

# Information transmission within federal fiscal architectures: Theory and evidence

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Abstract: This paper explores the role of information transmission and misaligned interests across levels of government in explaining variation in the degree of decentralization across countries. We analyze two alternative policy-decision schemes—‘decentralization’ and ‘centralization’— within a two-sided incomplete information principal-agent framework. The quality of communication depends on the conflict of interests between the government levels and on which government level controls the degree of decentralization. We show that the extent of misaligned interests and the relative importance of local and central government knowledge affect the optimal choice of policy-decision schemes. Our empirical analysis shows that countries’ choices depend on the relative importance of their private information and the results differ significantly between unitary and federal countries.

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

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# 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.<sup>1</sup> At the same time, there have been extensive debates on how much authority to delegate 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.<sup>2</sup> The implementation of decentralization policies, however, has varied substantially across countries and, in many cases, it has been problematic or not fully successful.<sup>3</sup> 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. In particular, with the notable exception of Kessler (2014) to which we return below, the role of the federal and local governments' differential access to information and the importance of their effective communication have not yet been analyzed. 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.

More specifically, this paper identifies 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, in determining the degree of decentralization, not only 'communication' is important but also institutional differences matter crucially in explaining the different impact that private information of the government levels with misaligned interests ('agency bias' or just 'bias') may have on the choice of decentralization.<sup>4</sup>

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<sup>1</sup>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. See also Musgrave (1959) and Oates (1972). Frey and Luechinger (2004) argue that decentralization increases stability by reducing terrorism; see Dreher and Fischer (2010) for an empirical test of this hypothesis.

<sup>2</sup>Think, for instance, of the recent debate on the formation of a European Fiscal Authority. Indeed, with the aggravation of the euro area crisis, a European Fiscal Union has been advocated for by scholars (e.g., Marzotto *et al.* 2011) and policy makers (e.g., Trichet 2011).

<sup>3</sup>Most notably in sub-Saharan African countries (Daflon and Madies 2013).

<sup>4</sup>It is worth emphasizing from the outset, however, that the focus is not on the precise nature of misaligned interests. These can arise through various channels, such as, for example, externalities, politics and lobbying (the intensity

One can think of examples where state governments react to changes in the environment, and in particular to changes in the relative importance of local and central knowledge, by adjusting their level of decentralization. Consider France. Traditionally, it is a highly centralized country whose constitution grants final control over the states' structure to the central government ('center as principal'). As a consequence of the increasing complexity of French society (Cole 2006, Crozier 1992, Caillole 2004), and the increasing importance of 'local' knowledge (Montricher 1995), the government passed a series of reforms in the 1980s and 2000s that aimed to increase decentralization.<sup>5</sup> Despite this ongoing process of decentralization, however, local decision-makers remain substantially constrained by the central government bureaucracy, keeping hold of the ultimate decision-rights in many political areas which reflects the strong unitary French tradition. Germany, for comparison, emerged from a group of historically independent and distinct states, which is reflected in its federal state structure that makes important political decisions subject to the agreement of its states ('local government as principal'). Recently in some areas (e.g., environmental policy and trade policies) the importance of externalities and of central coordination has resulted in some centralization of policies (Koch and Krohn 2006).<sup>6</sup> The state governments, however, have used their legislative power in the federal state structure to resist a more extensive centralization by retaining the right to deviate from national legislation in important areas (Chandna 2011, Ipsen 2006).

We conduct our analysis within a two-sided incomplete information framework in which the transmission of information (assumed to be costless) between the local and federal governments is 'soft' and cannot be verified (or is prohibitively costly to verify). Whenever the interests of the two levels differ, however, the quality of the reports will depend on such conflict of interests, with each level of government rationally expecting the information transmitted by the other government to be distorted (*cheap talk game*). Within this broad perspective, this paper focuses on the comparison of two types of incentive structures, relative to the quality of the transmitted information: 'centralization' and 'decentralization.' Under centralization the control rights over policies are assigned to the federal government, whereas under decentralization it is the local governments which own the control rights over policies.

Of particular interest is the possibility of delegation (either by the federal or the local governments) in policies which can arise given local knowledge of policies. If the decision to decentralize is made by the federal government, it might opt for delegating policies to the local government in order to

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of which may differ across the various levels of government). All that matters for the present analysis is that such misalignment exists.

<sup>5</sup>Between 1990 and 2010 the sub-national share of government expenditures increased from 18% to 21%. Decentralization was seen as an answer to the revival of ethno-territorial identities and cultural, linguistic, and territorial defense movements that reflect an increasing bias in the interests of the central government and the individual départements or regions (Chartier and Larvor 2004, Keating et al. 2003, de Winter and Türsan 1998).

<sup>6</sup>Germany's sub-national expenditure share decreased from 46% in 1991 to 43% in 2010.

be able to better utilize local knowledge. But the local government could decide, too, to delegate control to the federal government to benefit from the federal government's superior information. If the federal government opts for decentralization, the local government's knowledge will be fully utilized for the design of the policies, however, the federal government's own information will 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 bias) will be avoided. The design of the chosen policies will then only partially make use of the local government's knowledge. Alternatively, if the decision to centralize (decentralize) is made by local authorities, then, for given agency bias, the informational advantage of the federal (local) government must be strictly greater than the advantage of the local (federal) government for the centralization (decentralization) scheme to be optimal. Therefore, the optimal allocation of control rights over policies will depend on the relative importance of the two parties' information, as well as the size of the agency bias, which simultaneously affects the amount of information transmitted and the degree of (de)centralization chosen.

