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# Information Transmission within Federal Fiscal Architectures: Theory and Evidence

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## CESifo
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## Abstract

This paper explores the role of information transmission and misaligned interests across levels of government in explaining variation in the degree of decentralization across countries. Within a two-sided incomplete information principal-agent framework, it analyzes two alternative policy-decision schemes—'decentralization' and 'centralization'—when 'knowledge' consists of unverifiable information and the quality of communication depends on the conflict of interests between the government levels. It is shown that, depending on which level of policy decision-making controls the degree of decentralization, the extent of misaligned interests and the relative importance of local and central government knowledge affects the optimal choice of policy-decision schemes. The empirical analysis shows that countries' choices depend on the relative importance of their private information and the results differ significantly between unitary and federal countries.

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# 1 Introduction

During the last decade or so there has been a resurgence of interest in decentralization (federalism), in a significant number of countries around the world.[1] The reasons underlying this are broad and complex, but the existing literature, so far, has mainly focused on the trade-off between heterogeneity and economies of scale: heterogeneity calls for 'top down' governance while economies of scale call for 'bottom up' governance (see the classic treatise of Oates 1972 and, among others, the recent discussion in Rodrik 2012).[2] But successful decentralization also requires effective allocation of responsibilities across levels of government, which in turn require effective communication of information (over—for example—fiscal capacity, and preferences for public goods) distributed across levels of policy decision-making.

The relative importance of local and central knowledge thus influences the optimal degree of decentralization, as government levels will not fully reveal their information to each other when their interests are not aligned. This paper identifies the transmission of information between government levels, with misalignment of interests between them, as an additional mechanism that contributes to the understanding of what determines the optimal allocation of policy decision-making and so the degree of decentralization. It shows that not only 'communication' is important in determining the degree of decentralization but also that the institutional differences, across states, matter crucially in explaining the different impact that private information on the part of the government levels may have on the choice of decentralization, when their interests are not aligned.

One can think of examples where state governments react to changes in the environment, and in particular to changes in the relative importance of local and central knowledge, by adjusting their level of decentralization. Consider France. Traditionally, it is a highly centralized country that by its constitution grants final control over the states' structure to the central government ('center as principal'). As a consequence of increasing complexity of the French society (Cole 2006, Crozier 1992, Caillose 2004), and the increasing importance of 'local' knowledge (Montricher 1995), a series of reforms in the 1980s and 2000s aimed to increase decentralization.[3] Despite this ongoing pro-

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[1]Some countries have undertaken reforms to decentralize government functions, while, in contrast, others have centralized certain areas of policy making. The implementation of decentralization policies (and the process itself) has varied substantially and, in many cases, has been problematic or at least not as successful as one would have hoped for, most notably in sub-Saharan African countries (see Daflon and Madies 2013). In Europe, and in many European member states, there have been extensive debates on how much authority to delegate to the European Union. The European Union, overall, is a historically unique example of centralizing certain policy areas in a federation of distinctly heterogeneous countries with, in many cases, diverging interests.

[2]This trade off is, of course, also shaped by the inherent tension, driven by misaligned incentives, in the objectives across the different levels of policy decision-making.

[3]Between 1990 and 2010 the sub-national share of government expenditure increased from 18% to 21%. Decentralization was seen as an answer to the revival of ethno-territorial identities and cultural, linguistic, and territorial defense movements that reflect an increasing bias in the interests of the central government and the individual départements or regions (Chartier and Larvor 2004, Keating et al. 2003, de Winter and Türsan 1998).

cess of decentralization, however, local decision-makers remain substantially constrained by the central government bureaucracy, keeping hold of the ultimate decision-rights in many political areas that reflect the strong unitary French tradition. Germany, for comparison, emerged from a group of historically independent and distinct states, which is reflected in its federal state structure that makes important political decisions subject to the agreement of its states ('local government as principal'). Recently, though in some areas (such as, for instance, environmental policy and trade policies) the importance of externalities and of central coordination have resulted in some centralization of policies (Koch and Krohn 2006),[4] the states governments have resisted—relying on their legislative power in the federal state structure—a more far-reaching centralization by retaining the right to deviate from national legislation in important areas (Chandna 2011, Ipsen 2006). Clearly, then, as these examples indicate, depending on their institutional design and on the misalignment of interests between the federal and local government, strong differences not only remain but also the chosen level of decentralization may suboptimally be too low (or too high).

Decentralization has often been seen as the appropriate government structure to ensure an efficient allocation of resources within the federation, to establish an equitable allocation of income between member states and also to achieve economic and political stability.[5] More specifically, the federal government has the responsibility for two fiscal roles: first, the redistribution of resources across states to maintain (or enhance) horizontal equity and promote its redistributional goals; and, second, the internalization of fiscal externalities.[6] The theoretical literature has emphasized that redistribution can be problematic since any attempt on the part of the federal government to redistribute resources from one state to the other is liable to asymmetric information (moral hazard and adverse selection). But the emphasis of the literature has predominantly been on the unverifiability of information regarding preferences for public goods and production technologies; it pays no attention to the role of the federal and local government's differential access to information and communication with *misaligned incentives*. A fiscal federal system is a hierarchical system whose efficiency depends on the smooth flow of information between the levels of government. Surprisingly, the issue of communication of information has received very little attention in the literature on fiscal federalism.[7]

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[4]The sub-national expenditure share decreased from 46% in 1991 to 43% in 2010.

[5]The idea that fiscal federalism brings a better allocation of resources because local governments are better informed than federal ones can be traced back to von Hayek (1945). Tiebout (1956), in the same spirit, also argued that competition of jurisdictions for mobile consumers will bring about an efficient allocation of resources. Frey and Luechinger (2004) argue that decentralization increases stability by reducing terrorism; see Dreher and Fischer (2010) for an empirical test of this hypothesis.

[6]Early contributions on these fiscal roles are Musgrave (1959) and Oates (1972).

[7]The flow of information has received attention in the theory of the firm: See Alonso et al. (2008). Though there are similarities between the theory of the firm and that of fiscal federalism—namely the hierarchical organization structure—there are also distinct differences, most notably in the different functions implemented by firms and governments.

This paper explores the interaction between the incentives of local and federal governments to communicate information—country-wide and local, respectively—which is useful for the design of public policies when there is misalignment of interests (conveniently called 'agency bias' and sometimes referred to as 'bias').[8] The analysis is conducted within a two-sided incomplete information framework in which the transmission of information—assumed to be costless—between the local and federal governments is 'soft' and cannot be verified.[9] Whenever the interests of the two levels differ, however, the quality of the reports will depend on such conflict of interests, with each level of government rationally expecting the information transmitted by the other government to be distorted (*cheap talk game*). Within this broad perspective, this paper focuses on the comparison of two types of incentive structures, relative to the quality of the transmitted information: 'centralization' and 'decentralization.' Under centralization the control rights over policies are assigned to the federal government, whereas under decentralization it is the local governments which own the control rights over policies.

Of particular interest is the possibility of delegation in policies. On the one hand, the decision to decentralize is made by the federal government which might opt for less control in favor of being able to use more local information, while on the other hand, the local government decides to delegate control to the federal government in order to benefit from the federal government's superior information. When the decision to decentralize is made by the federal government, under decentralization, while the local government's knowledge will be fully utilized for the design of the policies, the federal government's information will only be partially exploited. Moreover, the implemented policy will differ from those preferred by the federal government because of agency bias. Conversely, under centralization, the federal government's knowledge will be fully utilized and any deviation from its preferences due to the local government's bias will be avoided; the design of the chosen policies will only partially make use of the local government's knowledge. Alternatively, if the decision to centralize (decentralize) is made by local authorities, then, for given agency bias, the informational advantage of the federal (local) government must be strictly greater than the advantage of the local (federal) government for the centralization (decentralization) scheme to be optimal. Therefore, the optimal allocation of control rights over policies will depend on the relative importance of the two parties' information, as well as the size of the agency bias, which simultaneously affects the amount of the information transmitted and the degree of (de)centralization chosen.

Agency bias can affect equilibrium outcomes. Intuition might suggest that more misaligned incentives between the two levels of government will lead towards more (less) centralization when the

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[8]It is worth emphasizing from the outset, however, that the focus is not on the precise nature of misaligned interests. These can arise through various channels, such as, for example, externalities, politics and lobbying (the intensity of which may differ across the various levels of government). All that matters for the present analysis is that such misalignment exists.

[9]Or it is prohibitively costly to verify.

federal (local) government is the principal. This reasoning is, however, incorrect as it ignores the fact that the agency bias also influences the quality of communication. The reason for this is that an increase in the agency bias reduces the amount of information transferred by the local governments to the federal government in the centralization regime and so the federal government's incentive to decentralize may increase. But an increase in the bias also reduces the quality of information transferred by the federal to the local government under decentralization, thereby increasing the attractiveness of centralization. The extent to which an increase in the misalignment of interests between the federal and local governments leads to centralization or decentralization is, therefore, ambiguous and depends on the relative importance of the information owned by the two levels of government.

An immediate empirical implication of the theoretical analysis is to investigate the degree of 'decision power' of the federal government to override local government decisions in relation to information transmission problems. The empirical analysis shows that most countries seem to follow allocation rules of control rights over *fiscal* federal structure, on average, according to the relative importance of the local and federal information in determining optimal policies. These results differ according to whether the federal or the local governments initially decide on who should have control over policies.

The paper is organized as follows. Section 2 briefly discusses the related literature, while Section 3 develops the model. Section 4 discusses the equilibrium in the centralization and in the decentralization case when the federal government is the principal, with Section 5 analyzing the optimal allocation of control rights by comparing the two incentive schemes (centralization and decentralization). Section 6 analyzes the case in which the local government is the principal and Section 7 analyzes the optimal allocation of control rights. Section 8 describes the main variables of the empirical analysis, while Section 9 describes the model and results. Finally, Section 10 summarizes and concludes.

## 2 Related literature

This paper is related to two strands of literature. The first is the cheap talk literature building on Crawford and Sobel (1982).[10] This literature—with the exception of Marchesi et al. (2011)—has originally considered an IO-type framework in which the conflict of interests relates to those between the owner of a firm and its managers (or between a CEO and the division managers, as in Harris and Raviv 2005).[11] The second strand of literature to which this paper relates is the literature on fiscal federalism and in particular the 'second-generation' contributions that emphasize political incentives—as in, for example, Lockwood (2002) and Kotsogiannis and Schwager (2008)—and asymmetric information—as in, for instance, Boadway, Horiba and Jha (1996), Bordignon, Manasse and Tabellini (1996), Raff and Wilson (1997) and Bucovetsky, Marchand and Pestieau (1998)— within the relationship between the levels of government. To the best of our knowledge none of these 'second-generation' contributions focuses on the role of information, within a principal-agent structure, under the assumption that the optimal policy functions of the local and federal governments diverge due to some 'agency bias'.

The contribution of this paper is also empirical. Following Oates (1972), several contributions have analyzed the determinants of the degree of fiscal decentralization. Predominately, however, the empirical literature on the degree of decentralization has lacked theoretical foundations (for discussion on this see Treisman 2006)—which this paper provides. Wallis and Oates (1988), for instance, investigated the socio-economic determinants, whereas Panizza (1999) identified ethnic fractionalization, as a proxy for heterogeneity in tastes, as a determinant of fiscal decentralization. Panizza (1999) concluded that mainly country size and income per capita are positively correlated with fiscal decentralization. Treisman (2006) identified size, colonization, and economic development as the most robust correlates of fiscal decentralization. More recently, a large number of empirical contributions have emerged that investigate the determinants of decentralization (Blume and Voigt 2008, Bahl and Wallace 2005, and Bodman et al. 2010), with some extending the scope of the literature by looking at decentralization in subcategories of government expenditures (Letelier 2005, Sacchi and Salotti 2013). This paper also contributes to this literature as none of these previous contributions has investigated the role of information as a possible determinant of the degree of decentralization.

