Essays on Education Decentralization

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PhD in Economics

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To my grandparents,
who always accompany me

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Table of Contents

Chapter 3. The Effect of Decentralization on Educational Outcomes: Real Autonomy Matters!

Chapter 1

Presentation

1. Introduction

In recent years, the most highly developed economies have seen their economic growth rates plummet, while most non-developed countries have failed to achieve their target of initiating economic growth. Drawing on these experiences, empirical research and economic policy have sought to identify the determinants of economic growth and the means for maintaining countries on the path of long-run growth. The importance attached to education in the economic literature derives, in fact, from the well-known theoretical relationship identified between human capital and economic growth (Romer, 1986, 1990). Growth theory is unequivocal in its claims that a country's level of human capital contributes to economic growth and empirical evidence likewise lends support to this theory (see Hanushek and Woessman (2011) for a review of this field)[1]. More recent research shows that quality of schooling (and not just quantity) is also relevant in determining long-run economic growth (Hanushek and Kimko, 2000; Hanushek and Woessmann, 2007), since it helps increase labour force productivity, innovation and technical progress, which in turn influence growth rates (Barro and Sala-i-Martin, 2004).

Given this evidence, there is a widely held consensus regarding the importance of investing in human capital, but also regarding the need to improve efficiency in the education process. In seeking to fulfil this objective, various

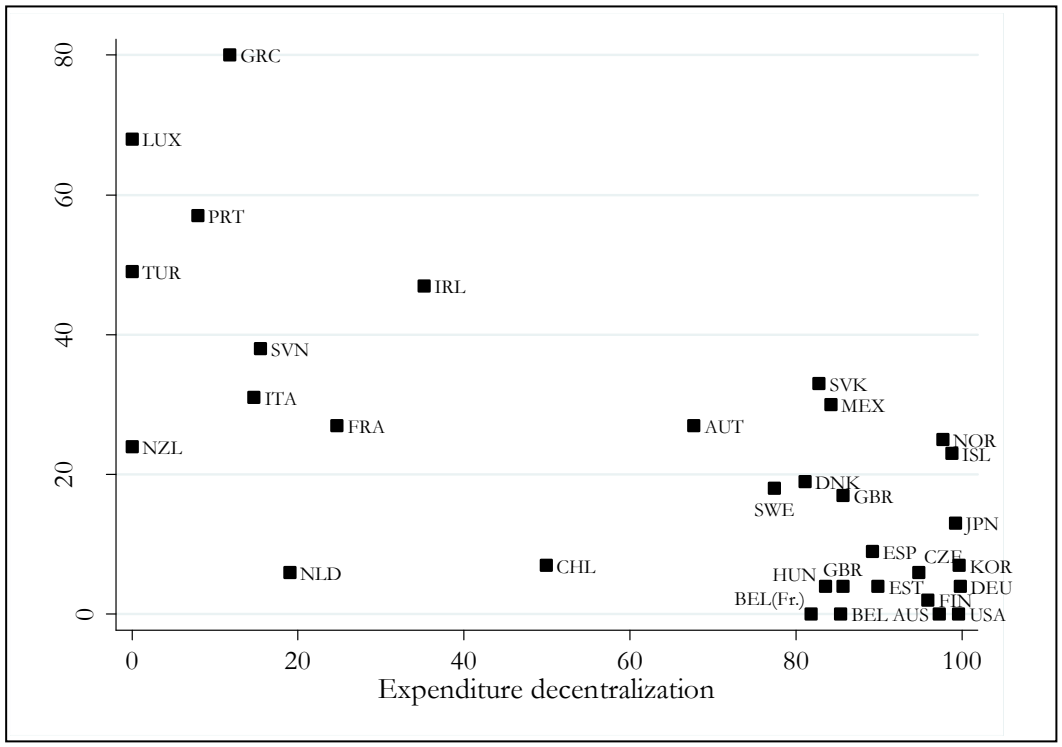
[1] The importance attached to education in economic literature also derives from its relevance to explain individual earnings, a relationship that started to be analyzed with the early contributions by Jacob Mincer and Gary Becker, and more recently, from its relevance to explain a variety of outcomes, such as health or life satisfaction (Salinas-Jiménez *et al.,* 2014).

