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Information transmission within federal fiscal architectures: Theory and evidence

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Keywords: delegation, centralization, communication, fiscal decentralization, state and local government

1 Introduction

During the last decade there has been a resurgence of interest in decentralization around the world. Decentralization, or federalism, has been seen as the appropriate government structure to ensure an efficient allocation of resources and to promote accountability.[1] At the same time, there have been extensive debates on how much authority to delegate, for example, to the European Union, which is a historically unique example of centralizing certain policy areas in a federation of distinctly heterogeneous countries with often diverging interests.[2] The implementation of decentralization policies, however, has varied substantially across countries and, in many cases, it has been problematic or not fully successful. The main reason has been that successful decentralization requires an effective allocation of responsibilities across levels of government, which, in turn, requires effective *communication of information* that is distributed across different levels of policy decision-making.

That policy decision-making in federal economies is liable to asymmetric information (moral hazard and adverse selection) has not gone unnoticed in the literature, but the emphasis has predominantly been on the unverifiability of information regarding preferences for public goods and production technologies. With the notable exception of Kessler (2014), the role of the federal and local governments' differential access to information and the importance of their effective communication have been neglected. This paper aims to fill this gap by focusing on the relative importance of local and central government knowledge as a determinant of the optimal degree of decentralization across countries when preferences across levels of government are misaligned. While most of the literature on federalism compares centralization and decentralization from a normative perspective, we look at the question from a positive angle and, to the best of our knowledge, are the first to examine the role of information asymmetries on the endogenous allocation of control rights in federations.

More specifically, we identify the *transmission of information* between government levels, under *misaligned interests* between them, as an additional element that determines the optimal allocation of policy decision-making and the degree of decentralization in a country. We show that the degree of decentralization is not only determined by 'communication', but also by institutional differences between unitary and federal states. These differences explain the different impact that the importance of private information of government levels has on the decentralization choice.[3] Our analysis uses a two-sided incomplete information principal-agent framework, in which the transmission of information (assumed to be costless) between local and federal governments is 'soft' and cannot be verified or is prohibitively costly to verify. Whenever the interests of the two levels differ, however, the quality of the transmitted information depends on such conflicts of interest, with each level of government rationally expecting the information transmitted by the other government level to be

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[1] 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. For recent empirical evidence, see Escobar-Lemmon and Ross (2014).

[2] With the aggravation of the eurozone crisis a European Fiscal Union, for example, has been advocated for by both scholars (e.g., Farhi and Werning 2014) and policy makers (e.g., Trichet 2011). More recently, after the terrorist attacks in France and Belgium, greater centralization of European intelligence has also been proposed to solve coordination and lack of information transmission within states. Similar arguments in favor of a more "coordinated response" have also been suggested to solve the emergency due to the increased level of migration flows into the European Union.

[3] 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, intergovernmental commitment problems (e.g., Rodden 2002), and lobbying. All that matters for the present analysis is that such misalignment exists.

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 the local governments own the control rights over policies.

Delegation (either by the federal or the local governments) of decision-making can be optimal depending on the relative importance of private knowledge. The federal government might opt for delegating policies to the local government in order to be able to fully utilize local knowledge. In equilibrium, the federal government's own information will then only be partially exploited. Under centralization, conversely, the federal government's knowledge will be fully utilized and any deviation from its preferences (due to the local government's reporting bias) will be avoided, at the cost of not fully using local information. Therefore, the optimal allocation of control rights over policies will depend on the relative importance of both level's information, as well as on the size of the agency bias, which simultaneously affects the amount of information transmitted and the degree of (de)centralization chosen.

An immediate empirical application 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. We demonstrate the importance of the model in a cross-sectional panel analysis of sub-national expenditure decisions over the 1972-2010 period. The empirical analysis is in line with the theoretical prediction of the model that relative importance of the local and federal information as well as the bias between national and sub-national governments helps to explain the degree of decentralization. As predicted, the results differ according to whether the federal or the local governments have the right to decide on the share of subnational expenditures.

2 Related literature

We relate to several strands of literature. The first is the cheap-talk literature building on the seminal work by Crawford and Sobel (1982). They consider the conflict of interests between the owner of a firm and its managers (see, for example, Dessein 2002) or between the CEO and its division managers (as in Harris and Raviv 2005). Though there are similarities between the theory of the firm and that of fiscal federalism—namely the hierarchical organization structure and the structure of incentives—there are also distinct differences, most notably in the different functions implemented by firms and governments.

The second strand of literature emphasizes political incentives (as in, among others, Bucovetsky *et al.* 1998, Bordignon *et al.* 2001, Lockwood 2002, and Kotsogiannis and Schwager 2008) within a decentralized system of governments.[4] More recently, Kessler (2014)—using the cheap talk model of Crawford and Sobel (1982)—analyzes the public spending decisions of a legislature when legislators engage in truthful information transmission. Assuming that only local governments have an informational advantage, Kessler (2014) finds that misaligned interests between government levels make communication incomplete, which leads to inefficiencies in federal spending decisions (either universalism or uniformity). Like Kessler (2014), we analyze issues of communication in a decentralized economy, but unlike her we focus on communication between a (representative)

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[4]The role of information and misaligned preferences has also been investigated in the context of creating international organizations. Johnson and Urpelainen (2012) show that international bureaucrats may get substantial leeway even when their preferences are misaligned with the positions of states, due to their informational advantage.

local and a federal government and the analysis of which level should, optimally, have control over policies when private information is two-sided.

Third, we also relate to the literature on state formation (as in, for example, Alesina and Spolaore 2003) as well as to the emerging literature on the structure of international unions (e.g., Alesina *et al*. 2005). Like in this literature, we also consider the trade-off between the benefits from economies of scale and the internalization of externalities versus the costs of combining heterogeneous populations and the limited use of local private information. While this literature endogenizes the boundaries of jurisdictions (Alesina and Spolaore 2003) and the decision to become members of international unions (Alesina *et al*. 2005), this paper takes the latter as given and endogenizes the allocation of policy control between the local and the central level.[5]

Finally, the contribution of this paper is also to some degree empirical. Following Oates (1972), several contributions have analyzed the determinants of the degree of fiscal decentralization. Oates (1988), for instance, investigate the socio-economic determinants, whereas Panizza (1999) identifies ethnic fractionalization (used as a proxy for heterogeneity in tastes) as a determinant of fiscal decentralization. Panizza (1999) concludes that country size and income per capita are the two factors that are most clearly, and positively correlated with fiscal decentralization. Treisman (2006) identifies 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 2011, Bodman *et al*. 2010, Falleti 2005, Bahl and Wallace 2005), with some extending the scope of the literature by looking at decentralization in subcategories of government expenditures (Sacchi and Salotti 2013).

None of these contributions, however, examines the role of information as a possible determinant of the degree of decentralization in a cross-country context. Closest to our contribution is the contribution by Hooghe and Marks (2013) who show that even with no heterogeneity of preferences across localities, more populous countries tend to be more decentralized. This is because public good provision depends on soft information which increases with population and is difficult to standardize. As such it is expensive to rely on centralized organizational hierarchy.

3   Modeling communication between government levels

The framework relies on the model of Marchesi *et al*. (2011), which we modify to be applicable to analyze federalism. Moreover, we distinguish between two regimes according to the government level having the decision power at the beginning of the game (that we call "the principal"). While in Marchesi *et al*. (2011), a multilateral organization is always the principal, and a borrowing country the agent, in our framework, the constitutionally granted rights determine the roles.

When the *status quo* is a unitary country, the federal government is the principal with the final decision rights or veto powers on whether or not to delegate decision-making power to the local governments (e.g., in France, the United Kingdom, and Sweden). A unitary system is one in which decision making may be decentralized, but final authority rests with the center. Conversely, a federal system (e.g., in the United States, Canada, and Switzerland) disperses authority between "regional governments and a central government in such a way that each kind of government has

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[5]Hatfield and Pedró i Miquel (2011) propose a positive theory of (partial) decentralization in which decentralization should balance the need for redistribution with the need to avoid highly distortive taxes. They also derive an endogenous federal structure but in their paper federalism is seen as a mechanism for commitment not for "information disclosure."

some activities on which it makes final decisions" (Riker 1987). Most importantly, regions or their representatives can veto constitutional reform. This distinction across regimes will become crucial when taking the theoretical predictions to the data.