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[10]See, among others, Dessein (2002), Harris and Raviv (2005, 2008), Marchesi et al. (2011). For an empirical application of two-sided incomplete information—using the International Monetary Fund's structural programs—also see Marchesi et al. (2011).

[11]As noted earlier, there are distinct differences in the functions performed between firms and governments. There are, however, some similarities between the structure of incentives. It is also reasonable to think of the difference in the objectives (and so the agency bias) between the CEO and the managers as being smaller than that across government levels.

# 3 Modeling communication between the levels of government

The model is that of Marchesi et al. (2011), appropriately modified to deal with the issues at hand. The model features two players—the federal and local governments—that possess different types of information of which both are required for the design of optimal policy defined by

$$p^* = u + c, \tag{1}$$

where $u$ $(c)$ is information observed only by the local (federal) government.[12] Both $u$ and $c$ are random variables—we return to this shortly below.

Events unfold in three stages:[13] allocation of control rights by the principal, communication, and policy implementation. In the first stage, the principal (whoever this might be) either allocates authority over the choice of the policy vector to the agent or retains authority itself. Recall that centralization is the regime in which the principal allocates the right to decide on policies to the federal government whereas decentralization is the regime in which control rights are allocated to the local governments. It is assumed that the state of the world is revealed after the first stage of the game. In the second stage communication takes place. Under centralization, the local government sends a 'message' to the federal regarding its 'local knowledge'. Upon receiving the message, the federal government updates its beliefs and chooses the policy. Under decentralization, the federal government sends a message to the local government concerning its private knowledge of the state of the world. In this case, the local government updates its beliefs and chooses policies. Finally, in the third stage, the agent implements the policy vector and outcomes are realized.

The stochastic variables $u$ and $c$ are independently and uniformly distributed on $[0, U]$ and $[0, C]$, respectively. Clearly, the larger is the interval $[0, U]$ $([0, C])$ the larger the informational advantage of the local (federal) government will be over the federal (local) government with respect to $u$ $(c)$.

The federal government is benevolent and assumed, for simplicity (and analytical tractability), to maximize the square of the distance between the implemented policy vector $p$ and the federal

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[12]The local government's superior information over $u$ can be seen, for example, as deriving from its greater proximity to the 'business environment' relative to the federal government officials; the federal government's informational advantage, relative to the local government, is derived from country-wide knowledge that it accumulates during its activities. The federal government is also more likely to have more information related to, at least partly, confidential issues such as military matters or activities related to commercial treaties or multilateral activities. The federal government is, therefore, better placed to take country-wide economic conditions into account when choosing an appropriate policy vector for the country. We assume both types of information to be soft.

[13]The analytics feature the case in which both levels of government cannot commit to an incentive-compatible decision rule in which the Revelation Principle applies. This assumption fits in well with the specific relationship between a federal and a local government in which the principal cannot use a standard mechanism to elicit private information from the agent.

government's preferred policy vector $p_F^*$ given by

$$W^F = w^F - (p - p_F^*)^2. \tag{2}$$

The local government maximizes

$$W^L = w^L - (p - p_L^*)^2, \tag{3}$$

which is monotonically decreasing in the distance between the policy $p$, which is actually implemented, and the local government's preferred policy $p_L^*$. Optimal policy of the local government deviates from the economy-wide optimal policy given by (2) in the sense that[14]

$$p_L^* = p^* - b. \tag{4}$$

Similarly, the optimal policy of the federal government $p_F^*$ differs from the economy-wide optimal policy in the sense that

$$p_F^* = p^* + e, \tag{5}$$

with $e > 0$.[15] This implies—following from (4) and (5)—that the difference in optimal policies

$$p_F^* - p_L^* = e + b = B, \tag{6}$$

reflects the extent of the policy bias, denoted by $B$.

The next section turns to the analysis of the communication game between the federal and local governments under centralization and decentralization under the two alternatives: the status quo is a (*i*) unitary country, where the federal government has the final decision rights or veto powers on whether or not to delegate decision-making power to the local governments; (*ii*) a federal country where the local governments have the final decision rights or veto powers on whether or not to opt for fiscal centralization.

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[14]$b > 0$ captures the extent to which the objectives of the local governments may be influenced by the pressure of some interest groups at the local level (opposing policy reforms). More generally, conflicts of interest over desired policy may reflect various causes and in principle the impact of lobbies can be as strong at the federal as at the local level. In this paper, however, we assume a benevolent federal government, in contrast with a local government which is assumed to be more responsive to private interests. Bordignon et al. (2008), for example, find that when regional lobbies have conflicting interests, then lobbying is less damaging for social welfare under centralization than under decentralization.

[15]A possible interpretation of $e$ is due to the existence of some externalities created by non-cooperative behavior on the part of the local government. Local governments, when choosing policy, do not internalize the impact of their policy actions on their neighboring localities (like, for example, providing tertiary education, regulation, roads or other public goods). This may generate some conflicts of interest between the two levels of government relative to the federal government's country-wide objectives.

# 4 Federal government as the principal

Recall that centralization refers to the case in which the federal government chooses the policies it wishes to implement communicating, in the process, with the local government. It will be shown that centralization results in an under-utilization of the local government's information, while the cost of misaligned incentives is avoided. The federal government's private knowledge, however, will be fully exploited.

Under decentralization the federal government allocates policy decision-making to the local government and, in the process, the latter extracts private information from the federal government. In this case, decentralization fully exploits the local government's private knowledge but results in—as a consequence of under-utilization of the information owned by the federal government—a sub-optimally chosen policy from the federal government's perspective. The next section analyzes these two schemes separately, starting with decentralization.

## 4.1 Communication under decentralization

The communication game—and the results here appropriately interpreted—follows Crawford and Sobel (1982). (Details of statements are delegated to Appendices). More specifically, in the communication equilibrium the local government only learns the interval to which the realization of $c$ belongs, and so obtains partial information about the federal government's knowledge.[16] The smaller the size of the partition interval, the more informative the federal government's message. Following Crawford and Sobel (1982), an informative equilibrium (always) exists in which the number of intervals $N$ is maximal. Denoting $N(C, B)$ the maximum number of intervals (recall that $B$ is the bias defined in (6)), the federal government's *ex ante* expected welfare (loss), denoted by $L_D^F(N, B, C)$, is given by

$$L_D^F(N, B, C) = B^2 + \sigma_C^2, \tag{7}$$

where

$$\sigma_C^2 \equiv \frac{C^2}{12N^2} + \frac{B^2 \left(N^2 - 1\right)}{3}, \tag{8}$$

is the ex-ante residual variance of $c$—and so the uncertainty about $c$ (faced by the local government before being reported by the federal government the equilibrium signal): $\sigma_C^2$ is decreasing with $N$ (the expected degree of informativeness of the federal government's message). The local

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[16]In more concrete terms, rather than thinking about direct manipulation of information (in the sense that organizations 'manipulate the books' in order to take advantage of information transmitted) one can think of information that is simply not 'produced'. We have in mind here a situation in which the local government collects precise information regarding the local preferences only when responsible for the policy design, but it may decide not to do so when the decision over the policy design is centralized.

government's *ex ante* expected loss is given by

$$L_D^L(N, B, C) = \sigma_C^2, \tag{9}$$

where $\sigma_C^2$ is again given by (8). Following Crawford and Sobel (1982), this communication game has a focal equilibrium: that of the most informative equilibrium $N(C, B)$, in which, given the bias $B$, $\sigma_C^2$ increases with $C$ (and so with the importance of the federal government's private information) which also implies that the federal government's expected loss increases with $C$. Since the federal government's private information is not fully exploited under decentralization, the federal's expected loss is increasing with its informational advantage $C$.[17] Finally, for any given $C$, the maximum precision of the information transmitted by the federal government decreases with the bias $B$. To put it differently, the extent and quality of information transmission depends on how close the preferences of the federal and the local governments are: the larger the bias $B$, the less precise the cheap talk will be.

## 4.2 Communication under centralization

In the centralization game the federal government, knowing $c$, chooses the policy vector $p$, having received a signal from the local government.[18] The structure of the communication game is analogous to that of the previous sub-section. The federal government's *ex ante* expected loss (for an equilibrium of size $N$) under centralization, denoted by $L_C^F$, is given by

$$L_C^F(N, B, U) = \sigma_U^2, \tag{10}$$

where

$$\sigma_U^2 \equiv \frac{U^2}{12N^2} + \frac{B^2 \left(N^2 - 1\right)}{3}, \tag{11}$$

is the *ex ante* residual variance of $u$ (that is the uncertainty faced by the federal government before it receives the equilibrium value of the signal sent by the local government). $\sigma_U^2$ is decreasing with $N$ (the expected degree of informativeness of the federal government's message). The local government's *ex ante* expected loss, denoted by $L_C^L$, is given by

$$L_C^L(N, B, C) = B^2 + \sigma_U^2. \tag{12}$$

Since both players' *ex ante* expected loss increases with the residual variance $\sigma_U^2$, the focus here too will be on the focal equilibrium, which is the equilibrium corresponding to the maximum number of partitions. Centralization results in an underuse of the local government's information. Thus,

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[17]More generally, the federal government's informational advantage may depend not only on how relevant her knowledge is per se (that is, in an absolute sense) but also on how easy it can be conveyed to the local government. The easier the transfer of information, the less 'crucial' such information becomes.

[18]The local government is now the 'sender' and the federal government the 'receiver.'

the local government's *ex ante* expected loss, under centralization, is increasing with its informational advantage $U$.[19]

The question that arises now is when the federal government will have the incentive to delegate the control of decision making to the local governments. This is the issue we turn to next.

### 4.3 Choice between centralization and decentralization

The federal government determines whether or not to retain its control rights over policies by comparing its *ex ante* expected loss under decentralization (that is, $L_D^F(N, B, C)$) with its expected loss under centralization (that is, $L_C^F(N, B, U)$). Since they are both increasing in $C$ (under decentralization) and in $U$ (under centralization), we expect to find cut off values of $C$ and $U$ corresponding to the choice of each regime. The choice will then depend on $(B, U, C)$, and so on the size of the conflict of interest ($B$) and the relative importance of the two players' informational advantage $(U, C)$. It turns out that the federal government will prefer decentralization if $U \geq C(U, B)$—where $C(U, B)$ is continuous and increasing in $U$—and, for any $B$, $C(U, B) < U$.

The choice of the federal government depends on the size of the bias ($B$) and on the relative importance of the two players' informational advantage $(U, C)$. In particular, the federal government will choose decentralization not only when the local government's private information $U$ is (strictly) greater than $C$ but $U$ should also be greater than a threshold level $C(U, B)$. Alternatively, the federal government always maintains centralization whenever its private information is more important than the agent's private information (that is, $C > U$). Additionally, the federal government will (optimally) choose centralization even when $C(U, B) \leq C < U$ that is, even when its informational advantage is smaller than $U$, but greater than the threshold value $C(U, B)$. In this case the loss related to the underuse of the local government's information will be more than compensated for by the elimination of the bias and by the full exploitation of the federal government's private information.

Figure 1 represents the choice between centralization and decentralization as a function of $U$ and $C$. The boundary level $C(U, B)$ is upward sloping, and divides the $(U, C)$ plane into two regions (centralization and decentralization) lying below the $45^o$ line. In line with the previous discussion, the decentralization region is smaller than the centralization region since the existence of the agency bias requires $U$ to be strictly greater than $C$ in order for decentralization to be optimal. Moreover, even when $C$ equals zero (that is, the federal government has no private information), delegating control rights over policies still requires $U$ to be strictly greater than zero.

