Decentralization as a multifaceted concept: a more encompassing index using bayesian statistics

La descentralización como un concepto polifacético: un índice más completo utilizando métodos bayesianos

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Resumen
La mayoría de mediciones de descentralización política solo consiguen capturar algunas de sus facetas. En particular, la excesiva dependencia con respecto a indicadores fiscales es comúnmente criticada debido a su incapacidad para valorar el nivel de autonomía ejercido por administraciones subnacionales. Por el contrario, esfuerzos dirigidos a la creación de índices de mayor cobertura han recurrido a la combinación de opiniones de expertos, un proceso susceptible de ser afectado por errores idiosincráticos. En este artículo propongo el diseño de un marco metodológico basado en el uso del análisis factorial bayesiano para variables continuas y ordinales. Este modelo combina eficientemente múltiples medidas de descentralización con independencia de su nivel de medición, y de esta manera hace uso de manera simultánea del rigor de indicadores fiscales y de la amplia cobertura que caracteriza a otros índices cualitativos. Aplicando un conjunto de 14 indicadores a este modelo elaboro un índice de descentralización más completo para 33 países OCDE. Con el objetivo de ilustrar la importancia del uso de medidas de descentralización que no sean parciales, utilizo este índice para replicar partes del análisis exploratorio realizado por De Mello y Barenstein (2001) sobre la relación entre descentralización y corrupción, mostrando que esta relación es prácticamente inexistente.

Palabras clave: medición, descentralización, índice, métodos Bayesianos, análisis factorial.

Abstract
Most measures of political decentralization seem to capture only specific facets of the concept. In particular, the excessive dependence on fiscal indicators has often been criticized since they seem unable to assess the degree of autonomy exerted by subnational governments. On the other hand, efforts directed at developing more encompassing indexes have had to rely on the aggregation of items developed by experts, a process

that is prone to idiosyncratic errors. In this paper I propose the development of a measurement framework using a Bayesian factor analysis model for mixed ordinal and continuous outcomes. This model can efficiently combine multiple measures of decentralization regardless of their level of measurement, and in this way make use of both the rigour of fiscal indicators and the wider coverage of qualitative indicators. Applying this model to a set of 14 indicators I elaborate a more encompassing index of decentralization for 33 OECD countries. In order to illustrate the importance of using non-partial measures of decentralization, I use this index to replicate parts of De Mello and Barenstein (2001) exploratory analysis regarding the relationship between decentralization and corruption, showing that such relationship is practically non-existent.

Keywords: measurement, decentralization, index, Bayesian statistics, factor analysis.

INTRODUCTION

During the last three decades governments all over the world have favoured processes of decentralization through the creation and strengthening of subnational levels of public administration. According to a World Bank study (Dillinger, 1994), 63 of the world's 75 developing countries with populations over 5 million declared to be involved in a process of transfer of political power to local government. This wave of political reform has been envisaged by politicians, the civic society and academics as a process that brings the government closer to the people and thereby improving democratic accountability and public sector performance.

Political scientists have pointed at the potential of decentralization as a policy to both appease ethnic conflicts by allowing empowered regional governments, and bolster political participation in general (Brancati, 2006; and Hutchcroft, 2001). The branch of Sciences of the Administration also underlines the benefits in increased government responsiveness and transparency stemming from the closer contact between the citizenship and its government (Huther and Shah, 1998, Shah, A., 1999; and Treisman, 2002b). From a more economic perspective, decentralization has been theorized to enhance growth and innovation through regional and local competition and to improve efficiency in the provision of public goods by better fitting the preferences of smaller and more homogeneous groups (Faguet, 2004; Rodríguez-Pose and Ezcurra, 2011; Thieben, 2001; and Vo, 2010). However, there are reasons to believe that decentralization might produce some undesirable effects too. For example, the multiplication of layers of government might in some cases hinder accountability. Moreover, due to economies of scale, the smaller the government the more likely there is to be a deficit in human, financial and technical resources, which reduces cost-effectiveness in the provision of public goods.

There is a large literature of empirical studies analysing the effect of decentralization on areas such as interregional equality, transparency, political participation, growth, inflation, or fiscal discipline; but results have often been inconclusive. The study of political decentralization on corruption represents a good example of this disagreement. Articles on this topic using a similar research design, namely regression analyses with

international cross section data, can be divided in two blocks: those denoting a positive effect of decentralization on government transparency, and those that find inconclusive or negative results.

Huther and Shah (1998) found that fiscal decentralisation measured by subnational share of government expenditures was associated with enhanced quality of governance as measured by political and bureaucratic accountability and reduced corruption. Similarly, using subnational government expenditure as a proxy for decentralization, Fisman and Gatti (2002) revealed a negative relation between decentralisation and corruption, measured by The International Country Risk Guide's Corruption Index. Gurgur and Shah (2005) found that decentralisation measured by subnational share of civilian government employment supports greater accountability and reduced corruption in the public sector, —these two outcomes measured by composite indexes that they generated—, and De Mello and Barenstein (2001) concluded that tax decentralisation was positively associated with improved quality of governance.

On the other hand, another group of studies have found different results. Treisman (2002a) indicates that nations which have more tiers of government tend to have higher perceived corruption, measured by the Transparency International's Corruption Perception Index (CPI), whereas other indicators capturing features of fiscal decentralization such as subnational expenditure were not significant. In a continuation of this study, Treisman (2002b), also found that federal states are perceived to be more corrupt than unitary ones. Freille *et al* (2008), found that corruption measured by the World Bank's Control of Corruption Index is higher in federalist than in Unitarian countries, although fiscal indicators such as subnational share of expenditure and revenue where associated with lower corruption. Finally, Fan, Lin and Treisman (2009) using data from surveys based on the concrete experience of businessmen found that decentralization measured by the number of tiers of government, the average area of the bottom administrations, and whether the lower tiers had some kind of authority in the different policy areas, were related with more frequent and more costly reported bribery. In addition, larger subnational shares of civilian government employment were also associated with bribery, although share of subnational revenue was found to be negatively related.

Shah *et al* (2004), Gil *et al* (2004), or Sharma (2006) have carried out reviews of the literature regarding the effects of decentralization in different areas such as fiscal balances, inflation, government accountability, responsiveness, political participation interregional inequality, or public sector size, and in all of them they have found opposing results like the ones I presented above. I argue that the lack of consistent findings in the study of decentralization is largely due to an improperly defined research framework. In particular there is a multiplicity of measures that are used rather loosely as proxies for decentralization. This is due to both the multidimensionality and complexity of the phenomenon of decentralization. In order to produce comparable findings that could be used to advance in the study of the effects of decentralization the concept needs first to be correctly operationalized.

