma)C_e(x^A,\cdot) - \gamma C_e(x^*,\cdot) - \gamma[V_x(x^A,\cdot) - C_x(x^A,\cdot)]\frac{dx^A(\cdot)}{de}\Big] = \psi_e(e) \quad (20)$$

for $(a,e) = (a^{DP}, e^{DP})$, respectively. In contrast to the scenario in Section 5 without political bargaining, the first order conditions now exhibit several novel effects. The direct effect changes because for given $x^A(\cdot)$, investments improve not only the region's default payoff but at the same time, they affect the available bargaining surplus.[30] Second, investments now have an indirect effect (captured in the last terms of (19) and (20)), which we might call the 'influence' effect: investments affect the default project x^A, and therefore, the bargaining surplus Δ_{DP}.[31] Specifically, if grants are large and the default policy is larger than efficient so that $V_x(x^A) - C_x(x^A) < 0$, a further investment-induced increase in x_A reduces the sum of default payoffs, boosting the bargaining surplus. This renders the influence effect positive and enhances investments. By the same token, the indirect effect is negative for $x^A(\cdot) < x^*(\cdot)$, and it disappears altogether for Pigouvian grants where $x^A(\cdot) = x^*(\cdot)$.

Suppose the regions set up an optimal grant system at stage 0, and consider the left-hand side of (19), region A's marginal return from value-increasing investments. For any cost grant $\alpha \geq 0$, there exists some output grant t which raises $x^A(\cdot)$ above $x^*(\cdot)$ and renders the indirect effect positive. At least if $\beta > \gamma$ so that the spillover effect is not too pronounced and the direct effect is positive, one can implement $a^*(e)$ by a grant design which leads A into choosing an optimal default policy $x^A > x^*$.[32] For any α, indicate the corresponding output grant which achieves this outcome as $\hat{t}(\alpha)$.

Next, consider (20) and note that as in the setting without bargaining, efficient cost-reducing investments can again be implemented without using cost grants ($\alpha = 0$). Fixing the output grant in a way that $x^A(\cdot) = x^*(\cdot)$, the indirect effect disappears and

[30] Larger investments have two countervailing effects on the bargaining surplus: they raise total surplus $S(x^*,\cdot)$ but also the sum of both regions' default payoffs. Overall, the direct effect (taking the familiar effect of investments on A's default payoff into account) remains strictly positive at least if $\beta > \gamma$.

[31] By the envelope theorem, an increase in $x^A(\cdot)$ has only a second-order effect on region A's default payoff $S^A(x^A,\cdot)$. We will later see that changes in the default project will affect region A's default payoff under centralization.

[32] We invoke part c) of Assumption 1 here. Notice that an optimal grant design must satisfy $x^A > x^*$: for a default policy x^A which is smaller than efficient, the indirect effect in (19) would be negative while the direct effect is not large enough to generate proper investment incentives.

efficiency is attained. In contrast to the scenario in Section 5, though, the absence of a cost grant is now by no means *necessary* to induce an efficient outcome. To see this, note that for *any* choice of $\alpha \leq 1-\gamma$, the direct effect is positive. Adjusting the output grant, it is then possible to make the direct effect arbitrarily large, and the influence effect unambiguously positive. By continuity, there must exist some $\tilde{t}(\alpha)$ that allows to achieve $e^*(a)$.

The final question is whether efficient value-increasing and cost-reducing investments are feasible at the same time. Remember that at least if $\beta \geq \gamma$, efficient value-enhancing investments $a^*(e)$ are implementable through constitutional grants $(\alpha \geq 0, \hat{t}(\alpha))$. Similarly, any constitution with $(\alpha \leq 1-\gamma, \tilde{t}(\alpha))$ implements $e^*(a)$. In combination, a first-best result prevails if the conditions $\beta \geq \gamma$ and $\hat{t}(\alpha^*) = \tilde{t}(\alpha^*)$ are satisfied for some $\alpha^* < 1-\gamma$. An analysis yields

Proposition 5. *Under decentralized politics, the political bargaining ensures an efficient policy level level $x^*(a, e, \theta)$. Moreover,*

(1) Suppose region A can undertake only one type of investment, e or a. For cost-reducing investments, various grant policies implement an efficient outcome. This is also true for value-enhancing investments (at least) if spillovers are not too pronounced, $\beta > \gamma$.