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[19]The local government's informational advantage may depend both on how relevant its knowledge is per se, as well as on how easily it can be made available to the federal one. The easier the transfer of information, the less crucial such information becomes.
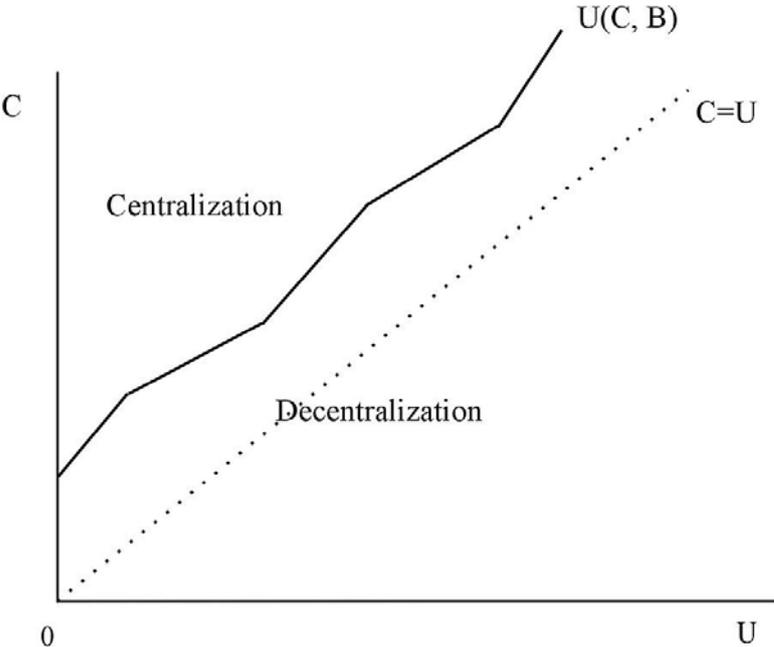
**Figures**



**Figure 1:** Choice between centralization and decentralization as a function of U and C when the federal government is the agenda setter
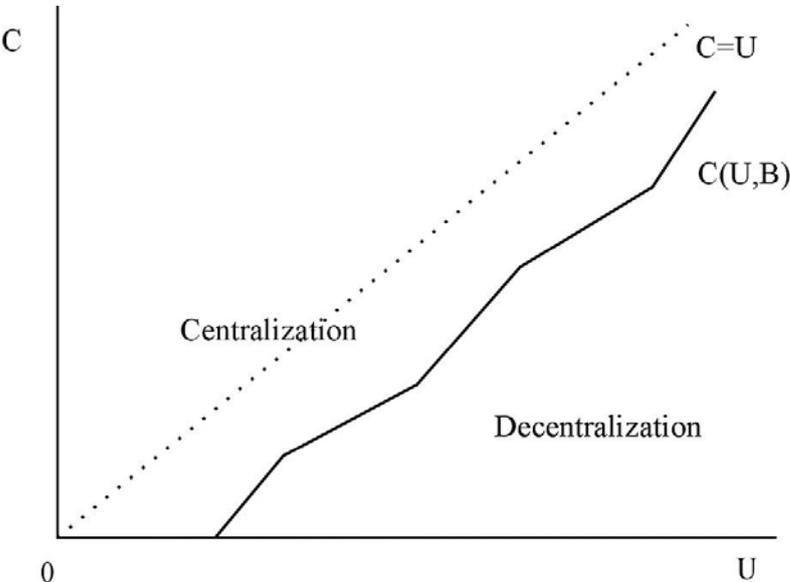


**Figure 2:** Choice between centralization and decentralization as a function of U and C when the local government is the agenda setter

In general, the boundary level $C(U, B)$ is not monotone in $B$, as an increase in $B$ has two different effects: a direct and an indirect one.[20] The direct effect is to increase the agency problem, thus reducing the federal government's incentive to delegate. The indirect effect reduces the information transmission, namely the amount of information transferred by the federal to the local government under decentralization (leading to centralization) and the amount of information transferred by the local to the federal government under centralization (leading to decentralization).

Therefore, the intuition suggests that the indirect effect will prevail only when communication is important to the decision maker (that is, either the federal or the local government). In the empirical analysis, by relating 'information transmission' to the 'bias' we will be able to disentangle the two cases where either the federal or the local government is the principal. More specifically, we expect to find a negative interaction between the two when the federal government is the principal (less decentralization with more information transmission) and a positive interaction when the local government is the principal (more decentralization with more information transmission).

## 5 Local government as the principal

This section considers the case in which the local government is the principal, while the federal government is the agent, which, by taking advantage of its agenda-setting condition, is now supposed to take the lead in deciding the level of fiscal centralization. More specifically, the local government has to choose whether or not to 'delegate' the choice of the policy to the federal government and any divergence of the implemented policy from its optimal policy confers a utility loss for the local government. Again, a decentralization or centralization regime can be chosen. Under the centralization regime, in designing the policy, the federal government will ask for the local government's advice and then decide which policies to implement. At this stage, the local government decides how much of its private information to communicate to the federal government. It will be shown that centralization results in an under-utilization of the local government's information and in sub-optimally chosen policies from the local government's point of view. The federal government's private knowledge, however, will be entirely exploited. The decentralization regime unfolds in analogy.

### 5.1 Choice between decentralization and centralization

When does the local government have an incentive to assign its control rights to the federal? Similarly to the previous analysis, the local government chooses whether or not to retain its control rights over policies by comparing its *ex ante* expected loss under decentralization ($L_D^L(N, B, C)$)

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[20]Since the derivative of $C(U, B)$ with respect to $B$ cannot be analytically derived, this result is obtained by numerical simulations (see Harris and Raviv 2008, and Marchesi et al. 2011).

with its expected loss under centralization ($L^L_C(N, B, U)$). The choice will then, again, depend on the size of the conflict of interest ($B$) and on the relative importance of the two players' informational advantage ($U, C$). In particular, the local government prefers centralization only if $C \geq U(C, B)$, where $U(C, B)$ is continuous and increasing in $C$ and, for any $B$, $U(C, B) > C$.

The local government will therefore prefer centralization when the federal government's informational advantage $C$ is not only (strictly) greater than its own private information $U$, but also greater than a threshold level $U(C, B)$. The local government will then always choose not to centralize whenever its private information is more important than the federal government's private information, that is, $U > C$. Moreover, the local government will maintain decentralization even when $U(C, B) \leq U < C$. Due to the bias, the local government can still optimally choose not to centralize even when its informational advantage is smaller than $C$, since the loss related to the underuse of the federal government's information will be more than compensated for by the elimination of the bias and by the full utilization of its own private information.

Figure 2 represents the choice between centralization and decentralization as a function of $U$ and $C$. The boundary level $U(C, B)$ is upward sloping, and divides the $(U, C)$ plane into two regions (centralization and decentralization) lying above the $45^o$ line. The centralization region is now smaller than the decentralization region since the existence of the agency bias requires $C$ to be strictly greater than $U$ in order for centralization to be optimal. Moreover, Figure 2 shows that, even when $U$ equals zero (that is, the local government has no private information), delegating control rights to the federal government (under centralization) requires $C$ to be strictly greater than zero. As above, the boundary level $U(C, B)$ is not monotone in $B$.

The theoretical model provides normative indications regarding the allocation of control rights over policy actions in the federal-local government relationship. This section empirically investigates the role that the issue of information transmission plays in the actual design of policies. The theoretical prediction of the model is that decentralization prevails when the importance of the local government's private knowledge either dominates the size of the bias or the importance of the federal government's private knowledge. To the contrary, centralization prevails when either the importance of the federal government's knowledge or the size of the agency bias dominates the role of the region's local knowledge. We turn to the empirics next.

# 6 Empirical model

The focus of the empirical analysis is expenditure decentralization. There are two reasons for this: the direct link between policy preferences; and data availability. The overwhelming majority of the empirical studies in the fiscal federalism literature have relied on fiscal expenditure and revenue data from the International Monetary Fund's (IMF) Government Finance Statistics (GFS). These data have some obvious limitations. First, they are somewhat incomplete. Second, simply looking at fiscal decentralization without taking the actual control local governments have over the collection and spending might be misleading. However, these data have the advantage of being available for a large and representative sample of countries, and for a long period of time. We thus follow the bulk of the literature in employing these measures, while being agnostic about their potential weaknesses.[21]

## 6.1 Data

### 6.1.1 Decentralization

As noted earlier, we are interested in expenditure decentralization and, thus, use the share of sub-federal expenditures in all government expenditures as our measure of decentralization. We measure fiscal decentralization based on data from the IMF's Government Finance Statistics (GFS). The measure is based on data submitted from countries following the Government Finance Statistics Manual (GFSM) 2001 accounting guidelines, meant to ensure cross-country comparability (Dziobek et al. 2010). The numerator of our measure is the total expenditure of sub-federal government tiers, while the denominator is total spending by all levels of government (referred to as general government by the IMF). In federal countries we use aggregated expenditures for the state and local level as proxy for 'local' expenditures given that the data do not allow a further distinction. We use data for the 1972-2010 period and a maximum of 66 countries. Among the countries in our sample, expenditure decentralization ranges between 3.6 to 64.13 percent. On average, 27.97 percent of government spending takes place at the sub-federal level (median: 27.62 percent).[22] We propose below a number of proxies to measure the size of the agency bias and the relative informational advantages of the federal or local governments.

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[21] An alternative dataset exists for OECD countries, allowing one to distinguish between those expenditures and revenues over which the sub-federal units actually execute control (see Ebel and Yilmaz 2003, Rodden 2004 for a discussion). However, the data are limited to a small sample of countries and years.

[22] We fill missing data for countries of the European Union since 1990 using data from Eurostat, which follows the same accounting guidelines. We tested for significant differences between the effects of data from the two sources by inserting a dummy in our regressions, which turned out to be insignificant at conventional levels. This allows us to conclude that there is no relevant structural break in the accounting practices of the European countries post-1990.

**Table 1:** Sources and Definitions

|  | Variable | Definition | Source |
|---|---|---|---|
| **DEPENDENT VARIABLE** | Expenditure Decentralization | Subnational expenditures (local and state level) / expenditure by general government (all levels) | IMF (2012) |
| **CONTROL VARIABLES** | | | |
|  | (log) GDP | Log of GDP p.c., purchasing power adjusted | Heston et al. (2012) |
|  | (log) Land Area | Log of land area (square km) | Treisman (2006) |
|  | (log) Population | Log of population | World Bank (2013) |
|  | Urbanization | Urban population as % of total | World Bank (2013) |
|  | Democracy Dummy | Dummy that takes the value 1 if country is classified as democracy | Cheibub et al. (2010) |
| **VARIABLES OF INTEREST** | | | |
| **Bias** | | | |
|  | Heterogeneity | Ethnic fractionalization (linguistic and ethnic) | Alesina et al. (2003) |
|  | Ethnic Tensions | Perception of the risk of ethnic tensions | ICRG (2013) |
|  | Government Stability | Perception that the government is stable | ICRG (2013) |
|  | Government Fractionalization | Chance that two random draws will produce legislators from two different parties | Beck et al. (2001) |
|  | Migrant Share | Migrants as % of total population | World Bank (2013) |
| **Externalities** | | | |
|  | Trade Openness | Exports plus imports as % of GDP | Heston et al. (2012) |
|  | Oil Rents | Oil rents (crude oil production value at world prices minus total production costs) as % of GDP | World Bank (2013) |
|  | Risk of External Conflicts | Perception of the risk of external conflict | ICRG (2013) |

**Table 1** continued

**Knowledge**

| | | |
|---|---|---|
| Information Transmission | Fixed telephone lines per 100 inhabitants | International Telecommunication Union (2011) |
| Transparency | Share in all data series for which data are reported | World Bank (2013) |
| Corruption | Perceived corruption | ICRG (2013) |
| Press Freedom | Annual survey of media independence | Freedom House (2011) |

**Importance of local knowledge**

| | | |
|---|---|---|
| Heterogeneity | Ethnic fractionalization (linguistic and ethnic) | Alesina et al. (2003) |
| Ethnic Tensions | Perception of the risk of ethnic tensions | ICRG (2013) |
| Migrant Share | Migrants as % of total population | World Bank (2013) |

**Importance of federal knowledge**

| | | |
|---|---|---|
| Educational Quality | Tertiary school enrollment as % of the age group that officially corresponds to this level of education | World Bank (2013) |
| Trade Openness | Exports plus imports as % of GDP | Heston et al. (2012) |
| Oil Rents | Oil rents (crude oil production value at world prices minus total production costs) as % of GDP | World Bank (2013) |
| Risk of External Conflicts | Perception of the risk of external conflict | ICRG (2013) |

### 6.1.2 Control variables

The choice of control variables is based on the literature that investigates the determinants of expenditure decentralization. Economic control variables include (log) real per capita GDP, (log) land area (in square kilometers), (log) population, the share of the urban population in total population and a dummy variable indicating whether the country is a democracy. One would expect that most of these variables have also a direct relationship to our hypotheses. With rising per capita GDP—and so economic activity—the exchange of information becomes more important for the design of the optimal policy. Per capita GDP is included in most studies that try to explain decentralization (see, for example, Sacchi and Salotti 2013). This variable is obtained from the Penn World Tables and is measured in purchasing power parities (constant 2005 prices).