I aim to tackle this problem here by generating a new index of decentralization for 33 OECD countries that, based on sound statistical foundations, will be able to encompass most of the facets of decentralization. In Section 2, I review the different measures of decentralization and discuss the reasons why they are not entirely satisfactory; in Section 3 I propose a new measurement framework based on the use of Bayesian statistics; the index of decentralization is presented in Section 4, where I also include a brief exploratory analysis to demonstrate how using proxies for decentralization can lead to misleading results; and in Section 5 I conclude by summarising my results and indicating how the index could be improved in future research.

THE PROBLEM OF MEASURING DECENTRALIZATION

There are two main problems associated with the measurement of decentralization. First it involves the quantification of power and its distribution, which are complex phenomena not easily amenable to measurable categories. In addition, there is a lack of agreement on the very meaning of decentralization. Scholars of Public Administration and scholars of Political Science have dealt with the study of decentralization, but unfortunately with too little interaction between their respective bodies of work (Hutchcroft, 2001). To this division a third discipline can be added: Fiscal Federalism, an academic area stemming from Economics which has largely contributed to the study of decentralization but unfortunately sharing the same lack of interdisciplinary contacts than the other two disciplines.

Schneider (2003) indicates that each of these disciplines highlights a dimension of decentralisation which is treated as distinct and separable. According to the author, arguments from Public Administration focus on the administrative effects of granting local jurisdictions autonomy from central control in the form of policymaking authority, and control over the personnel and public finances; Political Science theories focus on the processes of mobilization, organization, participation, contestation, and aggregation of interests occurring at subnational levels; whereas Fiscal Federalism is concerned about the extent to which resources handled by each level of government have an impact on the functioning of the public sector.

Having to choose between one of these definitions of decentralization seems rather restrictive; "*Researchers who do not explicitly look at each dimension will mismeasure the type and degree of decentralization and draw incorrect inferences about the relationship between decentralization and other phenomena*", (Schneider, 2003: 35). Instead Schneider (2003) recommends conceptualizing decentralization as a unique entity, in which three interrelated dimensions can be identified: economic, administrative, and political. This way the points of view used by the three disciplines mentioned before can be incorporated. Regretfully the use of proxies that account for a specific dimension of decentralization has been the norm rather than the exception in previous studies. Here I present those that are most commonly applied.

Federalist vs Unitarian and number of tiers

The simplest way to operationalize decentralization has been to use a binary variable capturing whether a country's constitution declares itself as a federal or unitary state. This exercise represents a brute simplification. Rodden (2004) even makes the point that these indicators are rather loosely coded; identifying federations by relying more on common sense and experience than on the rigorous review of constitutional charts. Another simple way used to measure decentralization consists of recording whether regional and, or, local elections are held. So, a variable ranging from 0 (non-democratic states) to 3 (fully decentralized states) is formed. These types of measures are, however, more frequently found in studies that are not focussed on decentralization per se, but rather look to include a variable that could control for its effect.

Fiscal indicators

The most popular approach when it comes to measuring decentralization is to use fiscal indicators, such as those published by the Government Finance Statistics (GFS) group at the International Monetary Fund, which represent practically the only approach used for studies examining the relationship of decentralization with aggregated measures of macroeconomic performance. These indicators reflect different features of the economic size of subnational governments. Two of the most basics, and for which the GFS panel covers a longer time period, are subnational share of total expenditures and subnational share of total taxations.

These measures possess two major advantages in the form of reliability and comparability. The GFS derives its indicators from national accounts, which in turn are rigorously calculated by each national department of statistics. In addition, they are precisely defined and it is straightforward to identify what they are really measuring. Second, the GFS has emphasized comparability by making a great effort at standardizing accounts from each country; nowadays covering 148 countries.

Nonetheless, and in spite of these merits, the GFS fall short in providing a full picture of decentralization. In particular, these fiscal indicators struggle to capture the level of autonomy enjoyed by subnational governments. As argued by Ebel and Yilmaz (2002), GFS indicators of expenditure do not distinguish the source of revenues (taxes, intergovernmental transfers, grants, etc.), making it complicated to evaluate the degree of independence allowed to subnational governments. For example, in many cases local expenditures are mandated by the central government or are spent on behalf of central government, reflecting a process of deconcentration instead of decentralization.

The indicator of subnational taxation offers additional information on autonomy degrees by capturing the percentage of taxes collected at subnational levels. Taxes are different from the total amount of resources, which is a better measure of wealth than control. "*Taxes offer*

the greatest degree of autonomy, grants, and loans offer somewhat less, and discretionary transfer probably the least", (Schneider, 2003: 39). However, subnational taxation still fails to address properly the intergovernmental fiscal structure of countries because it ignores the degree of central government control over local tax rates and tax bases.

The GFS has become increasingly aware of the shortfalls when it comes to measuring genuine autonomy, and recently it has released a new set of indicators more informative in this respect. They specify the percentage of conditional and unconditional transfers, and the share of intergovernmental transfers. The problem is that at the moment this data is only available for six eastern and central European countries in 2006. Nonetheless and despite improvements that are being made in this area, indicators based on monetary data will never be sufficient to describe the whole construct of decentralization on their own.

Oates (1999) pointed out that one cannot differentiate whether observed deviations by fiscal indicators are due to genuine decentralization or whether they reflect differences in economic policy. Even if there was an identical allocation of functions amongst subnational levels of government across two countries, the picture of decentralization painted by fiscal indicators will generally differ if they didn't have the same relative expenditure patterns across the whole nation. For example, given two countries that have decentralized the same set of competencies, the one with a larger portion of its resources devoted to national defence will appear to have, other things being equal, a lower degree of decentralization. In this sense, Stegarescu (2005) added that the economic cycle can produce significant changes in the relative size of government activities which might be confounded with real shifts in functions or resources between government tiers. For example, in a country where subnational governments provide unemployment benefits, subnational expenditure increases without an expansion of fiscal autonomy during times of high unemployment.

Qualitative indexes

Some researchers have tried to overcome the limitations of measuring decentralization using fiscal indicators by developing qualitative indexes that potentially incorporate all the facets of the concept. These indexes are more encompassing than fiscal indicators, but they are produced by a less reliable and objective process. Here I present the two most exhaustive indexes available in the literature in terms of number of countries, years, and dimensions covered: The "Index of Effective Decentralization" from Arzaghi and Henderson (2005), and the "Regional Authority Index" from Marks *et al* (2008).

Arzaghi and Henderson (2005) define their measure as a *"nuanced index of institutional decentralization"*. It covers 16 European and OECD countries, with eight observations that have been spaced in intervals of five years, from 1960 to 1995. It is constructed by averaging six indicators assessing fiscal, political, and administrative responsibilities of subnational government. A value between 0 and 4 is attributed to the following indicators: government structure, which identifies unitary and federal states at its extremes; election

of a regional executive, indicating whether elections are held at the regional level; election of a local executive (similar to the previous one); ability of the centre to suspend lower levels of government or to override their decisions; revenue raising authority of lower level governments; and revenue sharing, representing how public budgets are allocated within the hierarchy of governments.

