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THE EFFECT OF DECENTRALIZATION ON EDUCATIONAL OUTCOMES: REAL AUTONOMY MATTERS!

**Paula Salinas**

**Fiscal Federalism**

Document de treball de l'IEB

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# THE EFFECT OF DECENTRALIZATION ON EDUCATIONAL OUTCOMES: REAL AUTONOMY MATTERS!

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ABSTRACT: This paper uses cross-national data to examine the effects of different dimensions of decentralization on the efficiency of educational policies in OECD countries. The results show that the autonomy of subnational governments, both on the expenditure and revenue sides of their activities, is what really matters in determining the effect of decentralization on educational outcomes. The decision-making autonomy of subnational governments with regard to the regulation and management of the educational system has a significant and positive effect on educational attainment, though this varies with the degree to which subnational governments are held accountable for their taxing decisions. These results are robust to the different analyses conducted, thus corroborating that they are not driven by the potential endogeneity of decentralization policies.

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## 1. Introduction

Policies aimed at improving the quality of education are on the agenda of most developed economies. Among the educational reforms currently being discussed in these countries, I focus here on policies of decentralization. An examination of the OECD countries shows considerable variation in the distribution of education responsibilities between the different tiers of government and in the degree of autonomy with which these responsibilities are carried out (OECD, 2008, 2012a). For instance, in Spain the education decentralization process has meant the devolution of most expenditure responsibilities to the regional governments, while the central government has retained the decision-making power with regard to regulating important elements of the educational system, including curriculum design and teachers' salaries. Elsewhere, in Canada and Switzerland, for example, the central government does not have any decision-making power over the educational system. Variations in the degree of taxing autonomy of subnational governments are also to be found in countries with a similar degree of fiscal decentralization on the expenditure side (Blöchliger and Rabesona, 2009).

Here, drawing on cross-national data, my aim is to examine the effects of decentralization on the efficiency of educational policies, with a particular concern for different dimensions of decentralization. More specifically, I analyze the effects of decentralization on educational outcomes under different decentralization structures, with variables that measure the expenditure and revenue sides of decentralization. On the expenditure side, as well as including variables that take into account the distribution of education responsibilities between levels of government, I also examine the degree of autonomy with which these responsibilities are carried out by subnational governments. More specifically, I include three variables in the analysis that specifically measure decentralization in the education sector. The first is that of education *expenditure decentralization*, which takes into account the division of lower-secondary education responsibilities between different levels of government, although it does not inform us about the degree of autonomy with which subnational governments spend these resources. The second is that of education *conditioned expenditure*, which measures the degree of subnational autonomy to determine and allocate their lower-secondary education expenditure. And the third is that of education *decision-making decentralization*, which measures subnational governments' responsibility for regulating or deciding on the main features of the education system. On the revenue side, the variable included *(tax decentralization),* seeks to measure the autonomy of subnational governments to raise their own revenues.

The results show that the autonomy of subnational governments, both on the expenditure and revenue sides of their activity, is what really matters in determining the effect of

decentralization on educational outcomes. The decentralization of education expenditure responsibilities has a positive effect on educational attainment, corroborating previous empirical evidence on this question (Barankay and Lockwood, 2007; Falch and Fischer, 2012). However, this effect depends on whether subnational governments can decide with autonomy where to allocate their resources. When subnational education expenditures are financed with conditional grants from upper levels of government, in which case their autonomy to decide on the allocation of funds might be undermined, the effect of expenditure decentralization is lowered.

In addition, I find that the autonomy of subnational governments to take decisions with regard to the regulation and management of the education system has a quantitatively more relevant effect on educational attainment than expenditure decentralization, an impact that depends on subnational governments' taxing power. Although the effect of decentralizing educational decision-making power is positive or non-significant even when there is no decentralization of taxing decisions, increasing subnational tax autonomy has a positive impact on the efficiency with which educational services are provided by subnational governments. Finally, I find that these results hold both if education responsibilities are decentralized either to the regional or to the local levels of government. These results are robust to the different analyses conducted, thus corroborating that they are not driven by the potential endogeneity of decentralization policies.

I conduct the analysis within the education production function framework, which considers the education process as analogous to a firm's production process (Hanushek, 1986, 2003), where educational resources or inputs are transformed into educational outputs. Within this framework, the inputs to the educational process include student characteristics, family and school inputs and community and institutional factors, which include the country's level of decentralization. The output of the educational process is a measure of the achievement of individual students. In this study, the OECD PISA 2009 database provides information both on the achievement level of individual students in three subject areas (mathematics, science and reading) and the different inputs of the educational process for 294,156 students, grouped in 10,871 schools and belonging to 33 OECD countries.

The advantages of using internationally comparable test scores to measure educational achievement have been well documented in the empirical literature. It has been demonstrated that higher achievement on standardised test scores is related to higher labour market returns (Bishop, 1992) and to higher productivity and national growth rates (Hanushek and Kimko, 2000; Hanushek and Woessmann, 2007), and that an additional part of the return to school performance can be attributed to continuation in school

(Bishop, 1991). Since the interest in students performance in the economic literature comes from the well-known theoretical relationship between human capital and growth, students' test scores seem to be a good measure of educational attainment. In addition, PISA test scores have the advantage of not only capturing differences in curricular achievement, but also of identifying differences in other factors that may be linked with future earnings, even if they do not affect students' test scores at school (OECD, 2012b). Finally, the use of internationally comparable test score data allows researchers to analyze the effect of different institutional settings on educational attainment, something that is not possible in single country cases studies.

The rest of this chapter is organized as follows. Section 2 offers a review of the literature examining the effects of decentralization. Section 3 describes the methodology I follow in the analysis, including the empirical and identification strategies, the measurement of decentralization and the data I use in the analysis. Section 4 presents the results when regional and local levels of government are jointly analyzed, and section 5 presents the results when I differentiate between decentralization at the regional and local level. Finally, the last section reports the conclusions and policy implications that can be drawn from the analysis.

## 2. Literature Review

### 2.1. Theoretical background

According to what has become known as the First Generation Theory of Fiscal Federalism, in the absence of externalities and economies of scale, decentralization will improve *allocative efficiency*, since it is assumed that subnational governments have a better knowledge than the central government of local preferences and needs, so that the former are better placed to match the provision of public goods and services with these preferences (Oates, 1972). This argument, though, is based on some assumptions that have been called into question by more than one author. First, it is assumed that subnational governments have the same technical and economic capacity as that enjoyed by the central government to manage the delivery of decentralized services (Prud'homme, 1995). Second, it is assumed that governments are benevolent, in the sense that they act in the best interests of their citizens. However, subnational governments may not have the same capabilities as those of the central government and, as underlined by the Second Generation Theory of Fiscal Federalism, governments might very well prioritise their own interests (Oates, 2005; Weingast, 2009) or fall under the sway of lobbies and rent-seeking groups (Redoano, 2010; Bardhan and Mookherjee, 2000, 2006).

Seabright (1996) modelled the way in which decentralization can affect a government's incentives to act in the best interests of its citizens. This author argues that government's incentives depend on the degree of *political accountability*, defined as the probability that the welfare of a given region might determine the re-election of the government. Since *political accountability* or the electoral control over incumbents is greater at the subnational level, decentralized governments might have more incentives than centralized authorities to act in accordance with the preferences of their population and, therefore, to be less corrupt. Persson and Tabellini (2000) and Hindriks and Lockwood (2005) reach similar conclusions about the relationship between decentralization, political accountability and government behaviour[1]. Thus, in the context of education, the shortened distance between policymakers and parents derived from decentralization is supposed to increase the voice of parents, who can thus more effectively demand better education in return for the taxes they pay.

Problems might arise, however, when taxes are collected at the central level of government, but education services are provided by subnational governments. If subnational governments are highly dependent on intergovernmental fiscal grants to finance their expenditures they are not as accountable as they would be if they were financed by their own revenues, and their incentives to act in the best interests of their citizens could be undermined (Weingast, 2009). It has been demonstrated that this situation of vertical fiscal imbalance encourages subnational governments to overspend and generates unsustainable deficits and bailout demands, since the costs of local programs are not apparent to the local electorate (Bosch and Suárez-Pandiello, 1993; Wildasin, 1997). However, more recent studies show that under such a partial fiscal decentralization setting, the efficiency with which public goods and services are provided at the subnational level can also be superior to that at the central level of government (Brueckner, 2009; Borge *et al.*, 2014).

Thus, it might be expected that the efficiency with which educational services are provided in decentralized countries is also dependent on how subnational governments are financed. Greater efficiency is not therefore the automatic outcome of decentralization policies, but it will depend on the technical and economic capabilities of subnational governments, and their incentives to act in the best interests of their citizens. Thus, empirical analysis is necessary in order to determine the circumstances under which a decentralization reform might have beneficial or detrimental effects.