It is well documented that a country's land size benefits decentralization.[23] The larger the country, the more diverse we would expect it to be, on average. More effort and logistical skills are required for the federal government to collect information in large areas. Distance from the center might also lead to larger ideological distances from the median voter (Panizza 1999).

A country's (log) population is a further proxy for its size that is frequently included in the related literature. We use this variable and also include a country's urban population relative to its total population. Letelier (2005) argues that improvements in urban infrastructure induce centralization by attracting parts of the rural population and thus a further concentration of public expenditure. We take population and urbanization from the World Bank's World Development Indicators (2013).

The literature suggests a positive effect of democracy on decentralization (see, for example, Panizza 1999, and Treisman 2006), as dictatorships often promote one rather large capital city and, hence, more centralized expenditures. On the other hand, autocratic leaders might have a tighter grasp on sub-national decision-makers and thus decide to decentralize expenditures, while still controlling their use. We, therefore, include a dummy variable indicating whether a country is democratic, taken from Cheibub et al. (2010). In addition, we also include regional dummies and period fixed effects to account for unobserved characteristics that might be correlated with our variables of interest.[24]

### 6.1.3 Variables of interest

Attention is focused on what we call '*informational variables.*' These (groups of) variables capture the impact of the bias, and the importance of the country's local and federal knowledge for optimal

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[23]We use a country's (log) land size in square kilometers, taken from Treisman (2006).

[24]Note that we do not want to eliminate cross-country variation from our sample, which we argue will be crucial to identify the effects of our variables of interest on decentralization. We, therefore, deliberately do not include dummies for each country.

decision-making. Part of the variables are available for much of the sample, while we have others for only a smaller subgroup of countries and years. We, therefore, run separate regressions, one for the most extensive sample, and one that contains all variables (but is restricted to a smaller sample). Table 1 presents an overview of all variables, assigned to one of the groups introduced above. Variables printed in bold are available for the whole sample, while variables in regular font are available only for the smaller sample.

**Bias:** The conflict of interest between the federal and the local governments (agency bias) depends on the degree of externalities. Centralized decision-making can have the advantage of taking externalities into account. Our model shows that, *ceteris paribus*, larger externalities should lead to less decentralization. As one proxy for externalities, we use the perceived risk of *external conflict*. The larger the risk of conflict, the more important the potential externalities from centralized foreign policy on the regions. In the presence of local decision-making the deviation from the federal government's bliss point thus increases with external conflict. We take the International Country Risk Guide's (ICRG) external risk index to measure conflict. We transformed the original scale so that higher values imply more external risk, on a scale of 1-12. We include *trade openness*, as trading with other countries involves negotiations about trade agreements or meetings and travel to other countries to open new markets for national companies. Both local and state policies might thus impose externalities on other regions and the center that are not taken account of. For example, the federal government might negotiate tariff-reductions in certain areas that benefit the country as a whole, but might increase unemployment in certain regions. Local governments' trade missions might result in competition among regions, leading to trade diversion from other regions rather than trade creation. We measure openness to trade using the sum of imports and exports as a share of GDP (from the Penn World Table 7.1). *Oil production* also imposes externalities. Large parts of the proceeds usually accrue to the federal government (as oil is typically extracted and produced by state companies and requires substantial fixed investments), while environmental damages are born locally. Note that these variables measuring the bias can also be thought of as measuring the importance of the federal government's information, as we describe in more detail below.

We also include additional measures of heterogeneity. Our expectation is that greater diversity of the population will, on average, imply larger differences in the policy preferences of the federal government compared to that of the local governments. Our main index for the measurement of *heterogeneity* is the ethno-linguistic fractionalization index taken from Alesina (2003). It is widely used in empirical studies, and is available for a large number of countries. More heterogeneity is a proxy for a larger bias. As an alternative indicator we also consider an index of *ethnic tensions*, provided by the ICRG (2013). The index captures perceptions among experts, with a range between 1-12. We rescaled it so that higher values indicate larger tensions. We would expect the bias to

increase with higher perceived tensions between ethnicities, on average.[25] As a further potential measure of bias we include the *migrant share* of the total population, taken from the World Bank (2013), as migration also increases the heterogeneity of a society, *ceteris paribus*.

Furthermore, we include *government fractionalization*, as it reflects the relative political weight of the average governing party in national policy-making, which might also be an important factor in decisions about career advancement for local politicians (Banks 2011). Low fractionalization of government parties indicates that a government consists of a small number of strong parties, that each have substantial impact on policy decisions. High fractionalization, on the other hand, is indicative of a larger number of weak governing parties each of which has little influence over policies. Since the ability to influence policy makes national political office attractive, higher government fractionalization, *ceteris paribus*, should result in lower career concerns for local politicians. Their interest might consequently be less focused on central and overall country needs, which increases the misalignment of interests across government levels.

Finally, we also use an index of *government stability*, taken from the ICRG (2013). Arguably, stability of the political system is an important determinant of the politicians' career concerns; one could anticipate that local politicians take the expected lifetime of their party into account when making decisions about how much effort to invest in career advancement within the party. The higher stability, the more attractive national offices become, and the more local politicians take the center's and overall objectives of the country into account. Thus, higher stability should relate to a smaller bias and to interests that are more aligned. The index ranges between 1-12, with higher values indicating higher stability.

**Knowledge:** Knowledge variables can affect the degree of decentralization in both directions. The direction depends on who is in charge of deciding about the degree of centralization in policy-making—the federal or the local government. Lower quality of information affects both the ability of the local governments to use the federal government's information and the federal government's ability to use local information.

The quality of *information transmission* influences how easily the local governments can get access to the federal government's knowledge and vice versa. With a higher quality of *information transmission* it is easier to verify information and, therefore, to assess its relevance and importance for outcomes and decisions. We use the number of telephone lines per 100 inhabitants (World Telecommunications/ICT Indicators Database 2011) as a proxy for the quality of *information transmission*.

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[25]We also included Kolo's (2012) *DELF index*, taking account of the degree of diversity between groups, but did not obtain a significant result. Letelier (2005: 160) also discusses the potential importance of heterogeneity for the degree of decentralization.

For more recent years, the availability of internet access or mobile phones might be a better proxy but the use of this variable would substantially restrict our sample. The number of telephone lines correlates highly with this and other potential measures for the intensity of communication. Higher values indicate higher quality, and thus less importance of differences in knowledge endowment. As a measure of *transparency*, we use the share of data series missing for a particular country and year in the World Bank's World Development Indicators Database (2013). We calculate the indicator as the share of non-missing data out of all series for a given country and year. This follows Hollyer et al. (2011), who suggest missing data on standard economic indicators (like inflation, among others) as indicators for (a lack of) transparency. We also calculate the share of missing data for four main indicators separately (the rate of inflation, budget balance, current account balance, domestic investment). On both indicators, higher values indicate more transparency. The less reliable or detailed the available information is the lower the transparency, and the ability to get access to reliable information for both the local and the federal government.

Following similar intuiting, we include two additional proxies for the importance of differences between local and federal knowledge. We use an indicator measuring the degree of *press freedom* (taken from Freedom House 2011, on a scale from 0-100), and an indicator of perceived *corruption* (ICRG 2013). Higher values indicate more press freedom and more corruption (corruption being rescaled from the original scale, ranging from 1-12).

While these variables measure the importance of information, they do not per se indicate an informational advantage for the federal or local government. We next turn to proxies for knowledge that give a distinct advantage to one level over the other.

**Importance of local knowledge:** Local knowledge will become more important with greater complexity. We proxy for complexity using ethnic tensions ('heterogeneity'), ethno-linguistic fractionalization, and migration, as discussed above in the context of bias. Ethno-linguistic fractionalization relates to the existence of language barriers and cultural differences that make information transportation and verification more costly to the federal government. All three variables increase the dependence of the federal government on local knowledge and should, therefore, lead to more decentralization.

**Importance of federal knowledge:** There are also variables that specifically relate to the importance of federal knowledge. First, there is *educational quality*. In many countries in our sample highly skilled labor is scarce. Federal government jobs typically pay better and are better regarded than local government jobs. Hence, if there is a shortage of highly qualified bureaucrats, they will favor jobs with the federal government, on average. Accordingly, a lower overall level of education reduces the capacity and quality of the local bureaucracy relative to the federal one. A higher

quality of education will accordingly reduce the local government's dependence on the federal's knowledge and capacity and lead to more decentralization.

The importance of the federal government's knowledge increases when *external risk* is more prevalent. Given that negotiations with foreign authorities is the prerogative of the federal government, its knowledge gains in importance. A greater reliance on international trade, measured by *trade openness*, also makes the federal government's knowledge more important. Trading with other countries involves negotiations about trade agreements. While both the federal and the local governments might gather important private information from trade missions, negotiations on more important issues—like preferential trade agreements or negotiations in the context of the World Trade Organization—are the prerogative of the federal government, which should render its knowledge more important compared to local knowledge. *Oil production* might be also of importance in this context given that the federal government's knowledge should be of greater importance in oil-rich countries, for example due to tasks like working with other governments to maintain a cartel (for example, the Organization of the Petroleum Exporting Countries, OPEC), or building pipelines and other large-scale national and international projects. In addition, oil companies in oil-producing nations are at least partly state-owned with oil revenue making up a large part of total government revenue. In such cases, federal government knowledge will be of greater importance.

Table 1 contains the details of the definitions and sources of the variables included in the regressions below. We provide descriptive statistics in Appendix D. As outlined above, some of the variables refer to both the influence of the agency problem and the importance of federal knowledge. Since the impact of such indicators could have conflicting effects, in these cases the sign of the coefficient will show the net effect, that is, the impact that dominates.

Appendix E shows the correlations of the variables included in the analysis. Note in particular that the correlations between the variables measuring the bias and the informational variables are low.

# 7  Methodology and results

We examine the determinants of expenditure decentralization using data for a maximum of 100 countries over the 1972-2010 period, depending on the control variables being included. Given the lack of significant time variation in the decentralization variable the data have been averaged over three years.[26] We estimate (using OLS with standard errors clustered at the country level),

$$D_{i,t} = \alpha + \beta_1 Z_{i,t-1} + \eta_i + \tau_t + u_{i,t}, \tag{13}$$

where $D_{i,t}$ represents expenditure decentralization in country $i$ at period $t$, and $Z$ is a vector containing the (lagged) variables discussed above. Finally, $\eta_i$ and $\tau_t$ are region and period fixed effects, respectively, and $u_{i,t}$ is the error term.[27]

The results are presented in Table 2. Column 1 reports the coefficients of the variables that are most commonly used in decentralization studies. Column 2 shows those main variables of interest that are available for a reasonably large number of countries and years (that is, those variables that do not reduce the number of observations below 200). Column 3 includes them both.