To analyze whether the federal (local) government has an incentive to delegate the control of decision-making to the local (federal) governments we focus on the aspects of the model that are central for the derivation of our hypotheses. For reasons of clarity, all detailed derivations and proofs are delegated to the Online Appendix.[6] The model features two players—federal and local governments—that possess different types of information both required for the policy design. The optimal policy is defined by $p^* = l + f$, where l and f are stochastic variables that proxy for information observed only by the local and, respectively, the federal government. l and f are independently and uniformly distributed on the intervals $[0, L]$ and $[0, F]$, respectively. This captures that the larger the interval $[0, L]$ ($[0, F]$), the larger the informational advantage of the local (federal) government.[7]

Local government's superior information over l could, for example, originate from its greater proximity to the 'local business environment' relative to federal government officials or from better knowledge about the risks and opportunities of local investment projects. On the other hand, the federal government's informational advantage, relative to the local government, can originate from several sources. First, country-wide knowledge is accumulated during its activities across the local jurisdictions. Second, the federal government is also likely to possess information with higher informational value about confidential issues such as security or military matters or activities related to the negotiation and implementation of commercial treaties or multilateral activities. Overall, the federal government should therefore be better equipped to take country-wide economic conditions into account. We assume both types of information to be (at least partly) soft.

Events unfold in three stages: allocation of control rights by the principal, communication, and policy implementation.[8] In the first stage, the principal (federal or local government) either allocates authority over the choice of the policy vector to the agent or retains authority. Centralization refers to the scheme in which the federal government decides on the policy vector, whereas under decentralization control rights are allocated to the local governments. After the first stage of the game, the real state of the world is revealed to both players. Then, 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 vector. 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

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[6]Specifically, Appendix A defines and shows the properties of the communication game, Appendix B derives the ex ante expected losses of the federal and local governments, while Appendix C contains proofs of the statements made in Sections 5 and 7 below.

[7]To simplify the analytical setting, we focus on the interaction between a central government and one local government (taken as the 'representative region'), which is assumed not to cover the same population as the central government. While this assumption is strong, it allows us to focus on the implications of information transmission for the choice of centralization vs. decentralization. Importantly, a model with multiple regions would not provide additional insights to the issues at hand as data which empirically distinguish the degree of decentralization of different regions within a country do not exist.

[8]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 updates its beliefs and chooses the policy vector. Finally, in the third stage, the chosen government level implements the policy vector and outcomes are realized.

The federal government is benevolent and assumed, for simplicity (and analytical tractability), to maximize the following objective function

$$U^F = U_0^F - (p - p_F^*)^2. \tag{1}$$

where U^F decreases with the distance between the actually implemented policy p and the central government preferred policy p_F^*, and $U_0^F = U^F(p_F^*)$.[9] The optimal policy of the federal government, p_F^* differs from the economy-wide optimal policy in the sense that $p_F^* = p^* + b_F$, with $b_F > 0$. A possible (but not the only) interpretation of b_F is the existence of externalities created by non-cooperative behavior on the part of the local governments.[10] When choosing policies, local governments do not internalize the impact of their policy actions on their neighboring localities (for example, when deciding whether or not to provide tertiary education, sharing information potentially useful to national security, regulation, or other public goods). This generates a misalignment of interest between the two levels of government relative to the federal government's country-wide objectives.

Similarly, the local government maximizes

$$U^L = U_0^L - (p - p_L^*)^2, \tag{2}$$

which is decreasing in the distance between the actually implemented policy p, and the local government's preferred policy p_L^*.and $U_0^L = U^L(p_L^*)$[11] The optimal policy choice of the local government deviates from the economy-wide optimal policy p^* by a factor $b_L > 0$ and is given by $p_L^* = p^* - b_L$. b_L proxies for all factors that might lead to a deviation of the local government's preferences from p^*: the pressure of local interest groups, re-election concerns (election mechanisms need not be the same as at the federal level), different time-horizons.[12]

Therefore, the difference in optimal policies is given by

$$p_F^* - p_L^* = p^* + b_F - (p^* - b_L) = b_F + b_L = B, \tag{3}$$

where B reflects the extent of policy bias.

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[9]The utility function (1) can be derived from a more general objective function $\widehat{U}^F = W(p) + \gamma W^{RC}(p)$, where W is the country's welfare and W^{RC} measures the welfare of the Rest of the Country. They both depend on the region's policy p. The parameter γ ($0 \le \gamma \le 1$) denotes the importance of spillover effects. Taking a Taylor expansion of $\widehat{U}^F(p)$ up to the second term, ones obtains the desired form (1).

[10]Environmental policy is, for example, a central piece of US-President Obama's domestic policy agenda. While executive authority has enabled the President to pursue a relatively ambitious environmental agenda, states have continued to pursue their own policy goals in the absence of federal policy (Konisky and Woods 2016).

[11]The more general function is: $\widehat{U}^L = W(p) + \theta C(p)$, where C are contributions from special interests groups. We assume that C decreases with p and that the parameter θ ($0 \le \theta \le 1$) denotes the importance of lobbies. Using a Taylor expansion of $\widehat{U}^L(p)$ up to the second term, one obtains (2).

[12]In this paper we assume a benevolent federal government, in contrast to a local government that is assumed to be more responsive to private interests. Bordignon *et al.* (2008), for example, find that when regional lobbies have conflicting interests, lobbying is less damaging for social welfare under centralization than under decentralization. This assumption, however, is not crucial for the interpretation of our results.

4 Federal government as the principal

As principal, the federal government can choose between centralization or decentralization. In our model centralization refers to the case in which the federal government has the final choice over policies it wishes to implement in the third stage. It needs to communicate with the local governments in the second stage of the game. Opting for centralization, the federal government minimizes the costs of misaligned incentives as it makes full use of its private knowledge. At the same time, it under-utilizes the local government's information. Under decentralization the federal government allocates policy decision-making to the local government. In this case, the local government's private knowledge is fully exploited, but the results can deviate from the federal government's optimal policy.

In the communication equilibrium, the local government only learns the interval to which the realization of f belongs, and hence obtains only incomplete information about the federal government's knowledge. The smaller the size of the partition interval, the more informative the federal government's message. We denote the maximum number of intervals, $N(F, B)$, as a function of the bias B and the length of the partition of the federal's knowledge F. Following Crawford and Sobel (1982), the most informative equilibrium—in which the number of intervals N is maximal—always exists and is a focal equilibrium of the communication game.

In the focal equilibrium, the federal government's *ex ante* expected welfare loss increases with the importance of the federal government's private information F, since the federal government's private information is not fully exploited under decentralization. Finally, for any given F, the maximum precision of the information transmitted by the federal government decreases with the extent of the bias B. Put differently, the extent and quality of information transmission depends on the proximity of the preferences of the federal and the local governments: the larger the bias B, the less precise and informative cheap talk will be.

On the other hand, if the federal government chooses centralization, it fully exploits its own information F and chooses its preferred policy vector p, in the third stage, after receiving a signal from the local government in the second stage. As centralization results in an underutilization of the local government's information L, the local government's *ex ante* expected loss is increasing with its informational advantage.

The federal government determines whether or not to retain its control rights over policies by comparing its *ex ante* expected loss under decentralization with its expected loss under centralization. Since both are increasing in F (under decentralization) and L (under centralization), we can identify cut-off values of F and L at which the scheme choice switches. The scheme choice, thus, depends on the extent of the conflict of interest (B) and the relative importance of the two players' respective informational advantage (F, L).