The Regional Authority Index goes a step further in terms of completeness; it covers 42 countries on a yearly basis from 1950 to 2006. Different items are designed to capture abstract dimensions that are summarized in the master concept of regional authority. This concept is in turn conceived in two domains: self-rule, which refers to the authority of a regional government over those living in the region, and shared rule, referring to the authority a regional government exercises in the country as a whole. Some of the items for self-rule are: the range of policies for which a regional government is responsible; the extent to which a regional government can independently tax its population; or the extent to which a regional government is endowed with an independent legislature and executive.

An interesting development in Marks' index stems from the use of a coding scheme. Items receive values from 0 to either 3 or 4, but in contrast with Arzaghi's index, guidelines on how to allocate points for each item are included (Hooghe *et al* 2008). As the authors indicate the goal is to make the index inter-subjective, so that experts understand and apply it in a consistent way to arrive at convergent observations. These coding schemes make qualitative indexes more reliable and transparent. However, in the end, coding particular cases will usually involve expert judgment, no matter how clearly an item is formulated; *"Expert coding cannot be reduced to an algorithm",* Marks et al. (2008: 117). In conclusion, qualitative indexes help to overcome some of the fiscal indicators' limitations to account for the whole concept of decentralization, however, issues of reliability in general, and transparency and comparability in particular, remain when relying on qualitative indicators.

A MORE ENCOMPASSING, ROBUST, AND INFORMATIVE MEASURE OF DECENTRALIZATION

In order to improve the measurement of decentralization I propose a Bayesian factor analysis model for mixed ordinal and continuous responses. In doing so I build upon the works of Pemstein *et al* (2010), and Hoyland *et al* (2012), where the same approach was used to estimate an index for quality of democracy and human development, amongst others. This model allows for 1) the inclusion of all aspects of decentralization; 2) the combination of measures that use different scales; 3) the elimination of idiosyncratic errors arising from subjective choices; and 4) the simultaneous adjustment for missing data.

As in the qualitative indexes presented before I combine different measures that can collectively capture every aspect of the concept of decentralization (economic, administrative, and political). In addition, the method that I use allows me to aggregate

different measures based on an objective criterion, the estimated factor loadings, which represent the share of internal correlation explained by each indicator. In other words, how much each indicator contributes to the construct of decentralization. This way, idiosyncratic errors that occur in individual measures when experts are asked to give a rate, or when different measures are aggregated using arbitrary schemes are eliminated. The prevalence of the latter is substantial. For example, it occurs when researchers aim to obtain a better measure of decentralization by taking the arithmetic mean of different fiscal indicators (Díaz-Serrano and Rodríguez-Pose, 2011; and Thieben, 2001); but even qualitative indexes suffer from this problem. For example, Arzaghi and Henderson (2005) calculated an average for all the items that they assessed, and defended this procedure with the claim that each item is measured in the same scale (from 0 to 4).

In addition, the combination of factor analysis and item response theory under a Bayesian framework facilitates the joint use of variables measured by continuous, ordinal or categorical scales without generating problems of misspecification. This is an advantage of the simultaneous estimations produced in Bayesian statistics. Quinn (2004) indicates that the difficulty of combining these types of measures using latent variable models has been a major limitation in the estimation of political concepts. Most latent variable models are only appropriate when the indicators to be used are either all continuous (factor analysis), all ordinal (item-response), or all categorical (latent class). Ignoring the discrete nature of the indicators can result in falsely precise and possibly biased estimates (Quinn, 2004); discretizing continuous variables throws away information and reduces precision in estimates; while dropping variables in order to have a set of indicators with the same scale, reduces both precision and the availability of items that might be used to tap on specific aspects of the construct. The first of these problems can be found, for example, in Schneider (2003), where a factor analysis is inappropriately specified using four continuous variables from the GFS and two dichotomous ones representing whether regional and local elections are held in the country.

Furthermore, latent variable estimation from a Bayesian framework allows obtaining a measure of uncertainty of the latent trait in a robust, straightforward, and more informative way. The reliance of Bayesian estimation on Markov chain Monte Carlo (MCMC) methods, and the simulated draws from the joint posterior distribution of the model unknowns, makes it unnecessary to use large sample assumptions (asymptotic normality). That is, in small to moderate samples, these exact posteriors provide robust standard errors and confidence limits (i.e. credible intervals) for the estimates, regardless of the sample size. These posterior distributions of the model unknowns can be used to infer the level of uncertainty that surrounds every country-value of decentralization. I take advantage of this possibility by accompanying the point estimates of the latent variable with their respective 95% credible intervals. This is a type of information that a frequentist approach would not be able to offer. As Levendusky *et al* (2008) point out, most analyses of covariance structure approaches treat the latent variables as nuisance parameters, and, at best, will produce point estimates of these quantities, conditional on estimates of the factor structure.

In contrast, in the framework that I propose the latent trait of interest appears explicitly as a parameter to be estimated. Lastly, Bayesian statistics can adjust for missing cases -under the assumption of missing at random- as the model of interest is estimated, without having to rely on second stage processes such as multiple imputation, which facilitates the use of incomplete although still informative indicators.

Data

A set of 14 measures of decentralization for 33 OECD are used in the estimation of the model: *subnational expenditure, subnational revenue, subnational taxation, subnational employment, institutional depth*, *policy scope, fiscal autonomy, borrowing, federal, constitutional reform, representation, law making, executive control,* and *fiscal control.* These measures were chosen from the existing pool available in the literature according to three criteria: 1) reliability, only indicators that have been prepared through systematic processes are considered; 2) reflectivity, the measures given by the chosen indicators are not a direct cause or effect of the construct of decentralization, but a direct reflection of it; 3) relevance, indicators were chosen with the intention of making sure that all the three dimensions of decentralization considered in Schneider's (2003) definition (economic, administrative, and political), are sufficiently covered.

Subnational expenditure, revenue, *taxation,* and *employment* are used to tap on the economic facet of decentralization. The first three are fiscal indicators, which peculiarities have been recognized in the Section 2.2. Specifically, I use fiscal indicators published by the OECD as these are publicly available, unlike the GFS. Their most updated values are used (2010, 2011, and 2008, respectively). In addition, I include the *subnational share of civilian employment* —made publicly available by Treisman (2002a)—, which just like the other three indicators, it can be used to reflect subnational governments, relative size and capacity of spending.