countries have initiated educational reform programmes in recent decades, which range from measures aimed at improving schools' resources (for instance, reducing class sizes) to those that seek to improve teacher incentives or levels of accountability in the education system. Among the advice emanating from the World Bank and other international agencies are recommendations to developing countries that they implement decentralization reforms in order to achieve these objectives. Decentralization has also been central in a number of OECD countries, especially at the end of the last century. For instance, Spain introduced a far-reaching process of decentralization in its education sector at the beginning of the eighties, the process being concluded at the end of the nineties; Denmark also decentralized its education policy to the local level at the beginning of the nineties; and Finland increased the autonomy with which subnational governments could allocate their educational resources, although a considerable share of subnational education expenditure is financed with specific grants.

Today, OECD countries present considerable variation with regard to the degree of decentralization in their education sectors and the way in which such policies are implemented. Thus, while in some countries educational expenditure in lower-secondary education is highly decentralized to the subnational levels of government (this being the case, for example, in Germany, Finland and Mexico), in other countries most of this expenditure is the responsibility of the central level of government (the case, for example, of France and Italy). Likewise, the autonomy with which subnational governments implement their educational expenditure responsibilities is also highly varied in these countries. In Finland and Germany, for instance, 76 and 66 per cent of educational decisions, respectively, are taken at the subnational level of government. Since most of the other educational decisions are taken at the school level, the central government in these countries plays a highly limited role in regulating the educational system, as can be observed in Figure 1. By contrast, in Mexico only 50 per cent of educational decisions are taken at the subnational level of government, while the central government has the power to make 30 per cent of the decisions affecting education. Thus, as Figure 1 also shows, the percentage of educational decisions taken at the central level of government in countries with similar levels of decentralization in their education expenditure presents marked differences; or, expressed another way, the autonomy of subnational governments to regulate the main

features of the education system presents marked differences between countries with similar levels of decentralization in their education expenditure.

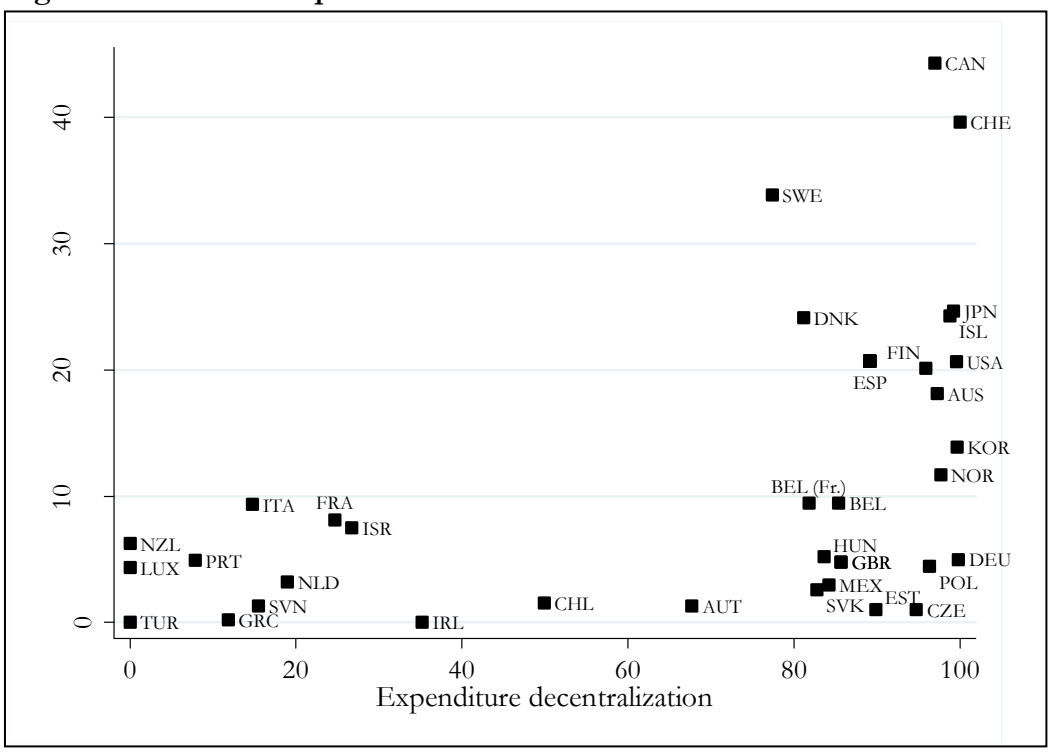
Figure 1. Education expenditure decentralization and autonomy.