Insert Figure 1 here

Figure 1 represents the choice between centralization and decentralization as a function of L and F. The threshold $F(L, B)$ is upward sloping, and divides the (L, F) plane into two regions (centralization and decentralization) lying below the 45° line. The federal government will opt for decentralization only if the local government's private information L is (strictly) greater than its own

private information F and greater than the threshold level $F(L, B)$. The decentralization region is smaller than the centralization region: the agency bias B requires L to be strictly greater than F in order for decentralization to be optimal. This holds because the loss due to underutilization of the local government's information is compensated for by the elimination of the bias and the full exploitation of the federal government's own private information L. Conversely, the federal government always chooses centralization whenever its private information F is more important than the agent's private information (that is, $F > L$). Additionally, it opts for centralization if $F(L, B) \leq F < L$, that is, even when its informational advantage F is smaller than L, but greater than the threshold value $F(L, B)$.

In general, the threshold $F(L, B)$ is not monotone in the bias B, as an increase in B has both direct and indirect effects. Directly, it increases the agency problem, thus reducing the federal government's incentive to delegate. Indirectly, an increase in B also reduces the equilibrium amount of information transferred by the local to the federal government under centralization, thus making decentralization more attractive. Therefore, an increase in the agent's bias, while making the agent's choice less attractive to the principal, can also decrease the incentives of the agent to communicate its private information in the centralization game more than in the decentralization game. This is a key insight we can derive from the model. The net effect can result in switching from centralization to decentralization if the bias increases in order to make full use of the agent's private information.[13]

5   Local government as the principal

When the local government takes the role of the principal and the federal government is the agent, by taking advantage of its agenda-setting power, the local government is able to take the lead in deciding the level of centralization. Like the federal government in the case described above, the local government chooses between a decentralization or centralization scheme. Thus, it decides whether or not to 'delegate' the choice of the policy vector p to the federal government. Any divergence of the implemented policy from its optimal policy p_L^* results in a utility loss for the local government. The game under the decentralization scheme unfolds in analogy 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 with its expected loss under centralization. The choice will then, once again, depend on the size of the conflict of interest (B) and on the relative importance of the two players' informational advantage (L, F).

Figure 2 depicts the choice between centralization and decentralization as a function of L and F. The boundary level $L(F, B)$ is upward sloping, and divides the (L, F) plane into two regions (centralization and decentralization) lying above the 45° line. In the setup with the local government as the principal, the centralization region is now smaller than the decentralization region: the existence of the agency bias requires F to be strictly greater than L in order for centralization to be optimal. Even when the local government has no private information and L equals zero, centralization with delegated control rights to the federal government requires F to be strictly greater than zero for all $B > 0$. Conversely, the local government will opt for the decentralization scheme whenever its private information is more important than that of the federal government, that is

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[13]Specifically, as the boundary between the centralization and decentralization regions is in general not monotone in B, for some parameter values, an increase in the agent's bias can result in more decentralization rather than less. Since the derivative of $F(L, B)$ with respect to B cannot be analytically derived, this result is obtained by numerical simulations (see Harris and Raviv 2005).

$L > F$, and if $L(F, B) \leq L < F$. Due to the misalignment of interests which causes the bias $B > 0$, it can still be optimal for the local government to decentralize even when its informational advantage is smaller than F; the reason being that the loss caused by the underutilization of the federal government's information is compensated for by the elimination of the bias and the full utilization of its own private information. As above, the threshold level (F, B) is not monotone in B.

Insert Figure 2 here

5.1   Empirical Implications

Several testable implications can be derived from the model. The main 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 importance of local knowledge*. A higher importance of local private knowledge should be related to more decentralization, while the importance of the central government's knowledge should be related to less decentralization.

Second, an important feature of the model is the presence of a non-monotonic relationship between decentralization and the misalignment of interests between the government levels, which depends on the differences between the preferences of the local and federal government. Specifically, this bias has both direct and indirect effects working in the opposite direction, as the federal (local) government's informational advantage may depend not only on how relevant its knowledge is per se, but also on how valuable such information is relative to the local (federal) government.

In countries that lack information transparency, informational advantages are salient compared to more transparent countries. Differences can originate from geographic features of countries but also from their developing status. Less transparency decreases the share of 'hard' information that can easily be transferred between government levels, and increases the importance of private 'soft' knowledge. The relative share of soft to hard information also depends on the quality of the communication infrastructure. The quality of information transmission can make the existing informational asymmetry, *ceteris paribus*, more (or less) salient and lead to a delegation of control rights over policies. Therefore, we expect that the indirect effect prevails in highly in-transparent environments, where the information transferred by the agent is of high value to the principal.

Finally, we highlight that the principal can either be a federal government delegating more decision-power to the local authority, or a local government delegating more decision-power to the central one. This distinction across regimes is a very interesting testable implication based on the theoretical considerations. For this reason we begin our empirical application with a sample that contains all countries, but also explore the two cases where either the federal or the local government is the principal. In these separate samples we interact the 'bias' with the quality of 'information transmission' to disentangle the direct and the indirect effects of the bias.

On the one hand, we expect to find a positive interaction between bias and information transmission when the local government is the principal, because better information transmission reduces the salience of the federal's information and should plausibly enhance the effect of the bias on decentralization. Simply put, the easier the local governments can access specific federal knowledge, the lower the likelihood that they are willing to delegate decision-making autority based on the

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importance of this knowledge. On the other hand, we would expect to find a negative (or insignificant) interaction between the two when the federal government is the principal. The reason is that better information transmission reduces the salience of local information and should weaken the effect of the bias on decentralization.

6 Data

The empirical analysis focuses on expenditure decentralization for two reasons: its direct link with 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 account of 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 therefore broadly 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 aware of their potential weaknesses.[14] We do not claim to be able to derive causal relationships, but rather aim to show that the data are in line with our predictions. Our model helps to better explain the existing variations across countries and augments the existing literature in an important way.[15]

6.1 Decentralization

We capture expenditure decentralization by the share of sub-federal expenditures in all government expenditures. 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*. 2011). 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 to proxy for 'local' expenditures given that the data do not allow further distinction. We use data for the 1972-2010 period and a maximum of 66 countries. In our estimations, we use three-year averages to capture long-term trends and eliminate the influence of short-term fluctuations. As mentioned above, even in the GFS dataset, which is the most comprehensive one available to researchers, many observations are missing. Only three countries, Austria, Denmark and Finland reported data to the IMF in every year. Out of the 66 countries, the average as well as the median number of observations for the dependent variable is about 16 years only, which translates in about six three-year periods. 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).[16] In the following, we propose a number of proxies to measure the extent of the agency bias and the relative informational advantages of the federal and local governments.

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[14]Appendix D contains the definitions and sources of the variables included in the regressions below, while we provide descriptive statistics in Appendix E.

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

[16]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 binary indicator in our regressions, which turned out to be insignificant at conventional levels.

6.2 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 binary 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 optimal policy. Per capita GDP is included in most studies that try to explain decentralization. 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 (e.g., Treisman 2006). 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 rather large capital cities 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). Finally, we also include regional dummies and period fixed effects to account for unobserved characteristics that might be correlated with our variables of interest.

6.3 Variables of interest

We focus 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 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).

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 predicts that, *ceteris paribus*, larger externalities 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 ethnic fractionalization index taken from Alesina *et al.* (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, ranging 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.[17] 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 is stability, the more attractive national office becomes, 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 capture the relative importance of each side's private information and can affect the degree of decentralization in both directions, depending on who is in charge

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

of deciding about the degree of centralization in policy-making. In order to proxy this measure we rely on two alternative variables for *information transmission* and *information transparency*, in tandem with a proxy for the availability of information (*missing data*). In additional specifications, we also include *press freedom* and *corruption*.