(2) Suppose region A can undertake both value-enhancing and cost-reducing investments. In this case, the first best generically prevails for any $\beta > \gamma$, and the optimal grant policy calls for positive output and cost subsidies.

Proof: see the Appendix.

When political bargaining is taken into account, decentralizion yields efficiency in a wide range of economic situations, provided an optimal grant system is in place.[33] Efficiency again prevails if the region can undertake only cost-reducing investments. In sharp contrast to the previous scenario without bargaining, though, a first best outcome is often attained when the region undertakes value-enhancing (or both types

[33]Without efficient grants, a commitment not to negotiate may be beneficial, even though it causes an inefficient project choice. For example, when $\alpha = t = 0$ so that $x^A(\cdot) < x^*(\cdot)$, the negative influence effect reduces investment incentives. This effect can be so severe that it outweighs the inefficiencies arising in a system where bargaining is prohibited.

of) investments, and generically so if the project region's benefit from its own public project is sufficiently large ($\beta > \gamma$).[34] In these situations, cost and output grants are to be set at a level where A's preferred default project x^A exceeds x^*.

The economic intuition for these findings is strong. When political bargaining is infeasible, grants not only have to assign proper investment incentives, but they also need to ensure an optimal policy choice. We have seen that these goals are generally incompatible. When political bargaining becomes feasible, an efficient project size is achieved irrespective of the grant design, and grants only need to implement appropriate investments. While this appears deceptively easy with two subsidy instruments at hand, one should notice that negotiations add an additional investment effect to the project region's payoff. The general efficiency result for $\beta > \gamma$ prevails because under decentralization, the direct and indirect (influence) investment effects of larger grants work into the same direction for $x^A > x^*$: a grant increase raises x^A, thereby increasing the direct effect without bounds while the influence effect remains positive.[35]

Conversely, if $\beta < \gamma$ so that spillovers are dominant, the direct effect is negative and decreasing in x^A. Hence, for $x^A(\cdot) > x^*$, the direct and the indirect effect in (19) have opposite signs. While this prevents a general efficiency result for this case, there are situations where decentralization is efficient regardless of the degree of spillovers, i.e., for any arbitrary combination of (β, γ). This is demonstrated in a simple example in the Appendix, where $V(a, x) = ax$ and $C(e, x) = (1/2)x^2(z - e)$ with z being a positive constant.

6.2 Centralized Politics

Under centralized governance, the policy outcome is determined in a federal parliament by majority rule. While a majority faction in the assembly is legally entitled to implement its preferred policy, renegotiations with the minority region are welfare improving

[34] For example, suppose a region's bargaining strength is a function of its population size only. For regions of equal size so that $\gamma = 1/2$, the first best is then attained when the project generates a larger benefit in A than in B.

[35] Remember the indirect effect is positive because changes in x^A do not affect region A's default payoff by the envelope theorem, while they increase the available bargaining surplus when $x^A > x^*$ (so that any increase in x^A lowers the sum of default payoffs).

and will lead to an outcome which reflects mutual interests.[36] Suppose again that delegates from the composite region B form the majority, and that political bargaining is successful. In the out-of-equilibrium event that stage-2 renegotiations fail, region B will in stage 3 implement

$$x^B(a,e,\theta) = \arg\max_x (1-\beta)V(x,a,\theta) - tx - \alpha C(x,e,\theta). \tag{21}$$