Notes: data compiled by author based on OECD publications (OECD, 2004, 2008, 2012) and OECD.Stat data. *Expenditure decentralization* is defined as the percentage of subnational governments' expenditure in lower-secondary education related to general government's expenditure in lower-secondary education. *Decision-making centralization* is defined as the percentage of decisions in lower-secondary education that are taken at the central level of government.

Cross-country variation is also considerable with regard to taxing autonomy, as Figure 2 highlights. For instance, in Germany, where the education policy is highly decentralized to the subnational level of government, the degree of tax decentralization is very low, as subnational governments are financed in the main with shared taxes and general transfers from upper tiers of government. By contrast, in Canada, Switzerland and Sweden, with a similar level of education expenditure decentralization to that in Germany, subnational governments have control over more than 30 per cent of the taxes collected in the country. Despite these differences between countries, we observe that, in general, the decentralization of taxing powers does not match the decentralization of expenditure and regulatory functions in most OECD countries (Bröchliger and Rabesona, 2009).

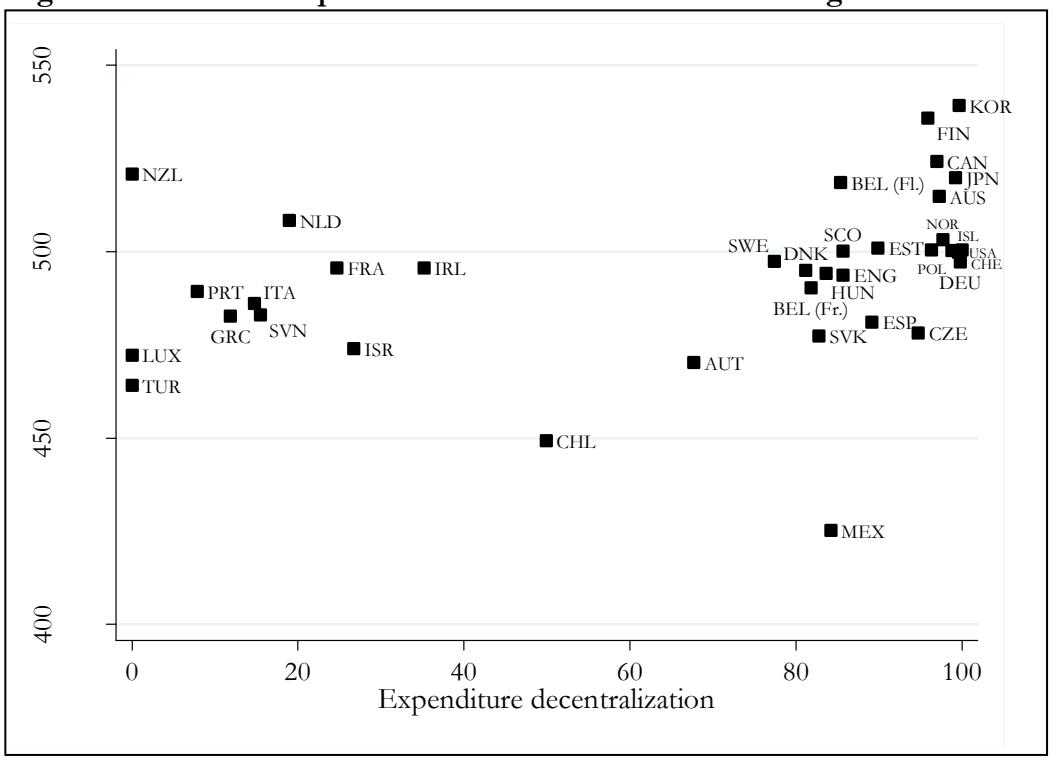
Figure 2. Education expenditure decentralization and tax decentralization.



