UNIVERSITAT
ROVIRA I VIRGILI
DEPARTAMENT D'ECONOMIA

(creip)
CENTRE DE RECERCA EN ECONOMIA
INDUSTRIAL I ECONOMIA PÚBLICA

WORKING PAPERS

Col·lecció "DOCUMENTS DE TREBALL DEL DEPARTAMENT D'ECONOMIA - CREIP"

Decentralization and the Quality of Public Services: Cross-Country Evidence from Educational Data

Luis Diaz-Serrano
Enric Meix-Llop

Document de treball n.26 - 2018

DEPARTAMENT D'ECONOMIA – CREIP
Facultat d'Economia i Empresa

UNIVERSITAT ROVIRA I VIRGILI

DEPARTAMENT D'ECONOMIA

Edita:

Departament d'Economia
https://gandalf.fee.urv.cat/departaments/economia/web
Universitat Rovira i Virgili
Facultat d'Economia i Empresa
Av. de la Universitat, 1
43204 Reus
Tel.: +34 977 759 811
Fax: +34 977 758 907
Email: sde@urv.cat

CREIP
www.urv.cat/creip
Universitat Rovira i Virgili
Departament d'Economia
Av. de la Universitat, 1
43204 Reus
Tel.: +34 977 758 936
Email: creip@urv.cat

Adreçar comentaris al Departament d'Economia / CREIP

ISSN edició en paper: 1576 - 3382
ISSN edició electrònica: 1988 - 0820

DEPARTAMENT D'ECONOMIA – CREIP
Facultat d'Economia i Empresa

Decentralization and the Quality of Public Services: Cross-Country Evidence from Educational Data

Luis Diaz-Serrano[♣]
CREIP - Universitat Rovira i Virgili

EnricMeix-Llop
CREIP – Universitat Rovira i Virgili

Abstract

In this paper, we study the impact of fiscal and political decentralization on the quality of public service delivery. While the effect of fiscal decentralization on public services is a recursive theme, to the best of our knowledge, our study is the first to investigate the impact of political decentralization. We use educational data as a proxy for the quality of public services. We use microdata from the PISA test scores from 22 countries and test for the impact of fiscal and political decentralization on students' performance. We use not only general measures of decentralization but, for the first time, also education-specific decentralization measures. Our results indicate that the impact of fiscal decentralization on school outcomes is positive. However, the results regarding political decentralization are more ambiguous. We also observe that the scalar effect of both political and economic decentralization becomes more evident in large cities.

Keywords: Public services, School outcomes, PISA, fiscal decentralization, political decentralization

[♣]Corresponding author: Luis Diaz-Serrano, CREIP - Universitat Rovira i Virgili, Departament d'Economia, Av. de la Universitat 1, 43204 Reus (Spain). Tel: (+34) 977759811 Email: luis.diaz@urv.cat.

Acknowledgements: The authors acknowledge the financial support from the Recercaixa research program, granted by the Obra Social "La Caixa" (grant # 2014ACUP0130) and from the Spanish Ministry of Economy and Competitiveness (grant # ECO2014-59055-R).

1. Introduction

In recent decades, a tendency towards decentralization in many developed and developing countries has arisen. Indeed, nowadays, the global population residing in countries under some level of decentralization outnumbers the population in totally centralized countries. This circumstance means that, in public economics, the relationship between universal public service provision and decentralization is a recurring issue. Despite its relevance, from an empirical point of view, this link is undoubtedly underresearched. We empirically analyze the impact of fiscal decentralization and, for the first time, political decentralization on students' achievement for a group of OECD countries. In this paper, for the first time, we also use education-specific decentralization measures in addition to the general decentralization measures commonly used in the literature. Our results using the general measures of decentralization indicate that, in more fiscally decentralized countries, students perform better, while the impact of political decentralization on student performance is statistically significant and negative. However, the results using the education-specific measures of decentralization suggest that both fiscal and political decentralization exert a positive impact on school outcomes. We also observe that the scalar effect of both political and economic decentralization becomes more evident in large cities.

Practically all the previous studies devoted to analyzing the effects of decentralization on many economic and non-economic outcomes focus on fiscal decentralization, while studies analyzing the role of political decentralization are much less abundant. In addition, most of the existing studies analyze the impact of decentralization on a variety of economic outcomes, such as economic growth (Davoodi and Zou, 1998; Iimi, 2005; Rodríguez-Pose and Ezcurra, 2010), income inequality and the redistribution of wealth (Qian and Weingast, 1997; Ezcurra and Pascual, 2008; Lessman, 2009; Sepulveda and Martinez-Vazquez, 2011). Although economic growth or the reduction of poverty are desirable side effects, we think that these studies lose sight of the fact that the main objective of decentralization is not economic growth or the redistribution of income but

better provision of public services to citizens. After all, the decentralization theorem (Oates, 1972, 1999) is about delivering services closer to the people because of the informational advantages of local governments with respect to the economic or social characteristics of regions. Therefore, the analysis of the impact of decentralization on efficiency in the provision of public services should receive more attention. In this context, the three pillars of the welfare state—education, health and social protection—should be at the core of the analyses. We would expect these public services to be affected by decentralization processes.

There is a growing interest in studying the non-economic dimension of decentralization. Thus, some recent studies link decentralization with subjective well-being (Frey and Stutzer, 2000; Bjørnskov et al., 2008; Diaz-Serrano and Rodríguez-Pose, 2012) or satisfaction with public services (Diaz-Serrano and Rodríguez-Pose, 2014; Filippetti and Cerulli, 2017). We consider these studies to be better targeted at analyzing the impact of decentralization on the citizenry. These studies rely on subjective measures, but we think that the use of objective measures over subjective ones such as satisfaction should be a priority. However, one of the main problems with this type of empirical analysis is that it is very difficult to measure objectively the quality of public services. Like Barankay and Lockwood (2007) and Falch and Fischer (2012), in this study we use student performance as a suitable proxy for the efficiency and quality of the delivery of education. According to the decentralization theorem, fiscal and political decentralization should promote more efficient provision of education, which one would expect to be translated into better student performance. In addition, following Barankay and Lockwood (2007), we use education-specific measures of both political and fiscal decentralization. Considering the previous literature, we are the first to analyze the link between educational outcomes and political decentralization. In this regard, our study fills some of the gaps left by the previous literature.

With the objectives described above, the paper is structured as follows. Section 2 provides the conceptual framework of the study and an overview of the previous empirical literature. In Section 3, we present the empirical framework. Section 5 reports and discusses the econometric results. Finally, Section 6 contains the conclusions.

2. Decentralization and Education: Theory and Evidence

2.1. Conceptual Framework

According to public choice theorists, the reasons why governments decide to initiate decentralization processes around education do not differ from the reasons to decentralize other public services, such as health or social protection. These include seeking improvements in efficiency and financing and redistributing power to more local decision-making bodies with better knowledge of educational needs. That is, geographical closeness of the public institutions to the local population (final beneficiaries) can improve the public service outcomes (Oates, 1972; Barankay and Lockwood, 2007; Bénassy-Quéré et al., 2007; Kappeler and Valila, 2008). The efficiency goal is advocated on the basis that a centralized system is often characterized as having a heavy and slow bureaucratic burden. By decentralizing decisions, implementation is accelerated and at the same time better information becomes available to operate (McGinn and Welsh, 1999). The efficient allocation of resources by sub-national governments allows better adjustment of the allocation in education as opposed to large national budgets, which are not always allocated efficiently. On the other hand, the redistribution of decision making is seen as a way to include the less weighted groups, providing better facilities to attend to their needs.