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[1] In these studies political accountability is considered in a broader sense, as the electoral rules and other institutional mechanisms that constrain the rent-seeking activities of office holders, such as taking bribes, favouring of particular interest groups and insufficient innovation and effort.

2.2. Related empirical studies

The general approach adopted in analyzing the effects of decentralization in the provision of educational services has not sought to identify its impact through any of the specific channels discussed above. Rather, previous analyses have tended to examine the relationship between a measure of fiscal decentralization and educational attainment, measured at the individual level or aggregated at the regional or local levels.

Examples include Barankay and Lockwood (2007), who measure decentralization as the ratio between local and total education expenditure, which is argued to correlate highly with local autonomy in the provision of education in Switzerland; Habibi *et al.* (2001), who focus on the revenue side of decentralization in Argentina, measuring it as the ratio of controlled resources to total provincial resources; and Galiani and Schargrodsky (2002) and Galiani *et al.* (2008), who analyze the effects of the education decentralization process in Argentina between 1992 and 1994. The general conclusion reached by these studies is that decentralization is positively related to educational outcomes, and that it is more beneficial when subnational governments have a low fiscal deficit (Barankay and Lockwood, 2007; Galiani and Schargrodsky, 2002), and when schools are located in non-poor municipalities (Galiani *et al.*, 2008). In the analysis conducted in Chapter 2 for the partial fiscal decentralization reform in Spain at the beginning of the eighties I find that while decentralization improved educational outcomes of the general programme in regions with a high level of public revenues, it had a negative impact on the outcomes of the vocational programme in regions with a low level of public revenues.

While these single country case studies have generated a good deal of useful information and plausible hypotheses, there are a number of drawbacks that need to be addressed. First, measuring the degree of fiscal decentralization is a complex task that requires identification of subnational autonomy and discretion with regard to expenditure and revenue arrangements (Ebel and Yilmaz, 2002). Thus, measuring the degree of fiscal decentralization with a single variable, such as the share of subnational expenditure or revenues or a dummy that indicates when a decentralization reform has been implemented, falls well short of providing a full picture of this decentralization. In this empirical analysis I seek to overcome this problem by including a set of decentralization variables that measure its different dimensions.

Second, the conclusions in these studies cannot be generalized to other countries. As discussed above, the effects of decentralization in each country will depend on how it is designed. Thus, to analyze whether previous evidence for Switzerland, Argentina and Spain can be generalized to other countries, evidence of how different structures of revenue and

expenditure decentralization could have a differential impact on educational outcomes is needed, and for this, cross-national evidence is necessary. To the best of my knowledge, only a few papers have conducted such a cross-national analysis of decentralization in the education sector in developed countries (Woessmann, 2001; Falch and Fischer, 2012)[2]; however, these analyses are not concerned with analyzing the way in which different decentralization structures have a differential impact on educational outcomes, and thus this question has not been addressed in previous empirical literature.

## 3. Methodology

### 3.1. Empirical strategy

The purpose of this paper is to analyze the effect of decentralization on the efficiency of education policy, and to examine the way in which different decentralization structures in the education sector can lead to different educational outcomes. In doing so I turn to international evidence, which encompasses many education systems typified by a wide variety of decentralized structures. I conduct the analysis within the contemporaneous education production function framework, which considers the education process as analogous to that of the firm (Hanushek 1986, 2003), where educational resources or inputs are transformed into educational achievement or outputs.

Within this framework, the inputs to the educational process include *school inputs*, namely the school resources (such as class sizes and facilities), teacher characteristics (such as educational level, experience or sex) and factors related to the organization of instruction (such as term length or educational practices); *family inputs*, which include both home resources (such as the financial resources dedicated to education and the time parents spend with their children) and family background variables (such as parental education and family size); and *student characteristics*, such as students' innate ability to learn and their sex. Some studies also include *community factors*, *peer group characteristics* or *institutional factors* of the education system (such as the decision-making power of the school or government decentralization). The output of the educational process is typically a measure of the achievement of individual students, in this case student test scores on PISA 2009.

Since the objective of this study is to estimate the total effects of decentralization on educational outcomes, I do not include in the regression equation those inputs that are

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[2]   Some studies have analyzed the impact of the countries' general level of decentralization on educational outcomes. For instance, Díaz-Serrano and Meix-Llop (2012) conduct a cross-national analysis of the effects of fiscal and political decentralization on educational outcomes, measured with PISA test scores, concluding that fiscal decentralization exerts a positive impact, while the effect of political decentralization is ambiguous.

likely to be affected by decentralization, such as school resources, teachers' characteristics or teaching practices[3]. Thus, I estimate the following expression for a cross-section of students in different schools and countries:

$$Y_{ijk} = \beta_0 + \beta_1 DC_k + \beta_2 Sc_{jk} + \beta_3 F_{ijk} + \beta_4 St_{ijk} + \varepsilon_{ijk} \qquad (1)$$

where $Y_{ijk}$ is the test score of student $i$ in school $j$ in country $k$; $\beta_0$ is the overall mean; $DC_k$ is the group of variables that measures the different dimensions of decentralization, which would represent the institutional factors considered in our model, measured at the country or regional level; $Sc_{jk}$, measured at the school level, represents the characteristics of school $j$ in country $k$; $F_{ijk}$ represents the family inputs of student $i$ in school $j$ in country $k$, which are measured at the student level; $St_{ijk}$ represents the characteristics of student $i$ in school $j$ in country $k$, which are also measured at the student level; and $\varepsilon_{ijk}$ is the student-specific error term. Individual and school level data were obtained from the OECD PISA 2009 database, which is described in Annex I. Table 1 in Annex I defines all the variables included in the analysis and the expected sign of their coefficients according to theoretical background and previous empirical evidence.

The advantage of the students' achievement measures provided by PISA is that they do not have a strong curricular focus. Rather, they focus on students' competencies in the key subject areas of mathematics, science and reading. Thus, what PISA seeks to assess is the extent to which students near the end of compulsory education have acquired the knowledge and skills considered essential to meet real life challenges (OECD, 2012b). Since the interest in, and concern for, the educational performance relate directly to the perceived importance of schooling in affecting the ability of students to perform in, and cope with, society after they leave school (Hanushek, 1986), the PISA test scores seem to be a good measure of educational outcomes.

Estimations are conducted using the weighted least-squares estimation method. Weights are equal to the students' sampling probability, normalised to give an equal weight to each country. Since students are grouped in schools, and schools are grouped in countries, we need to take into account the dependence between units in the same cluster, even though a considerable number of student, school and country level variables are included. Balanced repeated replication (BRR) with Fay's modification is used to compute estimates of the sampling variance. In this way, I am able to recognize this clustering of student-level data

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[3] Otherwise, we would be estimating the direct effects of decentralization without taking into account the indirect effects via these educational inputs.

within schools, and of school-level data within countries (Deaton, 1997), but I do not need to make any assumption about the distribution or the within-cluster dependence of the residuals. In addition, with this method I account for the complex survey data structure of the PISA dataset[4].

## 3.2. Identification strategy

The main concern in the empirical literature with contemporaneous education production functions is that education is seen as a cumulative process, that is, the entire history of family and school variables may contribute to a student's current levels of achievement (Hanushek, 1986, 1989). Thus, the history of inputs applied by families and schools and the innate ability of students are seen as omitted variables in this specification. As a consequence, if inputs into the educational process change over a student's school life, or if they are correlated with the students innate ability (due to the decision-making processes of parents or schools), the estimated parameters might be biased (Todd and Wolpin, 2003). These problems are more likely to arise in the case of school and family resources, since they depend on choices made by parents and schools which, at the same time, are likely to depend on a student's innate ability and to change over the student's school life. Instead, the student characteristics, the family background variables and the institutional factors, and, thus, the decentralization variables, are not likely to be affected by such omitted variables bias. Thus, this framework seems appropriate in meeting our objectives.

However, the coefficient of the decentralization variables in such a cross-national contemporaneous specification could be biased for a different reason, namely the potential endogeneity of decentralization (Strumpf and Oberholzer-Gee, 2002). If there were observable or non-observable characteristics of countries that were liable to affect both decentralization decisions and educational attainment, the omission of these variables would make the estimation of the effects of decentralization biased and inconsistent. Likewise, to the extent that countries with lower achievement levels are more likely to centralize or decentralize than countries with higher achievement levels, decentralization coefficients might be biased because of reverse causality.