Unlike decentralization, the default policy (here x^B) is now *increasing* in the size of the externality (decreasing in β), and *decreasing* in both the output grant parameter t and the cost grant parameter α. Anticipating this default policy and the outcome of stage-2 negotiations, region A maximizes in stage 1 (CP stands for centralized politics)

$$U^A_{CP}(\cdot) = E_\theta\left[S^A(x^B,a,e,\theta,\alpha,t)+\gamma(S^*(a,e,\theta)-S(x^B,a,e,\theta))\right]-\phi(a)-\psi(e) \qquad (CP),$$

and, using the envelope theorem, the first-order conditions for equilibrium investments (a^{CP}, e^{CP}) read[37]

$$E_\theta\left[(\beta-\gamma)V_a(x^B,\cdot)+\gamma V_a(x^*,\cdot)+(1-\gamma)[V_x(x^B,\cdot)-C_x(x^B,\cdot)]\frac{dx^B(\cdot)}{da}\right] = \phi_a(a) \tag{22}$$

and

$$E_\theta\left[-(1-\alpha-\gamma)C_e(x^B,\cdot)-\gamma C_e(x^*,\cdot)+(1-\gamma)[V_x(x^B,\cdot)-C_x(x^B,\cdot)]\frac{dx^B(\cdot)}{de}\right] = \psi_e(e) \tag{23}$$

for $(a,e) = (a^{CP}, e^{CP})$. A comparison with the corresponding conditions for the decentralization regime immediately yields a simple but notable result:

Proposition 6. *Consider a Pigouvian grant system $(\alpha,t)^P$ that implements $x^A(\cdot) = x^B(\cdot) = x^*(\cdot)$. Under any such system, investment outcomes under centralization and decentralization coincide.*

[36] Under the unanimity rule, region A will strictly underinvest in both types of activities whenever $\gamma < 1$, and the initial grant policy is irrelevant. To understand why, notice that each region can now veto the implementation of any deviation from the status quo. Hence, the default allocation is always $x = 0$ where region A receives no grant payments. Each region obtains its share of the bargaining surplus $S(x^*,a,e,\theta)$ as its equilibrium payoff after negotiations, and region A's investment first order conditions read $\gamma E_\theta S_a(x^*,a,\theta) = \phi_a(a)$ and $\gamma E_\theta S_e(x^*,e,\theta) = \psi_e(e)$, respectively. Hence, underinvestment is unavoidable unless region A has full bargaining power.

[37] Note that $S^A_x(x^B,\cdot) = S_x(x^B,\cdot)$ since $S^B_x(x^B,\cdot) = 0$.

Pigouvian grants implement efficient policies so that no political bargaining takes place and the influence effect vanishes. At the same time, they equalize regional default payoffs across institutional regimes, so that investment incentives coincide.[38]

To continue the analysis of (22) and (23), note that in comparison to decentralization, the sign of the indirect 'influence' effect is now *reversed* for any given default policy x. To understand why, notice that since B chooses the default policy, region A now has an additional motive to change x^B, namely, to boost its own default payoff $S^A(x^B, \cdot)$. Remember that B's default policy x^B is small when grants are large, and large when grants are small. Naturally, region A's interests are the exact opposite which means it will invest more (in order to raise x^B and to increase its default payoff) if grants are sizable, and vice versa. This default payoff effect dominates the countervailing bargaining surplus effect that also appears under decentralization. The overall influence effect is therefore negative whenever $x^B > x^*$.[39] Analyzing (22) and (23), we obtain

Proposition 7. *Consider centralized governance with majority rule, and suppose that delegates from region B form the majority. Then,*

(1) if region A undertakes only cost-reducing investments, there always exists a transfer scheme ($\alpha^* = 0, t^* > 0$) which achieves the first-best outcome.

(2) If region A undertakes value-increasing activities or both types of investments, a first-best outcome is not generally achieved even if $\beta > \gamma$.

Proof: For the previous Example, the Appendix demonstrates inefficient outcomes for any combination of (β, γ).