Overall, the regressions in column 1 focus on the main variables that have been shown to influence decentralization in the existing empirical literature. The results show that decentralization increases with per capita GDP and land size, at the one percent level of significance. To the extent that larger and richer countries are more diverse, controlling for the other variables in the regression, this is in line with the model: greater diversity increases decentralization. Size of the population, urbanization, and the democracy dummy are not significant at conventional levels.

Column 2 turns to our variables of interest. As can be seen, decentralization increases with greater heterogeneity (at the one percent level of significance). This is in line with the model. First, greater heterogeneity makes the local government's information comparably more important, leading to decentralization. Second, it increases the agency bias. As specified above, a greater bias has both a direct and an indirect effect making the overall impact *a priori* ambiguous. The direct effect is to increase the agency problem, thus reducing the local government's incentive to centralize (and *vice versa*). The indirect effect reduces the information transmission, namely the amount of information transferred by the federal to the local government under decentralization, leading to centralization (and *vice versa*). To the extent that the local government decides on the degree of centralized policy-making, we find that the direct effect dominates the indirect one.[28]

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[26]We replicated the analysis using averages of five years. While the number of observations is substantially lower, the results (available upon request) continue to hold.

[27]We include regional dummies rather than country fixed effects because we would like to use the cross-sectional variation of our variables for identification in addition to the within-country variation.

[28]While we aim to disentangle these effects further below, for now we note that the effects working in favor of more decentralization dominate among the countries and years in our overall sample.

**Table 2:** Decentralization, Bias and Knowledge, 1972 – 2010, OLS

| Dependent variable: | (1) | | (2) | | (3) | | (4) | | (5) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Expenditure Decentralization | Coef. | Std. err. | Coef. | Std. err. | Coef. | Std. err. | Coef. | Std. err. | Coef. | Std. err. |
| (log) GDP | 6.53*** | [2.33] | | | -0.58 | [2.89] | -2.40 | [4.16] | -3.33 | [2.61] |
| (log) Land Area | 3.37*** | [1.11] | | | 2.21* | [1.23] | 0.51 | [1.45] | 2.33** | [1.10] |
| (log) Population | 0.45 | [1.41] | | | 0.16 | [1.45] | 1.51 | [1.42] | 0.09 | [1.19] |
| Urbanization | 0.13 | [0.13] | | | -0.002 | [0.11] | 0.14 | [0.12] | 0.01 | [0.09] |
| Democracy Dummy | 2.07 | [2.52] | | | -3.50 | [2.57] | -8.88 | [5.80] | -5.85** | [2.38] |
| Heterogeneity | | | 0.24*** | [0.08] | 0.21** | [0.09] | 0.25** | [0.10] | -0.11 | [0.09] |
| Trade Openness | | | -0.10*** | [0.03] | -0.03 | [0.04] | -0.10* | [0.05] | -0.04 | [0.03] |
| Oil Rents | | | 0.03 | [0.13] | -0.15 | [0.12] | -0.18 | [0.17] | -0.01 | [0.12] |
| Information Transmission | | | 0.40*** | [0.13] | 0.48** | [0.20] | 0.30 | [0.21] | 0.31 | [0.19] |
| Transparency | | | -0.02 | [0.13] | -0.05 | [0.11] | -0.02 | [0.22] | -0.12 | [0.12] |
| Educational Quality | | | 0.29*** | [0.08] | 0.25*** | [0.09] | 0.27*** | [0.09] | 0.32*** | [0.08] |
| Ethnic Tensions | | | | | | | -1.41 | [1.47] | | |
| Government Stability | | | | | | | -0.49 | [0.67] | | |
| Government Fractionalization | | | | | | | 0.09 | [0.06] | | |
| Migrant Share | | | | | | | 0.37** | [0.17] | | |
| Risk of External Conflicts | | | | | | | -2.40*** | [0.69] | | |
| Corruption | | | | | | | 2.21 | [1.67] | | |
| Press Freedom | | | | | | | 0.004 | [0.10] | | |
| Heterogeneity*Information Transmission | | | | | | | | | 0.01*** | [0.00] |
| Period Dummies | Yes | | Yes | | Yes | | Yes | | Yes | |
| Region Dummies | Yes | | Yes | | Yes | | Yes | | Yes | |
| Adj. R-Squared | 0.43 | | 0.53 | | 0.56 | | 0.63 | | 0.60 | |
| Number of Observations | 388 | | 338 | | 338 | | 225 | | 338 | |

Notes: Standard errors (clustered at the country level) in brackets. * p<0.10, ** p<0.05, *** p<0.01.

The results also show that decentralization increases with less openness to trade, better information transmission, and better educational quality, all at the one percent level of significance. The negative effect of trade openness on decentralization is intuitive. In more open economies, the importance of externalities increases—implying a larger bias—so that centralization is better-suited compared to more closed economies. What is more, the knowledge of the federal government increases in importance, giving rise to more centralization. The positive effect of educational quality is in line with our hypothesis on the importance of federal knowledge: the larger availability of well-educated people allows local governments to recruit 'better' officials, making decentralization comparably beneficial. Oil rents and transparency are not significant at conventional levels. Finally, better information transmission makes any difference in the knowledge between the local and the federal government less crucial. To the extent that the local government is the principal it would opt for greater decentralization for any given bias, which seems to dominate in our sample.

Column 3 includes the two sets of variables jointly. Surprisingly, per capita GDP is no longer significant at conventional levels, and trade openness also loses its significance. Heterogeneity is significant at the five percent level and substantively important: an increase in heterogeneity by one standard deviation increases the share of subnational expenditures by about five percent. With regard to information transmission, the subnational share increases by over eight percent with an increase of the quality by one standard deviation, which is in line with the model predictions when local governments decide. An increase of one standard deviation in educational quality increases the local share of expenditures by about five percent. All of these effects are substantial in size and their coefficients are significant at the five percent level at least. They explain a significant share of the variation of the dependent variable which gives support to the relevance of our model.

Column 4 adds the variables which are available for a reduced sample only but care needs to be exercised in interpreting changes in the coefficients of the other variables which might be due to changes in sample size rather than the impact of the control variables per se. Note that, overall, the results are however similar. The exceptions are the country's land area and the quality of information transmission, which are no longer significant at conventional levels. Trade openness becomes significant (again), at the ten percent level, with a negative coefficient.

Turning to the additional control variables, decentralization significantly increases with a larger share of migrants in the population and lower risk of external conflict. The coefficients are significant at the five and one percent level. A larger migrant share reflects greater heterogeneity, which in turn makes more decentralization optimal. An increase in the share of migrants by one standard deviation implies an increase in decentralization by nearly seven percent. Larger risks increase the importance of federal knowledge and thereby decrease the optimal level of decentralization, given

the larger role of externalities. It is also economically significant, as an increase of one standard deviation would reduce the subnational expenditure share by over nineteen percent.

In summary, the evidence highlights the importance of local and federal knowledge, as well as the importance of externalities in the design of a country's degree of decentralization. Overall, the results are more in line with the model's predictions when the local governments decide on the degree of centralization. In what follows, we try to disentangle countries in our sample where the federal government is the principal and the local governments are the agents from those where the local governments decide on the degree of decentralization and the federal government is the agent. We also try to disentangle the two potential effects of the bias—the direct and the indirect one—depending on the availability of information.

Column 5 of Table 2 turns to the two components of the bias. In order to disentangle the counter-vailing effects of knowledge and bias, we interact *information transmission* with *heterogeneity*. Column 5 adds the interaction to our preferred specification (of column 3). Greater *heterogeneity* leads to a higher optimal degree of decentralization, as local knowledge becomes more important. As can be seen, the coefficient of the interaction term is positive and significant at the one percent level. The effect of *heterogeneity* increases with better quality of *information transmission*, so that the gap between federal and local knowledge is smaller. Thus, for any given bias, decentralization becomes more likely with easier availability of information, as predicted by the model when the *status quo* is decentralization.

Turning to the second component of the interaction term, the bias, note that decentralization should increase with a larger bias if the local government is the principal, and decrease otherwise. This argument, however, overlooks the fact that an increase in the bias also has the (indirect) effect of reducing the amount of communication, thus making decentralization more costly from the local government's perspective (and centralization more costly from the federal government's perspective). The interaction effect allows us to differentiate between the direct and the indirect effects. Specifically, with the local government being the principal, we expect to find that a greater bias increases centralization only when information transmission is low.[29] The results from column 5 in Table 2 confirm such intuition; the coefficient of the interaction variable is positive and significant. Figure 3 shows the marginal effect. The result shows that the marginal effect of heterogeneity on decentralization is positive and significant only for high levels of information transmission and not significant when information transmission would be more important (that is, information transmission is low). Therefore, overall, the data are in line with our model with the local government being the principal in this overall sample.

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[29]On the other hand, when the federal government is the principal, we expect decentralization to prevail with a larger bias only if information transmission is more difficult.
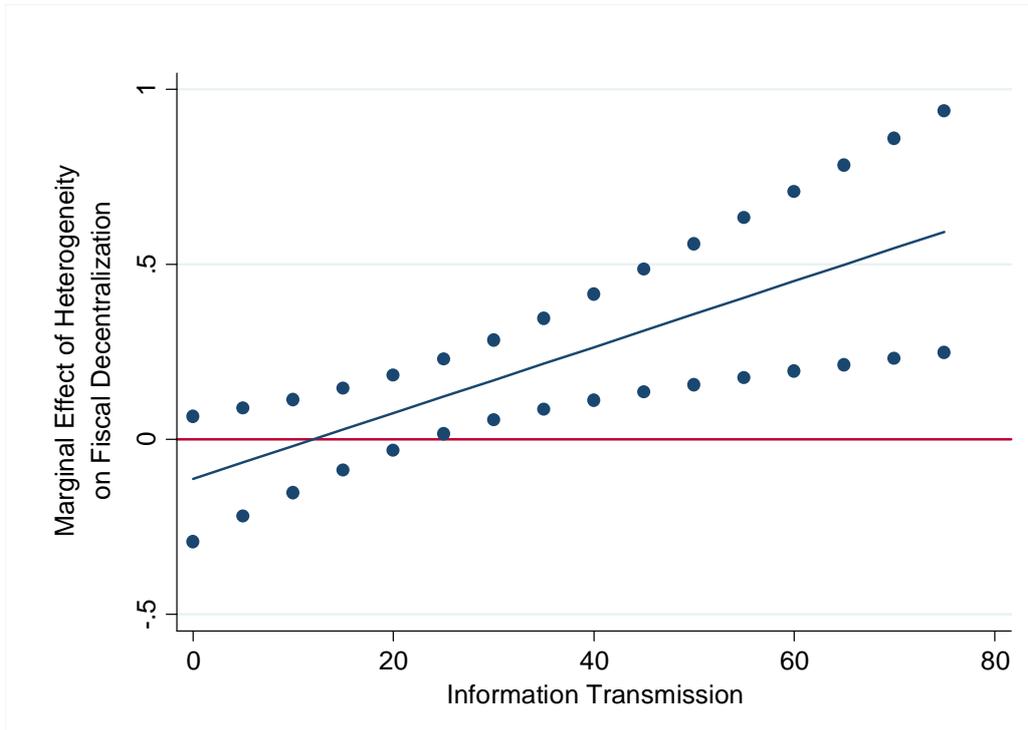
**Figure 3:** Marginal effect of Heterogeneity on the share of subnational government expenditure for different levels of Information Transmission (Table 2, column 5). The dashed line shows the 95%-confidence interval.