This question has rarely been addressed in the education decentralization literature. To the best of our knowledge, only Gallego (2010) has examined the endogeneity problem of decentralization in education by using the number of native cultures before colonization as

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[4] Some studies used multilevel regression methods to estimate education production functions that do not take into account the sample design information used in PISA to reduce the sampling variance. Thus, the sampling variances estimated with these multilevel models will always be greater than the sampling variances estimated with Fay replicate samples (OECD, 2009). Annex I presents a description of the sampling design of the PISA 2009 database.

an instrument for political decentralization. Falch and Fischer (2012) analyzed the effects of education decentralization with aggregated data for a pooled cross-section of 25 countries and six waves of educational tests for the period 1980-2000. This enabled them to include country fixed effects to control for the time unvarying characteristics of countries that might affect both decentralization and educational outcomes, and thus to deal partially with the potential endogeneity of decentralization. However, when they include such fixed effects they obtain a higher estimated coefficient for the decentralization variable, so that their omission makes the decentralization coefficient to be downwards biased.

In this study, though, by focusing on a cross-section of countries it is possible to use more precise measures of decentralization, which are not available for a long time period and which would not present sufficient time variation to estimate a fixed effects model for a short period. In addition, the inclusion of detailed measures of educational inputs at the individual and the school level, including family inputs and background variables, allows me to control for differences in the non-observable characteristics of countries that might affect educational outcomes via their effect on family inputs (for instance, out-of-school lessons or preferences for private schools) and students' characteristics (such as their interest in studying or expected level of education), which is the advantage of using student level data. Even though in this way the potential endogeneity of decentralization in such a cross-sectional setting is addressed, I conduct additional analyses to corroborate that the results are not driven by the potential endogeneity of decentralization.

First, I include fixed effects that account for the region to which each country belongs. We might expect most observable and non-observable characteristics of countries with an influence on educational attainment to be common in countries that are close geographically[5]. For instance, the importance attached to education might be similar in Asiatic countries, in Nordic countries or in the South of Europe countries. If these common characteristics correlated with decentralization policies, and their effect on educational attainment was not captured by the variables included in the model, their omission from the regression equation might bias the results.

Second, I run additional regressions controlling for countries' observable characteristics that might be liable to correlate with both educational attainment and decentralization policies. These characteristics include the level of economic development (measured with *per capita GDP*) and the perceived *corruption* in each country (measured using the Transparency International Corruption Perception Index, which ranges between 10, if the

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[5] I classify countries in eight regions: South of Europe; Centre of Europe; North of Europe; North America and Pacific; East Asia; Latin America and Caribbean; Eastern Europe (and Israel); and Ireland and the United Kingdom, the latter being the baseline category.

country is highly clean, and 0, if the country is highly corrupt). If countries were likely to decentralize in a systematic way depending on their level of development or corruption, and these variables had a significant effect on educational attainment, their omission in the regression equation might also cause the estimated effect of decentralization to be biased. Although there is not evidence that the level of decentralization depends on the level of development, Shah and Shah (2006) show that in lower-income countries subnational governments tend to rely more on intergovernmental transfers to finance their expenditures than higher-income countries. Finally, in order to corroborate that the results are not driven by any particular country in the sample, I repeat the estimations eliminating one country at a time.

### 3.3. Measuring decentralization

According to fiscal federalism theory, the positive effects of decentralization derive from the better knowledge subnational governments have of their citizens' preferences and needs and the greater accountability of subnational governments, which improves the efficiency with which public services are provided[6]. Thus, the effects of decentralization on educational attainment will depend not solely on whether subnational governments are responsible for delivering educational services, but also on whether they have the necessary autonomy to make decisions about different aspects of the provision of the education services and the allocation of educational resources. In addition, the effects of decentralization will also depend on how subnational governments are financed, since this determines both their economic capacity and their incentives to provide educational services with efficiency.

In order to account for these dimensions, I measure decentralization using a set of variables that can be classified according to whether they measure its expenditure or revenue sides. On the expenditure side, I include three variables in the analysis that specifically measure decentralization in lower-secondary education. The first, and the most commonly used in empirical studies, is that of education *expenditure decentralization*, that is, the percentage of direct expenditure dedicated to lower-secondary education by subnational levels of government related to the expenditure dedicated to lower-secondary education by all levels of government.

This measure, which takes into account the division of education responsibilities between different levels of government, has the disadvantage of not telling us anything about the degree of autonomy with which subnational governments spend these resources. It might

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[6] Efficiency is interpreted here in a broad sense to include inefficiencies such as corruption, waste and poor governance (Barankay and Lockwood, 2007).

be the case that most of the expenditure on education in a certain country is made by the regional or the local level of government, so that the education *expenditure decentralization* variable would be high, but key features of the educational sector continue to be regulated by the central level of government, or decisions about how to spend this money are taken centrally. In this situation, subnational governments might see restricted their capacity to match educational policies with citizens' needs and demands.

Thus, in order to account for these factors, I define two additional variables. First, that of education *conditioned expenditure*, measured as the percentage of subnational direct expenditure in lower-secondary education that is financed with specific transfers received from upper levels of government. These transfers might be general education transfers, that is, resources that have to be devoted to education but which can be freely allocated to different uses, or earmarked transfers, over which subnational governments have no autonomy as to how they should be spent. Second, the education *decision-making decentralization* variable, measured as the percentage of educational decisions that are taken at the subnational level of government. With this variable I measure who has responsibility for regulating or deciding on the main features of the education system, such as the organization of instruction or personnel management.

Note that even if subnational governments are responsible for expenditure on education, and if they enjoy a high degree of autonomy to decide how to allocate this expenditure or to regulate the educational sector, their autonomy can be undermined if they have no control over their revenues. For instance, their capacity to increase the level of expenditure on a specific education item, without decreasing their expenditure on other areas, can be limited under a partial fiscal decentralization regime. In addition, subnational government incentives to act in the best interests of their citizens will also depend on how they are financed, as discussed above. Thus, the revenue structure of subnational governments has major implications for the outcomes of the fiscal decentralization process and needs to be included in the analysis.

In order to take into account whether revenues are generated and controlled autonomously by subnational governments, and not whether funds can be spent independently, I define the *tax decentralization* variable. This variable is measured as the ratio of subnational own tax revenues (defined as those taxes over which subnational governments have the power to define the tax base, the tax rate or both) to general government tax revenues[7]. The definition of the decentralization variables described above is summarized in Table 1.

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[7] Alternative variables have been proposed in the literature for measuring revenue decentralization, the most common being the *vertical fiscal imbalance*, which measures the extent to

**Table 1. Summary of the decentralization variables.**

| |
|---|
| *Expenditure side of decentralization (in lower-secondary education):* |
|    *Expenditure Decentralization = (SNG educ. expenditure) / (GG educ. expenditure)* |
|    *Conditioned Expenditure = (Conditioned educ. grants) / (SNG educ. expenditure)* |
|    *Decision-Making Decentralization = (SNG educ. Decisions) / (number of decisions)* |
| *Revenue side of decentralization:* |
|    *Tax Decentralization = (SNG own taxes) / (GG taxes)* |

*Notes:* SNG denotes Subnational Government; GG denotes General Government.

3.4. Data

I estimate equation (1) by using a huge dataset, which contains personal and academic information for 294,156 students, grouped in 10,871 schools and belonging to 33 OECD countries. Individual and school level data were obtained from the OECD PISA 2009 database, which is described in detail in Annex I. Country level information is also included in the dataset to measure education and tax decentralization variables, and the set of variables required to conduct the robustness analyses. These data were compiled by author based on OECD publications (OECD 2004, 2008, 2012a), the OECD Fiscal Decentralization database and OECD.Stat data.

As we can observe in Table 2 in Annex I, for Belgium and the United Kingdom the information of the PISA database is provided at the regional level. Since decentralization data for these countries are also provided at the regional level, the number of independent observations for decentralization is increased to 35. Each country's average test scores in the subject areas of mathematics, science and reading are included in this table. As we can see, average test scores on maths range from 418.51 in Mexico to 546.23 in Korea, with an overall mean for OECD countries equal to 495.68. Average test scores on science range from 415.91 in Mexico to 554.08 in Finland, with an overall mean for OECD countries equal to 500.92. Finally, average test scores on reading range from 425.27 in Mexico to 539.27 in Korea, with an overall mean for OECD countries equal to 493.38. Thus, there is considerable variability in average test scores across countries. Although an important part of this can be explained by student, family and school factors, the countries' institutional factors are also relevant in explaining differences between countries (Fuchs and Woessmann, 2007).

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which the basic allocation of revenues is such that "governments at each level can command the financial resources necessary for them to carry out their expenditure and to be held accountable for both spending and taxing decisions" (definition of a fiscally balanced situation according to Hunter, 1974). The *subnational fiscal dependency* variable, which measures the share of subnational expenditures (or revenues) that is financed with transfers from other levels of government, has also been proposed in the literature (De Mello, 2000). With these measures, shared taxes and own taxes are treated as equal, although shared taxes are determined by the federal government and are outside subnational control. For a detailed discussion of these issues see Sharma (2012).