Notes: data compiled by author based on OECD Fiscal Decentralization Database and OECD.Stat data. *Expenditure decentralization* is defined as the percentage of subnational governments' expenditure in lower-secondary education related to general government's expenditure in lower-secondary education. *Tax decentralization* is defined as the ratio of subnational own tax revenue (over which subnational governments have the power to define the tax base, the tax rate or both) to general government tax revenues.

Differences in the division of education responsibilities between tiers of government and in the degree of autonomy the latter have to take decisions and raise their own revenues could imply differences in the level of efficiency with which these responsibilities are carried out. It is worth noting that the countries with the highest student test scores in the PISA assessment (Korea and Finland) are in the group of countries with the greatest levels of decentralization in the education sector. However, as Figure 3 shows, there is no clear pattern in the relationship between education decentralization and educational outcomes. This is unsurprising, since many of the differences in educational attainment between countries can be explained by student, family and school factors. However, the countries' institutional factors have recently been demonstrated as being relevant also in explaining differences between countries (Fuchs and Woessmann, 2007).

Figure 3. Education expenditure decentralization and reading test scores.



Notes: data compiled by author based on OECD PISA Database and OECD.Stat data. *Expenditure decentralization* is defined as the percentage of subnational governments' expenditure in lower-secondary education related to general government's expenditure in lower-secondary education. Reading test scores are scaled to have an average mean equal to 500 and a standard deviation equal to 100 in OECD countries (see Annex I for details).

The aim of this study is, therefore, to analyze the effects of decentralization on the efficiency of educational policy, by examining the way in which different decentralization structures can have differential effects and by exploring the channels via which decentralization can affect educational outcomes. To achieve this, I first analyze the effects of a partial fiscal decentralization reform introduced in Spain at the beginning of the eighties, when educational responsibilities were devolved to regions that were not, however, granted any decision-making power for raising their own taxes. Second, drawing on cross-national data, I analyze the effects of decentralization on educational outcomes under different decentralization structures. That is, I analyze whether different degrees of subnational government autonomy, both on the expenditure and revenue sides, have the expected differential effects. Finally, it should be borne in mind that schools, and above all teachers, are likely to be the focus of most educational reforms aimed at improving educational outcomes. Thus, I conduct an additional analysis to determine whether teacher quality is affected

by decentralization and the extent to which this effect accounts for the impact of decentralization on educational attainment.

The rest of this chapter is organized as follows. In section 2, I review the literature examining the effects of decentralization. Here, fiscal federalism theory has advanced a number of arguments identifying both the benefits and drawbacks of decentralization, and these serve as the theoretical framework for most empirical studies that have sought to verify these claims. In section 3, I present the contributions of this dissertation to the extant literature and summarize the three analyses described above and which constitute the central chapters of this dissertation.

2. Background literature review

There is a long-standing tradition of studies examining the effects of decentralization on the efficiency of public policies in fiscal federalism theory. The main argument in favour of a decentralized provision of public goods and services is that subnational governments have a better knowledge of local preferences and needs than the central government, and therefore the former might be better placed to match the provision of public goods and services with these preferences and needs (*preference-matching argument*). Thus, in the absence of externalities and economies of scale, the decentralized provision of public goods and services should always be preferable in terms of social welfare to that of a centralized provision (Oates, 1972).

However, there is an implicit assumption in this proposition that should not be overlooked. These studies assume that governments are benevolent, in the sense that they act in the best interests of their citizens. Alternative theoretical models, in which governments seek to maximize their power or influence, began to be modelled in the public choice literature at the beginning of the eighties. In this context, where a government's objective is to maximize the public budget, Brennan and Buchanan (1980) see fiscal decentralization as a mechanism for constraining the expansionary tendencies of government. However, the combination of the decentralization of expenditures and the centralization of tax collection means that subnational governments have an unclear perception of hard budget constraints, which results in them overspending and being inefficient (Bosch and Suárez-Pandiello, 1993; Wildasin, 1997; Rodden *et al.*, 2001).