In conjunction with Proposition 5, these results show that centralized authority may perform worse than decentralization even if monetary grants are endogenous and set optimally in either regime. Authority rights over policy projects matter, and tilt the

[38] This equivalence result nicely highlights the difference to the framework of Besley and Ghatak (2001): in their paper, investment incentives are regime dependent even though default projects are identical. Specifically, an agent's marginal investment return depends on the governance structure by assumption.

[39] A marginal change in x^B affects $S^A(\cdot)$ in the same way as it affects total payoff $S(\cdot)$ (because of the envelope theorem, B's default payoff $S^B(\cdot)$ remains unaffected). Whenever $\gamma < 1$, this default payoff effect always exceeds γ times the change in total default payoff (the bargaining surplus effect) brought about by a change in x^A, so that the influence effect has opposite signs in both regimes.

optimal governance structure in favor of decentralization, even though explicit incentives can tackle the underlying moral hazard problem.[40]

Our findings suggest an economically robust explanation for this dichotomy. Remember that under decentralization, larger grant payments trigger a larger default project, which raises the direct effect and the indirect effect of investing at the same time.[41] In simple terms, region A's incentives to raise its effort in response to a larger (default) quantity are aligned with its incentives to further raise the default project size.

Under centralization, this is not true. For $x^B > x^*$ which is again generally needed for efficiency, direct effect and influence necessarily operate in opposite directions. When grants are small so that region B chooses a large x^B, the direct effect is again positive for $\beta > \gamma$ but the indirect effect is negative: with small grants, region A has an interest to lower B's preferred x^B, which is achieved through smaller investments.[42] This fundamental misalignment of investment motives prevents an efficient outcome even if spillovers are not very pronounced, as shown in the Appendix for the previous simple example and all conceivable combinations $(\beta < 1, \gamma)$.

7 Conclusion

This paper investigates whether the performance of a federal system depends on its governance structure, even with an optimal design of inter-governmental grants. We show that this is the case when a project region is responsible for stages in the production process of public projects. This finding is in tension with a central tenet of the standard literature on federalism, namely that an appropriately chosen (Pigouvian) grant would make the economic outcome in each regime indistinguishable. Our results suggest that with a moral hazard component to government activities, the governance

[40] The finding also shows that efficiency remains elusive even if the number of instruments equals the number of goals. In our model, efficiency is obtained for one governance structure, but not for the other.

[41] As discussed in the previous Section, this is true if $\beta > \gamma$, and for the relevant grant parameters inducing $x^A > x^*$.

[42] Technically, any increase in x^B (for $x^B > x^*$) decreases A's default payoff by the same amount as it increases the available bargaining surplus. Since A reaps only a fraction γ of the bargaining surplus, the total (influence) influence effect is negative - and hence, investment reducing - for $x^B > x^*$. Note that for $x^B < x^*$, the direct effect is always negative for $\beta > \gamma$.

structure shapes the economic outcome even with monetary incentives in place.

A number of more specific results are borne out in our analysis. With a benevolent central government, centralization is preferable to decentralization and a first best outcome is achieved through an optimal combination of grants payable to the project region. Conversely, when centralized policies are chosen in a partisan fashion and political negotiations are ruled out, no grant system and no authority structure reaches the efficiency frontier. In this latter scenario, grants have to ensure efficient investments and an efficient project size, tasks that cannot be accomplished at the same time. Moreover, no authority structure inherently dominates in this setting.

This changes when political negotiations between regional politicians are taken into account. Perhaps the most striking conclusion of our analysis is that constitutional grant policies are then systematically less effective in a centralized system, at least when externalities are not too large. Under decentralization, grant levels and investment incentives are aligned because larger grants raise not only the region's investment incentives for given default policy (the direct effect), but also because they boost the default policy chosen by this region (the influence effect). Unlike decentralization, larger grants under centralization lead to smaller default policies, which triggers a misalignment of direct and indirect investment incentives.