Political decentralization is conceptually similar to fiscal decentralization. While fiscal decentralization transfers to subnational governments the full/partial competence in a number of the economic aspects, mainly budgetary, of a specific public service, political decentralization acts in the same way but in the policy area. This implies that the benefits or damage caused by political decentralization could emanate from the same causes as

in the case of fiscal decentralization. The benefits of fiscal decentralization in many outcomes of the public sphere, among them education, are well documented. However, very little is known about the impact of political decentralization.[1] More importantly, it is relevant to know how the fiscal and political dimensions of decentralization interact, since, contrary to what one might expect, not all of the most fiscally decentralized countries are the most politically decentralized and vice versa (see Figure 1).[2] In Figure 2, we present the relationship between fiscal and political decentralization in education. Political decentralization is proxied by the percentage of decisions not taken by the central government, while fiscal decentralization is proxied by the percentage of funds not provided by the central government. As in the cases of general fiscal and political decentralization, the relation is positive for education.[3]

[Figure 1 around here]

[Figure 2 around here]

A good balance in the optimal level of political and fiscal decentralization is not always achieved. For instance, Kyriacou and Roca (2011) find that fiscal decentralization improves government quality but not if it is accompanied by political decentralization. However, this negative impact of decentralization disappears after controlling for the extent of experience with statehood or public administration. This result is contrary to what is observed in the previous empirical literature analyzing the impact of fiscal decentralization on educational outcomes. In this sense, while empirical analyses

[1] Kyriacou and Roca (2011) are an exception. These authors also offer an extensive overview of the literature analyzing the impact of political decentralization and its interaction with fiscal decentralization on government quality.

[2] The political decentralization data come from the Regional Authority Index in Marks et al. (2008). This is a well-known data set that is commonly used in studies addressing political decentralization (239 references in Google Scholar). A more detailed description of our political decentralization index is given in sub-section 4.2. As shown in Figure 1, in these data, the score for Italy and France is 16, while that for Switzerland is 15. It is somewhat surprising that Italy and France exhibit a higher level of political decentralization than Switzerland. However, we have undertaken corresponding checks and the data that we use in this paper coincide with the original data. This result might indicate, from a political point of view, that France and Italy are more decentralized than one might expect or that Switzerland is not as politically decentralized as one might expect. A detailed description of our political decentralization index is offered in sub-section 4.2. These data are available from: http://www.arjanschakel.nl/data/RAI_country_scores_2009.xls. The data on fiscal decentralization come from the World Bank.

[3] The decentralization data on the specific field of education are taken from the OECD (2001, 2003, 2007 and 2009).

provide an unambiguously positive link between fiscal decentralization and educational outcomes, the direction of the effect of political decentralization is more uncertain. As Kyriacou and Roca (2011) point out, decision-making decentralization makes it more difficult to assign accountability between national and subnational government levels in fiscally decentralized settings.[4] This circumstance might cause political decentralization not to exert a positive impact if the level of fiscal decentralization is not high enough.

2.2. Empirical Evidence on the Link between Fiscal Decentralization and Educational Outcomes

Recent literature analyzing the impact of fiscal decentralization on the public expenditure on certain public services finds that, in the specific case of education, fiscal decentralization boosts public expenditure (Busemeyer, 2008; Pal and Wahhaj, 2017). However, more decentralized expenditure on education does not necessarily translate into better functioning of the education system if the educational policies designed at the subnational level are not appropriate or the budget is not managed efficiently. For instance, Adam et al. (2014) analyze the impact of fiscal decentralization on public sector efficiency. They use data from 21 OECD countries and find an inverted U-shaped relationship between government efficiency in providing health and educational services and fiscal decentralization. Diaz-Serrano and Rodríguez-Pose (2014) and Filippetti and Cerulli (2017) analyze the impact of political decentralization on the delivery of public services. Diaz-Serrano and Rodríguez-Pose (2014) use survey data on satisfaction with the education and health system, while Filippetti and Cerulli (2017) also rely on survey data regarding the perceived quality of public services. Regarding education, the first find a negative impact while the second find a U-shaped effect, that is, negative but not linearly decreasing.

[4] Gerring and Thacker (2004) and Fan et al. (2009) argue that the existence of multiple levels of decision-making authority makes it more difficult to assign accountability to any particular level.

Given the difficulty involved in constructing objective measures of the quality of public services, the literature analyzing the impact of decentralization on the quality of public services is not very abundant, though educational data are an exception. Like this paper, the few studies analyzing this issue resort to educational data, since data sets collecting information on students' achievement, school dropout rates and enrollment are plentiful. All the studies that address this issue using educational indicators find an unequivocal positive link between fiscal decentralization and school performance.

Using data from Swiss cantons, Barankay and Lockwood (2007) study the impact of fiscal decentralization on the 19-year-old population obtaining university entry qualifications at the county level. They observe that the relationship is positive. Using students' performance in the Scholastic Aptitude Test (SAT) and American College Testing (ACT), Akai (2007) carry out the same analysis for the US and find that the effect of fiscal decentralization is not clear at primary levels but positive at secondary levels. Using data covering over 95% of Colombian municipalities, Faguet and Sanchez (2014) show that decentralization improves the enrollment rates in public schools and the access of the poor to public health services. Falch and Fischer (2012) are the first to test the effect of fiscal decentralization on students' performance using cross-country data. They use aggregated test math scores at the country level from different sources (SIMSS, SISS, TIMSS and PISA) for 23 OECD countries and build a discontinuous panel.[5] They find that decentralization of government expenditure has a positive impact on students' performance.[6] Ferrari and Zanardi (2014) show that the potential impact of political reforms oriented towards decentralization in Italy may affect the degree of interregional redistribution accomplished by the education system. Despite this unequivocal positive link between fiscal decentralization and school performance, nothing can be said

[5] These authors use scores from the SIMS and SISS tests conducted by the International Association for the Evaluation of Educational Achievement (IEA) in 1980–1981 and 1983–1985, respectively. The IAE test in 1990–1991, the IEA's TIMSS tests in 1994–1995 and 1998–1999 and the OECD PISA test in 2000 are also utilized.

[6] Schütz et al. (2008) also use TIMSS individual data to test how equality is related to the organizational features of the education system. They find that equality of opportunity is positively related to late tracking into different school types and to longer pre-school education.

regarding the impact of political decentralization, since this issue remains unexplored. To the best of our knowledge, this is the first study to analyze the impact of political decentralization on school performance.

3. Empirical framework

Models on the determinants of academic achievement are generally represented by an educational production function (hereafter, EPF). This function is used in the empirical analyses as a way to understand the production processes by estimating the effects of various inputs on academic performance (Hanushek, 1972, 1979). Generally, these inputs include information regarding students' background (individual and family characteristics) and school characteristics. The usual EPF can be represented by the following linear relationship:

$$A_{is} = \alpha + \beta X_{is} + \gamma Z_s + \varepsilon_{is}, \quad (1)$$

where A_{is} is the academic achievement for student *i* studying at school *s*; X_{is} contains the variables that characterize the student; Z_s is a set of school characteristics, which are equal for all students attending the same school; ε_{is} is a random error term; and α, β, γ are the set of parameters to be estimated. Since our data set consists of a pool of cross-sections regarding different countries and periods, we expand equation (1) as follows:

$$A_{isct} = \alpha + \beta X_{isct} + \gamma Z_{sct} + \mu Y_{ct} + \lambda_c + \delta_t + \varepsilon_{istc}, \quad (2)$$

where Y_{ct} is a set of country characteristics including our variables of interest, specifically political or fiscal decentralization; δ_t are year fixed effects; and λ_c are country fixed effects. Time effects are included as dummy variables and are considered to control for any unobserved temporary shock that can alter the response variable and is not picked up by any of the other variables. On the other hand, λ_c are considered to

control for unobserved heterogeneity across countries. Furthermore, the inclusion of λ_c , jointly with the other country-specific variables, is necessary to identify the effects of our variables of interest (fiscal and political decentralization), which are also country specific and vary through time.

Initially, the estimation method selected to estimate equation (2) is the OLS fixed-effect model, in which the temporary effects, δ_t , are introduced as dummy variables for each year. Country fixed effects, λ_c , are considered to control for unobserved heterogeneity across countries. If unobserved heterogeneity (each country has its own specific characteristics that we do not observe that might influence the outcomes) is correlated with the covariates, then the fixed-effect model provides unbiased estimates. Given that our data are grouped into schools and countries, we also consider a multilevel model as a robustness check. In addition, given the potential endogeneity of our decentralization measures, we estimate equation (2) using the instrumental variable estimator (IV). This endogeneity may appear because of the existence of time-varying unobserved heterogeneity not captured by the country fixed effects. That is, there might be unobserved factors affecting both the propensity of a country to decentralize and the educational outcomes of its students.