Agency bias can affect equilibrium outcomes. Intuition might suggest that more misaligned incentives between the two levels of government will lead towards more (less) centralization when the federal (local) government is the principal. This reasoning ignores that the agency bias also influences the quality of communication. The reason for this is that an increase in the agency bias reduces the amount of information transferred by the local governments to the federal government in the centralization scheme and so the federal government's incentive to decentralize may increase. But an increase in the bias also reduces the quality of information transferred by the federal to the local government under decentralization, thereby increasing the attractiveness of centralization. The extent to which an increase in the misalignment of interests between the federal and local governments leads to centralization or decentralization is, therefore, ambiguous and depends on the relative importance of the information owned by the two levels of government.

An immediate empirical implication of the theoretical analysis is to investigate the degree of 'decision power' of the federal government to override local government decisions in relation to information transmission problems. 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 confirms 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, affects the degree of decentralization. As predicted by the model, the results differ according to whether the federal or the local governments have the right to decide on the share of subnational expenditures.

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

## 2 Related literature

This paper relates to several strands of literature. The first is the cheap-talk literature building on the seminal work by Crawford and Sobel (1982). This strand of literature considers the conflict of interests between the owner of a firm and its managers (see, for example, Dessein 2002) or between its CEO and its division managers (as in Harris and Raviv 2005). More specifically, assuming one-sided private information, Dessein (2002) examines the optimal allocation of authority inside an organization with the aim of enhancing the use of (managers') private information. He identifies a trade-off between loss of control (under delegation/decentralization) and loss of information (under centralization). His main result is that delegating control to the manager is optimal unless the bias between the owner and the manager is so large that communication transmits hardly any private information. Harris and Raviv (2005) provide a rationale for actual communication between a CEO and the division managers in a two-sided private information framework.<sup>7</sup> 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.<sup>8</sup>

The second strand of literature emphasizes political incentives (as in, among others, Boadway *et al.* 1996, Raff and Wilson 1997, Bucovetsky *et al.* 1998, Bordignon *et al.* 2001, Lockwood 2002, and Kotsogiannis and Schwager 2008) within a decentralized system of governments. 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, leading to inefficiencies in federal spending decisions (either universalism or uniformity).<sup>9</sup> Like Kessler (2014),

<sup>7</sup>For a theoretical and empirical application of two-sided incomplete information—using the IMF's structural programs—see Marchesi *et al.* (2011).

<sup>8</sup>For example, it is reasonable to think of the difference in the objectives (and so the agency bias) between the CEO and the managers as being smaller than that between government levels.

<sup>9</sup>Kessler (2014) revisits Oates' (1972) decentralization theorem in a world of incomplete information and strategic

we analyze issues of communication in a decentralized economy, but unlike Kessler we focus on communication between a (representative) local and a federal government and the determination of which level should, optimally, have control over policies when private information is two-sided.

This contribution also relates to the literature on state formations (as in, for example, Alesina and Spolaore 2003 and Spolaore 2013) as well as to the emerging literature on the structure of fiscal unions.<sup>10</sup> Like in this literature, this paper also considers the trade-off between the benefits from economies of scale and the internalization of externalities versus the costs of combining heterogeneous populations and the partial use of local private information. But it does this by providing an additional way of formalizing the terms of this trade-off, which sheds also light on the benefits of a fiscal union in the presence of misaligned interests between participating countries.

Finally, the contribution of this paper is also empirical. Following Oates (1972), several contributions have analyzed the determinants of the degree of fiscal decentralization. Wallis and 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, Bahl and Wallace 2005 and Bodman *et al.* 2010), with some extending the scope of the literature by looking at decentralization in subcategories of government expenditures (Letelier 2005, Sacchi and Salotti 2012, 2013). None of these contributions, however, identifies (in a cross-country context) the role of information as a possible determinant of the degree of decentralization.

### **3 Modeling communication between government levels**

The framework broadly relies on the model of Marchesi *et al.* (2011), which we modify in order to be applicable to the issues central to this paper. It features two players—federal and local governments—that possess different types of information that are both required for the design of

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communication in which policy uniformity is not assumed from the outset, but is a direct consequence of the inability of local governments to credibly communicate information about local tastes to higher levels of government. Similarly to Oates (1972), she identifies a trade-off between loss of coordination, under local authority, and loss of information, under federal authority (increasing in the number of districts).

<sup>10</sup>Fiscal unions could be considered beneficial for many different reasons; creating greater equality or greater insurance among union members (Morelli *et al.* 2012 and Fahri and Werning 2012); helping to manage frictions in a culturally dishomogeneous community (Guiso *et al.* 2013) or having a discipline effect by reducing the scope for local moral hazard by its single members.

optimal policy as defined by

$$p^* = l + f, \tag{1}$$

where  $l$  ( $f$ ) are stochastic variables that proxy for information observed only by the local (federal) government.  $l$  and  $f$  are independently and uniformly distributed on the intervals  $[0, L]$  and  $[0, F]$ , respectively, understood to mean that the larger the interval  $[0, L]$  ( $[0, F]$ ), the larger the informational advantage of the local (federal) government.

The local government's superior information over  $l$  could, for example, originate from its greater proximity to the 'local business environment' relative to the federal government officials or from better knowledge about the need and demand, as well as the chances and risks, of local investment projects.<sup>11</sup>

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, at least partly, confidential issues such as military matters or activities related to the negotiation and implementation of commercial treaties or multilateral activities. The federal government is, therefore, better equipped to take country-wide economic conditions into account when choosing an appropriate policy vector for the country. We assume both types of information to be (at least partly) soft.

Events unfold in three stages: allocation of control rights by the principal, communication, and policy implementation.<sup>12</sup> In the first stage, the principal (federal or local governments) either allocates authority over the choice of the policy vector to the agent or retains authority himself. 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,

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<sup>11</sup>This can also be viewed in the context of fiscal unions, for example in the EU. The EU Commission needs the member states to examine and evaluate the necessity and effectiveness of investment projects; on the other hand, the interests of member states might deviate from those of the Commission. Local capture, for instance, is often cited as a reason for the misuse and waste of EU Cohesion Fund resources in member countries by the European Court of Auditors.