Borrowing, institutional depth, policy scope, and *fiscal autonomy,* are used to tackle the extent of administrative decentralization; that is, the degree of autonomy from central authorities enjoyed by subnational governments. *Borrowing* is a qualitative indicator elaborated by the World Bank for the year 2000, which can be coded as a binary variable capturing whether subnational governments are allowed to borrow from financial markets. The other three measures are developed by Marks *et al* (2008) for their Index of Regional Authority and refer to the year 2006. *Institutional depth* can be defined as the extent to which a regional government is autonomous rather than deconcentrated. Each country-year observation receives a score ranging from 0 to 3, and the following codes have been used to improve inter-rater reliability: 0 if a functioning general-purpose administration at regional level does not exist; 1 if the administration can be considered as a deconcentrated and general-purpose one; 2 if it is a non-deconcentrated general-purpose administration subject to central government veto; and 3 if it is a non-deconcentrated general-purpose

administration not subject to central government veto. *Policy scope* captures the range of competences for which a regional government is responsible. It can go from 0, where no authoritative competencies are granted to 4, where regional government competences exist in almost all policy areas, including immigration or citizenship. *Fiscal autonomy* defines the extent to which a regional government can tax its population. It ranges from 0, where bases and rates of all taxes are controlled centrally to 4, where the regional government sets base and rate of at least one major tax (personal income, corporate, value added or sales tax).

To tackle political decentralization, or the extent to which political movements at the subnational level can be articulated and play a part in influencing national politics I use *federal, representation, constitutional reform, law making, executive control* and *fiscal control. Federal*, is a binary variable coded by Elazar (1995), which identifies whether the constitution of a country defines itself as federal or not. The other five measures are items developed by Marks *et al* (2008) referring to the year 2006. *Representation* measures the extent to which regional governments are endowed with an independent legislature and executive. It ranges from 0, given if there is no regional assembly, to 4, if the regional assembly is directly elected. *Constitutional reform*, defines the extent to which regional representatives co-determine constitutional change. It ranges from 0, where central governments can unilaterally determine a constitutional change, to 3, where a majority of regional governments can veto constitutional change. *Law making*, captures the extent to which regional representatives co-determine national legislation. It goes from 0 to 2, and 0.5 points are attributed according to the existence of the following features: regions are the unit of representation in the legislature, regional governments designate representatives in the legislature, regions have majority representation in the legislature, and the legislature with regional representation has extensive legislative authority. *Executive control*, defines the extent to which regions can determine national policy. It goes from 0, where no routine meetings between regional and central representatives are envisaged, to 2, where routine meetings can achieve legally binding decisions. Lastly, *Fiscal control,* defines the extent to which regional representatives can co-determine the distribution of national tax revenues. It ranges from 0, where regional representatives have no influence at all, to 2, where regional representatives can exert a veto over such issues.

Model

In the latent variable model that I propose the set of indicators reviewed above could be conceptualized as imperfect measures of the unobserved construct of decentralization; with the index itself seen as a continuous (i.e. with infinite degrees of intensity) unidimensional scale, arising from their patterns of association of the 14 indicators used.

The set of 14 indicators are ordered according to their measurement scale: interval or discrete. I assume that items from the Regional Authority Index are continuous since

very often experts give values in between their predefined discrete points (see Appendix 1, where I include all the data used and generated in this study). This way, the 12 first indicators that I use are considered interval variables and are fitted as the response variables in a confirmatory factor analysis (CFA). This model could be specified as follows:

$$y_{ij} = \alpha_j + \beta_j x_i + \varepsilon_{ij} \qquad (1)$$

where $j = 1,2,...,14$ and $i = 1,2,...,33$, are subscripts designating indicators and country level observations respectively. In this part of the model y_{ij} represents the first 12 interval indicators which are considered proxy measures of decentralization; β_j denotes the factor loadings describing the effects of the latent construct of decentralization on the observed measures, or put it differently, describing the index *j*'s ability to discriminate between countries with respect to levels of decentralization; α_j represents the intercept; x_i is the common underlying level of decentralization for each country that relates to the observed indicators; and ε_{ij} , denotes the error term, which is normally distributed with mean 0 and variance $\sigma^2_{\varepsilon j}$.

Following the work of authors such as Dunson (2000), Jackman (2002), and Quinn (2004) I upgraded the model in order to appropriately incorporate the two categorical indicators *federal* and *borrowing*, indexed by $j = 13$ and $j = 14$, which can be understood as ordinal variables with two values, 0 and 1. This is done by mixing the previously specified CFA model with an ordinary item response model (OIR). OIR models were first developed to account for scales indicating order of intensity in questionnaires and they are based on the assumption that each of the discrete items is measuring a same underlying construct, which is only observed in a sequence of steps.

In particular, for the case of a dichotomous variable such as *federal*, the probability of a country being unitary, $P(y_{i13}) = 0$, or federal, $P(y_{i13}) = 1$, can be expressed as a function of the latent trait decentralization, x_i with,

$$\begin{cases} P(y_{i,13} = 0 \mid \beta_{13}, x_i) = F(\tau - \mu_i) \\ P(y_{i,13} = 1 \mid \beta_{13}, x_i) = 1 - F(\tau - \mu_i) \end{cases} \qquad (2)$$

where $\mu_i = \beta_{13} x_i$ represent the latent variable of decentralization multiplied by the factor loading of *federal*, *F(.)* is the function mapping from the real line to the unit probability interval, which here was taken to be the logistic cumulative density function, with τ_j as the unobserved threshold for the latent variable, which discriminates whether $Y_{i13} = 1$ given β_{13} and x_i. Finally, the error term from uation 2 is logistically distributed and is represented by ζ_i with variance $\sigma^2_{j\zeta}$.

The logic of combining CFA and OIR is to build a joint distribution for a set of underlying variables, Y^*_{ij}, described by a mixture of linear and generalized linear models. The first 12 underlying variables are untransformed, whereas the underlying variable for *federal* and *borrowing* are assigned a logistic link function. Therefore, the values of the elements of Y_{ij} will be now determined by a 33x14 matrix Y^*_{ij} of latent variables and thresholds,

$$Y_{ij} = \begin{cases} Y^*_{ij} & \text{if variable } j \text{ is continuous;} \\ 1 & \text{if } Y^*_{ij} > \tau \text{ and variable } j \text{ is dichotomous;} \end{cases} \quad (3)$$

That is, in the continuous part of the model, the variables are tapping on the latent trait through equation 1, while in the item-response part, the dichotomous indicators included are tapping on the latent trait through equation 2.

Like in a standard factor analysis, the latent trait x_i is not observed, and the correlation between the different indicators across countries needs to be exploited to estimate the covariance matrix and within it β_j, $\sigma_{\varepsilon^2_j}$, and $\sigma_{\zeta^2_j}$. However, since the likelihood for the model is composed of a combination of latent constructs and factor (or item) parameters, changes in the latent trait can be offset by changes in the factor loadings, yet provide the same likelihood contributions. In order to overcome this lack of identification, and to rule out arbitrary shifts in location and scale in the latent variable, its distribution was constrained to have mean 0 and variance 1. This assumption does not have an impact in the validity or in the interpretation of the index as only relative performance is of interest and this performance does not have a particular scale. Then, after the distribution is constrained, α_j can be identified from the mean of the observed variables, and using the within country variation and the observed variables, x_i can be finally identified.