Since political negotiations are an often used tool to realize mutual gain, we found it crucial to incorporate them into an analysis of federal structures. Communication among decisionmakers happens on a constant basis in real-world politics, and the outcome of political negotiations is often enforceable to a large degree. While our results suggest that the possibility to bargain improves the relative performance of decentralized over centralized governance, future research into this important issue is certainly warranted.

Appendix

Proof of Proposition 2

To prove part (1), consider cost-reducing investments. By inspection of (17), $\alpha = 0$ in combination with some non-negative t so that $x^A(\cdot) = x^*(\cdot)$ implements an efficient outcome. To prove part (2), consider value-increasing investments. For $\beta = 1$ and $\alpha = t = 0$, we have $x^A(\cdot) = x^*(\cdot)$ and (16) as well as (17) coincide with the conditions for efficient investments, so that a first-best outcome is attained. Conversely, for $\beta < 1$, region A chooses $a < a^*(e)$ even if (t, α) are chosen such that $x^A(\cdot) = x^*(\cdot)$. Accordingly, efficient investments are incompatible with an ex-post efficient policy choice (allocative efficiency) if the region undertakes value-increasing investments. Next, observe that increasing $x^A(\cdot)$ marginally above $x^*(\cdot)$ has only a second-order effect on allocative efficiency and on e while the associated increase in a induces a positive first order effect. As a consequence, the second-best optimal policy must entail $x^A(\cdot) > x^*(\cdot)$. Finally, if the region expends both value-increasing and cost-reducing investments, it cannot be optimal to distort e away from the level that is optimal conditional on $x^A(\cdot)$. Hence, the second-best constitutional policy is characterized by $\alpha^* = 0$, $t^* > 0$ and $x^A(\cdot) > x^*(\cdot)$. □

Proof of Proposition 3

To prove the second part, note that since $x^A = x^*$ for the proposed Pigouvian grant structure, the indirect effect in (6) disappears and the first-order conditions (11) and (6) coincide. We now prove the first part, and consider a situation without grants. Comparing (6) and (11) shows that for any given policy level $x < x^*$, investments under decentralization strictly exceed those under centralization for any $\beta < 1$. At the same time, the policy level x^A which prevails under decentralization is strictly smaller than efficient which yields a countervailing effect with respect to overall efficiency. To show that decentralization can yield a larger social surplus $W = V - C - \phi - \psi$, consider now the following example: Let $V = ax$, $C = x^2/2$, and $\phi(a) = a^3/3$. Then, $x^*(a) = a$, $a^* = 1$, and $x^A = \beta a$ (for $\alpha = t = 0$). Region A's equilibrium investments then are $a_D = \beta^2$ under decentralization, and they are $a_C = \max\{0, 2\beta - 1\}$ under a benevolent central government [insert in (6) to obtain the first-order condition $\beta a + [\beta a - a] = a^2$].

Accordingly, equilibrium policies are $x(a_C) = \max\{0, 2\beta - 1\}$ under centralization, and $x(a_D) = \beta^3$ under decentralization. Inserting, total surplus in the centralization regime is $W_C = 0$ for $\beta \leq 1/2$, which implies that $W_C < W_D$. For $\beta > 1/2$, $a_C \leq a_D$ and $x(a_C) \leq x(a_D)$ with strict inequality for any $\beta < 1$, so that again $W_C < W_D \; \forall \beta < 1$. □