The Second Generation Theory of Fiscal Federalism, which has relaxed some of the hypotheses in Oates' theorem, seem to confirm Oates' conclusion that decentralization is preferable when externalities are small and when there is a high degree of heterogeneity between regions (Lockwood, 2002; Besley and Coate, 2003). Within this branch of the literature several authors emphasize that governments might very well prioritise their own interests or be under the sway of lobbies and rent-seeking groups, resulting in reduced efficiency (Oates, 2005; Weingast, 2009). Seabright (1996), for instance, modelled the way in which decentralization can affect a government's incentive to act in the best interests of its citizens. This author argues that government 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[2]. Since *political accountability* or the electoral control over incumbents is greater at the local level, decentralized governments will have more incentives than centralized authorities to act in accordance with the preferences of the population and, therefore, 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.

However, it has been argued that when 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. Empirical studies that have sought to test this proposition conclude that a situation of vertical fiscal imbalance encourages subnational governments to overspend and generates unsustainable deficits and demand bailouts, since the costs of local programs are not apparent to the local electorate (Rodden, 2002, 2003). Despite this evidence, recent theoretical studies conclude that the provision of public goods and services in a situation of *partial fiscal decentralization,* where subnational governments are not granted powers to raise their own revenues and rely on intergovernmental transfers to finance their expenditures, can be preferable to both full central control and

[2] Despite this definition of political accountability, the literature usually considers this term in a broader sense as the electoral rules and other institutional mechanisms that constrain the rent-seeking activities of office holders, such as the taking of bribes, the favouring of particular interest groups and insufficient innovation and effort (Lockwood, 2006).

full decentralization, when per capita spending is held fixed (Brueckner, 2009; Borge *et al.,* 2014).

It has also been argued that when decentralization generates confusion in the assignment of responsibilities between levels of government, citizens' control over incumbents can be misled (Lago-Peñas and Lago-Peñas, 2010). In addition, studies that have focused on the analysis of the relationship between decentralization and lobbying conclude that the effects of decentralization on corruption are ambiguous and context-specific, indicating the need for empirical studies (Redoano, 2010; Bardhan and Mookherjee, 2000, 2006). Thus, the theoretical effects of decentralization on the efficiency of public policies are ambiguous and empirical studies are needed in order to determine the circumstances under which a decentralization process might have beneficial effects. In the education context, the general approach adopted in analyzing the effects of decentralization 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 fiscal decentralization and educational attainment, measured at the individual level or aggregated at the regional or local levels.

The most relevant contributions include Barankay and Lockwood (2007), who analyze the relationship between expenditure decentralization and educational attainment in Switzerland; Galiani and Schargrodsky (2002) and Galiani *et al.* (2008), who analyze the effects of the decentralization process on educational attainment in Argentina between 1992 and 1994; and Falch and Fischer (2012) and Díaz-Serrano and Meix-Llop (2012), who analyze the effects of decentralization on educational attainment for a set of countries. 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).

While these studies have generated a good deal of useful information, there are a number of drawbacks that need to be addressed. First, the results of the studies focused on particular countries might not be extrapolable to other contexts. As we have seen in the previous section, there is a wide variation in the way in which countries have decentralized their education policies and in the way in which subnational governments are financed. As outlined above,

different decentralization structures are liable to generate differential effects in terms of efficiency in the provision of educational services, so that more evidence is needed in order to assure that the effects of decentralization on educational outcomes are positive. Second, related to this, measuring the degree of fiscal decentralization is a complex task that requires identifying subnational government 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 falls short at providing a full picture of decentralization. However, to provide evidence of how different structures of revenue and expenditure decentralization could have a differential impact on educational outcomes, cross-national evidence is necessary, and the question has not been addressed in the existing literature.