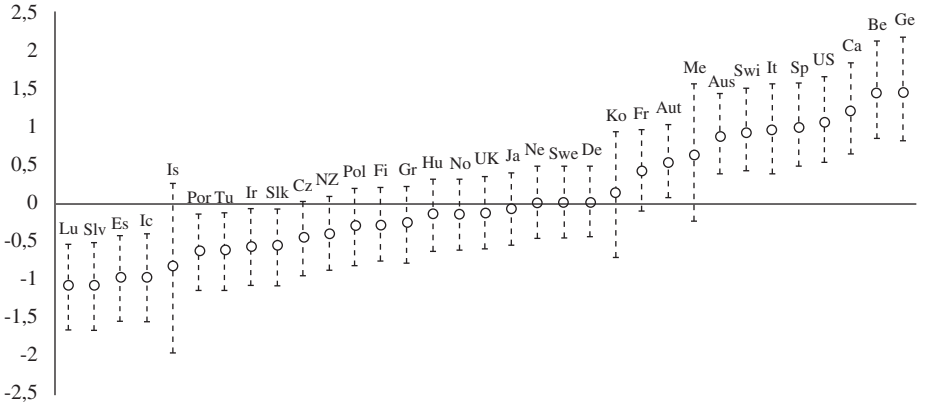
The estimation of the model was carried out using WinBUGS, a free Bayesian statistical package, developed by Lunn *et al* (2000), which implements the Gibbs sampler (a type of MCMC algorithm) to calculate the posterior distribution. Diffuse priors were used to generate the initial values and to ensure that inferences are drawn from the likelihood function only. In particular, estimations are taken from 7,000 iterations of the posterior distribution, after "burning-in" the first 3,000 iterations. Additional information on the set of priors used, graphical tests of convergence, and the WinBUGS syntax used to specify the model is included in Appendices 2 and 3.

RESULTS AND FURTHER COMPARISONS

All the factor loadings considered in the model are statistically significant, and point in the expected direction. The higher the value of each indicator, the higher the decentralisation score (see Appendix 4, where the mean standard deviations and 95% credible intervals for all the factor loadings are included). More interestingly, in Diagram 1 I present the decentralisation scores obtained for the 33 OECD countries analysed. Countries are ranked in increasing order of decentralization across the x-axis, with the y-axis capturing the number of standard deviations below or above the average country score. Circles show the locations of the means of the country scores and the horizontal lines represent the 95% credible intervals.

Diagram 1.

Point estimates and 95% credible intervals for the country scores*



*"Aus" stands for Australia, and "Aut" for Austria.

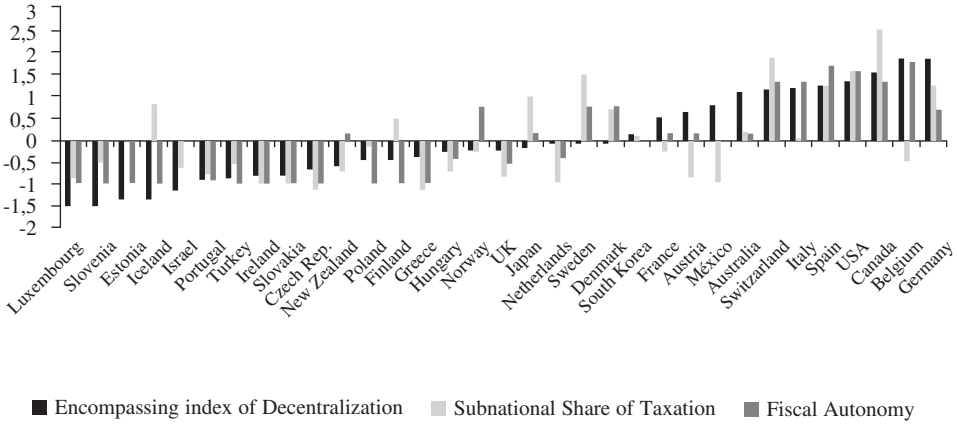
At first sight the order of countries according to this ranking seems reasonable. Federal countries as Germany, Belgium, Canada, and the US, occupy the top positions, whereas small unitary countries like Luxembourg, Slovenia, Estonia, or Iceland lie at the bottom. The credible intervals reflect, however, a considerable level of uncertainty in the estimation of the country scores, which makes some of the most similar countries statistically indistinguishable. This problem affects especially Israel, South Korea, and Mexico, countries for which many of the indicators used were missing (see Appendix 1).

Taking into account, the complexity of the concept studied and the model carried out —in which 101 parameters, including missing cases, need to be estimated using only 361 observations— the credible intervals are relatively narrow. After all, this type of model uncertainty is present in all latent variable models used to estimate unobserved concepts, although it is rarely reported when the model is estimated using frequentist statistics.

This is not, however, a problem to which proxy measures of decentralisation are prone to, suggesting a validity-reliability trade-off that could be used to defend the traditional choice of fiscal indicators —or any other particular proxy measure. However, the important limitations of fiscal indicators pointed out in Section 2.2 should suffice to deter researchers from that choice. To illustrate that point and the relevance of the more encompassing index of decentralization presented here I compare values from my index against *subnational share of taxation* and *fiscal autonomy*, a fiscal indicator and a qualitative index, respectively.

Diagram 2.

Values of decentralization using different measures*



*To facilitate comparisons the three measures of decentralization presented here have been standardised.

In Diagram 2 we can see how the levels of *subnational share of taxation* differ substantially from the index that I created, but also from *fiscal autonomy*, which underlines the incapacity of fiscal indicators to grasp the administrative autonomy dimension of decentralisation. In particular, the cases of Mexico, Italy, or Belgium stand out, as they show low levels of *subnational share of taxation* in spite of being undoubtedly decentralised countries. On the other hand, the Scandinavian countries (Norway, Sweden, and Denmark) show substantial level of regional *fiscal autonomy*, whereas when taking all other aspects of decentralization together they do not seem especially decentralised. In fact they lay around the mean levels of decentralization for the OECD sample of countries measured by the index presented here.

To further my argument regarding the perils of using proxies to measure decentralisation I replicate some of the exploratory analysis presented in De Mello and Barenstein (2001), in which the relationship between decentralisation using fiscal indicators and the level of government corruption was studied. To do that I compare scatter plots for the subnational share of taxation and the index presented here against three measures of corruption for the year 2012: the *International Country Risk Guide*, elaborated by the PRS group (used in De Mello and Barenstein, 2001); the *Corruption Perception Index*, elaborated by Transparency International; and the *Control of Corruption*, elaborated by the World Bank (these last two used in Freille *et al,* 2008).