Proof of Proposition 5

To prove part (1), consider first a situation where region A can undertake only cost-reducing investments. Define $\tilde{t}(\alpha)$ as an output grant that implements $e^*(a)$ for given a and given α. For $\alpha = 0$, $e = e^*(a)$ requires the indirect effect to disappear, i.e., $x^A(\cdot) = x^*(\cdot)$. Since $x^A(\cdot)$ is monotonically increasing in t without bounds and $x^A(\cdot) < x^*(\cdot)$ for $t = 0$ and $\beta < 1$, there exists some $\tilde{t}(0) > 0$ which implements $e = e^*(a)$. For any $\alpha < 1 - \gamma$, the direct effect is positive. Moreover, the output grant t makes it possible to let x^A become arbitrarily large. Since the indirect effect is positive for any $x^A > x^*$ and the direct effect becomes arbitrarily large as $x^A \to \bar{x}$ (refer Assumption 1e), $\tilde{t}(\alpha) > 0$ exists for any $\alpha < 1 - \gamma$. Continuity then ensures that $\tilde{t}(\alpha)$ also exists for any intermediate $\alpha \in [0, 1 - \gamma)$.[43]

Next, consider value-increasing investments. Consider an arbitrary $\beta \geq \gamma$ and let $\hat{t}(\alpha)$ be an output grant that implements $a = a^*(e)$ for given e and given α.[44] For any $\beta < 1$, implementing $a^*(e)$ requires the indirect effect to be positive, which in turn demands that the optimal grant design must ensure $x^A > x^*$. Note that the indirect effect is positive for any $x^A > x^*$ and converges to zero as $x^A \to x^*$. Also, the direct effect becomes arbitrarily large as $x^A \to \bar{x}$ (by Assumption 1e). By continuity, these arguments imply that $\hat{t}(\alpha)$ exists for any $\alpha \in [0, 1]$.

To prove part (2), verify that the first best can be implemented if and only if there exists some α with the property $\tilde{t}(\alpha) = \hat{t}(\alpha)$. We show that this condition is indeed satisfied for some α if $\beta > \gamma$. To do so, we first establish that $\hat{t}(\alpha) > \tilde{t}(\alpha) > 0$ for $\alpha = 0$. Recall that (20) is satisfied for $\alpha = 0$ if and only if $x^A(\cdot) = x^{FB}(\cdot)$, i.e., the

[43] The optimal output grant $\tilde{t}(\cdot)$ needs not to be monotonic in α. Note also that for $\alpha \geq 1 - \gamma$, $\tilde{t}(\alpha)$ does not necessarily exist: any output grant that raises $x^A(\cdot)$ and thus boosts the indirect effect increases the negative direct at the same time. See, however, our arguments below.

[44] For $\beta < \gamma$, the direct effect is negative and a raise in $x^A(\cdot)$ triggers countervailing incentives. Accordingly, the first best cannot generally be ensured.

indirect effect is zero. This requires some positive output grant $\tilde{t}(0) > 0$ for $\beta < 1$. Conversely, to satisfy (19) for $a = a^*(e)$ under a cost-grant policy $\alpha = 0$, it is necessary to have a strictly positive indirect effect whenever $\beta < 1$. Accordingly, some default policy $x^A(\cdot) > x^*(\cdot)$ must be implemented. Indicate this policy as x^A_A. Since $x^A(\cdot)$ is increasing in t, $\hat{t}(0) > \tilde{t}(0)$ is immediate. Next, note that $\hat{t}(\alpha)$ is strictly decreasing in α: since $x^A(\cdot, \alpha, t)$ is increasing in t and in α, $x^A = x^A_A$ requires $\hat{t}(\cdot)$ to be decreasing. Fix x^A at the level x^A_A, and consider (20). As α increases, the first term in this condition (the direct effect) decreases. Specifically, it becomes negative and decreases without bounds for cost grants $\alpha > 1 - \gamma$. Fix t at the level $\hat{t}(\alpha)$ which leaves the indirect effect constant. Then, the size of the LHS of (20) decreases in α without bounds. Accordingly, there must exist some $\alpha^* > 0$ such that $\hat{t}(\alpha^*) = \tilde{t}(\alpha^*)$, and a first-best outcome (a^{FB}, e^{FB}) is attained. □

Proof of Proposition 6- Example

Let $V(\cdot) = ax$ and $C(\cdot) = (1/2)x^2(z - e)$, where z is some positive constant. Suppose all optimization programs are well behaved, which is always guaranteed for sufficiently convex investment cost functions. Considering interior solutions, one then obtains $x^* = a/(z - e)$, $x^A = \beta(a + t)/[(1 - \alpha)(z - e)]$, and $x^B = (1 - \beta)(a - t)/[\alpha(z - e)]$.