The availability of information at the central level about the local level (and vice versa) is a crucial factor in determining the delegation-decision of the respective principal. The higher the share of hard relative to soft information, the lower the risk of not being fully informed by the agent. We choose two alternative proxies for this variable of central importance in our model, each with distinct advantages and disadvantages. Our first proxy is the quality of information transmission, measuring 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. Ideally, we would like to capture the quality of information transmission across time and for a wide range of countries. Our variable *information transmission* thus uses the number of telephone lines per 100 inhabitants (World Telecommunications/ICT Indicators Database 2011), which is widely available. This variable is meant to proxy for all kind of technological barriers to information transmission. The most relevant technology clearly varies over time, with the availability of internet access or mobile phones arguably being a better proxy in more recent years, but hardly being available in the earlier years of our sample. Note that the number of telephone lines is highly correlated with a combined 'media access' variable (0.80) and a variable capturing the number of computers per capita (0.87) in those periods where both are available.[18]

Our alternative indicator is a measure for the general data transparency in a country. If transparency is generally higher, more information is publicly available at both the central and local level. It thus decreases the principal's dependency on the respective other level, with more information being available in cases where no delegation is chosen. *Information transparency* is an indicator of Informational Transparency and Accountability (Williams 2014), with lower values indicating a lower ability to get access to reliable information about the other level for both the local and the federal government.[19]

As additional measure of transparency we also include the share of data series missing for a particular country and year in the World Bank's World Development Indicators Database (2013), labeled as *Missing data (World Bank)*. We calculate the indicator as the share of non-missing data out of all series for a given country and year.[20] 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. Following similar intuition, we include two further proxies for the importance of differences between local and federal knowledge in some of our regressions: 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

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[18]'Media access' combines access to TV, radio, papers, and internet (taken from Banks 2011). Higher values indicate higher quality, and thus less importance of differences in 'knowledge endowment'. Using the media access variable yields positive and significant coefficients as well, but in a much-reduced sample. Results are available on request.

[19]The index is available for 190 countries, and is a composite indicator based on 29 sources. Our results are robust to using *information transparency* proxied with the Informational Transparency and Accountability Index as measure for the importance of private information (see Table 2 and Appendix F) .

[20]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.

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 complexity using ethnic tensions ('heterogeneity'), ethnic fractionalization, and migration, as discussed above in the context of bias. Ethnic fractionalization relates to the existence of language barriers and cultural differences that make local information more important 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 the bulk of oil-producing nations are at least partly state-owned with oil revenue making up part of total government revenue. In such cases, federal government knowledge will be of greater importance.

Clearly, and as outlined above, some of the variables introduced here refer to both the influence of the agency problem and the importance of federal knowledge. Since the impact of such indicators could be conflicting, in these cases the sign of the coefficient will show the net effect, that is, the impact that dominates.[21]

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[21] Appendix G shows the correlations of all variables included in the analysis. Note in particular that the correlations between the variables measuring the bias and the informational variables are low.

7 Method and basic results

We examine the determinants of expenditure decentralization using data for a maximum of 66 countries over the 1972-2010 period, depending on the control variables being included. Given the lack of significant time variation in the decentralization variable we have averaged the data over three years.[22] We estimate (using OLS with standard errors clustered at the country level),

$$D_{i,t} = \alpha + \beta_1 Z_{i,t-1} + \eta_i + \tau_t + u_{i,t}, \tag{4}$$

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, η_i and τ_t are region- and period-fixed effects, respectively, and $u_{i,t}$ is the error term.[23]

The results are presented in Table 1, focusing on our first proxy, *information transmission*. Column 1 reports the coefficients of the variables that are most commonly used in decentralization studies. Column 2 shows the main variables of interest that are available for a reasonably large number of countries and years. Column 3 includes them both.

Insert Table 1 here

The results of column 1 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. The size of population, urbanization, and the dummy for democracies 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's predictions. 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 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.

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

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[22]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.

[23]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. Specifically, regional dummies are taken from the Harvard Democracy Time-series Dataset, 2009, Data for 1971-2000. As shown in Appendix H we find similar results using a random effects model.

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. 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's 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. Note that changes in the coefficients of the other variables might be due to changes in sample size rather than the impact of the control variables. Overall, however, the results are 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.

Column 5 of Table 1 turns to the two components of the bias. In order to disentangle the countervailing 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). As outlined above, 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. The results from column 5 in Table 1 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 is low and would be more important. Therefore, these results are consistent with the prediction of our model when the local government is the principal in this overall sample.

8   Who is the principal and who is the agent?

We split the sample in two sub-groups according to whether the federal or the local government is more likely to decide on the degree of decentralization to focus on the specific test of the distinction between the two regimes. It is arguably hard to decide which empirical proxy is most likely to capture our theoretical notion of principals and agents. To reduce subjectivity in the decision for a particular variable, we use a broad range of indicators. 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 legislative 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. What is more, 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 I shows how individual countries are classified according to all measures.

Ideally, we would like to test our hypotheses on the importance of who is in charge of deciding about decentralization in a model including country fixed effects. However, the noise-to-signal ratio is so high that the coefficients of all variables in this model become insignificant at conventional levels. Rather than including fixed effects we therefore address our main reason for why we would like to include them—the presence of unobserved omitted variables that are related to the decentralization ratio—by controlling for the level of decentralization in the first period to alleviate such concerns. If omitted factors only have an influence on the level and not on the change in decentralization and are time-invariant, we should capture the potential bias by conditioning on initial decentralization. We therefore include the initial level of decentralization in all models below.[24]

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[24]The results do however not depend on this.

Insert Table 2 here

Table 2 shows the results, focusing on the interaction between bias and information. The table employs both proxies for the importance of private information: *information transmission* and *information transpareny*, and the five different definitions of federal vs. unitary states. The fact that the indicators stem from different authors and sources should minimize sensitivity towards the choice of a certain specification. The theoretical effect of heterogeneity as a proxy for bias and importance of information are ambiguous when we do not take institutional differences into account. However, for a given level of heterogeneity of the country, an improvement in information transmission implies lower salience of federal information, leading to more decentralization when the local government is the principal ('agenda-setter'). Facing the trade-off between loss of control and loss of information, the local government will be less willing to give up part of its authority in exchange for an informational gain. This should be reflected in a positive interaction between the information variable and heterogeneity. On the contrary, if the central government maintains the final decision rights (federal level as 'agenda setter'), better access to information means less reliance on local information. In this case we would expect a negative interaction effect.

The results are in line with the predictions of the model, and are surprisingly robust across the five indicators. In all five specifications, the interaction between heterogeneity and our proxy for information is positive and significant at least at the five-percent level in federal countries, while it is negative or not significantly different from zero in unitary countries. While the number of observations that classify the local or federal government as the agenda-setter differs across the indicators, all of them seem to capture the institutional differences we modeled in a similar way. One reason why the negative interaction terms in unitary states are mostly insignificant is likely to be a lack of variation in decentralization rates in these subsamples, which leads to large standard errors. More importantly, the difference between the coefficients of the interaction terms in the two models is significant in all regressions (tested employing a seemingly unrelated regression model, with corresponding p-values shown in the table).

Insert Figure 4 here

Insert Figure 5 here

Figures 4 and 5 illustrate the differential effects (focussing on information transmission), using Elazar's (1995) classification, which results in the most equal share of federal and unitary states. Figure 4 depicts the marginal effect of better information transmission on the decentralization ratio for federal states. For low levels of information transmission, higher heterogeneity does not lead to more decentralization. However, conditional on a certain level of information transmission, higher heterogeneity makes local governments opt for more decentralization. The intuition is simple: the higher the perceived misalignment of interest, the fewer tasks local governments want to delegate to the central government. Hence, we expect a positive relation between heterogeneity and decentralization. However, decentralization is also limited by the need of local governments to receive information from the center. Thus, we expect a positive effect of heterogeneity on decentralization only when it is easier for the local government to independently access federal information. The opposite should hold when the central government is the agenda setter. As figure 5 shows, the picture for unitary states is again in line with our theory. If information transmission is of poor quality, greater heterogeneity makes the central government decentralize more, arguably to cope with the

increased importance of local information. When access to local information is easier, however, the central government—being aware of the increased misalignment in interests—refrains from decentralizing.

9   Conclusions

In this paper we examine the endogenous allocation of control rights in federations 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 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 be strictly greater than the informational advantage of the local governments for the centralization scheme to be optimal.