Scatterplots in Diagram 3 include lines of best fit, which illustrate a positive relationship between *subnational share of expenditures* and the three measures of decentralisation, but also how that relationship is attenuated in each of the three cases when the more encompassing index of decentralisation presented here is used. In Table 1 below I also include the specific correlation coefficients with their associated p-values, showing that two

of the positive and statistically significant relationships between measures of corruption and *subnational share of taxation* are not significant anymore when the encompassing index of decentralisation is used.

Diagram 3.

Scatterplots for measures of decentralization and corruption

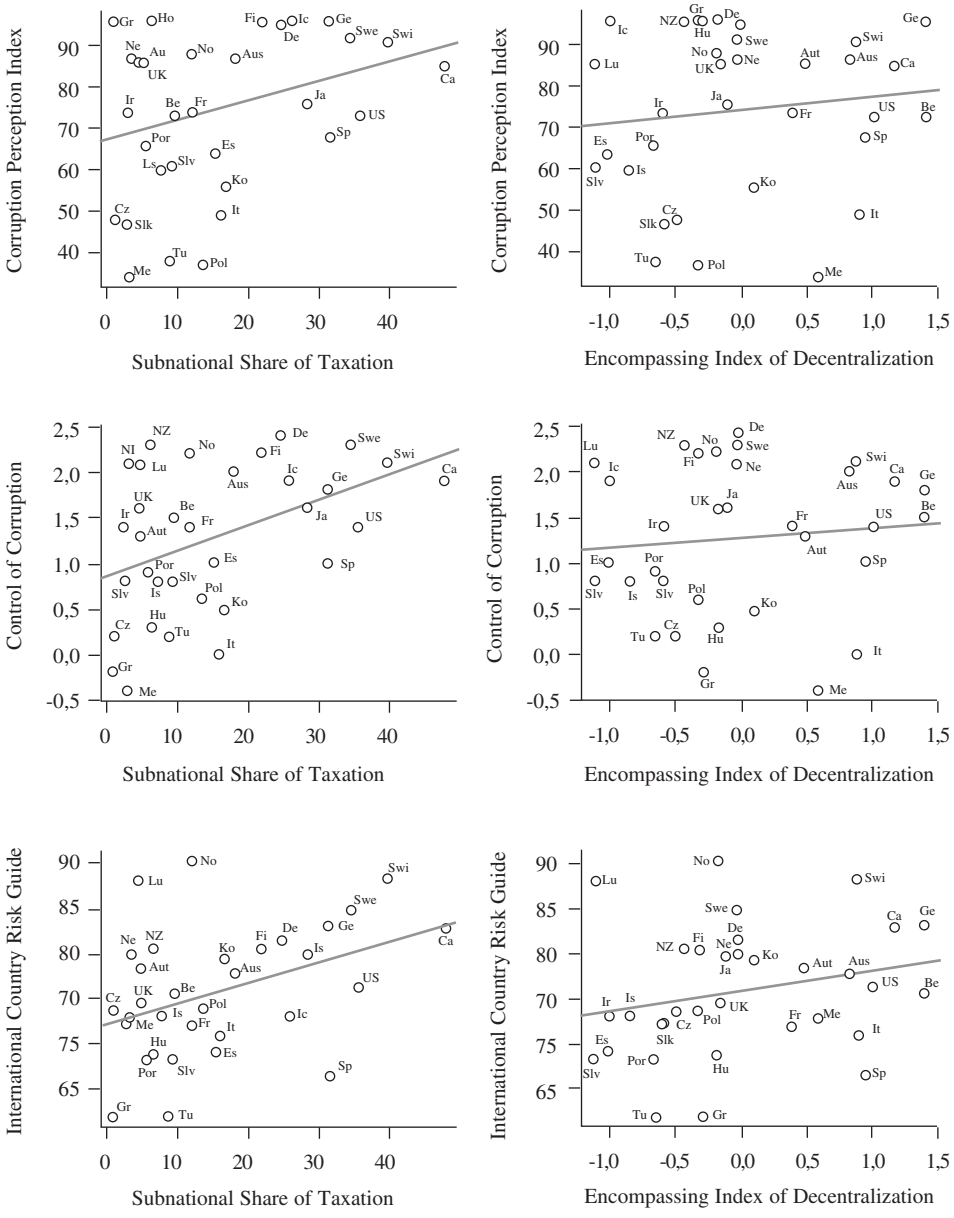


Table 1.
Correlations between measures of decentralization and corruption*

	Corruption perception	Control of corruption	Country risk
Subnational share of taxation	.31 (.08)	.44 (.01)	.41 (.02)
Index of decentralization	.12 (.5)	.1 (.59)	.24 (.17)

*p-values are reported within brackets.

Furthermore, for robustness sake I carried out additional comparisons using the *subnational share of expenditures* (see Appendix 5); finding the same types of attenuated correlations when the encompassing index of decentralisation is used.

DISCUSSION

The importance of measurement cannot be overlooked, it is the first stage in the process of scientific inference, it establishes the building blocks of any hypothesis to be announced or tested. However, in the Social Sciences, measurement is often a complex procedure. Here I have shown that this is especially true for the case of decentralization. In the introduction I reviewed some of the contradictory results found in the literature regarding the study of the effects of decentralization on corruption, arguing that this is partly due to the different measures that have been used to operationalize decentralization. In section 2 I revealed the main flaws of the most commonly used measures of decentralisation, namely their limitations to either restrict the measurement to a specific dimension of decentralization, or to rely on subjective scales prone to idiosyncratic errors. For the case of the ubiquitous fiscal indicators of decentralisation, I demonstrated empirically in Section 4 how they suffer from serious problems of validity. In particular, I showed how such problems can result in the generation of misleading rankings of decentralisation, or even point at spurious associations between decentralisation and corruption.

To advance the academic knowledge in the area of decentralisation we need better measures. In the spirit of Pemstein's *et al* Unified Democracy Scores (2010), I have proposed here the use of a framework where relevant and systematically created data available in the literature can be efficiently combined to form a more encompassing index of decentralisation. Specifically, I used a Bayesian factor analysis model for mixed ordinal and continuous responses, which can offer some interesting solutions to improve the way decentralization is measured. First, unlike standard factor analyses, the model presented here can be used flexibly and efficiently to combine any measures of decentralization available in the literature, regardless of the scale in which they are measured. Second, unlike indexes created by simple aggregation, the model presented here uses the internal correlation shared by the indicators included, which helps to identify the relative importance

of each indicator in the construction of the index, but also to eliminate any idiosyncratic errors affecting qualitative indicators elaborated by experts. Third, unlike similar models based on frequentist statistics, the model presented here can account for missing cases as it is estimated, which facilitates the use of measures of decentralisation that do not necessarily cover the same set of countries.