<sup>12</sup>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.

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

The federal government is benevolent and assumed, for simplicity (and analytical tractability), to minimize the square of the distance between the implemented policy vector  $p$  and the federal government's preferred policy vector  $p_F^*$  given by

$$W^F = w^F - (p - p_F^*)^2. \quad (2)$$

Similarly, the local government maximizes

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

which is monotonically decreasing in the distance between the actually implemented policy  $p$ , and the local government's preferred policy  $p_L^*$ . The optimal policy choice of the local government deviates from the economy-wide optimal policy  $p^*$  (given by (1)) by a factor  $b_L > 0$  and is given by

$$p_L^* = p^* - b_L. \quad (4)$$

$b_L$  proxies for all factors that might lead to a deviation of the local governments preferences from  $p^*$ : Re-election concerns (election mechanisms need not be the same as in the federal level), different time-horizons, or the pressure of local interest groups.<sup>13</sup>

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

$$p_F^* = p^* + b_F, \quad (5)$$

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. 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, regulation, roads, 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. This implies—following from (4) and (5)—that the difference in optimal policies

$$p_F^* - p_L^* = p^* + b_F - (p^* - b_L) = b_F + b_L = B. \quad (6)$$

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<sup>13</sup>More generally, conflicts of interest over desired policy may reflect various causes and in principle the impact of lobbies can be as strong at the federal as at the local level. In this paper, however, we assume a benevolent federal government, in contrast with a local government that is assumed to be more responsive to private interests. Bordignon *et al.* (2008), for example, find that when regional lobbies have conflicting interests, then lobbying is less damaging for social welfare under centralization than under decentralization.

$B$  reflects the extent of policy bias.

The next sections turn to the analysis of the communication game between the federal and local governments under centralization and decentralization and under the two alternatives we are interested in: Section 4 analyzes the case in which the status quo is a unitary country, where the federal government has the final decision rights or veto powers on whether or not to delegate decision-making power to the local governments (as, for example, in France, the United Kingdom, and Sweden). In unitary states, decision-making power or autonomy over spending can be delegated to local governments, but the federal government remains supreme, and possesses the power to revoke these rights. Section 5 analyzes the case in which local governments possess the final decision rights or veto powers on whether or not to opt for more fiscal centralization (as, for example, in the United States, Canada, and Switzerland). While spending and decision-rights might also be centralized to some degree, federal states' constitutions usually grant specific powers to the sub-national governments, which the federal government cannot unilaterally take away and so centralization beyond the degree outlined in the constitution needs the consent of the sub-national governments.

## **4 Federal government as the principal**

As the 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 the policies it wishes to implement in the third stage of the game, while it communicates with the local governments in the second stage of the game. We will demonstrate shortly below that while, by opting for centralization, the federal government minimizes the costs of misaligned incentives as it makes full use of its private knowledge, it also increases the under-utilization of the local government's information.

Under decentralization the federal government allocates policy decision-making in the third stage to the local government. To make their choices, the local governments try to extract private information from the federal government in the second stage. In this case, due to decentralization the local government's private knowledge is fully exploited, but the results—as a consequence of under-utilization of the information owned by the federal government and the misalignment in interests—deviate from the optimal policy from the federal government's perspective. The next section analyzes these two schemes separately.

### **4.1 Communication under decentralization**

The communication game in our model builds on Crawford and Sobel (1982). The detailed derivations and proofs are reported in the appendices. In the communication equilibrium, the local gov-

ernment only learns the interval to which the realization of  $f$  belongs, and hence obtains only incomplete information about the federal government's knowledge.<sup>14</sup> The smaller the size of the partition interval, the more informative the federal government's message. Following Crawford and Sobel (1982), an informative equilibrium (always) exists in which the number of intervals  $N$  is maximal. 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  $F$ . Accordingly, the federal government's *ex ante* expected welfare loss  $L_{Dec}^{Fed}(N, B, F)$ , is given by

$$L_{Dec}^{Fed}(N, B, F) = B^2 + \sigma_F^2, \quad (7)$$

Hence the uncertainty the local government faces before receiving the equilibrium signal by the federal government is reflected in the ex-ante residual variance of the federal's private information  $f$  given by

$$\sigma_f^2 \equiv \frac{F^2}{12N^2} + \frac{B^2(N^2 - 1)}{3}, \quad (8)$$

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

The local government's *ex ante* expected loss is then given by

$$L_{Dec}^{Loc}(N, B, F) = \sigma_f^2, \quad (9)$$

where  $\sigma_f^2$  is again derived from (8). Following Crawford and Sobel (1982), this communication game has a focal equilibrium: that of the most informative equilibrium  $N(F, B)$ . Given the bias  $B$ ,  $\sigma_f^2$  increases with  $F$  (the importance of the federal government's private information) which also implies that the federal government's expected loss  $L_{Dec}^{Loc}$  increases with  $F$ .<sup>15</sup> Since the federal government's private information is not fully exploited under decentralization, the federal's expected loss is increasing in its informational advantage  $F$ .<sup>16</sup> 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

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<sup>14</sup>To be more precise, rather than thinking about direct manipulation of information (in the sense that organizations 'manipulate the books' in order to take advantage of information transmitted) one can also think of information that is simply not 'produced'. Think of a situation where the local government collects precise information regarding the local preferences only when it is responsible for the policy design, but may decide not to do so when the decision over the policy design is centralized.

<sup>15</sup>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.

<sup>16</sup>The federal 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 government. For example, in highly intransparent environments such informational advantages would be more salient compared to more transparent ones.

informative the cheap talk will be.