Interestingly, it is possible to disentangle both centralization and decentralization 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, and the quality of information transmission is high, 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.

We test the model's implications by focusing on expenditure decentralization, which varies widely across countries and over time. More specifically, we relate 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. 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. What is more, 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 local governments.

To justify the theoretical emphasis on the importance of the institutional differences between unitary and federal states, we used five distinct constitutional and statutory country characteristics in order to separate those countries where the federal government is more likely to be the principal

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 decentralization only when the quality of information transmission is relatively high. When the federal government is the principal, the interaction effect is negative but insignificant. Most importantly, we find significant differences between the two regimes in line with the prediction of our model.

Important policy implications arise from these findings, especially for supranational institutions like the European Union, in which centralized fiscal spending is rare even among groups of nations that coordinate on many policy areas, such as the Eurozone (e.g., Simon and Valasek 2016). In this case, for example, 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 local governments (the member states) in certain areas, under-exploiting the knowledge of the EU Institutions in the presence of a bias.

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Table 1: 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]
Missing data (World Bank)			-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.

Table 2: Interaction between Heterogeneity and Information, 1972 – 2010, OLS

Agenda setting government level:	Local	Federal		Local	Federal	
	Information Transmission			Information Transparency		
	Coef.	Coef.	P-value	Coef.	Coef.	P-value
Federation type: Unitary or federal (Norris 2008)						
Heterogeneity*Information	0.013** [0.005]	-0.003 [0.002]	0.000	0.026*** [0.008]	0.001 [0.002]	0.001
Adj. R-Squared	0.83	0.89		0.71	0.89	
Number of observations	126	212		119	202	
Classified as "federal" (Elazar 1995)						
Heterogeneity*Information	0.008*** [0.003]	-0.002 [0.003]	0.000	0.021*** [0.006]	0.003 [0.004]	0.006
Adj. R-Squared	0.87	0.81		0.89	0.8	
Number of observations	191	147		176	145	
Residual powers to legislate (Treisman 2008)						
Heterogeneity*Information	0.009*** [0.002]	-0.001 [0.003]	0.000	0.021*** [0.006]	0.001 [0.003]	0.001
Adj. R-Squared	0.72	0.85		0.86	0.83	
Number of observations	207	131		192	129	
Sub-national government authority (Keefer 2013)						
Heterogeneity*Information	0.007*** [0.002]	-0.018 [0.018]	0.000	0.013*** [0.005]	-0.014** [0.005]	0.000
Adj. R-Squared	0.82	0.9		0.83	0.95	
Number of observations	299	39		285	36	
Legislature or executive locally elected (Treisman 2008)						
Heterogeneity*Information	0.009*** [0.002]	-0.003 [0.003]	0.000	0.016** [0.006]	-0.002 [0.006]	0.012
Adj. R-Squared	0.81	0.92		0.81	0.92	
Number of observations	265	71		249	70	