We next split the overall sample in two sub-samples according to whether the federal or the local governments are more likely to decide on the degree of decentralization. This allows a sharper test of our hypotheses, which depends on who the principal is and who the agent is. We use a number of different variables to capture this: first, we consider whether a country is federal or unitary. Classifications are available from Norris (2008) and Elazar (1995), the latter being updated by Treisman (2008). Second, we distinguish countries where the constitution explicitly grants sub-national governments residual power to legislate from those where all legislation power remains with the central government (Treisman 2008). Beck et al. (2001) provide data indicating whether sub-national governments have authority over taxing, spending, or legislating. In this case, they can directly influence the degree of expenditure decentralization. Moreover, we focus on countries where sub-national governments are locally elected (Treisman, 2008). Direct election by voters increases the legitimacy of subnational governments, so that it becomes more difficult for the federal government to resist and impede changes proposed by subnational governments, increasing their discretionary power. Appendix F shows how individual countries are classified according to all measures.

Table 3 shows the results, focusing on the interaction between the bias and information transmission. The results are very much in line with the predictions of the model. In all five regressions, the interaction between heterogeneity and information transmission is positive and significant at the five percent level at least when the local government is comparably more powerful. In countries where the federal government is more powerful the coefficient of the interaction term is always negative. It is significant at the ten percent level in one regression only. However, the difference between the coefficients of the interaction terms in the two models (tested employing a seemingly unrelated regression model) is always significant, at least at the ten percent level.

In line with the model, when the local government is the principal, better information transmission increases the effect of heterogeneity on decentralization. When the federal government is the principal, lower differences in information decrease the importance of local information and thus reduce the positive effect of heterogeneity on decentralization. In summary, our model fits the data well.

**Table 3:** Interaction between Heterogeneity and Information, 1972 – 2010, OLS

| Agenda setter: | Local government | | Federal government | | |
|---|---|---|---|---|---|
| | Coef. | Std. err. | Coef. | Std. err. | P-value |
| *Federation type: Unitary or federal (Norris 2008)* | | | | | |
| Heterogeneity*Information Transmission | 0.011*** | [0.004] | -0.002 | [0.005] | 0.018 |
| Adj. R-Squared | 0.54 | | 0.86 | | |
| Number of observations | 272 | | 71 | | |
| *Classified as "federal" (Elazar 1995)* | | | | | |
| Heterogeneity*Information Transmission | 0.010*** | [0.003] | -0.019* | [0.010] | 0.000 |
| Adj. R-Squared | 0.61 | | 0.92 | | |
| Number of observations | 306 | | 39 | | |
| *Residual powers to legislate (Treisman 2008)* | | | | | |
| Heterogeneity*Information Transmission | 0.008** | [0.003] | -0.003 | [0.006] | 0.077 |
| Adj. R-Squared | 0.72 | | 0.59 | | |
| Number of observations | 207 | | 138 | | |
| *Sub-national government authority (Keefer 2013)* | | | | | |
| Heterogeneity*Information Transmission | 0.013*** | [0.004] | -0.001 | [0.003] | 0.005 |
| Adj. R-Squared | 0.74 | | 0.56 | | |
| Number of observations | 126 | | 219 | | |
| *Legislature or executive locally elected (Treisman 2008)* | | | | | |
| Heterogeneity*Information Transmission | 0.009** | [0.004] | -0.003 | [0.005] | 0.056 |
| Adj. R-Squared | 0.75 | | 0.57 | | |
| Number of observations | 191 | | 154 | | |

Notes: Interaction effect between Heterogeneity and Information Transmission for local and federal government as agenda setters. Standard errors (clustered at the country level) in brackets. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. P-value corresponds to a test for significant differences between the coefficients for federal and unitary states.

# 8 Concluding remarks

The model analyzed has focused on the importance of information transmission between the federal and local governments in the design of policies. By explicitly relating the quality of the information supplied by local governments to the federal government (and *vice versa*) to the misalignment of interests between the two, the analysis has derived the properties of different decentralization schemes.

More specifically, the analysis has compared an institution in which control rights over policies are allocated to the federal government ('centralization'), with an institution in which local governments are left with considerable freedom to devise their own policy actions, ultimately being judged by outcomes ('decentralization'). The results have shown that, for a given agency bias, and when the local government decides about the degree of centralization, the informational advantage of the federal government must strictly be greater than the informational advantage of the local governments for the centralization scheme to be optimal. As far as the effect of the agency bias is concerned, intuition suggests that an increase in the misalignment of interests between the federal and the local government would lead towards decentralization.

Since an increase in the bias also reduces the amount of information transferred by the federal government to the local ones under the decentralization scheme, the local governments' incentives to centralize may increase. It is, therefore, the case that the impact of the agency bias alone on the optimal choice of decentralization is *a priori* undetermined, and this holds in analogy when the central government decides on the degree of decentralization. Interestingly, it is possible to disentangle both schemes by focusing on the interaction between the agency bias and information transmission. Depending on the quality of information transmission, an increase in the bias affects the optimal degree of decentralization differently when the local or the federal government is the principal. When control rights remain with the local units, if the quality of information transmission is high (less of the information is soft and unverifiable), the effect of the agency bias on decentralization should be higher. This is the case because local governments depend less on central information, and thus react to a larger misalignment of interests by increasing decentralization and providing more room for deviation from the policy preferred by the federal government. When control rights remain with the federal government, on the other hand, higher quality of information transmission causes less reliance on local soft and unverifiable information. Thus, the federal government will react to a larger misalignment of interests by increasing centralization.

Expenditure decentralization varies widely across countries and over time. In our sample, the range is between 3.6 to 64.13 percent, with an average of 27.97 percent of government spending

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taking place at the sub-federal level. Even controlling for factors identified in the literature as determinants of decentralization, stark differences across countries remain. This suggests that the combination of agency problems and informational asymmetries between the federal and local governments can explain such differences. We test the theoretical implications empirically by relating the degree of fiscal decentralization to information transmission and the size of the bias. Controlling for country-characteristics, their economic performance, and for 'political' motivations, we find empirical results consistent with the theory. In line with the existing literature, decentralization increases with land size, while GDP per capita, the size of the population, urbanization, and democracy do not robustly determine decentralization.

With respect to our variables of interest, we find that decentralization increases with less openness to trade and better educational quality, as the relative importance of the federal government's knowledge diminishes. Moreover, decentralization increases with better information transmission and greater heterogeneity. Overall, better information transmission leads to more decentralization, which is consistent with the model when the status quo is decentralization.

Heterogeneity is at the same time a measure of the importance of the local knowledge and the agency bias. Greater importance of the local government's knowledge does lead to more decentralization, consistent with the theory. The impact of the bias is, however, less straightforward, as it is influenced by who has control rights, that is, who has the final say in deciding on the degree of decentralization. In our overall sample, we find that the effect of heterogeneity on decentralization increases with better quality of information transmission. This positive interaction effect is in line with the case where control rights on the degree of decentralization lie with the local governments.

To justify the theoretical emphasis on the importance of control rights, we distinguished between the cases of federal and local control. This has lead us to the use of five distinct constitutional and statutory country characteristics in order to separate those countries where the federal government is more likely to be the principal and the local governments the agents, from those where the local governments have more political power to decide on the degree of decentralization. As predicted by our model, when the local government is the principal, an increase in the bias leads to the decentralization scheme only when the quality of information transmission is relatively high. This positive interaction effect is significant at the five- or one-percent level for all five characteristics. When the federal government is the principal, the interaction effect is negative or insignificant as expected. The differences between these coefficients are significant at least at the ten-percent level for all five constitutional and statutory country characteristics. In summary, the empirical results are thus well in line with our theoretical predictions.

Important policy implications arise from these findings. While we found that the average country

in our sample, to some extent, allocates policies in line with the prediction of the model, individual countries (our groups of countries) might deviate from the optimal design. For example, in the case of the European Union, centralization may be too low as a consequence of the bias in objectives between the member states and the institutions of the European Union. More specifically, the allocation of control rights over policies may sub-optimally remain with the local governments (the member states) in certain areas, under-exploiting the knowledge of the EU Institutions in the presence of a bias.

The analysis is of course limited in several respects. Other types of decentralization besides the fiscal realm have been neglected. It will be an important endeavor to test our theory again when data that allow a distinction about the actual control rights of local units over policy for a larger sample of countries become available. Moreover, it might be promising to explore the differences between developing and developed countries as well as the interaction between different local units, which in turn may have different degrees of bias, and different access to information. There remains much scope for the analysis of information transmission in richer models of fiscal federalism. We hope to have shown that the task is worthwhile and that the conclusions can be instructive.

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# Appendices

## Appendix A: Definition and properties of the communication game

This Appendix provides the definition of the communication game and the properties of the equilibrium outlined in Section 3.

Let $t \in [0, C]$ denote the message that the federal government sends to the local, when asked to offer its advice. Let $q(t|c)$ denote the density function that the federal government sends message $t$ when it has observed $c$. $q(t|c)$ is the reporting rule chosen by the federal government. Let $p(u, t)$ be the policy chosen by the local government, given the federal government has sent message $t$ to the local government. We then have that:

**Definition 1** *A Perfect Bayesian Nash Equilibrium of the communication game consists of a reporting rule $q(t|c)$ and an action rule for the local government $p(u, t)$ such that:*

*i) for each $c \in [0, C]$, $\int_R q(t|c)\, dt = 1$. If $t^*$ is in the support of $q(t|c)$, $t^*$ is such that:*

$$t^* = \arg\min L^F = \int_0^U [p(u, t) - p_F^*]^2 f_U(u) du, \tag{A.1}$$

*and*
*ii) for each $t$, $p(u, t)$ solves*

$$p(u, t) = \arg\min L^L = \int_0^C [p(u, t) - p_L^*]^2 g(c|t) dc, \tag{A.2}$$

*where $g(c|t) = \frac{q(t|c) f_C(c)}{\int_0^C q(t|\theta) f_C(\theta) d\theta}$.*

According to condition (*i*), the reporting rule $q(t|c)$ chosen by the federal government minimizes the federal government's expected loss, given the local government's action rule $p(u, t)$. In other words, the equilibrium reporting rule $q(t|c)$ induces the local government to choose policies $p(u, t)$, which minimize the expected loss of the federal government. Condition (*ii*) simply says that the local government responds optimally to each federal government report $t$. Namely, the local government uses Bayes' rule to update its prior on $c$, given the federal government's reporting strategy and the signal received. Then, given the federal government's report $t$ and the posterior density function of $c$ given $t$—that is, $g(c|t)$—$p(u, t)$ minimizes the local government's expected loss. Crawford and Sobel (1982) show that this communication game does not have a full revelation equilibrium, but that there are multiple equilibria which are all partition equilibria. More specifically, the state space $[0, C]$ is partitioned into intervals and the federal government only reveals which interval the true value of $c$ belongs to. The following characterizes the relevant equilibria of the communication game.