4. Data and variables

4..1. Dependent variables

Our dependent variable is students' scores in mathematics, reading and science from the Programme for International Student Assessment (PISA), which is an internationally standardized study that provides academic results in the areas of mathematics, science and reading.[7] When this study was conducted, there were 4 available waves conducted in

[7] In the PISA database, students' scores are presented in the form of five plausible values for each subject. The plausible values are students' imputed values, which are similar to the individual test scores and have approximately the same distribution as the measured latent feature. They were developed to obtain consistent estimates of population characteristics in assessing situations in which there are insufficient resources to make an accurate estimate of their abilities.

a total of 43 countries in 2000, 41 countries in 2003, 57 countries in 2006 and 65 countries in 2009. To allow for enough time variation in our variables, we restrict our analysis to the 22 countries that participated in the 4 waves of PISA. In Table 1, we present a summary of the outcome variables. The test scores in math, science and reading report a similar average and standard deviation, and all of them are negatively skewed and leptokurtic (a high concentration of values at the top of the distribution).

4.2. Explanatory variables

4.2.1. Individual and school characteristics

The PISA data also contain information regarding the school as well as the student and his or her family environment. The student and household characteristics considered in this study are gender, age, effort (weekly hours of study), the birthplace of the student and his or her parents, the number of books at home and the educational level of the father and mother.[8] The school characteristics are the city size, the type of school (public, private school independent of government and government-dependent private school) and the ratio between the number of students and the number of teachers.

As we report in Table 1, 49% of the members of our sample are female students and the mean age is 15.78 years. Around 7% of the students were born in a country different from that in which they conducted the PISA evaluation, and 15% of the sample had parents born in a foreign country. Regarding the number of books that they own at home, around 30% of the students declared that they had between 11 and 50 books. The mean level of parents' education is upper-secondary education (nearly post-secondary, non-tertiary education). One-third of the students attend education in schools located in medium-sized towns (15,000 to 100,000 inhabitants), and the school size/teacher ratio is around 12.4%. The share of public schools is almost 83%, while 14.2% are private but government dependent and only 2% are fully private schools.

[8] This level is measured using the International Standard Classification of Education, which refers to the standardized classification of the different educational levels established by UNESCO, allowing comparison between countries.

4.2.2. General political and fiscal decentralization

The general decentralization data are divided into political and fiscal decentralization. The political decentralization indices are taken from the Regional Authority Index (RAI) provided by Marks et al. (2008). These data cover 42 countries over the period 1950–2006. As a measure of political decentralization, we use an aggregated index called self-rule (SR), which is a measure of the authority exercised by subnational governments over their own citizens. This index is the aggregation of four indices picking up the level of political autonomy in specific domains. The first is institutional depth (ID), which measures the extent to which a regional government is autonomous rather than deconcentrated. The second, policy scope (PS), captures the range of policies for which a regional government is responsible, for example education, welfare state policies, immigration or citizenship. The third is representation (RP), which measures the extent to which a region is endowed with an independent legislature and executive body. Finally, fiscal autonomy (FA) refers to the capacity of a regional government to tax its own population on an independent basis. These four indices are ordinal variables that range from 0 to 3, 0 to 4 or 0 to 5, depending on the index. The SR indicator is computed as SR=ID+PS+FA+RP.

In the empirical literature, we can also find other measures of political decentralization. Some of the most relevant are those by Lane and Ersson (1999), Lijphart (1999), Woldendorp et al. (2000), Treisman (2002), Arzaghi and Henderson (2005) and Brancati (2006). Compared with these indices, the main limitation of the RAI is that it does not include local governance and the treatment of federal vs. non-federal countries. However, one of the most interesting features of the RAI is that it considers more dimensions than the other indices, thus capturing greater variation. The latter is the main reason for our decision to use the RAI over the other indices. However, it is worth

noting that, in a validation study, Schakel (2008) finds a great amount of agreement between the RAI and the other indices cited above, around 75%.[9]

In Table A1 in the annex, we briefly describe how these ordinal indicators of political decentralization are constructed.[10] For instance, in the case of the ordinal indicator policy scope (PS), the value of the indicator increases as the number of policy competences increases. The PS index ranges from 0 for countries where regions do not have authoritative competencies over economic policy, cultural–educational policy and welfare state policy; 1 or 2 for countries where regions have authoritative competencies in one, two or more of the previous areas, respectively; 3 if regions have more than two authoritative competences in the previous areas plus other residual powers, such as police, authority over their own institutional set-up and local government; or 4, the highest value in the scale, corresponding to countries where, in addition to the authoritative competences reflected by 1, 2 and 3, regions also may decide on immigration and citizenship. The remainder of the political decentralization indices in the other three domains (ID, FA and RP) are constructed analogously.

The fiscal decentralization variables consist of yearly indicators calculated as the share of subnational expenditure (revenue) in the national expenditure (revenue) covering the period 1972–2005. The source of these variables is the Government Finance Statistics of the International Monetary Fund. We have to mention that these measures of fiscal and political decentralization are not specific to education. Figure 1 shows the levels of fiscal and political decentralization for the countries in our sample. The sample averages of the general decentralization variables (Table 1) reveal that the highest level of fiscal decentralization occurs in current expenditures, since sub-national governments spend

[9] The RAI is a widely used index in studies dealing with political decentralization. A quick look at the literature provides more than 80 references in peer-refereed journals, most of them being very recent. Some examples are Diaz-Serrano and Rodriguez-Pose (2012, 2014), Ezcurra and Rodriguez-Pose (2013), Cowell et al. (2017), Ercolano et al. (2017) and Sachi and Salotti (2017). Recently, the RAI has also become the index of reference for the OECD in many studies on decentralization (OECD, 2013, 2014, 2016a, 2016b).
[10] See Marks et al. (2008) for a detailed description of the political decentralization indexes.

more than 60% of the overall current expenditures. However, the subnational levels of total expenditures and revenues are fairly low, 35% and 36%, respectively.

4.2.3. Fiscal and political decentralization in education

To allow a better understanding of how decentralization may affect the education system, we also use specific measures of decentralization in the area of education. To capture the two dimensions of decentralization, economic and political, we use two variables. Economic (fiscal) decentralization is proxied as the percentage of funds for lower-secondary and primary education provided by other subnational administrative territorial entities. This measure captures the expenditure dimension of economic decentralization in education. Analogously, the variable regarding political decentralization in education is proxied as the percentage of decisions taken by other administrative territorial entities at the subnational level. For this variable, we run separate regressions for the decisions taken at any level below the central government and above the local government (regional). These data come from the OECD (2003, 2004, 2007, 2009, 2011). In Figure 2, we present the levels of fiscal and political decentralization in education for the countries in our sample. The sample averages (Table 1) show that the level of economic decentralization in education is significantly lower than the level of political decentralization. The percentage of non-centralized funds in education is 62%, whereas the level of decentralized decisions in education is very high, 83%.

[Table 1 around here]

To identify the effect of fiscal and political decentralization on student performance, in addition to the country fixed effects, we include the GDP per capita at constant 2000 prices and the total public expenditure on education as the percentage of the GDP as a country-level variable.

4.2.4. Matching the data

To test the impact of decentralization on academic achievement, we matched the PISA data with the decentralization data. All the students surveyed within the scope of PISA data collection and residing in the same country are assigned the same value for the corresponding decentralization indicator. Institutional changes do not have immediate effects on the education system and the level of human capital of the population. Therefore, in this matching, we take into consideration not only the spatial dimension but also the appropriate time horizon. For the general decentralization measures, we assign to each country the average of the last 10 years of the decentralization index prior to each PISA wave. By doing so, we smooth our decentralization measures, which will thus pick up the long-term effect of decentralization to a greater extent. As the decentralization indices cover the period 1965–2006, for the PISA wave of 2009, we assign the average of the last seven available years before 2009 (2000–2006).[11] Our decentralization data cover fewer countries than the PISA database; therefore, our final sample is composed of 22 countries. However, for the education-specific measures, we cannot proceed in this way, since these measures are only available for a very limited number of years. Therefore, the corresponding decentralization measures in education correspond to the same year of the corresponding or closest PISA wave.