The index of decentralisation that I have elaborated shows an adequate level of content validity as it is made of 14 indicators tapping on the three dimensions of decentralisation identified by Schneider (2003): economic, administrative, and political. However, it could still be improved by the inclusion of new indicators. In this respect, Marks *et al.* have recently announced (In their Regional Authority Index website) updated values of their indicators for the year 2010 to be published in the next months; including a new item that captures borrowing capacity of subnational governments. Similarly, the index could benefit from the addition of indicators that help to account for political mobilisation and representation at the local level. For example, future enhancements of the index could include an indicator capturing whether local governments are elected through open list systems. The addition of such data would improve the validity of the index as it would underline aspects that are not very well covered at the moment, but it will also improve reliability, as it would allow using more data to inform the model.

Once the measurement of decentralisation is perfected, I believe that ensuing academic efforts should be directed at adding a temporal dimension to the index. This could be done through the inclusion of a longitudinal structure (years within countries) to the model that I present here. Much of the data is now available, fiscal indicators from the IMF and OECD and the Regional Authority Index can be traced back for some countries to the 1950s. Other indicators do not show the same coverage, but they could be included anyway as long as they provide relevant information, since missing data —at random— can be easily accounted for within the framework suggested here. The availability of truly encompassing and longitudinal data on decentralisation would allow using more sophisticated empirical analyses, such as time series or panel data analysis, which would help to disentangle many of the presently unresolved questions regarding the effect of decentralisation on different matters; amongst which corruption is only one of them.

APPENDIX 1: DATA

	Subnational Expenditure	Subnational Revenue	Subnational Taxation	Subnational Employment	Institutional Depth	Represent.	Law Making	Policy Scope	Fiscal Autonomy	Executive Control	Fiscal Control	Constitut. Reform	Federal	Borrowing	CPI	Control of Corruption	Country Risk	Index of Decentralis.
Australia	38	na	18.1	63.6	3	4	1.5	4	2	2	2	1	1	1	87	2	77.8	.83
Austria	31.1	24.7	4.7	42.5	3	4	1	3	2	1	1	3	1	1	86	1.3	78.3	.49
Belgium	36.7	16.9	9.5	57.1	5	7	2	4.8	4.8	2	2	1	1	1	73	1.5	75.5	1.4
Canada	66.5	55.2	48	63.8	3.8	5.1	0	4.8	4	1	1	3	1	1	85	1.9	82.8	1.17
Czech Rep.	26.9	18.5	1	na	2	4	0	1	0	0	0	0	0	1	48	0.2	73.6	-.49
Denmark	63.4	28.9	24.7	65	2	3	0	2	3	0	0	0	0	1	95	2.4	81.5	-.02
Estonia	24.6	15.4	15.4	34.4	0	0	0	0	0	0	0	0	0	1	64	1	69.2	-1.02
Finland	39.8	28.6	22	77.8	3	3.1	0	1	0	0	0	0	0	1	96	2.2	80.4	-.32
France	20.3	16.3	12.1	44	4	6	0	4	2	0	0	0	0	1	74	1.4	72	.39
Germany	37.4	34.5	31.4	87.7	5.5	8	2	3.9	2.9	2	2	3	1	1	96	1.8	83.1	1.41
Greece	5.6	2.6	0.8	25.6	3	5	0	2	0	0	0	0	0	1	96	-0.2	61.9	-.29
Hungary	25.4	9.3	6.4	48.1	3	4	0	2	1	0	0	0	0	1	96	0.3	68.8	-.18
Iceland	25.8	27.9	25.9	na	0	0	0	0	0	0	0	0	0	na	96	1.9	73.1	-1
Ireland	10.1	7.5	2.6	39.5	2	3	0	1	0	0	0	0	0	1	74	1.4	72.2	-.60
Israel	12.6	9.5	7.5	na	na	na	na	na	na	na	na	na	0	na	60	0.8	73.1	-.85
Italy	31	18.4	16.1	48.4	5	7	0	5	4	1	0.3	0.3	0	1	49	0	70.9	.91
Japan	30.1	na	28.4	63.1	2	4	0	2	2	0	0	0	0	1	76	1.6	79.8	-.12
Korea	45.7	16.5	16.7	55.2	na	na	na	na	na	na	na	na	0	1	56	0.5	79.3	.1
Luxembourg	11.4	6.8	4.5	na	0	0	0	0	0	0	0	0	0	na	86	2.1	88	-1.12

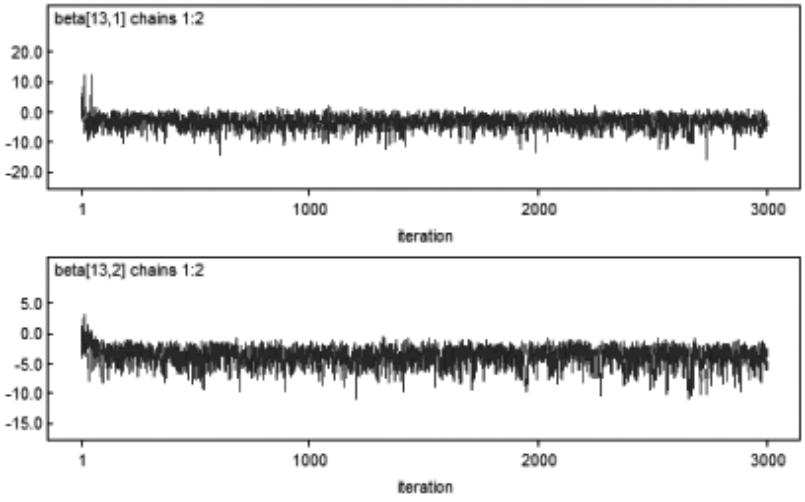
	Subnational Expenditure	Subnational Revenue	Subnational Taxation	Subnational Employment	Institutional Depth	Represent.	Law Making	Policy Scope	Fiscal Auto-nomy	Executive Control	Fiscal Control	Constitut. Reform	Federal	Borrowing	CPI	Control of Corruption	Country Risk	Index of Decentralis.
Mexico	46.7	9.7	3	na	na	na	na	na	na	na	na	na	1	1	34	-0.4	72.9	.6
Netherlands	33.3	10.5	3.3	24.8	2	3	1.5	2	1	0	2	3	0	1	87	2.1	79.8	-.04
New Zealand	11	na	6.3	49	1.9	3.8	0	1	2	0	0	0	0	na	96	2.3	80.5	-.43
Norway	33.4	13.8	11.9	38	2	3	0	2	3	0	0	0	0	1	88	2.2	90.2	-.18
Poland	32.7	17.9	13.5	63.6	2	4	0	2	0	0	0	0	0	0	37	0.6	73.7	-.33
Portugal	13.9	10	5.5	32.7	2.1	1.1	0	1	0.1	0	0	0	0	1	66	0.9	68.3	-.67
Slovakia	16	12.2	2.6	39.6	2	3	0	1	0	0	0	0	0	na	47	0.8	72.3	-.59
Slovenia	20.3	13.4	8.9	na	0	0	0	0	0	0	0	0	0	0	61	0.8	68.4	-1.12
Spain	48	34.2	31.4	60.5	4.5	6.3	1.3	3.8	4.6	0	1	0.8	1	1	68	1	66.5	.95
Sweden	47.7	36.8	34.6	56.7	2	3	0	2	3	0	0	0	0	1	92	2.3	84.7	-.04
Switzerland	56.1	47.3	39.8	54.4	3	4	1.5	4	4	1	1	1	1	1	91	2.1	88.2	.89
Turkey	9.9	na	8.7	29.4	2	2	0	1	0	0	0	0	0	na	38	0.2	61.9	-.66
UK	27.3	9.5	4.8	63.5	2.9	3.3	0.1	2.1	0.8	0.1	0	0.3	0	1	86	1.6	74.4	-.16
USA	46.5	46	35.7	72.5	3.8	5.6	1.5	3.8	4.4	1	0	3	1	1	73	1.4	76.2	1.01