Notes: Interaction effect between Heterogeneity and an information proxy (specified in second row) for local and federal government as agenda setters. Includes initial decentralization and control variables of column 3 in Table 1 as additional regressors. 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.
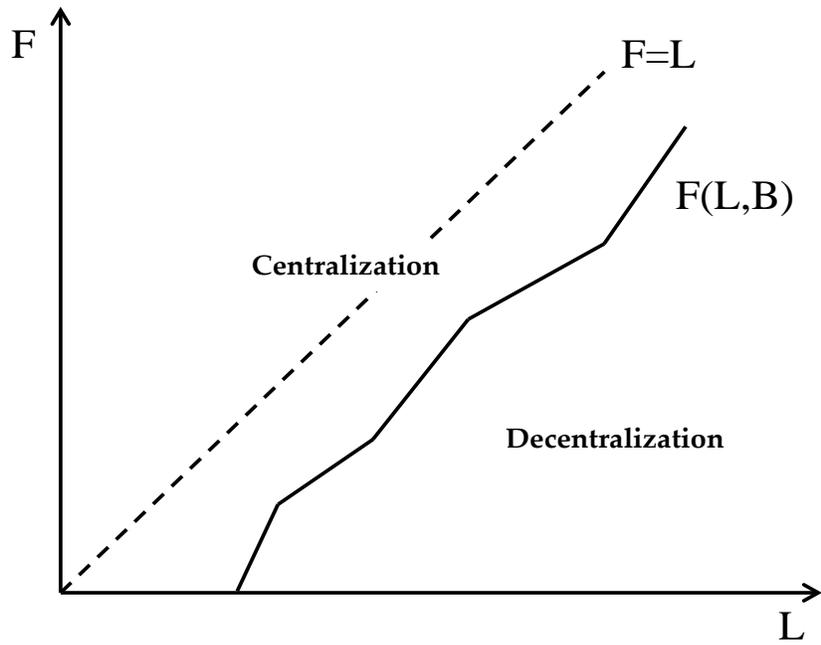
Figure 1: Choice between centralization and decentralization as a function of L and F when the federal government is the agenda setter
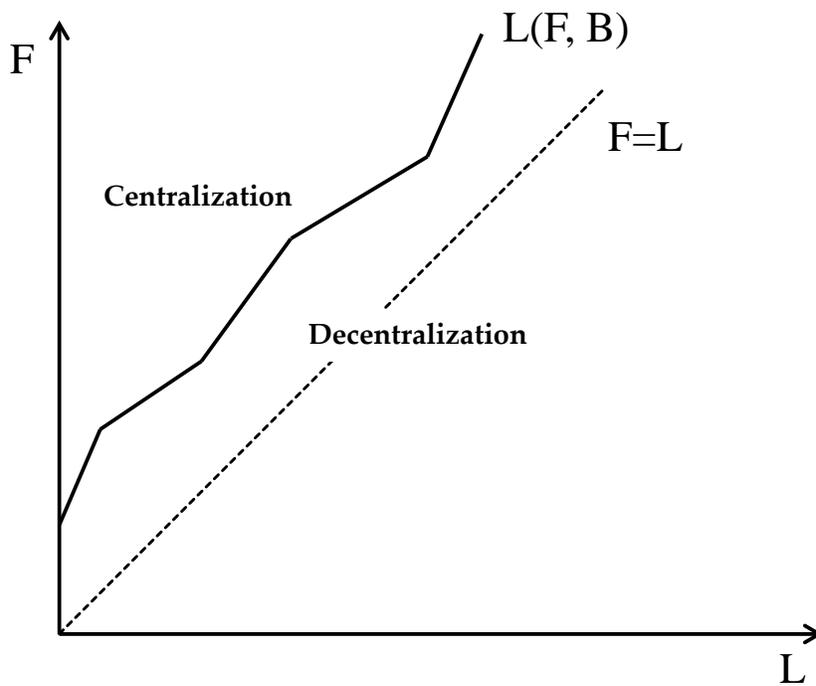
Figure 2: Choice between centralization and decentralization as a function of L and F when the local government is the agenda setter
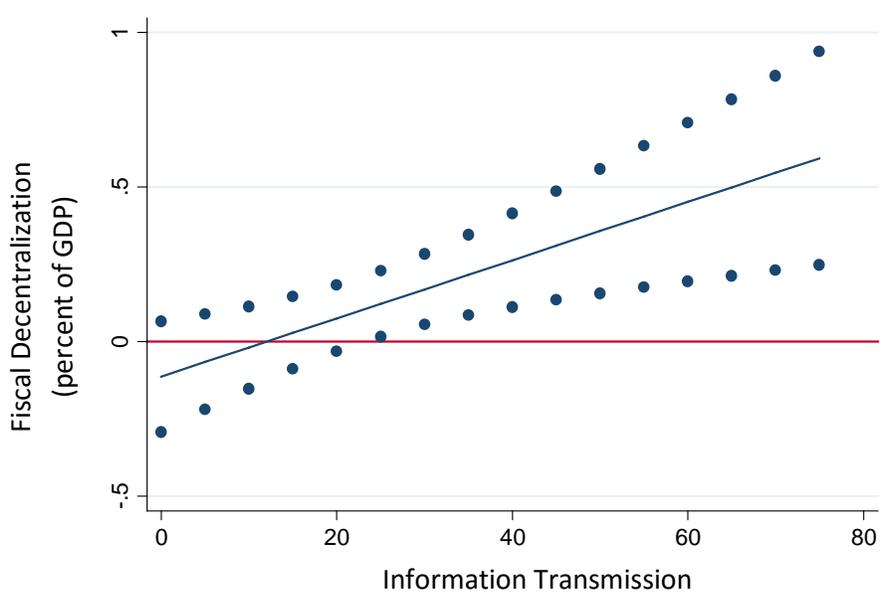
Figure 3: Marginal effect of Heterogeneity on the share of subnational government expenditure for different levels of Information Transmission (Table 1, column 5). The dashed line shows the 90%-confidence interval.
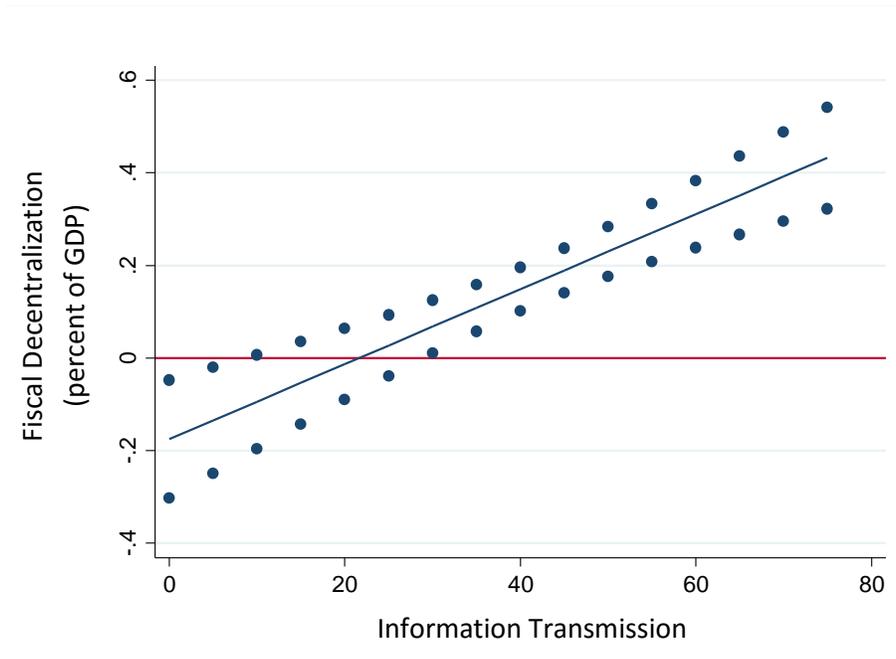
Figure 4: Marginal effect of Heterogeneity on the share of subnational government expenditure for different levels of Information Transmission (Table 2, row 2). The regressions are restricted to countries that Elazar (1995) defines as "local," i.e., where the local government is the agenda setter. The dashed line shows the 90%-confidence interval.
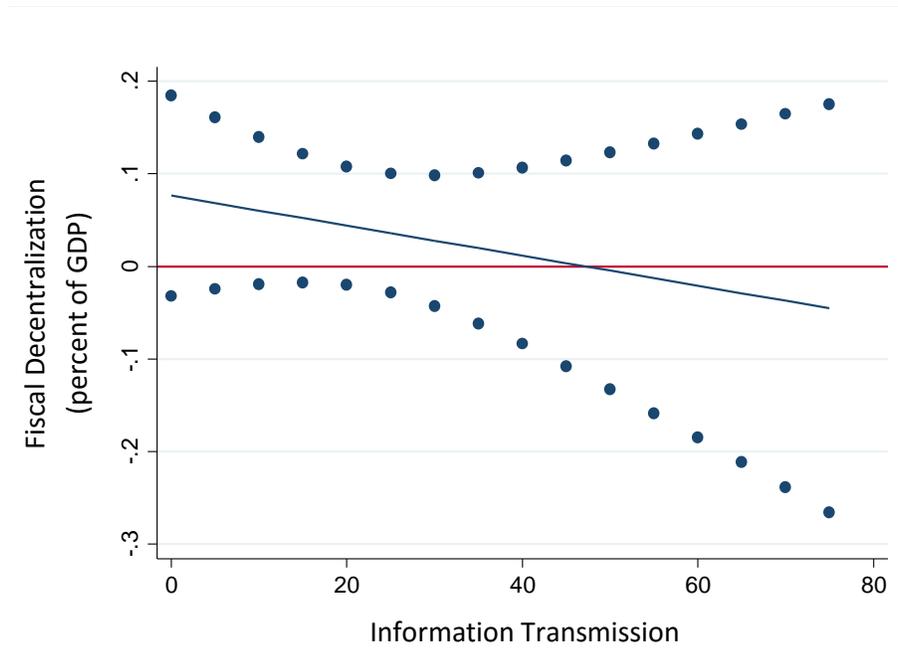
Figure 5: Marginal effect of Heterogeneity on the share of subnational government expenditure for different levels of Information Transmission (Table 2, row 2). The regressions are restricted to countries that Elazar (1995) defines as "federal," i.e., where the federal government is the agenda setter. The dashed line shows the 90%-confidence interval.

Online Appendix

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

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

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

$$t^* = \arg\min L^{Fed} = \int_0^L [p(l,t) - p_F^*]^2 f_L(l)\, dl, \tag{A.1}$$

and

> *ii) for each t, $p(l, t)$ solves*

$$p(l,t) = \arg\min L^{Loc} = \int_0^F [p(l,t) - p_L^*]^2 g(f|t)\, df, \tag{A.2}$$

where $g(f|t) = \frac{q(t|f) f_F(f)}{\int_0^F q(t|\theta) f_F(\theta)\, d\theta}$.

According to condition (*i*), the reporting rule $q(t|f)$ chosen by the federal government minimizes the federal government's expected loss, given the local government's action rule $p(l, t)$. In other words, the equilibrium reporting rule $q(t|f)$ induces the local government to choose policies $p(l, t)$, 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 f, 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 f given t—that is, $g(f|t)$—$p(l, t)$ 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 $[0, F]$ is partitioned into intervals and the federal government only reveals which interval the true value of f 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 f_i, such that $0 = f_0 < f_1 < ... < f_{N-1} < f_N = 1$, and*

> *(a) $q(t|f)$ is uniform, supported on $[f_i, f_{i+1}]$, if $t \in (f_i, f_{i+1})$;*

> *(b) $p(l, t) = l + \frac{f_i + f_{i+1}}{2} - b_L$, for all $t \in (f_i, f_{i+1})$.*

Moreover:

(i) $\int_0^L \left[l + (\frac{f_i + f_{i+1}}{2}) - (l + f_i) - B\right]^2 f(l)dl = \int_0^L \left[(l + f_i) - \left[l + (\frac{f_{i-1} + f_i}{2})\right] + B\right]^2 f(l)dl;$

(ii) $f_0 = 0;\ f_N = F.$

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 $(p(l,t))$ on these two intervals. Condition (*i*) defines a second order linear differential equation on f_i, while condition (*ii*) specifies its initial and terminal conditions. Since the federal government is not informed on the true value of l, when choosing t, it will take the expected value of l, that is $L/2$. The arbitrage condition (*i*) then reduces to, for $i = 1, ..., N-1$,

$$\frac{L}{2} + \left(\frac{f_{i+1} + f_i}{2}\right) - \left(\frac{L}{2} + f_i\right) - B = \frac{L}{2} + f_i - \left[\frac{L}{2} + \left(\frac{f_{i-1} + f_i}{2}\right)\right] + B, \qquad \text{(A.3)}$$

from which it implies

$$f_{i+1} = 2f_i - f_{i-1} + 4B. \qquad \text{(A.4)}$$

This second order linear difference equation has a class of solutions parameterized by f_1 (given that $f_0 = 0$)

$$f_i = if_1 + 2i(i-1)B, \quad i = 1, ..., N-1. \qquad \text{(A.5)}$$

Given that $f_N = F$ it is the case that

$$f_1 = \frac{F - 2N(N-1)B}{N}, \qquad \text{(A.6)}$$

which, using (A.4) and substituting for the value of f_1, becomes

$$f_i = \frac{iF}{N} - 2i(N-i)B, \quad i = 1, ..., N. \qquad \text{(A.7)}$$

From (A.7) it follows that

$$f_i - f_{i-1} = \frac{F}{N} + 2(2i - N - 1)B, \qquad \text{(A.8)}$$

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 $\{l_i\}$ of $[0, L]$. Again, it is possible to define a reporting rule $q(r|l)$ and a posterior belief

$$g(l|r) = \frac{q(r|l)f_l(l)}{\int_0^L q(r|\eta)f_L(\eta)d(\eta)}, \qquad \text{(A.9)}$$