5. Econometric results

5.1. Multilevel and OLS fixed-effect estimation

For the sake of brevity, we focus only on the results regarding the impact of our key explanatory variables, namely fiscal and political decentralization, which are presented in Table 2.[12] We report the estimated coefficients and their corresponding standard errors. It is worth noting that the multilevel and OLS models provide practically identical results in all the areas of the PISA tests: maths, science and reading.

[11] We admit that this measure for 2009 can be slightly biased compared with the decentralization measures for 2000, 2003 and 2006. However, as the time horizon for each PISA wave will be different, this should be enough to pick up potential differences in the decentralization level between 2006 and 2009.
[12] As in many other studies using PISA data, the individual characteristics behave according to expectations.

In all the specifications, our indicator of general political decentralization (self-rule) is statistically significant and negative. In all the cases, we observe similar magnitudes in the effect. The results regarding general fiscal decentralization are a little puzzling. The subnational total expenditure is statistically significant in all the specifications. However, the estimated impact is positive for math test scores but negative for science and reading test scores. On the contrary, the estimated effects of the subnational current expenditure and subnational revenue exert an unambiguous statistically significant and positive impact on students' achievement in all the cases. In Table 2, we also report the results regarding our estimates using the specific measures of decentralization in education. In this case, the results are more homogeneous across the board, and both political and economic decentralization in education show a statistically significant and positive effect.

From the multilevel and OLS models, we can reach the general conclusion that political decentralization provides a mixed impact on students' outcomes depending on whether we consider a general or an education-specific measure of decentralization. In contrast, the effect exerted by fiscal decentralization is generally positive, with the exception of subnational total expenditure for science and reading scores, for both general and education-specific measures of decentralization. However, these results should be taken with caution, as our decentralization variables are likely to be endogenous. It is possible that unobserved factors affecting students' achievement in a given country and not picked up by the country fixed effects may also determine the propensity of this country to decentralize. This may generate inconsistent estimates of the parameters associated with our explanatory variables of interest. To address this problem, we resort to the instrumental variable (IV) estimator, which is explained in more detail in the next subsection. As the IV estimation method provides a more appropriate framework for the analysis, we focus our comments regarding the size of the impact of decentralization on the estimated coefficients with the model using IVs.

[Table 2 around here]

5.2. Instrumental variable estimation

Any estimation that relies on IVs is always interesting, since it requires the challenging, but not always fruitful, exercise of finding suitable instruments. In our case, to find suitable instruments, we follow Arzaghi and Henderson (2005). These authors disentangle the underlying factors leading sub-national governments to demand regional decentralization and federalism. They find that the move to decentralization increases with the national income growth, the relative sub-national population, the ideology of the government, the country size and the degree of democratization. Therefore, we try to find our instruments from this list of variables. The idea behind this choice is that some of these variables promoting decentralization are correlated with our decentralization key variables but not necessarily with students' academic outcomes.[13] More specifically, we consider as potential instruments the logarithm of population, the logarithm of population density, the logarithm of a country's land area, the percentage of a country's population living in the largest urban area and the percentage of a country's population living in urban areas.

The land area of the country represents the degree of spatial dispersion, from central public services to sub-national regions. Urban concentration, measured as population density, the urban population and the largest urban area, represents the relative degree of economic and population concentration. Table 3 contains the correlations between the potential instruments and the decentralization measures. All the correlations are

[13] The use of IV estimation is common in the study of the link between economic growth and fiscal decentralization. These studies resort to country panel data and tend to use lagged values of the decentralization variables as instruments (e.g. Iimi, 2005). However, given that our data are a pool of annual microdata, we cannot use these instruments. In the context of country panel data, Ligthart and van Oudheusden (2017) revisit the link between economic growth and fiscal decentralization using new instruments based on the distance between countries regarding the main cities in each country, the origin of the legal system and the relative country size. They find a positive relationship between fiscal decentralization and economic growth.

statistically significant at the 1% level of significance. Indeed, some correlations are quite high, above 0.6 in absolute values.

In Table 2, we report the results of the IV estimation for our variables of interest. The instruments used in each specification are at the bottom of the table. To allow for the implementation of statistical tests of the suitability of the chosen instruments, we instrument each decentralization variable with two instruments. In all the models, we do not reject the null hypothesis of endogeneity, which strengthens the adoption of the IV approach. According to the Hansen test of over-identifying restrictions, we have suitable instruments in all the cases, since we do not reject the null hypothesis that the instruments are uncorrelated with the error term. In addition, we reject the null hypotheses of underidentification and weak identification.[14] The results of these tests taken together indicate that our IV estimation performs quite well. Indeed, the results reported in Table 2 reveal that, compared with the consistent estimates provided by the IV estimator, the coefficients obtained through the OLS and the multilevel models tend to be biased downwards. Indeed, in six of the eighteen estimated specifications, the sign of the estimated coefficients is reversed.

According to our IV estimates, the subnational current expenditure and total expenditure exert a statistically significant positive effect. However, the subnational total revenues show a positive coefficient for science and reading scores but a negative coefficient for math. The IV coefficient for self-rule turns positive for science but keeps the negative sign for math and reading. The IV coefficients associated with the decentralization measures in education are again positive, except for fiscal decentralization for science and political decentralization for reading. Since the outcome variables are in logarithms, the estimated coefficients are semi-elasticities; that is, they indicate the percentage

[14] From a statistical point of view, an instrument is suitable (good) if it is strictly exogenous and is not weak. Exogeneity requires the instrument not to be correlated with the error term in the main equation, while the second condition requires the instrument to be correlated with the endogenous variables that has to be instrumented.

increase in the outcome as we increase the explanatory variable by one unit. In addition, as our decentralization variables are expressed as a percentage, except self-rule, the estimated coefficients multiplied by 100 can be interpreted directly as an elasticity. To gain an idea of the magnitude of the estimated effects, let us quantify the impact of one of the coefficients. The estimated coefficient for the impact of subnational current expenditure on the log of the math scores is 0.00656, which indicates that a 1% increase in the subnational current expenditure increases math scores by 0.656%. The average math score in our sample is 497, this means that an increase of 10 percentage points in the subnational current expenditure will increase the average math score by $497 \times 0.00656 \times 10 = 32.6$. This is quite a sizeable effect. The quantification of the estimated impacts for the remaining decentralization variables should be calculated in the same way.

5.3. Decentralization and the city

The level of heterogeneity in the demand for public services and needs is directly proportional to the level of heterogeneity of the population. Thus, one should expect rural and urban populations to exhibit different needs. That is, we should expect a more uniform demand across the inhabitants residing in the same city because they probably have more uniform tastes and incomes compared with individuals residing in a city of a different size or location (Tiebout, 1961). Analogously, because of scale economies, we might also expect the provision of public services to the citizenry in a big city to be more efficient. This circumstance raises the question of whether the scalar effects of decentralization become more evident in big cities. To test this hypothesis, we re-estimate all the models, interacting the decentralization measures with the dummies for city size. More specifically, we use two dummies, one indicating whether the student lives in a city with between 100,000 and 1,000,000 inhabitants and another for cities with more than 1,000,000 inhabitants. Thus, the estimated coefficients capture the differential impacts in these two types of cities with respect to cities with fewer than 100,000 inhabitants.