## 4.2 Communication under centralization

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. The local government is now the ‘sender’ and the federal government the ‘receiver.’ The federal government’s *ex ante* expected loss (for an equilibrium of size  $N$ ) under centralization,  $L_{Cen}^{Fed}$ , is given by

$$L_{Cen}^{Fed}(N, B, L) = \sigma_l^2, \quad (10)$$

with the *ex ante* residual variance of  $l$  being given by

$$\sigma_l^2 \equiv \frac{L^2}{12N^2} + \frac{B^2(N^2 - 1)}{3}, \quad (11)$$

where  $\sigma_l^2$  is decreasing in  $N$ , the expected degree of informativeness of the federal government’s message. The local government’s *ex ante* expected loss, denoted by  $L_{Cen}^{Loc}$ , is given by

$$L_{Cen}^{Loc}(N, B, F) = B^2 + \sigma_l^2. \quad (12)$$

Since both players’ *ex ante* expected loss increases with the residual variance  $\sigma_l^2$ , we focus on the focal equilibrium, which corresponds to the maximum number of partitions. As centralization results in an underuse of the local government’s information, the local government’s *ex ante* expected loss is increasing with its informational advantage  $L$ .<sup>17</sup>

We next turn to whether the federal government has an incentive to delegate the control of decision making to the local governments.

## 4.3 The choice between centralization and decentralization

As outlined above, the federal government determines whether or not to retain its control rights over policies by comparing its *ex ante* expected loss under decentralization,  $L_{Dec}^{Fed}(N, B, F)$ , with its expected loss under centralization,  $L_{Cen}^{Fed}(N, B, L)$ . 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  $(B, F, L)$ , that is the extent of the conflict of interest ( $B$ ) and the relative importance of the two players’ respective informational advantage  $(F, L)$ .

Hence, the federal government will opt for decentralization only if the local government’s private

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<sup>17</sup>The local government’s informational advantage, similarly to that of the federal’s above, may depend both on how relevant its knowledge is per se, as well as on how important it is relative to the federal government.

information  $L$  is (strictly) greater than its own private information  $F$  and greater than the threshold level  $F(L, B)$ . The threshold level  $F(L, B)$  is continuous and increasing in  $L$ , and, for any  $B$ ,  $F(L, B) < L$ . 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  $F(L, B)$ .

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. In line with the previous discussion, 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. Even when the federal government has no private information and  $F$  equals zero the decision for decentralization still requires  $L$  to be strictly greater than zero for all  $B > 0$ .

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  $B$  reduces the amount of information that the federal government would reveal to the local government under decentralization, which also makes centralization the more attractive choice. However, 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. For some parameter values, the latter effect can outweigh the first two. The empirical implications of this are discussed below.<sup>18</sup>

Insert Figure 1 here

## 5 Local government as the principal

We now consider the case in which the local government is in the role of the principal and the federal government is the agent. We assume that by taking advantage of its agenda-setting power, the local government is able to take the lead in deciding the level of fiscal 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

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<sup>18</sup>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 2008, and Marchesi *et al.* 2011).

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.

If it chooses centralization, the federal government will ask for the local government's advice in the second stage to decide which policies to implement in the third stage. The local government then decides in the second stage how much of its private information it should communicate to the federal government. Centralization entirely exploits the federal government's private knowledge, but results in an under-utilization of the local government's information and in sub-optimally chosen policies from the local government's point of view. The game under the decentralization scheme unfolds in analogy.

### 5.1 Choice between decentralization and centralization

When does the local government have an incentive to assign its competence of the policy vector  $p$  to the federal? Analogously to the previous analysis, the local government chooses whether or not to retain its control rights over policies by comparing its *ex ante* expected loss under decentralization,  $L_{Dec}^{Loc}(N, B, F)$ , with its expected loss under centralization,  $L_{Cen}^{Loc}(N, B, L)$ . 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 ( $L, F$ ). In particular, the local government prefers centralization only if  $F \geq L(F, B)$ , where  $L(F, B)$  is continuous and increasing in  $F$ , and, for any level of the bias  $B$ ,  $L(F, B) > F$ .

Hence, for the local government to prefer centralization the federal government's informational advantage  $F$  must not only be (strictly) greater than its own private information  $L$ , but also greater than a threshold level  $L(F, B)$ . Conversely, the local government will opt for the decentralization scheme whenever its private information is more important than that of the federal government's, that is  $L > F$ , 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.

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  $45^\circ$  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 central-

ization which delegated control rights to the federal government requires  $F$  to be strictly greater than zero for all  $B > 0$ . As above, the threshold level  $(F, B)$  is not monotone in  $B$ .

Insert Figure 2 here

## 5.2 Empirical Implications

The model allows us to draw some normative indications regarding the allocation of control rights over policy actions in the federal-local government relationship. 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 role of the region's local knowledge.

Several testable implication can be derived from the model. First, clearly, the importance of local private knowledge should be related to more decentralization, and the importance of the central government's knowledge related to less decentralization. The key feature of the model, however, is the presence of a non-monotonic relationship between decentralization and the misalignment of interest between the government levels, which is caused by the differences between the preferences of the local and federal government. Specifically, this bias has both direct and indirect effects. The direct effect of the bias reduces the incentives of the principal to delegate control rights to the agent. Therefore, all else equal, the direct effect of the bias is negatively correlated with decentralization if the federal government is the principal and positively correlated with decentralization if the local government is the principal.

The indirect effect of the bias works in the opposite direction. The larger the bias, the smaller the incentives the agent has to reveal its private information. Hence, the incentives for the principal to delegate the authority over policies increases in order to make full use of the agent's private information. Therefore, the indirect effect should prevail if the information transferred by the agent is of high value to the principal. The availability of information that is recorded can be limited, for example in developing countries. This 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 hard to soft information, in turn, may depend on the quality of the communication infrastructure. In fact, such quality may make, *ceteris paribus*, the existing informational asymmetry more (or less) salient relative to the principal (whoever that is) leading to maintaining control rights over policies.<sup>19</sup> The following additional testable implications can thus be derived from the model:

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<sup>19</sup>We should emphasize that the quality of information transmission is not all related here to the actual cost of infor-

(1) In cases where the local government is the principal, the positive effect of the bias on decentralization should be larger when the federal's private information is less salient relative to the local.