We first analyze decentralization. In this regime, the optimality condition (19) reads for $(a, e) = (a^*, e^*)$ and using $\phi_a(\cdot) = V_a(x^*, \cdot)$ and $\frac{dx^A}{da} = x^A/(a + t)$,

$$(\beta - \gamma)x^A - \gamma[(a^* + t) - (z - e)x^A]\frac{x^A}{a^* + t} = (1 - \gamma)x^*.$$

Since $z - e = a^*/x^*$ and defining $q = a^*/(a^* + t) \leq 1$, this condition can be rewritten as

$$x^A[(\beta - \gamma) + \gamma[q\frac{x^A}{x^*} - 1]] = (1 - \gamma)x^* \qquad (DP^*)$$

Observe that for any $x^A \leq x^*$, (DP^*) cannot hold because (for $\beta < 1$) the left-hand side is smaller than the right-hand side. For $\beta \geq \gamma$, increasing x^A above x^* raises the left-hand side without bounds. (Note that because qx^A does not depend on t, this is true for any increase in t or α that raises x^A). Accordingly, there exists some $\hat{x}^*_A$ - and some grant policy (α, t) that implements $\hat{x}^*_A$ - which generates efficient value-increasing investments. Next, consider $\beta < \gamma$. Note that for sufficiently small x_A, the left-hand

side turns negative while it increases in x^A without bounds. Accordingly, there again exists some default policy level $x_A^* > x^*$ and some constitutional grant policy (α, t) which implements the optimum.

We now show that efficient cost-reducing investments are feasible at the same time. To see this, note first that condition (DP^*) does not directly depend on α (but only indirectly via x^A) nor on t (noting that qx^A does not vary in t). Now, using $\psi_e(e^*) = -C_e(x^*, \cdot)$, rewrite (20) as

$$(1 - \alpha - \gamma)x^A - \gamma[V_x(x^A, \cdot) - C_x(x^A, \cdot)]\frac{dx^A}{de} = (1 - \gamma)x^*.$$

Fix $x^A (> x^*)$ at the level required to satisfy (DP^*). Verify that the second term in the above condition is then positive, and overinvestments prevail for $\alpha = 0$. Increasing α - while lowering t in a way as to keep x^A constant - decreases the LHS of the condition without bounds, which immediately yields the result.

Consider now the Centralization regime. Repeating the previous steps, noting that $dx^B/da = x^B/(a - t)$ and defining $\delta = a/(a - t) \geq 1$, the condition for efficient value-increasing investments now reads

$$x^B[(\beta - \gamma) + (1 - \gamma)[1 - \delta\frac{x^B}{x^*}]] = (1 - \gamma)x^*.$$

Note that underinvestments prevail for $x^B = x^*$. Taking the derivative of the left-hand side with respect to x^B shows that its maximizer is $\hat{x}^B = \frac{x^*}{2\delta}[1 + \frac{\beta - \gamma}{1 - \gamma}]$ (i.e., at an interior solution), and $\hat{x}^B = 0$ otherwise. If $\hat{x}^B = 0$, the left-hand side is obviously smaller than the right-hand side for any $x^* > 0$, with the consequence of underinvestments. For positive $\hat{x}^B$, the above condition becomes

$$\frac{x^*}{4\delta}[1 + \frac{\beta - \gamma}{1 - \gamma}]^2 = x^*$$

which never holds for $\beta < 1$. Overall, regardless of the size of x^*, there exists no constitutional grant policy (i.e., no x^B) which implements an efficient outcome, irrespective of the parameter combinations $(\beta < 1, \gamma)$.

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