In Table 4, we report the estimated coefficients of these interactions. Given the difficulty of the IV estimator with one potential endogenous regressor plus two interaction terms of this regressor, we only show the results from the OLS fixed-effect model and the multilevel model. Recall that, as we could see in Table 2, the results provided by these two estimation methods are qualitatively fairly similar to those provided by the IV estimator, though for the latter the estimated impacts are significantly more sizeable. Our results are quite revealing, since practically all the interactions turn out to be statistically significant. The impact of decentralization tends to be higher as the size of the city increases. This scalar effect becomes much more evident in cities with more than a million of inhabitants. To understand the magnitude of this scalar effect with city size, let us suppose an increase of 1 percentage point in the subnational current expenditure. The impact on math scores in cities with fewer than 100,000 inhabitants will result in an increase of 0.275%, while, math scores will increase by 0.275+0.014=0.289% in cities with between 100,000 and 1,000,000 inhabitants and by 0.275+0.116=0.391% in cities with more than 1,000,000 inhabitants. This scalar effect persists for all the decentralization measures and PISA scores. Indeed, in most of the cases, big cities absorb most of the impact of fiscal decentralization on students' outcomes.

[Table 4 around here]

6. Discussion and conclusions

This paper extends beyond the traditional economic growth and territorial disparity analyses that have been at the heart of most studies of fiscal—and to a lesser extent political—decentralization until recently. A very limited number of more recent studies have also ventured into the black box of how institutions affect the assessment of the provision of basic public services linked to the welfare state by individuals. However, we think that this paper takes one step further, as suggested by Barankay and Lockwood (2007) or Falch and Fischer (2012), by analyzing the impact of decentralization on the

efficiency of the provision of public goods such as education. Thus, this paper shines the spotlight on the ultimate goal of decentralization: the improvement of the delivery of policies and services to citizens. As far as we know, our study is indeed also the first to consider political decentralization in this type of analysis in addition to fiscal decentralization.

Regarding the general measures of decentralization, we find a positive impact of fiscal decentralization on educational outcomes, which is in line with the previous empirical evidence (Akai, 2007; Barankay and Lockwood, 2007; Falch and Fischer, 2012; Faguet and Sanchez, 2014). These results confirm the decentralization theorem (Oates, 1972), which states the advantage of local governments in delivering services to citizens because of their informational advantages with respect to the economic or social characteristics of regions. In contrast, our results also indicate that the impact of political decentralization is negative. Although there is no previous evidence on the impact of political decentralization that can provide a contrast to our results, our results are in line with those of Diaz-Serrano and Rodríguez-Pose (2014). These authors find that political decentralization exerts a statistically significant negative effect on citizens' satisfaction with the education system, whereas the effect of fiscal decentralization is positive. It is worth noting that our results are quite robust to different specification and estimation methods (OLS, multilevel and IV). The interpretation of the negative effect of political decentralization on school outcomes is not obvious, but our conjecture is that it might be driven by a mismatch between the levels of political and fiscal decentralization. High levels of political decentralization are not endowed with equivalent high levels of fiscal decentralization, that is, in conditions of unfunded mandates, when subnational governments are endowed with the capacity to decide but not with the capacity to deliver. There are decision-making costs of political decentralization, as the implementation of political decisions may lead to significant transaction costs. However, this result regarding general political decentralization contrasts with the result provided by our

indicator of political decentralization in education, which indicates a positive impact on PISA test scores.

Last but not least, as pointed out by Martinez-Vazquez et al. (2017), a relevant issue regarding the analysis of the impact of decentralization is the proper measurement of decentralization itself and its potential endogeneity in econometric estimates. In this paper, we overcome the endogeneity issue, but we emphasize the measurement problem. While the results regarding fiscal decentralization obtained in this study suggest a positive effect, the impact of political decentralization may vary depending on the type of decentralization indicator (general or education-specific), the type of outcome (maths, science or reading scores) and the estimation method (OLS fixed effects, multilevel or IV). Boex and Simatupang (2008) highlight the problem of how decentralization should be measured and claim that most of the existing measures are somehow unsatisfactory. They propose an alternative measure of fiscal decentralization based on the empowerment of the people by the empowerment of their local governments.

Another important question concerns the extent to which PISA scores are a good proxy for the quality of the education system in each country and of the "real" student educational outcomes. PISA scores are often criticized by practitioners in the education system, arguing that, while they capture the level of excellence of an education system, they omit other aspects, for instance the level of equity. However, Fischbach et al. (2013) analyze the validity of PISA proficiency scores in math, science and reading for a representative sample of students from Luxembourg. They find that PISA scores are good predictors of key educational outcomes, such as class repetition and subject-specific grades, not only in final exams but also during the five following years after the PISA test. We think that the suitable measurement of decentralization and the quality of public services, as well as the causal link between these variables, should be a main concern in future research. Given that the positive impact of fiscal decentralization on public

services is well documented, more evidence regarding the role of political decentralization should be a priority on the research agenda.

References

Adam, A., M.D. Delis & P. Kammas, (2014). Fiscal decentralization and public sector efficiency: Evidence from OECD countries, *Economics of Governance*. 15: 17-49.

Akai, N., Sakata, M. and Tanaka, R. (2007). Financial Decentralization and Educational Performance: Evidence form State-level Panel Data for the United States, Institute of Business and Economic Research, Conference Paper No. C07-011, University of California, Berkeley.

Arzaghi, M. and Henderson, J.V. (2005). Why countries are fiscally decentralizing, *Journal of Public Economics*, 89 (7), 1157-1189

Barankay, I. and Lockwood, B. (2007). Decentralization and Productive Efficiency of Government: Evidence form Swiss Cantons, *Journal of Public Economics*. 91: 1197-1218.

Bénassy-Quéré A., Gobalraja N. and Trannoy A. (2007). Tax and Public Input Competition, *Economic Policy*. 22: 385-430.

Bjørnskov, C., Drehe, A. and Fischer, J.A.V. (2008). On decentralization and life satisfaction, *Economics Letters*. 99: 147-151.

Boex, J. and Simatupang, R. (2008). Fiscal Decentralisation and Empowerment: Evolving Concepts and Alternative Measures, Fiscal Studies. 29: 435-465.

Boli, J., Ramirez, F. O. and Meyer, J. W. (1985) Explaining the Origins and Expansion of Mass Education, *Comparative Education Review*. 29: 145-170.

Brancati, D. (2006). Decentralization: fueling or dampening the flames of ethnic conflict and secessionisme, *International Organization*. 60:.651–685.

Busemeyer, M.R. (2008). The impact of fiscal decentralisation on education and other types of spending, *Swiss Political Science Review*. 14: 451-481.

Cowell,R,, Ellis, G. and Sherry-Brennan, F.(2017). Sub-national government and pathways to sustainable energy. *Environment and Planning C*. 35: 1139-1155

Davoodi, H. and Zou, H. (1998). Fiscal Decentralization and Economic Growth: a Cross-Country Study, *Journal of UrbanEconomics*. 43: 244-257.

Diaz-Serrano, L., and Rodríguez-Pose, A. (2012). Decentralization, Subjective Well-Being and the Perception of institutions, *Kyklos. 65: 179-193.*

Diaz-Serrano, L. and A. Rodríguez-Pose (2014). Decentralization and the Welfare State: What Do Individuals Perceive? *Social Indicators Research*. 120: 411-435.

Ercolano, S., Gaeta, G.L. and Guarino, M. (2016). Anti-poverty competences in a multilevel government: an empirical analysis of citizens' preferences in Europe, *Applied Economics*. 49: 3979-3994.

Ezcurra, R., and Pascual, P. (2008). Fiscal Decentralization and Regional Disparities: Evidence from Several European Union Countries, *Environment and Planning A*. 40: 1185-1201.

Ezcurra, R. and Rodríguez-Pose, A. (2013). Political decentralisation, economic growth and regional disparities in the OECD, *Regional Studies*. 47: 388-401.

Faguet, J. and Sanchez, F., (2014). Decentralization and access to social services in Colombia, *Public Choice*. 160: 227-249.

Falch, T. and Fischer, J. (2012). Public Sector Decentralization and School Performance: International Evidence, *Economic Letters*. 114: 276-279.

Fan, C.S., Lin, C. and Treisman, D. (2009). Political decentralization and corruption: Evidence from around the world, *Journal of Public Economics*. 93: 14-34.