There is also considerable variability across countries with regard to the degree of decentralization and the way in which it is implemented. Table 2 below presents the mean and standard deviation of each decentralization variable included in the analysis. As it can be observed, average education *expenditure decentralization* in OECD countries is 66.12 per cent, and it presents considerable variation between countries. Average *decision-making decentralization* is significantly lower (35.03 per cent), although it might be partly due to the fact that most countries have decentralized educational decisions to the school level rather than to subnational levels of government. Figure A.1.a. shows the relationship between *expenditure decentralization* and decision-making centralization. As it can be observed, among countries with a similar level of education *expenditure decentralization* (horizontal axis), there is a wide variability with regard to the percentage of educational decisions that are taken at the central level of government, especially in the case of countries with a low level of *expenditure decentralization*. This is likely to be explained by the fact that most of these countries, with a low level of fiscal decentralization, have granted schools with a high level of decision-making autonomy.

**Table 2. Descriptive analysis of the decentralization variables.**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| *Expenditure decentralization* | 66.12 | 36.91 | 0 | 100.00 |
| *Decision-making decentralization* | 35.03 | 24.76 | 0 | 80.28 |
| *Conditioned expenditure* | 15.59 | 21.08 | 0 | 64.10 |
| *Tax decentralization* | 11.29 | 11.82 | 0 | 44.27 |

*Notes:* decentralization data was compiled by author based on OECD publications (OECD 2004, 2008, 2012a), the OECD Fiscal Decentralization Database and OECD.Stat data.

Figure A.1.b also shows considerable variability in the percentage of educational expenditure that is financed with conditional transfers among countries with similar levels of *expenditure decentralization*, which ranges between 0 and 64.1%. Finally, *tax decentralization* also presents considerable variation across countries with a high level of education *expenditure decentralization*. However, it should be noted that tax decentralization is below 50% for all the countries in the sample, with subnational governments being highly dependent on transfers from upper levels of government or on shared taxes in most countries. Average *tax decentralization* in OECD countries is 11.29 per cent, a measure that contrasts with the average level of education *expenditure decentralization*, which is 66.12 per cent. Despite the variability that countries present with regard to their decentralization

structures, the correlation between these measures of decentralization is quite high, as we can observe in Table 3[8].

**Table 3. Coefficient of correlation between decentralization variables.**

|  | *Expenditure decentralization* | *Decision-making decentralization* | *Conditioned expenditure* |
|---|---|---|---|
| *Decision-making decentralization* | 0.728 | | |
| *Conditioned expenditure* | 0.220 | 0.103 | |
| *Tax decentralization* | 0.487 | 0.641 | -0.294 |

*Notes:* all the coefficients are significant at the 1 per cent level.

## 4. Empirical findings

### 4.1. The effect of education policy decentralization

Table 4 presents the results obtained when estimating equation (1) for educational attainment in the subject areas of maths, science and reading. For each subject, I estimate three alternative specifications. In the first specification, decentralization is measured with the education *expenditure decentralization* variable, which measures the percentage of education expenditure in lower-secondary education made at the subnational level of government. This variable tells us which level of government is responsible for spending. In order to take into account the (lack of) autonomy of subnational governments to spend in the area of education, the second specification also includes the education *conditioned expenditure* variable, measured as the percentage of subnational education expenditure that is financed with specific educational transfers. Finally, the third specification measures the decentralization of education policy with the education *decision-making decentralization* variable, which measures the percentage of educational decisions made at the subnational level of government. Thus, this variable accounts both for the responsibility of subnational governments to carry out the educational services and their decision-making autonomy.

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[8]    Since the correlation between education *expenditure decentralization* and education *decision-making decentralization* is above 70 per cent, they cannot be included in the same specification in order to identify their effects. In the specifications in which education decentralization is measured using the *decision-making decentralization* variable I also control for the percentage of decisions that are taken at the school level.

**Table 4. Education decentralization, autonomy and educational attainment.**

| | Maths | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| *Expenditure decentralization* | 0.185[***] | 0.202[***] | |
| | (0.010) | (0.011) | |
| *Conditioned expenditure* | | -0.136[***] | |
| | | (0.019) | |
| *Decision-making decentralization* | | | 0.466[***] |
| | | | (0.019) |
| $R^2$ | 0.426 | 0.427 | 0.432 |
| | **Science** | | |
| | (1) | (2) | (3) |
| *Expenditure decentralization* | 0.131[***] | 0.138[***] | |
| | (0.012) | (0.012) | |
| *Conditioned expenditure* | | -0.055[***] | |
| | | (0.019) | |
| *Decision-making decentralization* | | | 0.421[***] |
| | | | (0.022) |
| $R^2$ | 0.432 | 0.432 | 0.439 |
| | **Reading** | | |
| | (1) | (2) | (3) |
| *Expenditure decentralization* | 0.105[***] | 0.119[***] | |
| | (0.011) | (0.012) | |
| *Conditioned expenditure* | | -0.111[***] | |
| | | (0.017) | |
| *Decision-making decentralization* | | | 0.292[***] |
| | | | (0.020) |
| $R^2$ | 0.476 | 0.477 | 0.479 |
| Students | 294,156 | 294,156 | 294,156 |
| Schools | 10,871 | 10,871 | 10,871 |
| Regions | 35 | 35 | 35 |

*Notes:* the dependent variable is the PISA 2009 international test score for maths, science and reading. All the regressions control for the school characteristics, family inputs and student characteristics described in Annex I. Missing dummy variables are also included in all the specifications. Least-squares regressions weighted by students' sampling probability, normalized to give an equal weight to each country. Robust standard errors adjusted for clustering at the country level and school level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The first specification shows that education *expenditure decentralization* has a positive and significant effect on educational attainment for all three subjects. More specifically, a country with the 100% of its expenditure having been decentralized to the subnational

government is expected to score 18.5 points more than a non-decentralized country on the maths assessment, 13.1 points more on science and 10.5 points more on reading[9]. When the education *conditioned expenditure* is also included in the second specification, the estimated effect of education *expenditure decentralization* is even higher. However, as expected, the percentage of educational expenditure that is financed with conditional transfers from upper levels of government is negatively related to the students' educational achievement.

Thus, based on these results, if additional subnational expenditure is financed with conditioned transfers, subnational autonomy to determine the allocation of funds might be low, and thus, the effect of *expenditure decentralization* might not be so great as if it is financed with general transfers or own revenues. As explained above, the positive effects of decentralization on educational outcomes are due, to some extent, to the better knowledge subnational governments have about local preferences and needs. Thus, if the allocation of funds is decided at the central level of government, with less knowledge about local circumstances and needs, the efficiency with which these resources are used is not as great as if their allocation is decided by the subnational level of government and so the effect of decentralizing educational expenditures is also reduced. In addition, it has been widely demonstrated that the efficiency with which resources received from upper levels of government are used is lower than the efficiency with which own resources are used (Rodden, 2002). As a consequence, the higher the percentage of education expenditures that is financed with specific grants from upper levels of government, the lower the educational outcomes.

The third specification offers an alternative way to capture the autonomy enjoyed by subnational governments in the provision of educational services, by measuring decentralization with the education *decision-making decentralization* variable. This variable does not only capture the decision-making autonomy to allocate funds, but also the decision-making autonomy to regulate the main aspects of the educational process. It can be observed that the effect of decentralizing decision-making power more than doubles the effect of decentralizing expenditure responsibilities[10]. Based on these results, a country in which all the educational decisions are taken at the subnational level of government can be

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[9]  As a benchmark for size comparisons, the difference in performance between 9th and 10th grades, those with the highest percentage of 15-year-old students, is 14 points on the maths assessment, 12.5 on science and 17.7 on reading. This difference might be interpreted as what a student is expected to learn in a school-year. Alternatively, as PISA test scores were scaled so as to have an international standard deviation for OECD countries of 100 points, these effects can also be interpreted in terms of percentage points of an international standard deviation.

[10]  Table A.1 in the annex of this chapter reports the estimated coefficients for the whole set of variables included in this specification. The complete results for the other specifications, which include the same set of explanatory variables, are available upon request.

expected to score 46.6 points more than a country in which all the decisions are centralized on the maths assessment, 42.1 points more on science and 29.2 points more on reading. Thus, the improvement in the educational outcomes as a consequence of decentralization appears to be highly dependent on the autonomy of subnational governments to take their own decisions.