Finally, none of these studies has analyzed the process via which decentralization might affect educational outcomes. That is, they focus on analysing the effects of decentralization on educational attainment, without concerning themselves with the way in which subnational governments achieve the goal of improving these outcomes. Is it because there is an improvement in government and school incentives that educational resources are used more efficiently, or is it because there is a change in the level and allocation of these resources? I will focus my attention on these questions in the analyses conducted in this dissertation, which are summarized in the section below.

3. Overview of the dissertation

3.1. Filling the gaps

As discussed above, the literature analyzing the effects of decentralization on the efficiency of education policy is scarce, and has tended to focus on the decentralization processes in particular countries. However, the autonomy of subnational governments to provide educational services and the way in which such governments are financed are likely to determine the efficiency with which public policies are provided at the subnational level; thus, the results in the countries analyzed in previous studies might not be extrapolable to the education systems operated in other countries. In addition, theoretical analyses do not allow us to predict the effects of decentralization in specific contexts. For instance, while some studies predict that when subnational governments are highly dependent on intergovernmental transfers decentralization will have

a negative impact on the governments' incentives to act in the best interests of their citizens and, thus, on policy outcomes, other studies conclude that positive effects of decentralization can also be observed in such a setting. The Spanish education decentralization reform introduced at the beginning of the eighties, which was a partial fiscal decentralization reform, allows me to empirically test these hypotheses in Chapter 2.

I believe that the study reported in Chapter 2 makes a relevant contribution to the scarce empirical evidence gathered to date about the effects of decentralization on educational outcomes. First, this is the first study to analyze these effects in the context of a partial fiscal decentralization, which enables me to provide empirical evidence about one of the main points of debate in the fiscal federalism literature. Second, the way in which education policy has been decentralized in Spain, with a set of regions receiving educational powers at the beginning of the eighties and the remaining regions having to wait until the end of the nineties to receive the same powers, provides a unique benchmark against which to conduct a consistent identification of the effects of decentralization. Finally, I believe that the conclusions that can be drawn from this study are especially relevant at a time in which a process of recentralization of decision-making autonomy in the education sector in Spain is being undertaken.

While the contributions I make to the literature are relevant, the conclusions drawn from this analysis cannot be generalized to other education systems. As I have shown above, today most subnational governments enjoy a certain degree of tax autonomy, which can vary substantially from one country to another. In addition, the autonomy of subnational governments to take education policy decisions also varies greatly across countries. These differences may well mean that effects of decentralization on educational outcomes differ markedly in each country. For instance, if subnational governments are responsible for providing educational services, but they are not granted powers to decide on the main features of the education system (including such elements as teaching methods, school inputs and the allocation of school resources), they are unlikely to be able to improve the levels of educational attainment. I address these questions in Chapter 3.

The analysis in Chapter 3 contrasts with analyses reported in previous studies, since it draws on cross-national evidence to analyse the way in which different structures of expenditure and revenue decentralization have a differential

impact on the efficiency of public education policies, a question hitherto unaddressed in this branch of literature. Thus, I am able to determine whether evidence previously reported for Switzerland, Argentina and Spain can be generalized to other countries, and I can provide evidence of the expected effects of decentralization when subnational governments enjoy different degrees of autonomy, both on the expenditure and revenue sides. In addition, in this study educational outcomes are measured with the PISA test scores, which have certain advantages with regard to the discussion of the economic implications of the results, as higher achievement on 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).

Thus, the analyses conducted in Chapters 2 and 3 provide evidence of the effects of decentralization on educational attainment, and they allow us to determine, as the theory predicts, whether these effects depend on the autonomy enjoyed by subnational governments to match policies with local preferences and needs and to raise their own revenues. However, these studies tell us nothing about the process via which the educational outcomes might vary depending on whether a country operates a decentralized or a centralized system. In Chapter 4 I provide a number of insights into this question, by analyzing the role of teacher quality in a decentralization process, that is, how teacher quality might be affected by decentralization and the extent to which this effect explains the effects of decentralization on educational attainment.