Filippetti, A., and Cerulli, G. (2017) Are local public services better delivered in more autonomous regions? Evidence from European regions using a dose-response approach. *Papers in Regional Science*, doi: 10.1111/pirs.12283.

Frey, B.S. and Stutzer, A. (2000). Happiness, Economy and Institutions, *The Economic Journal*. 110: 918 – 938.

Gerring, J. and Thacker, S.C. (2004). Political Institutions and Corruption: The Role of Unitarism and Parliamentarism, *British Journal of Political Science*. 34: 295-330.

Hanushek, E.A. (1972). *Education and race*. Lexington, Mass: D.C. Heath.

Hanushek, E.A. (1979). Conceptual and empirical issues in the estimation of educational production functions. *Journal of Human Resources*. 14:351-388.

Iimi, A. (2005). Decentralization and Economic Growth Revisited: an Empirical Note. *Journal of Urban Economics*. 57: 449-461

Kappeler, A. and Valila, T. (2008). Fiscal Federalism and the Composition of Public Investment in Europe, *European Journal of Political Economy*. 24: 562-570.

Kyriacou, A. and Roca, O. (2011). Fiscal and Political Decentralization and Government Quality, *Environment and Planning C*. 29: 204-223.

Lane, J.E. and Ersson, S. (1999). *Politics and society in Western Europe*, London: Sage Publications.

Lessman, C. (2009). Fiscal Decentralization and Regional Disparity: Evidence from Cross-Section and Panel Data, *Environment and Planning A*. 41: 2455-2473.

Ligthart, J.E. and P. van Oudheusden (2017). Fiscal decentralisation and Economic Growth Nexus Revisited. *Fiscal Studies*. 38: 141-171.

Lijphart, A. (1999). *Patterns of democracy: government forms and performance in thirty-six countries*, New Haven: Yale University Press.

Marks, G., Hooghe, L. and Schakel, A.H. (2008). Patterns of Regional Authority, *Regional and Federal Studies*. 18: 167-181.

Martinez-Vazquez, J., Lago-Peñas, S. and Sachi, A. (2017). The Impact of Fiscal Decentralization: A Survey, *Journal of Economic Surveys*. 31: 1095-1129.

McGinn, N., and Welsh, T. (1999). Decentralization of Education: Why, When, What and How? Fundamentals of educational planning UNESCO, IIEP, Paris.

Oates, W. E. (1972). *Fiscal Federalism*, New York: Harcourt Brace Jovanovich.

Oates, W. E. (1999). An Essay on Fiscal Federalism, *Journal of Economic Literature*. 37: 1120-1149.

OECD (2013) *Investing together. Working effectively across levels of government*. Paris: OECD.

OECD (2014) OECD *Territorial Reviews: Netherlands 2014*. Paris: OECD.

OECD (2016a) *Making the most of public investment in Colombia. Working effectively across levels of government*. OECD Multi-Level Governance Studies. Paris: OECD.

OECD (2016b) *Fiscal Federalism 2016. Making decentralisation work*. OECD Multi-Level Governance Studies. Paris: OECD.

OECD (2003, 2004, 2007, 2009, 2001). *Education at a Glance*. Paris: OECD.

Pal, S. and Wahhaj, Z. (2017). Fiscal decentralisation, local institutions and public good provision: evidence from Indonesia, *Journal of Comparative Economics*. 45: 383-409

Qian Y., Weingast B. (1997). Federalism as a commitment to preserving market incentives, *Journal of Economic Perspectives*. 11: 83-92.

Rodriguez-Pose, A. and Ezcurra, R. (2011). Is Fiscal Decentralization Harmful for Economic Growth? Evidence from the OECD countries, *Journal of Economic Geography*. 11: 619-643.

Sacchi, A. and Salotti, S. (2015). The influence of decentralized taxes and intergovernmental grants on local spending volatility, *Regional Studies*. 51: 507-522

Schakel, A.H. (2008). Validation of the Regional Authority Index, *Regional & Federal Studies*. 18: 143-166.

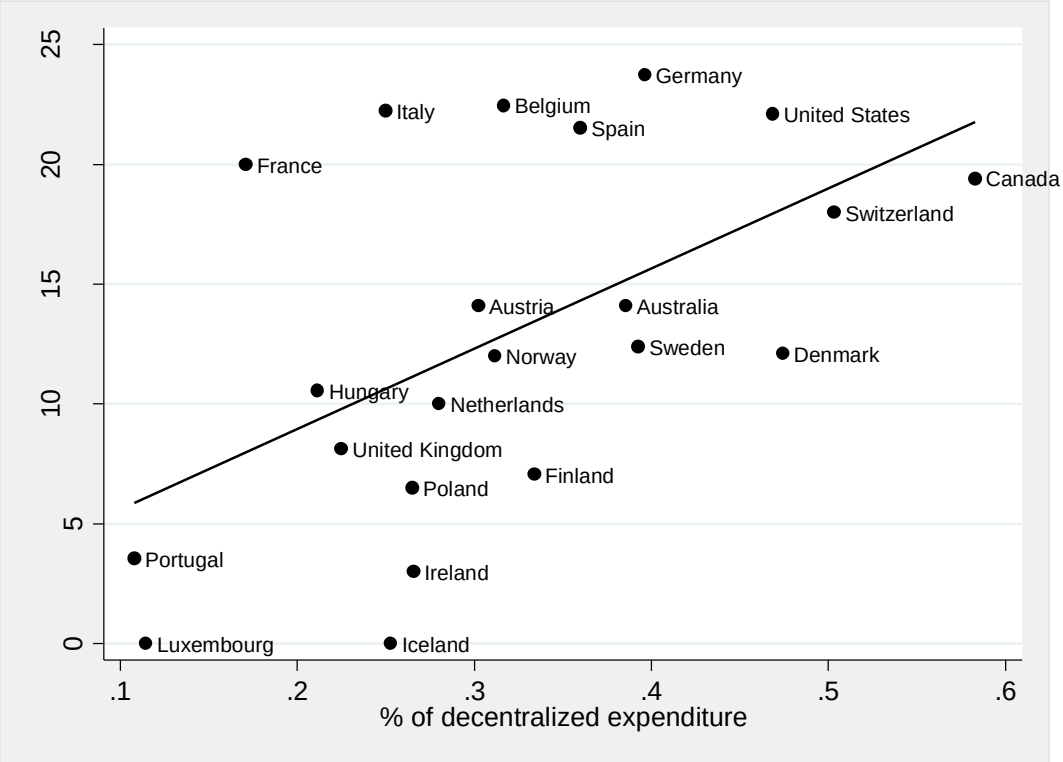
Schütz, G., Heinrich W. Ursprung and Ludger Wößmann (2008). Education Policy and Equality of Opportunity. *Kyklos*. 61: 279–308.

Sepulveda C.F., and Martinez-Vazquez J. (2011). The consequences of fiscal decentralization on poverty and income equality, *Environment and Planning C: Government and Policy*. 29: 321 – 343.

Treisman, Daniel. 2002. *Defining and measuring decentralization: a global perspective* – Dataset on Decentralization. UCLA.