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

$$p(l,r) = \frac{l_i + l_{i+1}}{2} + f + b_F \quad \text{if} \quad r \in [l_i, l_{i+1}], \quad i = 1, ..., N-1. \qquad \text{(A.10)}$$

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

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

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

$\square$

Appendix B: Derivation of federal and local governments's ex ante expected losses

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

$$
\begin{aligned}
L_{Dec}^{Fed}(N, B, F) &= \int_0^F (p(l, t) - p_F^*)^2 \, g\left(f \,|\, t\right) df, \\
&= \int_0^F \left(l + \frac{f_i + f_{i+1}}{2} - b_L - l - f - b_F\right)^2 g\left(f \,|\, t\right) df, \\
&= \frac{1}{F} \sum_{i=1}^N \int_{f_{i-1}}^{f_i} \left(\frac{f_{i-1} + f_i}{2} - f - B\right)^2 df, \\
&= \frac{1}{F} \frac{1}{12} \sum_{i=1}^N (f_i - f_{i-1})^3 + \frac{1}{F} B^2 \left(f_0 - f_N\right), \\
&= \frac{1}{12} \sum_{i=1}^N \left[\frac{F}{N} + 2(2i - N - 1)B\right]^3 + \frac{1}{F} B^2 \left(f_0 - f_N\right), \\
&= \sigma_f^2 + B^2 \quad (f_0 = 0; \; f_N = F, \text{ see Proposition 1}), \tag{B.1}
\end{aligned}
$$

Here, D stands for decentralization and σ_f^2 is the ex-ante residual variance of f, that is the uncertainty about f faced by the local government before being reported by the federal government the equilibrium signal t, which is given by

$$\sigma_f^2 \equiv \frac{F^2}{12N^2} + \frac{B^2\left(N^2 - 1\right)}{3}, \tag{B.2}$$

and it is decreasing in N, the expected degree of informativeness of the federal government's message.

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

$$
\begin{aligned}
L_{Dec}^{Loc}(N, B, F) &= \int_0^F \left(p(l,t) - p_L^*\right)^2 g\left(f \mid t\right) df, \\
&= \int_0^F \left(l + \frac{f_i + f_{i+1}}{2} - b_L - l - f + b_L\right)^2 g\left(f \mid t\right) df, \\
&= \frac{1}{F} \sum_{i=1}^N \int_{f_{i-1}}^{f_i} \left(\frac{f_{i-1} + f_i}{2} - f\right)^2 df, \\
&= \frac{1}{12} \sum_{i=1}^N \left(f_i - f_{i-1}\right)^3, \\
&= \frac{1}{12} \sum_{i=1}^N \left[\frac{F}{N} + 2(2i - N - 1)B\right]^3, \\
&= \sigma_f^2,
\end{aligned}
\tag{B.3}
$$

with the last equality following again from equation (B.2). Since both players' *ex ante* expected loss is decreasing with N, Crawford and Sobel assume that both agents coordinate on the most informative equilibrium $N(F, B)$, which is thus a focal equilibrium.[25]

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:

$$
\begin{aligned}
L_{Cen}^{Fed}(N, B, F) &= \int_0^L \left[p(f,r) - p_F^*\right]^2 g\left(l \mid r\right) dl, \\
&= \frac{1}{L} \sum_{i=1}^N \int_{l_{i-1}}^{l_i} \left(\frac{l_i + l_{i+1}}{2} + f + b_F - f - l - b_F\right)^2 df, \\
&= \frac{1}{L} \sum_{i=1}^N \int_{l_{i-1}}^{l_i} \left(\frac{l_{i-1} + l_i}{2} - l\right)^2 df, \\
&= \frac{1}{L} \frac{1}{12} \sum_{i=1}^N \left(l_i - l_{i-1}\right)^3 \\
&= \frac{1}{L} \frac{1}{12} \sum_{i=1}^N \left[\frac{L}{N} + 2(2i - N - 1)B\right]^3, \\
&= \sigma_l^2,
\end{aligned}
\tag{B.4}
$$

where σ_l^2 is the ex-ante residual variance of l, that is the uncertainty about l faced by the federal government before being reported by the local government the equilibrium signal r, which is given by

$$
\sigma_l^2 \equiv \frac{L^2}{12N^2} + \frac{B^2\left(N^2 - 1\right)}{3}.
\tag{B.5}
$$

---

[25]There are, in general, multiple equilibria but, as in Crawford and Sobel (1982), one can argue that agents would reasonably coordinate on the one whose partition has the greatest number of elements. The reason is that before the sender observes her private information, this is Pareto-superior to all other equilibria.

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

$$
\begin{aligned}
L_{Cen}^{Loc}(N, B, F) &= \int_0^L [p(f, r) - p_L^*]^2 \, g\,(l\,|\,r)dl, \\
&= \frac{1}{L} \sum_{i=1}^N \int_{l_{i-1}}^{l_i} \left(\frac{l_i + l_{i+1}}{2} + f + b_F - f - l + b_L \right)^2 df, \\
&= \frac{1}{L} \sum_{i=1}^N \int_{l_{i-1}}^{l_i} \left(\frac{l_{i-1} + l_i}{2} - l + B \right)^2 df, \\
&= \frac{1}{L} \frac{1}{12} \sum_{i=1}^N (l_i - l_{i-1})^3 + \frac{B^2}{L} \sum_{i=1}^N (l_i - l_{i-1}) \\
&= \frac{1}{L} \frac{1}{12} \sum_{i=1}^N \left[\frac{L}{N} + 2(2i - N - 1)B \right]^3 - \frac{B^2}{L} (l_0 - l_N) \\
&= \sigma_l^2 + B^2 \ (l_0 = 0; \ l_N = L, \text{ see Proposition 1}) . \quad\quad\quad\quad \text{(B.6)}
\end{aligned}
$$

$\square$

Appendix C: Proof of statements in Sections 5 and 7

The statement given in Section 5 follows directly from Proposition 2 below. By comparing its *ex ante* expected loss under decentralization ($L_{Dec}^{Fed}(N, B, F)$) with the one it incurs under centralization ($L_{Cen}^{Fed}(N, B, F)$), 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 $L \geq F(L, B)$, where $F(L, B)$ is continuous and increasing in L and, for any B, $F(L, B) < L$.*

Proof: The proof follows Theorem 1 in Harris and Raviv (2005). □

The statement given in Section 7 follows directly from Proposition 3 below. By comparing its *ex ante* expected loss under decentralization ($L_{Dec}^{Loc}(N, B, F)$) with the one it incurs under centralization ($L_{Cen}^{Loc}(N, B, F)$), 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 $F \geq L(F, B)$, where $L(F, B)$ is continuous and increasing in F and, for any B, $L(F, B) > F$.*

Proof: The proof follows Theorem 1 in Harris and Raviv (2005). □

Appendix D: 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	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)

Knowledge

Information Transmission	Fixed telephone lines per 100 inhabitants	International Telecommunication Union (2011)
Information Transparency Index	Composite global index of information transparency	Williams (2014)
Missing data (World Bank)	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	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)