(2) In cases where the federal government is the principal, the negative effect of the bias on decentralization should be larger when the local's private information is more salient relative to the federal.

The next section empirically investigates the role that information plays in fiscal decentralization using observations for a maximum of 66 countries over the 1972-2010 period. We begin 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. 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 enhancing the effect of the bias on decentralization. We expect to find a negative (or insignificant) interaction between the two when the federal government is the principal, because better information transmission reduces the salience of local information, weakening 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). But these data have some obvious limitations. First, they are somewhat incomplete. Second, simply looking at fiscal decentralization without taking the actual control local governments have over the collection and spending might be misleading. However, these data have the advantage of being available for a large and representative sample of countries, and for a long period of time. We thus follow the bulk of the literature in employing these measures, while being aware of their potential weaknesses. 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 Ebel and Yilmaz 2003 and Rodden 2004 for a discussion). However, these data are limited to a small sample of countries and years.

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mation transmission (as signals are assumed to be costless) but simply to the relative importance of each side's private information.

## 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 a 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).<sup>20</sup> 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.

## 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 the optimal policy. Per capita GDP is included in most studies that try to explain decentralization (see, for example, Sacchi and Salotti 2012). 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.<sup>21</sup> The larger the country, the more diverse we would expect it to be, on average. More effort and logistical skills are required

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<sup>20</sup>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.

<sup>21</sup>We use a country’s (log) land size in square kilometers, taken from Treisman (2006).

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).<sup>22</sup> 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). Table 1 presents an overview of all variables, assigned to one of the groups introduced above. Variables printed in bold are available for the whole sample, while variables in regular font are available only for the smaller sample.

**Bias:** The conflict of interest between the federal and the local governments (agency bias) depends on the degree of externalities. Centralized decision-making can have the advantage of taking externalities into account. Our model shows that, *ceteris paribus*, larger externalities should lead to less decentralization. As one proxy for externalities, we use the perceived risk of *external conflict*. The larger the risk of conflict, the more important the potential externalities from centralized foreign policy on the regions. In the presence of local decision-making the deviation from the federal government's bliss point thus increases with external conflict. We take the International Country Risk Guide's (ICRG) external risk index to measure conflict. We transformed the original scale so that higher values imply more external risk, on a scale of 1-12. We include *trade openness*, as trading

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<sup>22</sup>In addition, as for example in Panizza (1999), we have also controlled for the initial level of decentralization finding unchanged results.

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, with a range between 1-12. We rescaled it so that higher values indicate larger tensions. We would expect the bias to increase with higher perceived tensions between ethnicities, on average.<sup>23</sup> 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.

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<sup>23</sup>We also included Kolo's (2012) *DELFI index*, taking account of the degree of diversity between groups, but did not obtain a significant result. Letelier (2005: 160) also discusses the potential importance of heterogeneity for the degree of decentralization.

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 can affect the degree of decentralization in both directions as they are meant to capture the relative importance of each side's private information. The direction depends on who is in charge of deciding about the degree of centralization in policy-making—the federal or the local government. In order to proxy this measure we use *information transmission*, *transparency*, *press freedom* and *corruption*.

The quality of *information transmission* influences how easily the local governments can get access to the federal government's knowledge and vice versa.<sup>24</sup> With a higher quality of *information transmission* it is easier to verify information and, therefore, to assess its relevance and importance for outcomes and decisions. We use the number of telephone lines per 100 inhabitants (World Telecommunications/ICT Indicators Database 2011) as a proxy for the quality of *information transmission*. For more recent years, the availability of internet access or mobile phones might be a better proxy but the use of this variable would substantially restrict our sample. Our variable correlates highly with both a combined 'media access' variable (0.8) and a variable capturing the number of computers per capita (0.87). The former combines access to TV, radio, papers and internet (both variables are extracted from Banks 2011). Higher values indicate higher quality, and thus less importance of differences in 'knowledge endowment'.<sup>25</sup>

As a measure of *transparency*, we use the share of data series missing for a particular country and year in the World Bank's World Development Indicators Database (2013). We calculate the indicator as the share of non-missing data out of all series for a given country and year.<sup>26</sup> We also calculate the share of missing data for four main indicators separately (the rate of inflation, budget balance, current account balance, domestic investment). On both indicators, higher values indicate more transparency. The less reliable or detailed the available information is the lower the transparency,

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<sup>24</sup>This measure should capture how salient federal/local private information is. As described in section 5.2 it refers to the relative share of hard to soft information.

<sup>25</sup>Using the media access variable yields positive and significant coefficients in our main sample as well, however, for a smaller sample due to data availability. Results are available on request.

<sup>26</sup>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.

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

Following similar intuition, we include two additional proxies for the importance of differences between local and federal knowledge. We use an indicator measuring the degree of *press freedom* (taken from Freedom House 2011, on a scale from 0-100), and an indicator of perceived *corruption* (ICRG 2013). Higher values indicate more press freedom and more corruption (corruption being rescaled from the original scale, ranging from 1-12). While these variables measure the importance of information, they do not per se indicate an informational advantage for the federal or local government. We next turn to proxies for knowledge that give a distinct advantage to one level over the other.

**Importance of local knowledge:** Local knowledge will become more important with greater complexity. We proxy for complexity using ethnic tensions ('heterogeneity'), 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 oil-producing nations are at least partly state-owned with oil revenue making up a large part of total government revenue. In such cases, federal government knowledge will be of greater importance.