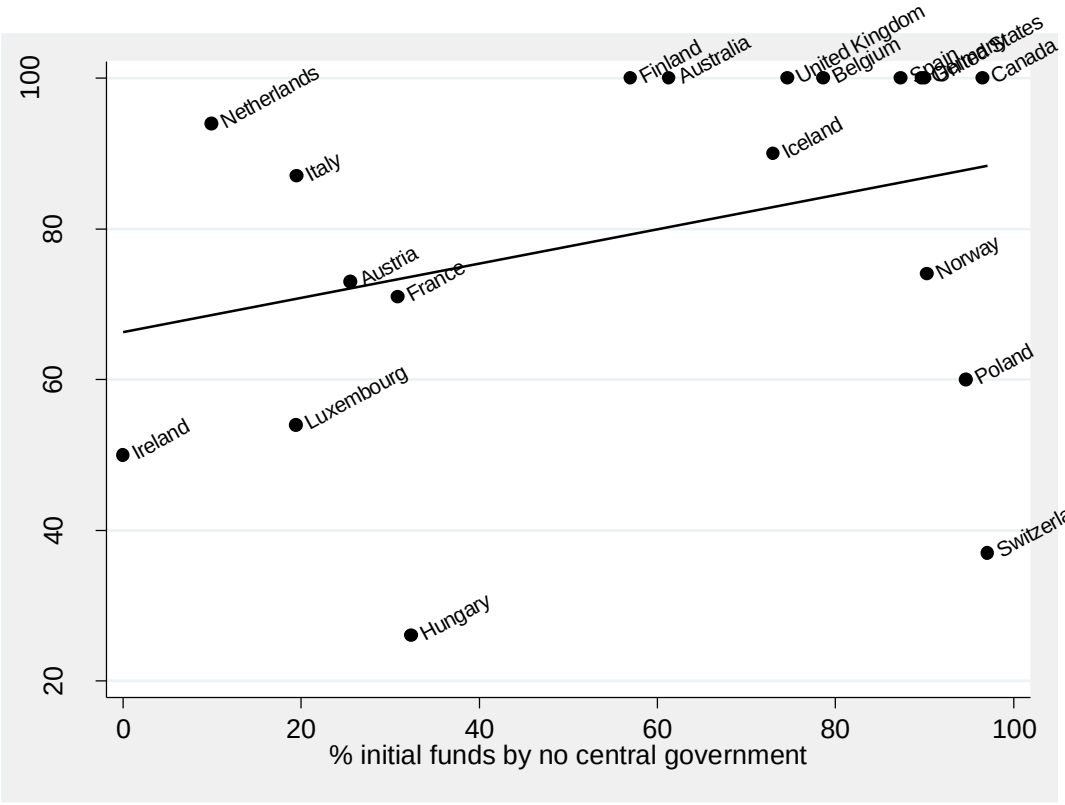
Woldendorp, J., Keman, H. and Budge, I. (2000). *Party government in 28 democracies (1945–1998): composition - duration - personnel*, Dordrecht: Kluwer Academic Publishers.

Figure 1: Relationship between Fiscal and Political decentralization



Source: Political decentralization (Regional Authority Index 1950-2006) and fiscal decentralization (Government Finance Statistics of the International Monetary Fund 1972-2005)

Figure 2: Relationship between Fiscal and Political decentralization in education



Source: OECD.

Table 1

Summary statistics of the independent and outcome variables

	Mean	Std. Dev.	Skewness	Kurtosis
log(math)	6.222	0.180	-0.833	7.098
log(science)	6.223	0.188	-0.772	4.167
log(read)	6.209	0.194	-1.450	15.431
Sub-national current expenditure	61.702	14.980	-0.666	3.375
Sub-national total expenditure	35.755	12.508	0.509	2.314
Sub-national total revenue	36.342	12.555	0.562	2.181
Self-Rule	15.956	6.629	-0.702	2.205
Fiscal decentralization (education)	62.646	34.758	-0.633	1.772
Political decentralization (education)	83.783	20.533	-1.221	3.359
Female	0.503	0.500		
Age	22.485	33.361		
Student born in foreign country	0.064	0.244		
Mother born in foreign country	0.128	0.334		
Father born in foreign country	0.124	0.329		
1 - 10 Books	0.134	0.341		
11 - 50 Books	0.306	0.461		
51 - 100 Books	0.205	0.404		
101 - 250 Books	0.168	0.374		
251 - 500 Books	0.101	0.301		
More than 500	0.005	0.069		
Father isced qualification	3.961	1.596		
Mother isced qualification	4.000	1.552		
Village (less 3.000)	0.117	0.313		
Small town (3.000 to 15.000)	0.269	0.444		
Town (15.000 to 100.000)	0.337	0.473		
City (100.000 to 1.000.000)	0.213	0.409		
Large city (more 1.000.000)	0.064	0.244		
School size/# teacher ratio	12.477	4.602		
Private, government dependent	0.316	0.376		
Private, government independent	0.148	0.355		
Public	0.536	0.499		
Log GDP pc constant 2000	9.925	0.484		
Expenditure in education % GDP	5.680	0.774		

Table 2

Correlation matrix between decentralization measures and instruments

	Log(Land area)	Log(population)	Log(pop. density)	% population living in the largest urban area	% urban population
Current Expenditure	0.5006	0.1923	-0.4500	-0.2677	0.3437
Total Expenditure	0.6119	0.1889	-0.5847	-0.1433	0.2614
Total Revenues	0.6188	0.2212	-0.5686	-0.1397	0.2553
Political decentralization (Self-rule)	0.3829	0.648	0.0331	-0.6055	0.0792
Fiscal Decentralization (Education)	0.3627	0.1358	-0.3286	-0.1184	0.3994
Political decentralization (Education)	0.5907	0.4454	-0.3663	-0.2291	0.4820

Note: All correlations are statistically significant at 1 percent level of significance.

Table 3

Multilevel, OLS and IV fixed-effects estimation of equation (2), overall decentralization variables.

	Math			**Science**			**Reading**		
Decentralization measures	*OLS*	*Multilevel*	*IV*	*OLS*	*Multilevel*	*IV*	*OLS*	*Multilevel*	*IV*
Current expenditure	0.00282***	0.00272***	0.00656***	0.00133***	0.00107***	0.00409***	0.00134***	0.00124***	0.00785***
	(0.000214)	(0.000207)	(0.000588)	(0.000225)	(0.000194)	(0.000560)	(0.000230)	(0.000210)	(0.000648)
Total expenditure	0.000777***	0.000955***	0.00625***	-0.000509**	-0.000473**	0.00405***	-0.000777***	-0.000492**	0.00751***
	(0.000247)	(0.000237)	(0.000597)	(0.000259)	(0.000230)	(0.000627)	(0.000265)	(0.000248)	(0.000643)
Total revenues	0.00472***	0.00443***	-0.00544***	0.000429	0.000191	0.00954***	0.00205***	0.00181***	0.0156***
	(0.000444)	(0.000409)	(0.00111)	(0.000466)	(0.000354)	(0.00123)	(0.000477)	(0.000400)	(0.00128)
Political (Self-rule)	-0.0112***	-0.0101***	-0.0251***	-0.0198***	-0.0186***	0.0220***	-0.0143***	-0.0127***	-0.0337***
	(0.00100)	(0.000954)	(0.00492)	(0.00105)	(0.00102)	(0.00391)	(0.00108)	(0.00102)	(0.00533)
Fiscal (Education)[1]	0.000119***	0.000119***	0.00273***	0.000134***	0.000135***	-0.00169***	0.000265***	0.000242***	0.00297***
	(3.10e-05)	(3.09e-05)	(0.000563)	(3.26e-05)	(3.20e-05)	(0.000302)	(8.43e-05)	(7.90e-05)	(0.000474)
Political (Education)[2]	0.000282***	0.000298***	0.00319***	0.000127***	9.82e-05**	0.00274***	0.000247***	0.000249***	-0.00127***
	(4.13e-05)	(4.05e-05)	(0.000290)	(4.33e-05)	(4.14e-05)	(0.000304)	(4.44e-05)	(4.29e-05)	(0.000206)
Observations		391,164			391,163			387,045	
R-squared		0.184			0.187			0.205	
(1) Underidentification test (χ^2)		Rejected***			Rejected***			Rejected***	
(2) Weak identification test (F)		Rejected***			Rejected***			Rejected***	
(3) Hansen J statistic (χ^2)		Not Rejected			Not Rejected			Not Rejected	
(4) Endogeneity test (χ^2)		Not Rejected			Not Rejected			Not Rejected	

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Countries included in the regressions are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.
(1) Null hypothesis: The equation is underidentified; (2) Null hypothesis: Instruments are weak, i.e. instruments are not correlated with the endogenous regressors; (3) Null hypothesis: Instruments are valid (uncorrelated with the error term); (4) Null hypothesis: Regressors are endogenous

List of instruments:
Current expenditure: Math (log-land area, log-population); Science (% pop. largest urban area, log-pop. density); Reading (log-pop. density, log-population)
Total expenditure: Math, Science and Reading (% pop. largest urban area, log-population)
Total revenues: Math (% pop. in largest urban area; % of urban population); Science (% pop. in largest urban area, log-population); Reading (log-pop. density, log-population)
Political (Self-rule): Math (% pop. largest urban area; % of urban population); Science (% pop. largest urban area, log-land area); Reading (% pop. largest urban area, log-population)
Fiscal (Education): Math (log-land area, log-population); Science (log-land area, log-population); Reading (% pop. largest urban area; % of urban population)

Table 4

Multilevel, OLS and IV fixed-effects estimation of equation (2), overall decentralization variables.