4.2. The effect of revenue decentralization on educational policy outcomes

The previous section has provided an examination of whether the decentralization of educational responsibilities and the level of autonomy of subnational governments to carry out these expenditures affect educational outcomes. The next step logically, therefore, is to examine whether the effects of education decentralization vary according to the degree of autonomy enjoyed by subnational governments to raise their own revenues. As discussed above, subnational government autonomy to raise their own revenues might influence both their economic capacity to carry out their responsibilities and their incentives to act in the best interests of their citizens, given that they can be held more accountable if they are responsible for raising the revenues required to finance their expenditures. I measure subnational government autonomy to raise their own revenues with the *tax decentralization* variable, defined as the percentage of tax revenues over which subnational governments have the power to set the tax base or the tax rate.

Table 5 reports the results obtained in this analysis, when education decentralization is measured using the *decision-making decentralization* variable. As above, I present the estimated effects of decentralization on the tests scores for maths, science and reading, and for each subject I report two alternative models. In the first model, I test independent effects of education *decision-making decentralization* and *tax decentralization*. In the second model, I test the hypothesis that the effect of education *decision-making decentralization* depends on the level of *tax decentralization* by including a multiplicative interaction term. The decentralization variables have been centred with respect to their means to facilitate the interpretation of their coefficients in this specification. The results show that *tax decentralization* is quantitatively significant at explaining educational attainment, especially for maths and reading, and that the effect of the decentralization of the education policy significantly depends on the tax autonomy of subnational governments.

Table 5 shows that when *tax decentralization* is included in the first specification, it lowers the predicted effect of education *decision-making decentralization*. Since both variables of decentralization are correlated with each other, when *tax decentralization* was omitted from the regressions above, the *decision-making decentralization* variable captured its effect. Despite the decrease in the coefficients, the effect of *decision-making decentralization* is still positive

and highly significant. Based on the results in this table, if we compare a country in which all educational decisions have been decentralized to the subnational level of government with a country in which all the decisions are centralized and with a similar level of *tax decentralization*, we might expect a difference equal to 31 points on the maths assessment, 40.1 points on science and 16.5 points on reading. As for *tax decentralization*, if we compare two countries with a similar degree of subnational autonomy in education, for each percentage point of difference in *tax decentralization* we might expect a difference equal to 0.53 points on the maths assessment, 0.06 points on science and 0.43 points on reading.

**Table 5. Decision-making decentralization, tax decentralization and educational attainment.**

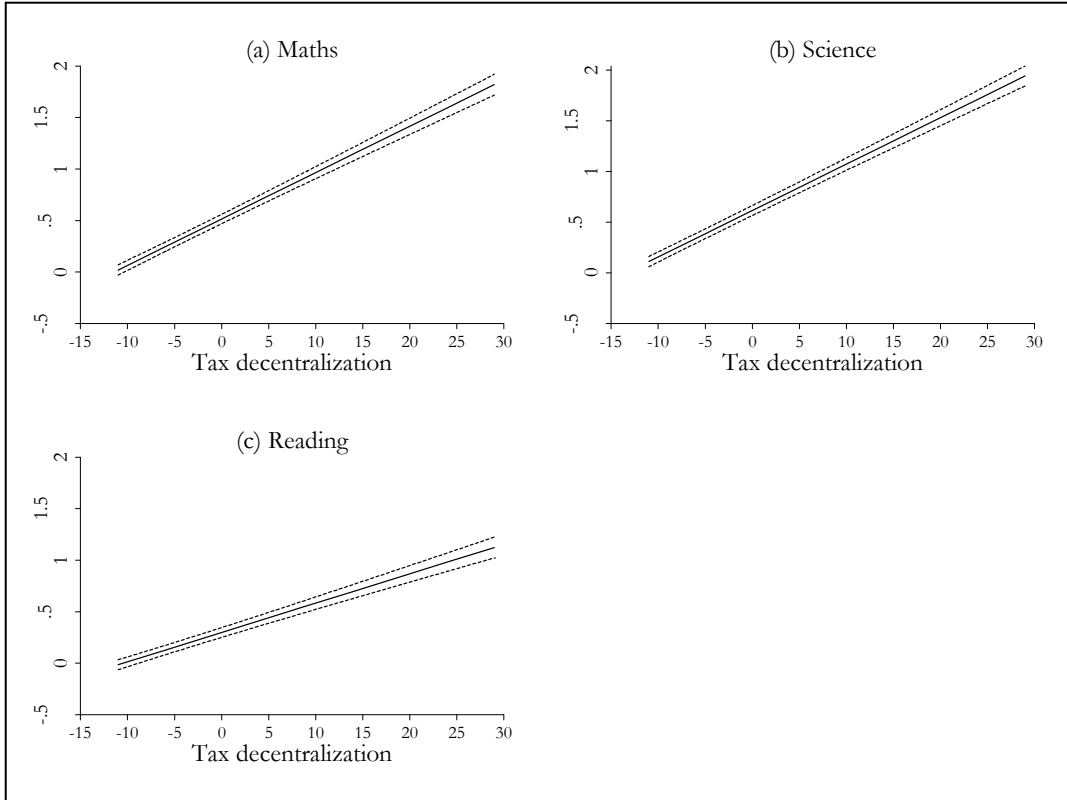|  | Maths | | Science | | Reading | |
|---|---|---|---|---|---|---|
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| *Decision-making decentralization* | 0.310*** | 0.516*** | 0.401*** | 0.610*** | 0.165*** | 0.298*** |
|  | (0.023) | (0.024) | (0.025) | (0.025) | (0.024) | (0.024) |
| *Tax decentralization* | 0.533*** | -0.354*** | 0.067* | -0.833*** | 0.433*** | -0.139*** |
|  | (0.041) | (0.050) | (0.037) | (0.047) | (0.035) | (0.048) |
| *Decision-making x Tax decentralization* |  | 0.045*** |  | 0.046*** |  | 0.029*** |
|  |  | (0.001) |  | (0.001) |  | (0.001) |
| $R^2$ | 0.434 | 0.444 | 0.439 | 0.450 | 0.480 | 0.485 |
| Students | 294,156 | 294,156 | 294,156 | 294,156 | 294,156 | 294,156 |
| Schools | 10,871 | 10,871 | 10,871 | 10,871 | 10,871 | 10,871 |
| Regions | 35 | 35 | 35 | 35 | 35 | 35 |

*Notes:* see Table 4.

When I include the interaction term between the education *decision-making decentralization* and *tax decentralization* variables, the coefficient of the interaction term is positive and significant. Thus, the effect of education *decision-making decentralization* on test scores is greater the higher the percentage of taxes that are collected at the subnational level of government, as can be observed in Figure 1.

When *tax decentralization* is set to the mean (11.29 percentage points), the effect of a one percentage point increase in *decision-making decentralization* is 0.516 points for maths, 0.610 points for science and 0.298 points for reading. For values of *tax decentralization* below the mean this effect decreases, while for values of tax decentralization over the mean this effect increases. When *tax decentralization* is 11 percentage points below the mean, that is, when there is no *tax decentralization*, the effect remains positive for science and non-significant for maths and reading. When *tax decentralization* is 30 percentage points over the mean, as it is in Canada and Switzerland, the expected effect of a one percentage increase in education

*decision-making decentralization* is 1.86 points for maths, 1.99 points for science and 1.15 points for reading[11].

**Figure 1. Heterogeneous effects of decision-making decentralization.**



*Notes:* marginal effects of *decision-making decentralization* on the PISA 2009 international test scores for maths (Figure (a)), science (Figure (b)) and reading (Figure (c)), as a function of *tax decentralization*. Decentralization variables have been centred with respect to their means. 95% confidence intervals computed with the Delta method.

These results corroborate the hypothesis that the efficiency with which education services are provided by subnational governments depends on their degree of responsibility in raising the revenues required to finance their expenditure, that is, on the accountability with which public services are provided. In addition, these results show that the effects of decentralizing the education policy are positive or zero when subnational governments are not granted powers to raise their own revenues, thus corroborating theoretical prescriptions in Brueckner (2009).

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[11] Also the marginal effect of increasing *tax decentralization* on students test scores in the three subjects depend on subnational decision-making autonomy in education. Thus, based on these results, the effect of increasing *tax decentralization* is positive when *decision-making decentralization* is above 7.9 per cent for the maths assessment, above 18.1 per cent for science and above 4.8 per cent for reading.

4.3. Robustness tests

Table 6 reports the results of the additional analyses conducted to check the robustness of the conclusions above. Specifications (1) to (3) include different sets of control variables considered to measure those factors most likely to be correlated both with decentralization and educational attainment, that is, *region fixed effects*, *GDP per capita* and the index of perceived *corruption*. As we can observe, these results confirm previous findings about the positive effects of education *decision-making decentralization* and *tax decentralization* on educational outcomes*,* with the exception of science, for which a negative coefficient is found for *tax decentralization[12]*.