Appendix E: 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
Information Transparency Index	310	68.55	9.19	28	85
Missing data (World Bank)	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 F: Decentralization, Bias and Knowledge, 1972 – 2010, OLS, Alternative knowledge proxy

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	6.51***	[2.33]			5.59*	[3.24]	1.34	[3.00]	5.01	[3.10]
(log) Land Area	3.37***	[1.11]			2.38	[1.63]	0.54	[1.92]	2.42	[1.61]
(log) Population	0.45	[1.41]			-0.62	[1.53]	1.65	[1.62]	-0.25	[1.47]
Urbanization	0.13	[0.13]			0.11	[0.13]	0.25*	[0.13]	0.09	[0.13]
Democracy Dummy	2.10	[2.52]			-2.33	[2.44]	-7.22	[4.89]	-3.52	[2.75]
Heterogeneity			0.27***	[0.08]	0.22*	[0.13]	0.22*	[0.12]	-0.51	[0.32]
Trade Openness			-0.10***	[0.03]	-0.05	[0.05]	-0.11	[0.07]	-0.05	[0.05]
Oil Rents			0.19	[0.17]	-0.12	[0.15]	-0.03	[0.24]	-0.04	[0.15]
Information Transparency			-0.06	[0.24]	0.09	[0.27]	-0.20	[0.36]	-0.26	[0.32]
Missing data (World Bank)			-0.08	[0.14]	-0.06	[0.16]	0.13	[0.23]	-0.18	[0.16]
Educational Quality			0.31***	[0.09]	0.23*	[0.13]	0.26**	[0.12]	0.25*	[0.13]
Ethnic Tensions							-2.10	[1.33]		
Government Stability							-0.08	[0.71]		
Government Fractionalization							0.12	[0.09]		
Migrant Share							0.48**	[0.21]		
Risk of External Conflicts							-2.38***	[0.75]		
Corruption							2.65	[1.60]		
Press Freedom							0.10	[0.11]		
Heterogeneity* Information Transparency									0.01***	[0.00]
Period Dummies	Yes		Yes		Yes		Yes		Yes	
Region Dummies	Yes		Yes		Yes		Yes		Yes	
Adj. R-Squared	0.43		0.54		0.51		0.62		0.53	
Number of Observations	387		321		321		222		321	

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

Appendix G: Correlations

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Exp. Decentralization	(1)	1																			
(log) GDP	(2)	0.45	1																		
(log) Land Area	(3)	0.35	-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	-0.3	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										
Information Transparency Index	(11)	0.37	0.72	0.06	0.13	0.61	0.62	-0.34	0.07	-0.13	0.73	1									
Missing data (World Bank)	(12)	-0.16	-0.13	0.20	0.22	0.01	0.19	0.10	0.07	0.01	0.02	0.40	1								
Educational Quality	(13)	0.42	0.65	0.13	0.14	0.58	0.47	-0.33	0.05	-0.15	0.72	0.70	0.16	1							
Ethnic Tensions	(14)	-0.04	-0.39	0.10	0.16	-0.40	-0.17	0.51	-0.08	0.07	-0.37	-0.35	0.07	-0.28	1						
Government Stability	(15)	0.03	0.25	-0.10	-0.07	0.18	0.01	-0.10	0.28	0.12	0.30	0.37	0.21	0.24	-0.28	1					
Gov. Fractionalization	(16)	0.29	0.39	-0.11	-0.12	0.35	0.48	-0.11	0.08	-0.08	0.38	0.43	0.08	0.42	-0.16	0.23	1				
Migrant Share	(17)	0.13	0.40	-0.32	-0.25	0.48	0.03	0.10	0.35	0.30	0.31	0.18	-0.18	0.19	-0.02	0.18	0.22	1			
Risk of Ext. Conflicts	(18)	-0.18	-0.41	0.09	0.11	-0.27	-0.35	0.25	-0.16	0.15	-0.35	-0.50	0.01	-0.26	0.40	-0.24	-0.26	0.05	1		
Corruption	(19)	0.40	0.59	-0.09	-0.15	0.45	0.32	-0.34	-0.03	-0.20	0.61	0.33	-0.58	0.28	-0.27	-0.01	0.22	0.19	-0.26	1	
Press Freedom	(20)	0.33	0.63	-0.09	-0.09	0.43	0.71	-0.34	-0.05	-0.29	0.63	0.65	-0.09	0.49	-0.27	0.03	0.42	0.05	-0.42	0.53	1

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

Appendix H: Decentralization, Bias and Knowledge, 1972 – 2010, Random Effects

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	4.45**	[1.79]			2.81	[1.89]	2.23	[2.60]	0.99	[2.13]
(log) Land Area	3.35***	[0.97]			3.69***	[1.11]	3.67***	[1.26]	4.32***	[1.15]
(log) Population	0.69	[1.29]			0.04	[1.29]	1.00	[1.69]	0.00	[1.25]
Urbanization	0.15	[0.10]			0.15*	[0.08]	0.20*	[0.11]	0.09	[0.10]
Democracy Dummy	2.64	[2.10]			1.58	[2.51]	-4.16	[4.87]	1.17	[2.10]
Heterogeneity			0.12*	[0.07]	0.12	[0.07]	0.18**	[0.09]	-0.20	[0.13]
Trade Openness			-0.05**	[0.02]	-0.02	[0.03]	-0.02	[0.04]	-0.02	[0.02]
Oil Rents			-0.20**	[0.09]	-0.32***	[0.09]	-0.39***	[0.12]	-0.27**	[0.12]
Information Transmission			0.21***	[0.08]	0.13	[0.09]	0.13	[0.11]	-0.13	[0.11]
Missing data (World Bank)			0.01	[0.11]	0.02	[0.11]	-0.17	[0.25]	-0.09	[0.12]
Educational Quality			0.10*	[0.06]	0.06	[0.06]	0.03	[0.06]	0.12**	[0.06]
Ethnic Tensions							-0.87	[0.80]		
Government Stability							0.14	[0.45]		
Government Fractionalization							0.05	[0.07]		
Migrant Share							-0.03	[0.38]		
Risk of External Conflicts							-0.38	[0.63]		
Corruption							0.80	[0.91]		
Press Freedom							0.09	[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	387		338		338		225		338	

Notes: Re-estimation of table 1 using the random-effects estimator. Standard errors (clustered at the country level) in brackets.

* p<0.10, ** p<0.05, *** p<0.01.

Appendix I: 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
Cape Verde	X		Estonia	X		Ethiopia		X	Croatia	X		Cape Verde		X
Chile	X		Ethiopia		X	France	X		Czech Republic		X	Chile	X	

Appendix I: Classification of countries (continued)

Country	X	X	Country	X	Country	X	X	Country	X	X	Country	X	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
Indonesia		X	Romania	X	Slovak Republic	X		Switzerland		X	Ireland		X

Appendix I: Classification of countries (continued)

Country			Country			Country			Country		Country		
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							Mongolia		X
Maldives	X										Netherlands		X

Country	1	2	Country	1	2
Malta	X		New Zealand		X
Mauritius	X		Nicaragua	X	
Mexico		X	Norway		X
Moldova	X		Panama	X	X
Mongolia	X		Paraguay	X	
Netherlands		X	Peru	X	
New Zealand	X		Philippines		X
Nicaragua	X		Poland		X
Norway	X		Portugal	X	X
Panama	X		Romania		X
Paraguay	X		Senegal		X
Peru	X		Singapore	X	
Philippines	X		Slovak Republic	X	X
Poland	X		South Africa		X
Portugal		X	Spain		X
Romania	X		Sri Lanka	X	X
Russia		X	Swaziland	X	
Senegal	X		Sweden		X
Singapore	X		Switzerland		X
Slovak Republic	X		Syria	X	X
Slovenia	X		Tajikistan		X
South Africa		X	Thailand	X	
Spain		X	Togo		X
Sri Lanka	X		Trinidad & Tobago		X
Swaziland	X		Tunisia		X

Appendix I: Classification of countries (continued)

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.