	Math		**Science**		**Reading**	
Decentralization measures	*OLS*	*Multilevel*	*OLS*	*Multilevel*	*OLS*	*Multilevel*
Current expenditure	0.00275***	0.00266***	0.00128***	0.00101***	0.00130***	0.00120***
	(0.000214)	(0.000207)	(0.000225)	(0.000194)	(0.000231)	(0.000210)
x (100,000 – 1,000,000)	0.000141***	0.000141***	0.000103**	0.000104**	4.41e-05	4.41e-05
	(4.31e-05)	(4.31e-05)	(4.53e-05)	(4.53e-05)	(4.63e-05)	(4.63e-05)
x (> 1,000,000)	0.00116***	0.00115***	0.00101***	0.00101***	0.000987***	0.000986***
	(7.40e-05)	(7.40e-05)	(7.77e-05)	(7.77e-05)	(7.95e-05)	(7.95e-05)
Total expenditure	0.000688***	0.000862***	-0.000583**	-0.000547**	-0.00085***	-0.000574**
	(0.000247)	(0.000237)	(0.000259)	(0.000230)	(0.000266)	(0.000248)
x (100,000 – 1,000,000)	0.000289***	0.000289***	0.000241***	0.000240***	0.000254***	0.000254***
	(5.20e-05)	(5.20e-05)	(5.46e-05)	(5.46e-05)	(5.61e-05)	(5.61e-05)
x (> 1,000,000)	0.00146***	0.00146***	0.00118***	0.00118***	0.00135***	0.00135***
	(8.33e-05)	(8.33e-05)	(8.75e-05)	(8.75e-05)	(9.00e-05)	(9.00e-05)
Total revenues	0.00469***	0.00440***	0.000403	0.000148	0.00203***	0.00178***
	(0.000443)	(0.000410)	(0.000466)	(0.000354)	(0.000477)	(0.000402)
x (100,000 – 1,000,000)	0.000238***	0.000238***	0.000189***	0.000189***	0.000195***	0.000195***
	(5.19e-05)	(5.19e-05)	(5.45e-05)	(5.45e-05)	(5.62e-05)	(5.62e-05)
x (> 1,000,000)	0.00135***	0.00135***	0.00103***	0.00103***	0.00126***	0.00126***
	(8.51e-05)	(8.51e-05)	(8.94e-05)	(8.94e-05)	(9.24e-05)	(9.24e-05)
Political. (Self-rule)	-0.0111***	-0.00994***	-0.0197***	-0.0184***	-0.0142***	-0.0127***
	(0.00100)	(0.000954)	(0.00105)	(0.00102)	(0.00108)	(0.00102)
x (100,000 – 1,000,000)	-0.000231**	-0.000231**	-5.20e-05	-5.14e-05	-0.000152	-0.000151
	(9.62e-05)	(9.62e-05)	(0.000101)	(0.000101)	(0.000104)	(0.000104)
x (> 1,000,000)	-0.00068***	-0.00069***	-0.00078***	-0.00078***	-0.000316*	-0.000323*
	(0.000175)	(0.000175)	(0.000184)	(0.000184)	(0.000190)	(0.000190)
Fiscal (Education)[1]	6.71e-05**	6.68e-05**	9.31e-05***	9.55e-05***	0.000239***	0.000218***
	(3.15e-05)	(3.14e-05)	(3.31e-05)	(3.25e-05)	(8.46e-05)	(7.94e-05)
x (100,000 – 1,000,000)	6.23e-05***	6.22e-05***	9.39e-06	9.05e-06	-3.00e-05	-2.99e-05
	(1.89e-05)	(1.89e-05)	(1.98e-05)	(1.98e-05)	(2.07e-05)	(2.07e-05)
x (> 1,000,000)	0.000378***	0.000377***	0.000377***	0.000377***	0.000278***	0.000276***
	(3.09e-05)	(3.09e-05)	(3.24e-05)	(3.24e-05)	(3.40e-05)	(3.40e-05)
Political (Education)[2]	0.000236***	0.000252***	0.000104**	7.63e-05*	0.000245***	0.000248***
	(4.31e-05)	(4.24e-05)	(4.53e-05)	(4.34e-05)	(4.64e-05)	(4.50e-05)
x (100,000 – 1,000,000)	-1.13e-05	-1.15e-05	-0.00012***	-0.00012***	-0.00018***	-0.00018***
	(3.54e-05)	(3.53e-05)	(3.71e-05)	(3.71e-05)	(3.81e-05)	(3.81e-05)
x (> 1,000,000)	0.000339***	0.000338***	0.000358***	0.000360***	0.000315***	0.000314***
	(5.66e-05)	(5.66e-05)	(5.95e-05)	(5.95e-05)	(6.11e-05)	(6.11e-05)
Observations	391,164		391,163		387,045	
R-squared	0.185		0.187		0.205	

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Countries included in the regressions are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

ANNEX OF TABLES

Table A1

Description of the decentralization variables

General Political decentralization ***Self Rule (SR) = ID+PS+FA+RP*** The authority exercised by a regional government over those who live in the region.	***Institutional depth (ID)*** Extent to which a regional government is autonomous rather than deconcentrated	0: no functioning general-purpose at the regional level 1: deconcentrated, general-purpose, administration 2: non-deconcentrated, general-purpose, administration subject to central government veto 3: non deconcentrated, general-purpose, administration not subject to central government veto
	Policy Scope (PS) Range of policies for which a regional government is responsible	0: no authoritative competencies over economic policy, cultural-educational policy, welfare state policy 1: authoritative competencies in one area: economic policy, cultural-educational policy welfare state policy 2: authoritative competencies in at least two areas: economic policy, cultural-educational policy, welfare state policy 3: authoritative competencies in at least two areas above, and in at least two of the following: residual powers, police, authority over own institutional set-up, local government. 4: regional government meets the criteria for 3, and has authority over immigration or citizenship
	Fiscal Autonomy (FA) Extent to which a regional government can independently tax it's population	0: the central government sets base of rate of all regional taxes 1: the regional government sets the rate of minor taxes 2: the regional government sets base and rate of minor taxes 3: the regional government sets the rate of at least one major tax: personal income, corporate, value added or sales tax 4: the regional government sets base rate of at least one major tax: personal income, corporate, value added or sales tax
	Representation (RP) Extent to which a region is endowed with an independent legislature and executive.	0: no regional assembly 1: an indirectly elected regional assembly 2: a directly elected assembly 3: the regional executive is appointed by central government 4: dual executives appointed by central government and the regional assembly 5: the regional executive is appointed by a regional assembly or directly elected
General Fiscal decentralization	***Subnational Expenditure***	Indicator: Subcentral Expenditure/General Expenditure Definition Expenditure: (State Government + Local Government)/(Central Government-Social Security + State Government + Local Government)
	Subnational Current Expenditure	Indicator: Subcentral Current Expenditure/General Current Expenditure Definition Current Expenditure: (State Government + Local Government)/(Central Government-Social Security + State Government + Local Government)
	Subnational Revenue	Indicator: Subcentral Revenuy& Grants/General Revenue and Grants Definition Revenue & Grants: (State Government+Local Government)/(Central Government-Social Security+StateGovernment+Local Government)
Decentralization in Education	***Political***	Share of decentralized decisions in primary and lower-secondary education
	Fiscal	Share of decentralized funds in primary and lower-secondary education