We can observe that the education *decision-making decentralization* coefficients remain the same when *region fixed effects* are added in specification (1) for the three subjects, corroborating that the results are not driven by the omission of those characteristics of countries that might affect both educational outcomes and decentralization policies and which might be common among countries in the same region (although these characteristics are relevant to explain educational attainment). When *per capita GDP* is included as a control for the level of development in the different countries in specification (2), the effect of education *decision-making decentralization* increases to 0.40 points on the maths assessment, 0.49 points on science and 0.22 points on reading. Similar results are obtained when *corruption* is also included in the regression in specification (3).

Instead, the effect of *tax decentralization* on educational attainment falls when I include these control variables for the three subjects. As discussed above, *tax decentralization* is generally higher in countries with a higher level of development (Shah and Shah, 2006), so that in the specifications in which I do not control for the *region fixed effects* or the *per capita GDP* the *tax decentralization* coefficient might be including also the effect of these omitted characteristics. Nevertheless, we can observe that it remains positive and significant for the maths and reading assessments, although it turns out negative for the science assessment. In addition, we observe that the effect of *tax decentralization* on science educational attainment also decreases when I control for the perceived corruption.

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[12] *Region fixed effects* and *per capita GDP* are statistically significant for the three subjects. The perceived *corruption* index is only statistically significant for science.

**Table 6. Robustness analyses.**

| | Maths | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| *Decision-making decentralization* | 0.298*** | 0.400*** | 0.402*** |
| | (0.026) | (0.026) | (0.027) |
| *Tax decentralization* | 0.508*** | 0.363*** | 0.370*** |
| | (0.058) | (0.044) | (0.045) |
| $R^2$ | 0.455 | 0.436 | 0.436 |
| | **Science** | | |
| | (1) | (2) | (3) |
| *Decision-making decentralization* | 0.417*** | 0.490*** | 0.471*** |
| | (0.026) | (0.026) | (0.027) |
| *Tax decentralization* | -0.117** | -0.100** | -0.201*** |
| | (0.052) | (0.039) | (0.041) |
| $R^2$ | 0.454 | 0.442 | 0.442 |
| | **Reading** | | |
| | (1) | (2) | (3) |
| *Decision-making decentralization* | 0.173*** | 0.215*** | 0.219*** |
| | (0.027) | (0.026) | (0.027) |
| *Tax decentralization* | 0.196*** | 0.339*** | 0.363*** |
| | (0.047) | (0.039) | (0.037) |
| $R^2$ | 0.488 | 0.481 | 0.481 |
| *Region fixed effects* | Yes | No | No |
| *Per capita GDP* | No | Yes | Yes |
| *Corruption* | No | No | Yes |
| Students | 294,156 | 294,156 | 294,156 |
| Schools | 10,871 | 10,871 | 10,871 |
| Regions | 35 | 35 | 35 |

*Notes:* see Table 4.

With the exception of the effect of *tax decentralization* on science test scores, the general conclusion to be drawn from this analysis is that the conclusions presented in the previous sections are robust, thus corroborating that they are not driven by the potential endogeneity of decentralization. Education *decision-making decentralization* has a clear positive effect on educational attainment in the three subjects, an effect that even increases once I control for countries' characteristics. The effect of *tax decentralization* decreases when I control for such characteristics, although it remains positive and significant for maths and science. The results are also robust to the elimination of countries from the sample estimation.

## 5. Comparison of the effects of decentralization to regional and local governments

The previous sections examined the effects of decentralization on educational attainment without differentiating as to whether responsibilities are decentralized to the regional or the local levels of government. However, as different levels of government might have different technical and economic capabilities, as well as different incentives to act in the best interests of their citizens, it might be interesting to examine the separate effects of decentralization when the responsibilities are devolved to the regional and the local levels of government. Table 7 provides the results of conducting such an analysis. For each subject, the first specification measures decentralization with the education *decision-making decentralization* variable and the second specification measures it with the education *expenditure decentralization* variable. Both of them control for the *per capita GDP*.

The general conclusion to be drawn from this table is similar to that obtained in the previous sections. We can observe a positive and significant effect of education decentralization at both levels of government on educational outcomes for the three subjects. This is observed both if education decentralization is measured with the *decision-making decentralization* variable or the *expenditure decentralization* variable. As before, the effect of education decentralization when it is measured with the *decision-making decentralization* variable more than doubles the effect captured by the *expenditure decentralization* variable. Thus, the improvement in educational outcomes as a consequence of decentralization appears to be highly dependent on the autonomy of subnational governments to take their own decisions, both at the regional and the local level.

The effect of decentralizing education responsibilities to subnational levels of government differ statistically depending on whether they are decentralized to the regional or the local levels of government in some specifications, as indicated by the equality tests presented in Table 7. For instance, we can observe that the effect of *decision-making decentralization* on maths test scores is greater when educational decisions are decentralized to the regional level and the opposite is true for science and reading test scores. The effect of decentralizing expenditure responsibilities is also greater in the science and reading areas when they are decentralized to the local governments, while the difference is non significant for maths.

**Table 7. Regional and local decentralization and educational attainment.**

| | Math's | | Science | | Reading | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Regional decision-making decentralization* | 0.579*** (0.022) | - | 0.442*** (0.024) | - | 0.268*** (0.021) | - |
| *Local decision-making decentralization* | 0.440*** (0.023) | - | 0.478*** (0.026) | - | 0.378*** (0.025) | - |
| *Regional expenditure decentralization* | - | 0.188*** (0.013) | - | 0.126*** (0.014) | - | 0.026** (0.013) |
| *Local expenditure decentralization* | - | 0.197*** (0.012) | - | 0.145*** (0.012) | - | 0.168*** (0.012) |
| **Equality tests** | | | | | | |
| *Decision-making decent.* | 42.29*** | | 2.86* | | 35.82*** | |
| *Expenditure decent.* | | 0.60 | | 2.74* | | 211.62*** |
| $R^2$ | 0.436 | 0.437 | 0.442 | 0.443 | 0.480 | 0.482 |
| Students | 294,156 | 294,156 | 294,156 | 294,156 | 294,156 | 294,156 |
| Schools | 10,871 | 10,871 | 10,871 | 10,871 | 10,871 | 10,871 |
| Regions | 35 | 35 | 35 | 35 | 35 | 35 |

*Notes:* see Table 4. The results from testing whether decentralization coefficients are equal at the regional and local government are included in the table (Null: coefficients are equal).     *** $p<0.01$, ** $p<0.05$,  * $p<0.1$

## 6. Summary and concluding remarks

The effects of decentralization on the efficiency of public services provision remains unclear from a theoretical perspective and so empirical analyses are required. However, despite this need, empirical studies of this question are scarce. In the context of education, studies conducted to date conclude that decentralization is positively related to educational attainment, and that it is more beneficial when subnational governments have a low fiscal deficit (Barankay and Lockwood, 2007; Galiani and Schargrodsky, 2002) and when schools are located in non-poor municipalities (Galiani *et al.*, 2008). These studies, however, focus their attention on the situation in specific countries, so that their results might not be extrapolable to other contexts, and they are unable to provide evidence on how different structures of expenditure and revenue decentralization can have a differential effect on educational outcomes.

Thus, the aim of this study has been to use cross-national data to examine the effects of decentralization on the efficiency of educational policies, taking into consideration the different dimensions of decentralization. More specifically, variables that measure the expenditure and revenue sides of decentralization were included in the analysis. On the expenditure side, I included variables that take into account the distribution of education

responsibilities between levels of government and the degree of autonomy with which these responsibilities are carried out by subnational governments. On the revenue side, the variable included in this study seeks to measure the autonomy of subnational governments to raise their own revenues. This analysis contrasts with previous ones, since it draws on cross-national evidence to analyse how different structures of expenditure and revenue decentralization have a differential impact on the efficiency of public education policies.

The results showed that the decentralization of education expenditure responsibilities has a positive effect on educational outcomes in the three subject areas, corroborating previous empirical evidence on this topic (Barankay and Lockwood, 2007; Falch and Fischer, 2012). However, the effect of decentralizing decision-making power is significantly more relevant than decentralizing expenditure responsibilities. In addition, the effect of education decentralization depends on the way in which subnational governments are financed. More specifically, the effect of education decentralization is greater the higher the percentage of taxes that are collected at the subnational level of government, that is, when subnational governments are held accountable for taxing decisions. The estimated effects of education decision-making decentralization and tax decentralization are quantitatively relevant. More specifically, we observe that depending on the level of tax decentralization, the effect of an additional percentage point of education decision-making decentralization ranges from 0 to 1.86 points on the maths assessment, from 0.1 to 1.99 points on science and from 0 to 1.15 points on reading. When I differentiated between the effects of decentralization depending on the level of government that is granted responsibility for education, we observed positive effects of decision-making and expenditure decentralization both at the regional and the local levels of government.