**Proposition 1** *There exists at least one equilibrium with the following properties: there is a positive integer $N$, such that one can define a set of $N + 1$ real numbers, with generic element denoted by $c_i$, such that $0 = c_0 < c_1 < ... < c_{N-1} < c_N = 1$, and*

*(a) $q(t|c)$ is uniform, supported on $[c_i, c_{i+1}]$, if $t \in (c_i, c_{i+1})$;*

*(b) $p(u, t) = u + \frac{c_i + c_{i+1}}{2} - b$, for all $t \in (c_i, c_{i+1})$.*

*Moreover:*

(i) $\int_0^U \left[ u + (\frac{c_i + c_{i+1}}{2}) - (u + c_i) - B \right]^2 f(u)du = \int_0^U \left[ (u + c_i) - \left[ u + (\frac{c_{i-1} + c_i}{2}) \right] + B \right]^2 f(u)du;$

(ii) $c_0 = 0; c_N = C.$

**Proof:** The proof follows directly from Theorem 1 in Crawford and Sobel (1982). $\square$

Condition (*i*) is an 'arbitrage' condition which says that for states of nature that fall on the boundaries of two intervals the federal government must be indifferent between the actions $(p(u, t))$ on these two intervals. Condition (*i*) defines a second order linear differential equation on $c_i$, while condition (*ii*) specifies its initial and terminal conditions. Since the federal government is not informed on the true value of $u$, when choosing $t$, it will take the expected value of $u$, that is $U/2$. The arbitrage condition (*i*) then reduces to, for $i = 1, ..., N - 1$,

$$\frac{U}{2} + \left( \frac{c_{i+1} + c_i}{2} \right) - \left( \frac{U}{2} + c_i \right) - B = \frac{U}{2} + p_i - \left[ \frac{U}{2} + \left( \frac{c_{i-1} + c_i}{2} \right) \right] + B, \tag{A.3}$$

from which it implies

$$c_{i+1} = 2c_i - c_{i-1} + 4B. \tag{A.4}$$

This second order linear difference equation has a class of solutions parameterized by $c_1$ (given that $c_0 = 0$)

$$p_i = ip_1 + 2i(i - 1)B, \quad i = 1, ..., N - 1. \tag{A.5}$$

Given that $c_N = C$ it is the case that

$$c_1 = \frac{C - 2N(N - 1)B}{N}, \tag{A.6}$$

which, using (A.4) and substituting for the value of $c_1$, becomes

$$c_i = \frac{iC}{N} - 2i(N - i)B, \quad i = 1, ..., N. \tag{A.7}$$

From (A.7) it follows that

$$c_i - c_{i-1} = \frac{C}{N} + 2(2i - N - 1)B, \tag{A.8}$$

where the width of the interval increases by $4B$ for each increase in $i$.

Notice that the centralization game is entirely symmetric to the decentralization game. As before, the government's report $r$ is determined by a partition $\{u_i\}$ of $[0, \ U]$. Again, it is possible to define a reporting rule $q(r|u)$ and a posterior belief

$$g(u|r) = \frac{q(r|u)f_u(u)}{\int_0^U q(r|\theta)f_U(\theta)d(\theta)}, \tag{A.9}$$

such that, given the report $r \in [u_i, \ u_{i+1}]$, the federal's expected value of $u$ is $(u_i + u_{i+1})/2$ (posterior mean of the random variable $\widetilde{u}$, given $r$). Thus, the federal government will implement the following policy:

$$p(u, r) = \frac{u_i + u_{i+1}}{2} + c + e \quad \text{if} \quad r \in [u_i, u_{i+1}], \quad i = 1, ..., N - 1. \tag{A.10}$$

The partition $\{u_i\}$ of $[0,\ U]$ is computed using the conditions (*i*) and (*ii*) in Proposition 1, in a similar way as above, that is:

$$u_{N-i} - u_{N-(i-1)} = \frac{A}{N} - 2(2i - N - 1)B, \tag{A.11}$$

where the width of the interval decreases by $4B$ for each increase in $i$.

$\square$

## Appendix B: Derivation of equations (7), (9), (10) and (12)

Under decentralization, following Proposition 1 and using (A.8), the federal government's *ex ante* expected loss for the equilibrium of size $N$ is given by

$$
\begin{aligned}
L_D^F(N, B, C) &= \int_0^C \left(p(u,t) - p_F^*\right)^2 g\left(c \,|\, t\right) dc, \\
&= \int_0^C \left(u + \frac{c_i + c_{i+1}}{2} - b - u - c - e\right)^2 g\left(c \,|\, t\right) dc, \\
&= \frac{1}{C} \sum_{i=1}^N \int_{c_{i-1}}^{c_i} \left(\frac{c_{i-1} + c_i}{2} - c - B\right)^2 dc, \\
&= \frac{1}{C} \frac{1}{12} \sum_{i=1}^N (c_i - c_{i-1})^3 + \frac{1}{C} B^2 \left(c_0 - c_N\right), \\
&= \frac{1}{12} \sum_{i=1}^N \left[\frac{C}{N} + 2(2i - N - 1)B\right]^3 + \frac{1}{C} B^2 \left(c_0 - c_N\right), \\
&= \sigma_C^2 + B^2 \quad (c_0 = 0;\ c_N = C, \text{ see Proposition 1}), \tag{B.1}
\end{aligned}
$$

with the last equality following from equation (8). Here, $D$ stands for decentralization and $\sigma_C^2$ is the ex-ante residual variance of $c$, that is the uncertainty about $c$ faced by the local government before being reported by the federal government the equilibrium signal $t$.

On the other hand, the local government's *ex ante* expected loss is given by

$$
\begin{aligned}
L_D^L(N, B, C) &= \int_0^C \left(p(u,t) - p_L^*\right)^2 g\left(c \,|\, t\right) dc, \\
&= \int_0^C \left(u + \frac{c_i + c_{i+1}}{2} - b - u - c + b\right)^2 g\left(c \,|\, t\right) dc, \\
&= \frac{1}{C} \sum_{i=1}^N \int_{c_{i-1}}^{c_i} \left(\frac{c_{i-1} + c_i}{2} - c\right)^2 dc, \\
&= \frac{1}{12} \sum_{i=1}^N (c_i - c_{i-1})^3, \\
&= \frac{1}{12} \sum_{i=1}^N \left[\frac{C}{N} + 2(2i - N - 1)B\right]^3, \\
&= \sigma_C^2, \tag{B.2}
\end{aligned}
$$

with the last equality following again from equation (8). Since both players' *ex ante* expected loss

is decreasing with $N$, Crawford and Sobel assume that both agents coordinate on the most informative equilibrium $N(C, B)$, which is thus a focal equilibrium.

Under centralization, following Proposition 1 and using (A.11), the federal government's *ex ante* expected loss for the equilibrium of size $N$ is given by:

$$
\begin{aligned}
L_C^F(N, B, C) &= \int_0^U [p(c, r) - p_F^*]^2\, g\left(u\,|\,r\right)du, \\
&= \frac{1}{U} \sum_{i=1}^N \int_{u_i-1}^{u_i} \left( \frac{u_i + u_{i+1}}{2} + c + e - c - u - e \right)^2 dc, \\
&= \frac{1}{U} \sum_{i=1}^N \int_{u_i-1}^{u_i} \left( \frac{u_{i-1} + u_i}{2} - u \right)^2 dc, \\
&= \frac{1}{U} \frac{1}{12} \sum_{i=1}^N (u_i - u_{i-1})^3 \\
&= \frac{1}{U} \frac{1}{12} \sum_{i=1}^N \left[ \frac{A}{N} + 2(2i - N - 1)B \right]^3, \\
&= \sigma_u^2, \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad (\text{B.3})
\end{aligned}
$$

where the last equality follows from equation (11).

On the other hand, the local government's *ex ante* expected loss is given by

$$
\begin{aligned}
L_C^L(N, B, C) &= \int_0^U [p(c, r) - p_L^*]^2\, g\left(u\,|\,r\right)du, \\
&= \frac{1}{U} \sum_{i=1}^N \int_{u_i-1}^{u_i} \left( \frac{u_i + u_{i+1}}{2} + c + e - c - u + b \right)^2 dc, \\
&= \frac{1}{U} \sum_{i=1}^N \int_{u_i-1}^{u_i} \left( \frac{u_{i-1} + u_i}{2} - u + B \right)^2 dc, \\
&= \frac{1}{U} \frac{1}{12} \sum_{i=1}^N (u_i - u_{i-1})^3 + \frac{B^2}{U} \sum_{i=1}^N (u_i - u_{i-1}) \\
&= \frac{1}{U} \frac{1}{12} \sum_{i=1}^N \left[ \frac{A}{N} + 2(2i - N - 1)B \right]^3 - \frac{B^2}{U}(u_0 - u_N) \\
&= \sigma_u^2 + B^2 \,(u_0 = 0; \ u_N = U, \text{see Proposition 1}). \quad\quad\quad (\text{B.4})
\end{aligned}
$$

$\square$

## Appendix C: Proof of statements in Section 5 and 7

The statement given in Section 5 follows directly from Proposition 2 below. By comparing its *ex ante* expected loss under decentralization ($L_D^F(N, B, C)$) with the one it incurs under centralization ($L_C^F(N, B, C)$), the federal government determines whether or not to retain its control rights over policies.

**Proposition 2** *The federal government prefers decentralization if and only if $U \geq C(U, B)$, where $C(U, B)$ is continuous and increasing in $U$ and, for any $B$, $C(U, B) < U$.*

**Proof:** The proof follows Theorem 1 in Harris and Raviv (2005). $\square$

The statement given in Section 7 follows directly from Proposition 3 below. By comparing its *ex ante* expected loss under decentralization ($L_D^L(N, B, C)$) with the one it incurs under centralization ($L_C^L(N, B, C)$), the local government determines whether or not to retain its control rights over policies.

**Proposition 3** *The local government prefers centralization if and only if $C \geq U(C, B)$, where $U(C, B)$ is continuous and increasing in $C$ and, for any $B$, $U(C, B) > C$.*

**Proof:** The proof follows Theorem 1 in Harris and Raviv (2005). $\square$

# Appendix D: Descriptive Statistics

| | Observations | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Exp. Decentralization | 338 | 27.5 | 15.15 | 0.61 | 63.77 |
| (log) GDP | 338 | 9.66 | 0.82 | 6.51 | 11.24 |
| (log) Land Area | 338 | 11.82 | 1.93 | 5.77 | 16.61 |
| (log) Population | 338 | 15.97 | 1.46 | 12.30 | 19.42 |
| Urbanization | 338 | 70.19 | 14.62 | 20.02 | 97.38 |
| Democracy Dummy | 338 | 0.89 | 0.31 | 0.00 | 1.00 |
| Heterogeneity | 338 | 28.8 | 21.82 | 0.20 | 87.47 |
| Trade Openness | 338 | 80.5 | 46.51 | 14.92 | 314.71 |
| Oil Rents | 338 | 1.81 | 6.84 | 0.00 | 63.98 |
| Information Transmission | 338 | 35.53 | 17.27 | 0.15 | 72.91 |
| Transparency | 338 | 54.09 | 14.02 | 20.21 | 84.44 |
| Educational Quality | 338 | 39.81 | 20.18 | 1.14 | 97.69 |
| Ethnic Tensions | 279 | 1.38 | 1.14 | 0.00 | 4.92 |
| Government Stability | 279 | 8.2 | 1.58 | 3.94 | 11.42 |
| Gov. Fractionalization | 279 | 66.21 | 18.79 | 0.00 | 89.71 |
| Migrant Share | 314 | 8.63 | 8.03 | 0.13 | 48.00 |
| Risk of External Conflicts | 279 | 1.19 | 1.37 | 0.00 | 9.00 |
| Corruption | 298 | 3.97 | 1.44 | 1.00 | 6.00 |
| Press Freedom | 324 | 70.98 | 18.03 | 10.67 | 95.00 |