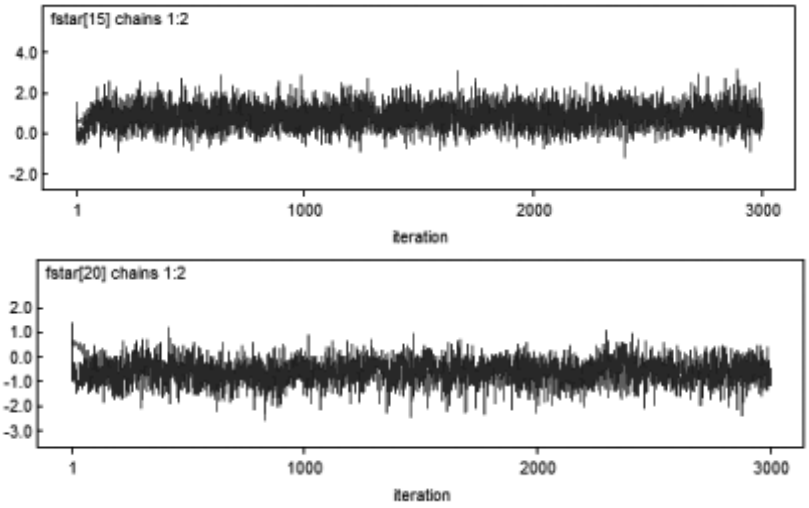
APPENDIX 2: PRIORS AND CONVERGENCE

Every parameter in the model was assigned diffuse priors. This way, I put no a priori restrictions on the values that the parameters can or are likely to take, and their identification relies on the data through the likelihood function. As explained in the Model Section, in order to make the model identifiable the latent variable was constrained to be distributed as a N(0,1). In addition, as Jackman (2004) points out, this limitation of the latent traits to have a standard deviation of one suggests that the likely values of the factor loadings will not be massive; therefore I can express the prior uncertainty over the α and β parameters with independent $N(0,10^2)$ priors. Following Jackman (2004), I also employ diffuse, independent, inverse-Gamma priors on the parameters of precision, $1/\sigma^2_j$, which are approximately uniform over the plausible range of values for these parameters.

In the estimation of the posterior distribution, as the number of iterations grows larger, the likelihood function gains weight at the expense of the prior distributions. In order to eliminate early values that were mainly generated after draws from the prior distributions, the first 3,000 MCMC iterations were discarded. In fact we can detect the MCMC algorithm reaching convergence before that figure. Diagram A1 below depicts two chains simultaneously run for a sample of the most complicated parameters to estimate in our model: the country values of Israel and Mexico (two of the countries with a higher prevalence of missing values), and the coefficients for the indicator *federal*, β_{13} and α_{13x}. The four parameters have a rather erratic beginning due to the choice of non-informative priors, but they all seem to have reach convergence even before running 300 iterations.

Diagram A1.
Convergence trace-plots





APPENDIX 3: WINBUGS SYNTAX

```
model{
## Likelihood
 for (i in 1:33) { #index countries
   for (j in 1:12) { #index continuous indicators
     mu[i,j] <- beta[j,1]+beta[j,2]*fstar[i]
     x[i,j] ~ dnorm(mu[i,j],psi[j])
   }
   for (j in 13:14) { #index binary indicator
     logit(p[i,j]) <- fstar[i]*beta[j,1]-beta[j,2]
     x[i,j] ~ dbern(p[i,j])
   }
  }
## Priors on countries
  for(i in 1:33){
    fstar[i] ~ dnorm(0,1)
  }
## Priors on indicators
  for (j in 1:12) { #index continuous indicators
    beta[j,1:2] ~ dmnorm(g0[1:2],G0[1:2,1:2])
    psi[j] ~ dgamma(.05,.05)
  }
  for (j in 13:14) { #index binary indicators
    beta[j,1:2] ~ dmnorm(b0[1:2],B0[1:2,1:2])
  }
```

```
## Hyperparameters
   g0[1] <- 0
   g0[2] <- 0
   G0[1,1] <- .0000001
   G0[2,2] <- .0000001
   G0[1,2] <- 0
   G0[2,1] <- 0
   b0[1] <- 0 b0[2] <- 0
   B0[1,1] <- .04 B0[2,2] <- .04
   B0[1,2] <- 0 B0[2,1] <- 0
}
```

APPENDIX 4: FACTOR LOADINGS

	Mean	**Std. dev.**	**95% CI**
Subnational expenditure	13.02	3.77	(6.34, 21.11)
Subnational revenue	9.64	3.37	(3.35, 16.8)
Subnational taxation	8.27	3.16	(2.47, 14.91)
Subnational employment	.63	.18	(.32, 1.02)
Institutional depth	12.13	4.68	(3.76, 22.05)
Representation	1.66	.35	(1.09, 2.43)
Law making	1.91	.36	(1.34, 2.72)
Policy scope	1.88	.4	(1.22, 2.77)
Fiscal autonomy	.67	.16	(.4, 1.02)
Executive control	2.33	.50	(1.49, 3.47)
Fiscal control	.65	.17	(.35, 1.04)
Constitutional reform	.93	.28	(.44, 1.53)
Federal	3.22	1.92	(.14, 7.62)
Borrowing	5.61	2.17	(2.35, 10.85)

APPENDIX 5: CORRELATIONS

	Corruption perception	Control of corruption	Country risk
Subnational share of expenditure	.16 (.38)	.32 (.07)	.49 (.004)
Index of decentralisation	.12 (.45)	.1 (.59)	.24 (.17)

*p-values are reported within brackets.

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