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

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

Insert Table 1 here

## 7 Methodology and 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.<sup>27</sup> We estimate (using OLS with standard errors clustered at the country level),

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

where  $D_{i,t}$  represents expenditure decentralization in country  $i$  at period  $t$ , and  $Z$  is a vector containing the (lagged) variables discussed above. Finally,  $\eta_i$  and  $\tau_t$  are region and period fixed effects, respectively, and  $u_{i,t}$  is the error term.<sup>28</sup>

<sup>27</sup>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.

<sup>28</sup>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. Our results, however, are confirmed by a random effect specification (see Table 5).

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

Overall, the regressions in column 1 focus on the main variables that have been shown to influence decentralization in the existing empirical literature. The results show that decentralization increases with per capita GDP and land size, at the one-percent level of significance. To the extent that larger and richer countries are more diverse, controlling for the other variables in the regression, this is in line with the model: greater diversity increases decentralization. The size of the 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 the information transmission, namely the amount of information transferred by the federal to the local government under decentralization, leading to centralization (and *vice versa*). To the extent that the local government decides on the degree of centralized policy-making, we find that the direct effect dominates the indirect one.<sup>29</sup>

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

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<sup>29</sup>While we aim to disentangle these effects further below, for now we note that the effects working in favor of more decentralization dominate among the countries and years in our overall sample.

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 predictions when local governments decide. An increase of one standard deviation in educational quality increases the local share of expenditures by about five-percent. All of these effects are substantial in size and their coefficients are significant at the five-percent level at least. They explain a significant share of the variation of the dependent variable which gives support to the relevance of our model.

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

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

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

Column 5 of Table 2 turns to the two components of the bias. In order to disentangle the countervailing effects of knowledge and bias, we interact *information transmission* with *heterogeneity*. Col-

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

Turning to the second component of the interaction term, the bias, note that decentralization should increase with a larger bias if the local government is the principal, and decrease otherwise. This argument, however, overlooks the fact that an increase in the bias also has the (indirect) effect of reducing the amount of communication, thus making decentralization more costly from the local government's perspective (and centralization more costly from the federal government's perspective). The interaction effect allows us to differentiate between the direct and the indirect effects. Specifically, with the local government being the principal, we expect to find that a greater bias increases centralization only when information transmission is low.<sup>30</sup> The results from column 5 in Table 2 confirm such intuition; the coefficient of the interaction variable is positive and significant. Figure 3 shows the marginal effect. The result shows that the marginal effect of heterogeneity on decentralization is positive and significant only for high levels of information transmission and not significant when information transmission 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.

We next split the full sample in two sub-samples according to whether the federal or the local governments are more likely to decide on the degree of decentralization. This allows a sharper test of our hypotheses, which depend on who is the principal and who the agent. We use a number of different variables to capture this: first, we consider whether a country is federal or unitary. Classifications are available from Norris (2008) and Elazar (1995), the latter being updated by Treisman (2008). Second, we distinguish countries where the constitution explicitly grants sub-national governments residual power to legislate from those where all 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 fed-

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<sup>30</sup>On the other hand, when the federal government is the principal, we expect decentralization to prevail with a larger bias only if information transmission is more difficult.

eral government to resist and impede changes proposed by subnational governments, increasing their discretionary power. Appendix F shows how individual countries are classified according to all measures.

Table 3 shows the results, focusing on the interaction between the bias and information transmission. It employs five different definitions of federal vs. unitary states from different authors and sources to minimize the sensitivity towards the choice of a certain specification. The model predictions for the effect of heterogeneity as a proxy for bias and importance of information are ambiguous: It could lead to more decentralization or more centralization. However, for a given level of heterogeneity of the country, an improvement in information transmission should lead to more decentralization when the local governments are the principals. If the central government maintains the final decision rights, better information transmission means less reliance on local information, thus, we would expect a negative interaction effect. The results are in line with the predictions of the model. In all five specifications, the interaction between heterogeneity and information transmission is positive and significant at least at the five-percent level in federal countries. In countries where the federal government has the final decision rights, the coefficient of the interaction term is always negative as expected. However, it is significant at the ten-percent level in one regression only. One reason might be a lack of variation in decentralization in unitary states. However, as predicted by the model, the difference between the coefficients of the interaction terms in the two models (tested employing a seemingly unrelated regression model) is always significant, at least at the ten-percent level. This also holds when we include the initial degree of decentralization as a robustness test in Table 4.<sup>31</sup>

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

Insert Figure 3 here

## 8 Conclusions

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

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<sup>31</sup>Table 5 shows the results using a random effects model as a robustness test. As outlined above, we do not estimate fixed effects models due the lack of variation in our variables of interest over time. Additional tables with the full specifications of all models are available on request from the authors.

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

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

Expenditure decentralization varies widely across countries and over time. In our sample, the range is between 3.6 to 64.13 percent, with an average of 27.97 percent of government spending taking place at the sub-federal level. Even controlling for factors identified in the literature as determinants of decentralization, stark differences across countries remain. This suggests that the combination of agency problems and informational asymmetries between the federal and local governments can explain such differences. We test the theoretical implications empirically by relating the degree of fiscal decentralization to information transmission and the size of the bias. Controlling for country-characteristics, their economic performance, and for 'political' motivations, we find empirical results consistent with the theory. In line with the existing literature, decentralization increases with land size, while GDP per capita, the size of the population, urbanization, and

democracy do not robustly determine decentralization.

With respect to our variables of interest, we find that decentralization increases with less openness to trade and better educational quality, as the relative importance of the federal government's knowledge diminishes. 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 the local governments.

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

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 2013). 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 the local governments (the member states) in certain areas, under-exploiting the knowledge of the EU Institutions in the presence of a bias.

The analysis is of course limited in several respects. Other types of decentralization besides the fiscal realm have been neglected. It will be an important endeavor to test our theory again when data that allow a distinction about the actual control rights of local units over policy for a larger sample of countries become available. What is more, it might be promising to explore the differences between developing and developed countries as well as the interaction between different local units, which in turn may have different degrees of bias, and different access to information.<sup>32</sup> There remains much scope for the analysis of information transmission in richer models of fiscal federalism. We hope to have shown that the task is worthwhile and that the conclusions can be instructive.