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**Annex**

**Figure A.1. Decentralization in OECD countries.**

*Figure A.1.a. Education expenditure decentralization and decision-making centralization.*
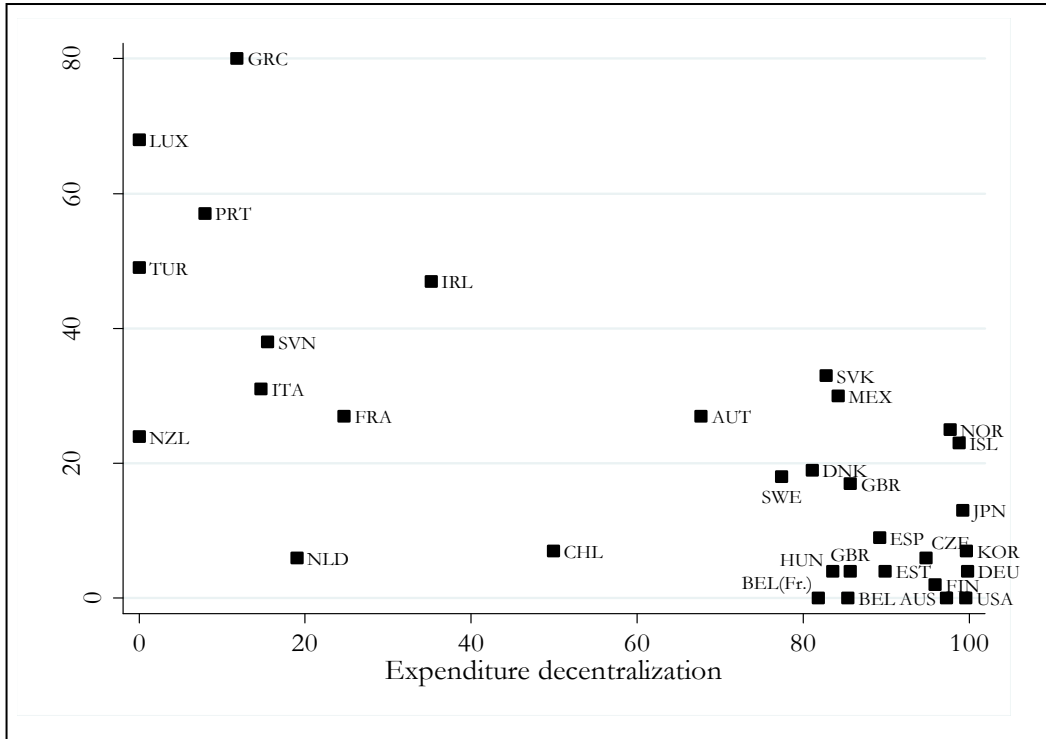


*Figure A.1.b. Education expenditure decentralization and conditioned expenditure.*
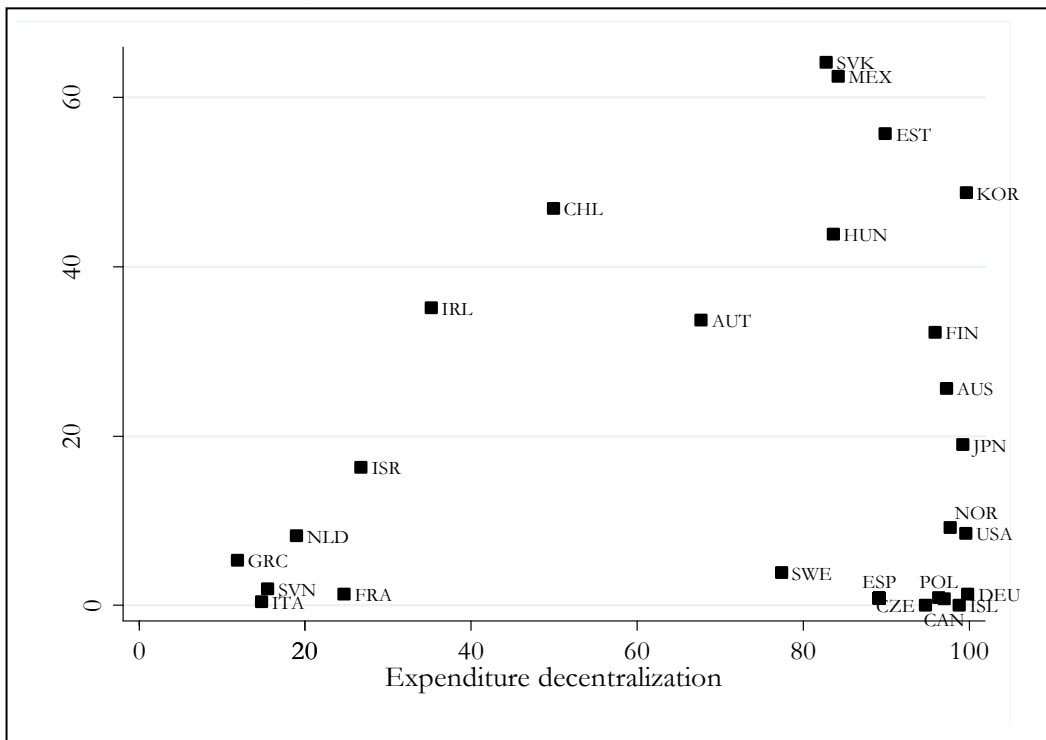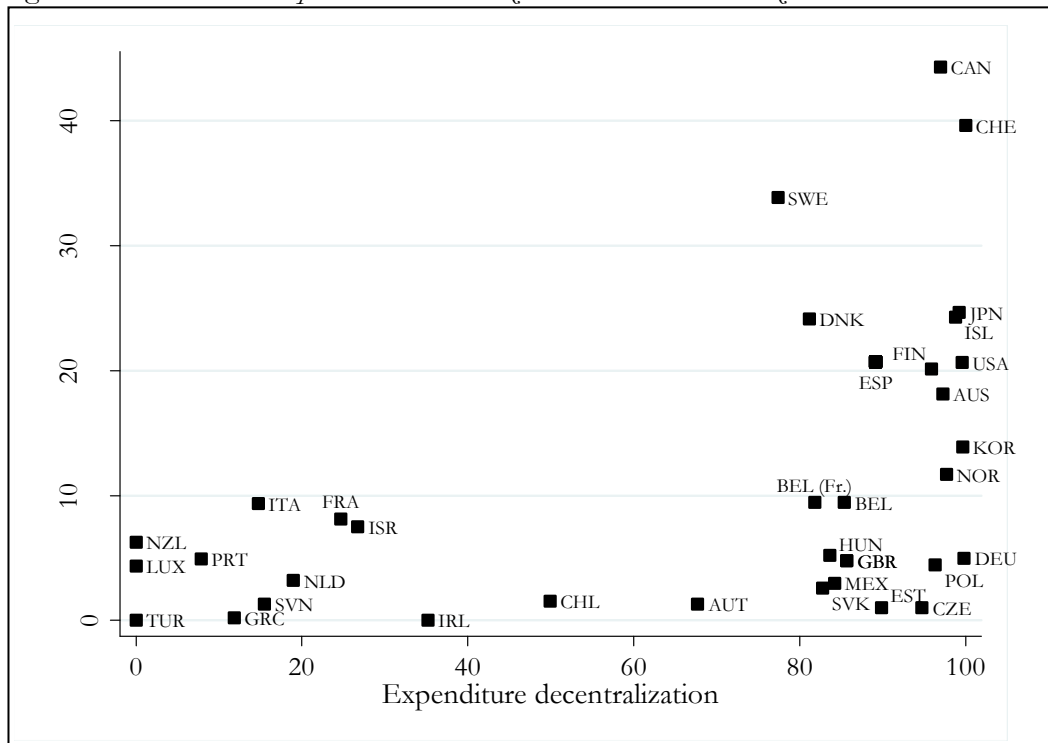
*Figure A.1.c. Education expenditure decentralization and tax decentralization*



*Notes:* in Figure A.1.a. education decision-making centralization is represented, because some countries have decentralized the decision-making power to the schools instead of to the subnational governments, and thus the education *decision-making decentralization* variable would not provide a complete picture of the decentralization scheme. In Figure A.1.b. countries in which the education *conditioned expenditure* was equal to zero are not represented.