# Appendix E: Correlations

| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exp. Decentralization | (1) | 1 | | | | | | | | | | | | | | | | | | |
| (log) GDP | (2) | 0.45 | 1 | | | | | | | | | | | | | | | | | |
| (log) Land Area | (3) | 0.36 | -0.17 | 1 | | | | | | | | | | | | | | | | |
| (log) Population | (4) | 0.29 | -0.09 | 0.81 | 1 | | | | | | | | | | | | | | | |
| Urbanization | (5) | 0.33 | 0.76 | -0.03 | 0.02 | 1 | | | | | | | | | | | | | | |
| Democracy Dummy | (6) | 0.18 | 0.53 | -0.13 | -0.04 | 0.35 | 1 | | | | | | | | | | | | | |
| Heterogeneity | (7) | -0.08 | -0.45 | 0.12 | 0.00 | -0.33 | -0.30 | 1 | | | | | | | | | | | | |
| Trade Openness | (8) | -0.30 | 0.14 | -0.61 | -0.52 | 0.12 | -0.05 | 0.06 | 1 | | | | | | | | | | | |
| Oil Rents | (9) | -0.10 | 0.00 | 0.05 | 0.01 | 0.05 | -0.29 | 0.22 | 0.05 | 1 | | | | | | | | | | |
| Inf. Transmission | (10) | 0.50 | 0.82 | -0.10 | -0.02 | 0.63 | 0.54 | -0.44 | 0.12 | -0.15 | 1 | | | | | | | | | |
| Transparency | (11) | -0.16 | -0.13 | 0.20 | 0.22 | 0.01 | 0.19 | 0.10 | 0.07 | 0.01 | 0.02 | 1 | | | | | | | | |
| Educational Quality | (12) | 0.42 | 0.65 | 0.13 | 0.14 | 0.58 | 0.47 | -0.33 | 0.05 | -0.15 | 0.72 | 0.16 | 1 | | | | | | | |
| Ethnic Tensions | (13) | -0.05 | -0.39 | 0.10 | 0.16 | -0.40 | -0.17 | 0.51 | -0.08 | 0.07 | -0.37 | 0.07 | -0.28 | 1 | | | | | | |
| Government Stability | (14) | 0.03 | 0.25 | -0.10 | -0.07 | 0.18 | 0.01 | -0.10 | 0.28 | 0.12 | 0.30 | 0.21 | 0.24 | -0.28 | 1 | | | | | |
| Gov. Fractionalization | (15) | 0.29 | 0.39 | -0.11 | -0.12 | 0.35 | 0.48 | -0.11 | 0.08 | -0.08 | 0.38 | 0.08 | 0.42 | -0.16 | 0.23 | 1 | | | | |
| Migrant Share | (16) | 0.13 | 0.40 | -0.32 | -0.25 | 0.48 | 0.03 | 0.10 | 0.35 | 0.30 | 0.31 | -0.18 | 0.19 | -0.02 | 0.18 | 0.22 | 1 | | | |
| Risk of Ext. Conflicts | (17) | -0.19 | -0.41 | 0.09 | 0.11 | -0.27 | -0.35 | 0.25 | -0.16 | 0.15 | -0.35 | 0.01 | -0.26 | 0.40 | -0.24 | -0.26 | 0.05 | 1 | | |
| Corruption | (18) | 0.41 | 0.59 | -0.09 | -0.15 | 0.45 | 0.32 | -0.34 | -0.03 | -0.20 | 0.61 | -0.58 | 0.28 | -0.27 | -0.01 | 0.22 | 0.19 | -0.26 | 1 | |
| Press Freedom | (19) | 0.33 | 0.63 | -0.09 | -0.09 | 0.43 | 0.71 | -0.34 | -0.05 | -0.29 | 0.63 | -0.09 | 0.49 | -0.27 | 0.03 | 0.42 | 0.05 | -0.42 | 0.53 | 1 |

Notes: Simple correlations between all variables contained in the empirical section

## Appendix F: Classification of countries

| Federation type: Unitary or federal (Norris 2008) | | | Classified as "federal" (Elazar 1995) | | | Residual powers to legislate (Treisman 2008) | | | Sub-national government authority over taxing, spending, or legislating (Keefer 2013) | | | Legislature or executive locally elected (Treisman 2008) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | 0 | 1 | Country | 0 | 1 | Country | 0 | 1 | Country | 0 | 1 | Country | 0 | 1 |
| Afghanistan | X | | Albania | X | | Albania | X | | Argentina | | X | Afghanistan | X | |
| Albania | X | | Argentina | | X | Argentina | | X | Armenia | X | | Albania | | X |
| Argentina | | X | Armenia | X | | Armenia | X | | Australia | | X | Argentina | X | X |
| Armenia | X | | Azerbaijan | X | | Azerbaijan | X | | Austria | | X | Armenia | X | X |
| Australia | | X | Belarus | X | | Belarus | X | | Bahrain | X | | Australia | | X |
| Austria | | X | Bolivia | X | | Bolivia | X | | Belarus | X | | Austria | | X |
| Azerbaijan | X | | Botswana | X | | Brazil | | X | Belgium | X | X | Azerbaijan | X | X |
| Bahrain | X | | Brazil | | X | Bulgaria | X | | Bhutan | X | | Bahrain | X | |
| Barbados | X | | Bulgaria | X | | Canada | | X | Botswana | | X | Barbados | X | |
| Belarus | X | | Canada | | X | Chile | X | | Brazil | | X | Belarus | X | X |
| Belgium | | X | Chile | X | | China | X | | Bulgaria | X | | Belgium | | X |
| Bhutan | | X | China | X | | Colombia | X | | Canada | | X | Bhutan | X | |
| Bolivia | X | | Colombia | X | | Costa Rica | X | | Chile | X | | Bolivia | X | |
| Botswana | X | | Costa Rica | X | | Croatia | X | | Colombia | | X | Botswana | | X |
| Brazil | | X | Croatia | X | | Czech Republic | X | | Congo, Rep. | X | | Brazil | | X |
| Bulgaria | X | | Czech Republic | X | | Egypt | X | | Costa Rica | X | | Bulgaria | | X |
| Canada | | X | Egypt | X | | Estonia | X | | Cote d'Ivoire | X | | Canada | | X |

| Country | | | Country | | | Country | | | Country | | | Country | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cape Verde | X | | Estonia | X | | Ethiopia | | X | Croatia | X | | Cape Verde | | X |
| Chile | X | | Ethiopia | | X | France | X | | Czech Republic | X | | Chile | X | |
| China | | X | France | X | | Georgia | X | | Dominican Republic | X | | China | | X |
| Colombia | | X | Georgia | X | | Germany | | X | Egypt | X | X | Colombia | | X |
| Congo, Rep. | X | | Germany | | X | Hungary | X | | Estonia | X | | Congo, Rep. | | X |
| Costa Rica | X | | Guatemala | X | | India | X | | Ethiopia | X | | Costa Rica | X | |
| Cote d'Ivoire | X | | Hungary | X | | Indonesia | X | | Fiji | | X | Cote d'Ivoire | | X |
| Croatia | X | | India | | X | Italy | | X | Finland | | X | Croatia | | X |
| Czech Republic | X | | Indonesia | X | | Kazakhstan | X | | France | X | X | Czech Republic | | X |
| Denmark | X | | Italy | X | | Kenya | X | | Georgia | X | | Denmark | | X |
| Dominican Republic | X | | Kazakhstan | X | | Kyrgyz Republic | X | | Germany | | X | Dominican Republic | X | |
| Egypt | X | | Kenya | X | | Lithuania | X | | Guatemala | X | | Egypt | | X |
| Estonia | X | | Kyrgyz Republic | X | | Malaysia | | X | Hungary | X | | Ethiopia | | X |
| Ethiopia | | X | Lithuania | X | | Mexico | | X | India | | X | Fiji | | X |
| Fiji | | X | Malaysia | | X | Moldova | X | | Italy | | X | Finland | X | X |
| Finland | X | | Mexico | | X | Peru | X | | Kuwait | X | | France | | X |
| France | X | | Moldova | X | | Philippines | X | | Malaysia | | X | Germany | | X |
| Georgia | | X | Nicaragua | X | | Poland | X | | Mexico | | X | Guatemala | X | |
| Germany | | X | Panama | X | | Portugal | X | | Philippines | | X | Hungary | X | |
| Guatemala | X | | Peru | X | | Romania | X | | Senegal | | X | Iceland | | X |
| Hungary | X | | Philippines | X | | Russia | | X | Singapore | X | | India | | X |
| Iceland | X | | Poland | X | | Senegal | X | | Spain | | X | Indonesia | X | X |
| India | | X | Portugal | X | | Singapore | X | | Sweden | | X | Iran | X | X |

| Country | | | Country | | | Country | | | Country | | Country | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indonesia | | X | Romania | X | | Slovak Republic | X | | Switzerland | X | Ireland | | X |
| Iran | X | | Russia | | X | Slovenia | X | | Trinidad and Tobago | X | Israel | | X |
| Ireland | X | | Senegal | X | | South Africa | X | | United States | X | Italy | | X |
| Israel | X | | Singapore | X | | Spain | X | | | | Japan | | X |
| Italy | | X | Slovak Republic | X | | Sweden | X | | | | Jordan | X | |
| Jamaica | X | | Slovenia | X | | Thailand | X | | | | Kazakhstan | | X |
| Japan | | X | South Africa | X | | Trinidad and Tobago | X | | | | Korea, Rep. | X | X |
| Jordan | X | | Spain | | X | Tunisia | X | | | | Kuwait | X | |
| Kazakhstan | X | | Sweden | X | | Uganda | X | | | | Kyrgyz Republic | | X |
| Kenya | X | | Thailand | X | | United Kingdom | X | | | | Lesotho | X | |
| Korea, Rep. | X | | Trinidad and Tobago | X | | United States | | X | | | Lithuania | X | |
| Kuwait | X | | Tunisia | X | | Zambia | X | | | | Luxembourg | X | |
| Kyrgyz Republic | X | | Uganda | X | | Zimbabwe | X | | | | Macedonia | X | |
| Latvia | X | | Ukraine | X | | | | | | | Malaysia | | X |
| Lesotho | X | | United Kingdom | X | | | | | | | Maldives | X | |
| Lithuania | X | | United States | | X | | | | | | Malta | X | |
| Luxembourg | X | | Uruguay | X | | | | | | | Mauritius | | X |
| Macedonia | X | | Zambia | X | | | | | | | Mexico | | X |

| | | | | | |
|---|---|---|---|---|---|
| Malaysia | | X | Zimbabwe | X | |
| Maldives | X | | | | |
| Malta | X | | | | |
| Mauritius | X | | | | |
| Mexico | | X | | | |
| Moldova | X | | | | |
| Mongolia | X | | | | |
| Netherlands | | X | | | |
| New Zealand | X | | | | |
| Nicaragua | X | | | | |
| Norway | X | | | | |
| Panama | X | | | | |
| Paraguay | X | | | | |
| Peru | X | | | | |
| Philippines | X | | | | |
| Poland | X | | | | |
| Portugal | | X | | | |
| Romania | X | | | | |
| Russia | | X | | | |
| Senegal | X | | | | |
| Singapore | X | | | | |
| Slovak Republic | X | | | | |
| Slovenia | X | | | | |
| South Africa | | X | | | |
| Spain | | X | | | |

| | | |
|---|---|---|
| Mongolia | | X |
| Netherlands | | X |
| New Zealand | | X |
| Nicaragua | X | |
| Norway | | X |
| Panama | X | X |
| Paraguay | X | |
| Peru | X | |
| Philippines | | X |
| Poland | | X |
| Portugal | X | X |
| Romania | | X |
| Senegal | | X |
| Singapore | X | |
| Slovak Republic | X | X |
| South Africa | | X |
| Spain | | X |
| Sri Lanka | X | X |
| Swaziland | X | |
| Sweden | | X |
| Switzerland | | X |
| Syria | X | X |
| Tajikistan | | X |
| Thailand | X | |
| Togo | | X |

| Country | | | Country | | |
|---|---|---|---|---|---|
| Sri Lanka | X | | Trinidad and Tobago | | X |
| Swaziland | X | | Tunisia | | X |
| Sweden | X | | Uganda | X | |
| Switzerland | | X | United Kingdom | | X |
| Syria | X | | United States | | X |
| Tajikistan | X | | Uruguay | X | X |
| Thailand | X | | Vietnam | X | |
| Togo | X | | Yemen, Rep. | X | X |
| Trinidad and Tobago | | X | Zambia | | X |
| Tunisia | X | | Zimbabwe | X | |
| Uganda | X | | | | |
| Ukraine | | X | | | |
| United Kingdom | | X | | | |
| United States | | X | | | |
| Uruguay | X | | | | |
| Vietnam | X | | | | |
| Yemen, Rep. | X | | | | |
| Zambia | X | | | | |
| Zimbabwe | X | | | | |

Notes: Classification of countries as federal or unitary. Countries where both categories are filled with an "X" changed within this classification during the sample period. The estimations use the classification in the respective period. For more details please refer to the original sources as provided in the references.