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<sup>32</sup>Due to the interdependency in communication strategies this case will be much more difficult to analyze, which explains why we have postponed such analysis to future research.

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## Tables

**Table 1:** Sources and Definitions

	<b>Variable</b>	<b>Definition</b>	<b>Source</b>
<b>DEPENDENT VARIABLE</b>	Expenditure Decentralization	Subnational expenditures (local and state level) / expenditure by general government (all levels)	IMF (2012)
<b>CONTROL VARIABLES</b>			
	(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)
<b>VARIABLES OF INTEREST</b>			
<b>Bias</b>			
	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)
<b>Externalities</b>			
	Trade Openness	Exports plus imports as % of GDP	Heston et al. (2012)
	Oil Rents	Oil rents (crude oil production value at world prices minus total production costs) as % of GDP	World Bank (2013)
	Risk of External Conflicts	Perception of the risk of external conflict	ICRG (2013)

**Table 1** continued

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<b>Knowledge</b>		
Information Transmission	Fixed telephone lines per 100 inhabitants	International Telecommunication Union (2011)
Transparency	Share in all data series for which data are reported	World Bank (2013)
Corruption	Perceived corruption	ICRG (2013)
Press Freedom	Annual survey of media independence	Freedom House (2011)
<b>Importance of local knowledge</b>		
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)
<b>Importance of federal knowledge</b>		
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)

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

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

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

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

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

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

**Table 4:** Interaction between Heterogeneity and Information, 1972 – 2010, OLS (with initial decentralization)

Agenda setter:	Local government		Federal government		P-value
	Coef.	Std. err.	Coef.	Std. err.	
<i>Federation type: Unitary or federal (Norris 2008)</i>					
Heterogeneity*Information Transmission	0.013**	[0.005]	-0.003	[0.002]	0.000
Adj. R-Squared	0.83		0.89		
Number of observations	126		212		
<i>Classified as "federal" (Elazar 1995)</i>					
Heterogeneity*Information Transmission	0.008***	[0.003]	-0.002	[0.003]	0.000
Adj. R-Squared	0.87		0.81		
Number of observations	191		147		
<i>Residual powers to legislate (Treisman 2008)</i>					
Heterogeneity*Information Transmission	0.009***	[0.002]	-0.001	[0.003]	0.000
Adj. R-Squared	0.72		0.85		
Number of observations	207		131		
<i>Sub-national government authority (Keefer 2013)</i>					
Heterogeneity*Information Transmission	0.007***	[0.002]	-0.018	[0.018]	0.000
Adj. R-Squared	0.82		0.9		
Number of observations	299		39		
<i>Legislature or executive locally elected (Treisman 2008)</i>					
Heterogeneity*Information Transmission	0.009***	[0.002]	-0.003	[0.003]	0.000
Adj. R-Squared	0.81		0.92		
Number of observations	265		71		

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

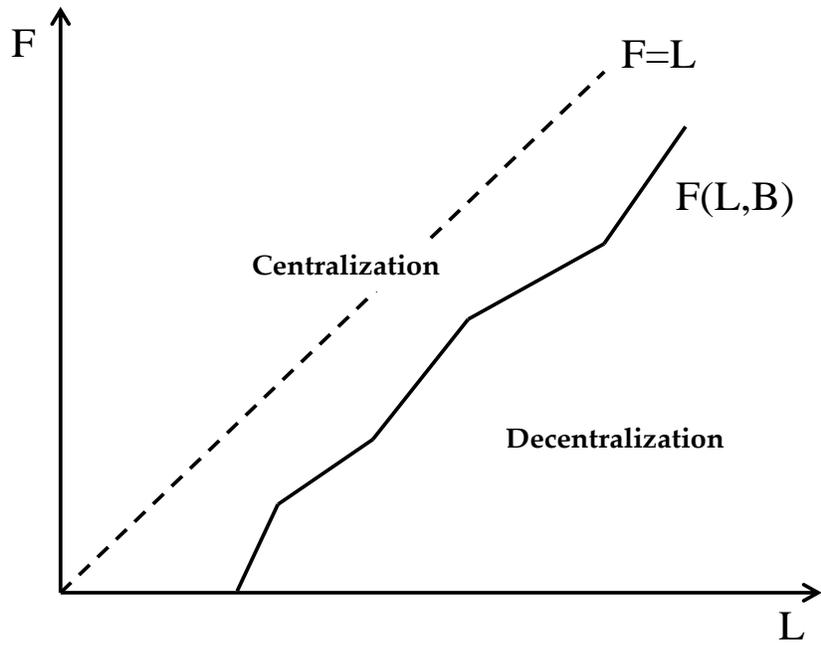
**Table 5: Decentralization, Bias and Knowledge, 1972 – 2010, Random Effects**

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]
Transparency			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	