**Table A.1. Complete results of the model (3) in Table 4.**

| | Maths | | Science | | Reading | |
|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | |
| | coef. | s.e. | coef. | s.e. | coef. | s.e. |
| *Decentralization* | | | | | | |
| *Decision-making decentralization* | 0.466*** | 0.019 | 0.421*** | 0.022 | 0.292*** | 0.020 |
| *School characteristics* | | | | | | |
| *Public school* | -8.312*** | 2.407 | -9.698*** | 2.457 | -8.523*** | 2.434 |
| *Private govern. depend. school* | -8.094*** | 2.977 | -9.852*** | 3.005 | -4.316 | 2.851 |
| *Location - Small town* | 5.027*** | 1.608 | 3.745** | 1.780 | 2.085 | 1.463 |
| *Location - Town* | 4.325*** | 1.318 | 2.344 | 1.483 | 3.671*** | 1.277 |
| *Location - City* | 3.685** | 1.468 | 2.060 | 1.469 | 7.230*** | 1.402 |
| *Location - Large city* | -0.663 | 1.667 | -2.022 | 1.851 | 5.028*** | 1.584 |
| *Availability of other schools* | 1.178 | 1.068 | 2.403** | 0.961 | 3.379*** | 0.884 |
| *Schools decision-making power* | 0.573*** | 0.027 | 0.647*** | 0.025 | 0.375*** | 0.024 |
| *Family inputs* | | | | | | |
| **Family resources** | | | | | | |
| *Mother full-time* | 2.743*** | 0.638 | 2.686*** | 0.622 | 2.466*** | 0.424 |
| *Mother part-time* | 8.458*** | 0.680 | 7.700*** | 0.707 | 5.267*** | 0.602 |
| *Father full-time* | 4.065*** | 0.698 | 1.789** | 0.763 | 0.812 | 0.685 |
| *Father part-time* | -11.622*** | 0.895 | -12.939*** | 0.931 | -11.798*** | 0.894 |
| *Out-of-school lessons 0h* | 18.018*** | 0.696 | 10.274*** | 0.759 | 14.397*** | 0.787 |
| *Out-of-school lessons 2-4h* | -1.782** | 0.898 | -9.544*** | 1.139 | -5.151*** | 1.041 |
| *Out-of-school lessons 4-6h* | -2.636** | 1.221 | -20.103*** | 1.417 | -18.755*** | 1.478 |
| *Out-of-school lessons more 6h* | -2.346 | 2.152 | -28.512*** | 2.730 | -31.182*** | 1.973 |
| *Home educational resources* | 7.796*** | 0.337 | 6.003*** | 0.285 | 4.935*** | 0.259 |
| *Wealth index* | 0.524* | 0.316 | -0.149 | 0.317 | -0.635** | 0.300 |
| **Family background** | | | | | | |
| *Parents' education* | 1.980*** | 0.100 | 2.023*** | 0.096 | 1.631*** | 0.087 |
| *Parents' job white collar high skil.* | 22.589*** | 0.903 | 21.637*** | 0.840 | 24.147*** | 0.800 |
| *Parents' job white collar low skil.* | 9.803*** | 0.896 | 9.225*** | 0.877 | 10.220*** | 0.792 |
| *Parents' job blue collar high skil.* | 5.508*** | 0.872 | 5.054*** | 0.806 | 3.981*** | 0.896 |
| *Books 11-25* | 7.204*** | 0.729 | 9.684*** | 0.697 | 7.826*** | 0.759 |
| *Books 26-100* | 20.605*** | 0.731 | 23.271*** | 0.731 | 20.099*** | 0.705 |
| *Books 101-200* | 32.619*** | 0.812 | 33.766*** | 0.871 | 30.138*** | 0.800 |
| *Books 201-500* | 45.444*** | 0.912 | 45.931*** | 0.992 | 39.523*** | 0.962 |
| *Books more 500* | 43.912*** | 1.019 | 44.014*** | 1.181 | 35.403*** | 1.092 |
| *Living with both parents* | 42.590*** | 1.619 | 42.198*** | 1.654 | 39.609*** | 1.567 |
| *Living with single mother* | 38.137*** | 1.686 | 40.207*** | 1.677 | 38.092*** | 1.595 |
| *Living with single father* | 36.307*** | 2.161 | 37.041*** | 2.110 | 33.192*** | 2.016 |
| *Living with siblings* | 1.455*** | 0.522 | -2.048*** | 0.597 | -1.877*** | 0.580 |
| *Living with grandparents* | -5.396*** | 0.734 | -2.691*** | 0.763 | -6.746*** | 0.683 |
| *Native students* | 2.673*** | 0.914 | 8.699*** | 0.949 | 3.338*** | 0.887 |
| *Speak test language* | -1.656* | 0.886 | 7.108*** | 0.996 | 9.293*** | 0.890 |

**Table A.1. Complete results of the model (3) in Table 4** *(continued).*

| | Maths | | Science | | Reading | |
|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | |
| | coef. | s.e. | coef. | s.e. | coef. | s.e. |
| *Student characteristics* | | | | | | |
| *Female* | -27.136*** | 0.538 | -20.575*** | 0.474 | 17.116*** | 0.412 |
| *Grade 7* | -80.969*** | 4.752 | -80.956*** | 5.835 | -88.505*** | 4.403 |
| *Grade 8* | -48.509*** | 1.927 | -49.237*** | 1.823 | -58.224*** | 1.606 |
| *Grade 9* | -14.881*** | 1.257 | -19.579*** | 1.409 | -22.210*** | 1.241 |
| *Grade 10* | 0.894 | 1.247 | -7.026*** | 1.321 | -4.449*** | 1.178 |
| *Age (months)* | 0.422*** | 0.056 | 0.543*** | 0.069 | 0.261*** | 0.063 |
| *General programme* | 19.389*** | 0.946 | 15.882*** | 1.053 | 21.069*** | 0.965 |
| *Pre-primary educ. no* | -12.751*** | 0.948 | -10.107*** | 0.853 | -11.433*** | 0.777 |
| *Pre-primary educ. less 1 year* | -8.028*** | 0.725 | -2.230*** | 0.599 | -2.170*** | 0.552 |
| *Expected university* | 35.993*** | 0.818 | 31.518*** | 0.810 | 33.727*** | 0.576 |
| *Enjoyment of reading* | 17.007*** | 0.266 | 24.756*** | 0.305 | 26.263*** | 0.236 |
| *Library use* | -10.544*** | 0.242 | -10.908*** | 0.208 | -9.867*** | 0.200 |
| *Constant* | 411.665*** | 4.540 | 419.247*** | 4.239 | 385.690*** | 3.986 |
| $R^2$ | 0.432 | | 0.439 | | 0.479 | |
| Students | 294,135 | | 294,135 | | 294,135 | |
| Schools | 10,871 | | 10,871 | | 10,871 | |
| Regions | 35 | | 35 | | 35 | |

*Notes:* the dependent variable is the PISA 2009 international test score for maths, science and reading. All the regressions include missing dummy variables. Least-squares regressions weighted by students' sampling probability, normalised to give an equal weight to each country. Robust standard errors adjusted for clustering at the country level and school level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

## 2011

**2011/1, Oppedisano, V; Turati, G.:** "What are the causes of educational inequalities and of their evolution over time in Europe? Evidence from PISA"

**2011/2, Dahlberg, M; Edmark, K; Lundqvist, H.:** "Ethnic diversity and preferences for redistribution"

**2011/3, Canova, L.; Vaglio, A.:** "Why do educated mothers matter? A model of parental help"

**2011/4, Delgado, F.J.; Lago-Peñas, S.; Mayor, M.: "**On the determinants of local tax rates: new evidence from Spain"

**2011/5, Piolatto, A.; Schuett, F.: "**A model of music piracy with popularity-dependent copying costs"

**2011/6, Duch, N.; García-Estévez, J.; Parellada, M.: "**Universities and regional economic growth in Spanish regions"

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**2011/8, Dahlberg, M.; Mörk, E.: "**Is there an election cycle in public employment? Separating time effects from election year effects"

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**2011/10, Choi, A.; Calero, J.; Escardíbul, J.O.: "**Hell to touch the sky? Private tutoring and academic achievement in Korea"

**2011/11, Mira Godinho, M.; Cartaxo, R.: "**University patenting, licensing and technology transfer: how organizational context and available resources determine performance"

**2011/12, Duch-Brown, N.; García-Quevedo, J.; Montolio, D.: "**The link between public support and private R&D effort: What is the optimal subsidy?"

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**2011/23, Banal-Estañol, A.; Macho-Stadler, I.; Pérez-Castrillo, D.: "**Research output from university-industry collaborative projects"

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## 2012

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## 2013

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## 2014

**2014/1, Montolio, D.; Planells-Struse, S.:** "When police patrols matter. The effect of police proximity on citizens' crime risk perception"

**2014/2, Garcia-López, M.A.; Solé-Ollé, A.; Viladecans-Marsal, E.:** "Do land use policies follow road construction?"

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