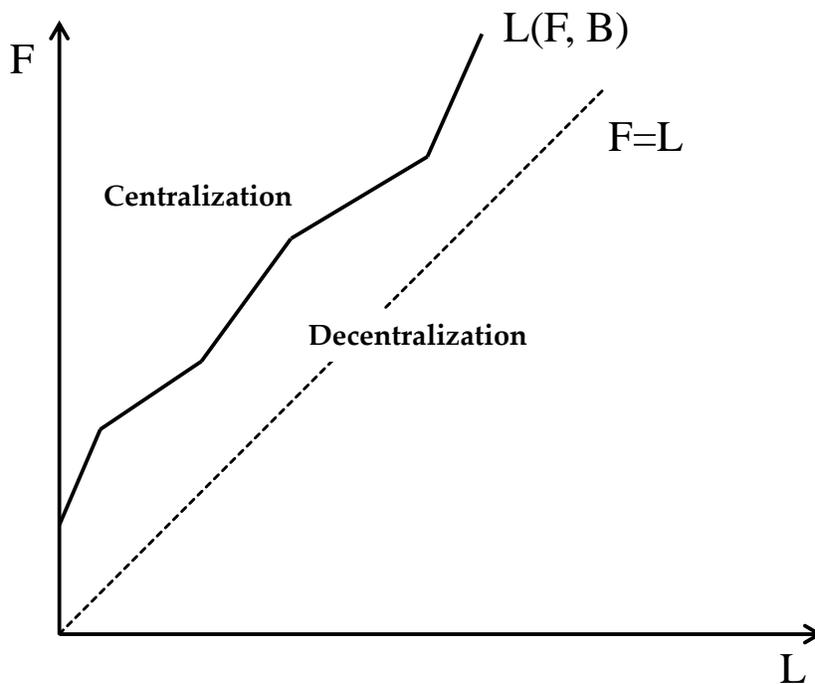
Notes: Re-estimation of table two using the random-effects estimator. Standard errors (clustered at the country level) in brackets.

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

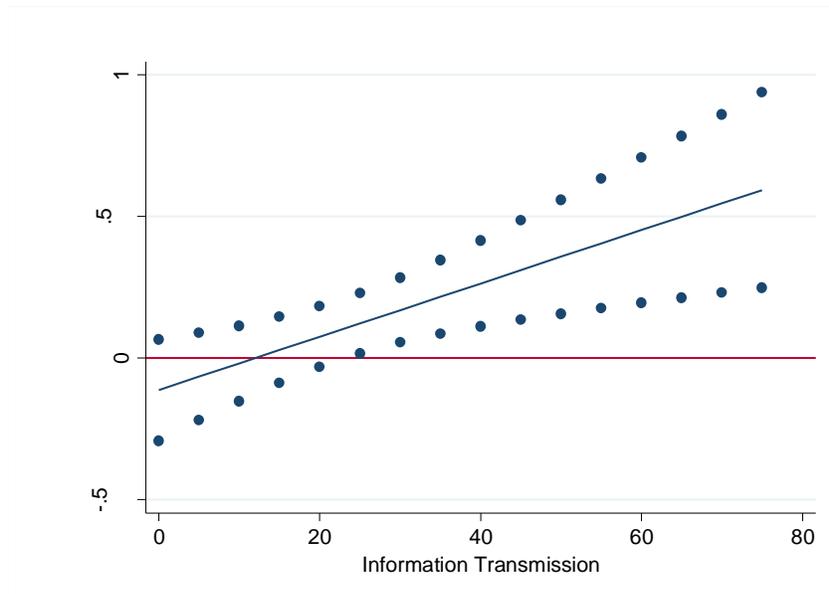
## Figures



**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 2, column 5). The dashed line shows the 95%-confidence interval.

## Appendices

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

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

Let  $t \in [0, F]$  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 that: de

**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:*

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

and

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

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

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  $0 = f_0 < f_1 < \dots < f_{N-1} < f_N = 1$ , 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)  $\int_0^L \left[ l + \left( \frac{f_i + f_{i+1}}{2} \right) - (l + f_i) - B \right]^2 f(l) dl = \int_0^L \left[ (l + f_i) - \left[ l + \left( \frac{f_{i-1} + f_i}{2} \right) \right] + B \right]^2 f(l) dl$ ;
- (ii)  $f_0 = 0$ ;  $f_N = F$ .

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

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  $i = 1, \dots, N - 1$ ,

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

from which it implies

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

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

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

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

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

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

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

From (A.7) it follows that

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

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

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

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:

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

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:

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

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

□

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

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

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

with the last equality following from equation (8). Here,  $D$  stands for decentralization and  $\sigma_F^2$  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  $t$ .

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

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

with the last equality following again from equation (8). Since both players' *ex ante* expected loss is decreasing with  $N$ , Crawford and Sobel assume that both agents coordinate on the most informative equilibrium  $N(F, B)$ , which is thus a focal equilibrium.

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

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

where the last equality follows from equation (11).

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

$$\begin{aligned}
L_{Cen}^{Loc}(N, B, F) &= \int_0^L [p(f, r) - p_L^*]^2 g(l|r) dl, \\
&= \frac{1}{L} \sum_{i=1}^N \int_{l_{i-1}}^{l_i} \left( \frac{l_i + l_{i+1}}{2} + f + b_F - f - l + b_L \right)^2 df, \\
&= \frac{1}{L} \sum_{i=1}^N \int_{l_{i-1}}^{l_i} \left( \frac{l_{i-1} + l_i}{2} - l + B \right)^2 df, \\
&= \frac{1}{L} \frac{1}{12} \sum_{i=1}^N (l_i - l_{i-1})^3 + \frac{B^2}{L} \sum_{i=1}^N (l_i - l_{i-1}) \\
&= \frac{1}{L} \frac{1}{12} \sum_{i=1}^N \left[ \frac{L}{N} + 2(2i - N - 1)B \right]^3 - \frac{B^2}{L} (l_0 - l_N) \\
&= \sigma_l^2 + B^2 (l_0 = 0; l_N = L, \text{ see Proposition 1}). \tag{A.4}
\end{aligned}$$

□

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

The statement given in Section 5 follows directly from Proposition 2 below. By comparing its *ex ante* expected loss under decentralization ( $L_{Dec}^{Fed}(N, B, F)$ ) 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: Descriptive Statistics

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

## Appendix E: Correlations

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

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

## Appendix F: Classification of countries

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

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**Appendix F: Classification of countries (continued)**


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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 F: Classification of countries (continued)**

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

**Appendix F: Classification of countries (continued)**

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 &	X
		Tobago	
Swaziland	X	Tunisia	X

**Appendix F: 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.