The relationship between decentralization and teacher quality has received little attention in the literature and, to the best of my knowledge, the study in chapter 4 is the first attempt to empirically analyze it. In addition to the empirical analysis, an effort has been made in Chapter 4 to summarize the arguments that underpin the relationship between decentralization and teacher quality. Finally, this is also the first study that seeks to analyze the process via which decentralization might affect educational attainment. The methodology used in this study to address this question, which decomposes the total effect of decentralization into a direct effect and an indirect effect via teacher quality has not been applied before in the economics of education empirical literature, which has always tended to focus on the estimation of reduced-form equations of educational attainment. Here, however, I estimate a structural model in which teacher quality variables are also considered endogenous variables.

3.2. Dissertation structure

The three analyses conducted in this dissertation are presented in Chapters 2, 3 and 4, and the conclusions are presented in Chapter 5. In Chapter 2 I analyze the effects on educational outcomes of the partial fiscal decentralization reform in Spain. The decentralization of education in Spain meant the devolution of most educational responsibilities to the regions (or Autonomous Communities) of Cataluña, País Vasco, Galicia, Andalucía, Comunidad Valenciana and Canarias at the beginning of the eighties. This reform was marked by the fact that the recently created regional governments were not granted any powers to raise their own revenues. The public services supplied by these regions were financed with general grants awarded by the central government. The regional governments were then free to allocate these grants as they saw fit to different uses and policies. An additional feature of this reform was that while these historic regions and islands were able to accede to all the powers not specifically assigned to the central government in the constitution at the beginning of the eighties, the other regions did not receive these powers until the end of the nineties.

These circumstances provide a natural benchmark against which to identify the effects of the partial education decentralization reform in Spain, since the regions that did not receive these educational powers in each time period can be used as a comparison group. Given that the decision to decentralize educational policy to these regions was made on historical grounds, and as part of a broader decentralization process affecting other areas of expenditure policy, I do not expect the implementation of the reform to have been determined by the characteristics of the educational sector. Despite this, I estimate the effects of the reform on educational outcomes with a *difference-in-differences* approach, which allows me, on the one hand, to control for the temporary shocks that affect the outcomes of all the regions equally and, on the other, to control for the non-observable characteristics of the regions that might influence the evolution of their educational outcomes and which could result in differences between the treatment and comparison groups before decentralization. I conduct the analysis with a panel dataset containing information on the 50 provinces of Spain for the period 1977-1991.

In Chapter 3, drawing on cross-national data, I examine the effects of decentralization on the efficiency of educational policies under different decentralization structures, with variables that measure the expenditure and

revenue sides of decentralization. I conduct the analysis within the education production function framework, which considers the education process as analogous to a firm's production process, where educational resources or inputs are transformed into educational achievement or 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. For this analysis I use 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 provides internationally comparable information about students' achievement and the relevant inputs to the educational process.

By including detailed information about educational inputs, I can 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). In this way, the potential endogeneity of decentralization in a cross-sectional setting is addressed. I additionally test the robustness of the results by controlling for the observable and non-observable characteristics of countries that are common in countries which are close geographically and for countries' observable characteristics, such as economic development and perceived corruption, which are likely to be related to both educational outcomes and decentralization policies.

In Chapter 4 I seek to analyze the role of teacher quality in a decentralization process –that is, how it might be affected by decentralization and the extent to which this explains decentralization effects on educational attainment. In addition, I analyze whether these effects vary according to whether educational policy is decentralized to the regional or to the local level of government, and so take into account that the impact might depend on the size of the labour market in which subnational governments can hire teachers. Positive effects of decentralization on teacher quality derived from the better knowledge that subnational have regarding their population and their schools' needs and from the improved accountability may be undermined if the labour market in which the decentralized government can hire teachers is small or if the shortened

distance between policy-makers and schools makes school-based interest groups more influential, resulting in an increase in the level of corruption in the education sector.

Evidence regarding which characteristics of teachers are relevant for teacher quality is mixed. While some studies conclude that attributes such as a teacher's experience, knowledge and certification have a significant effect on student achievement (Wiswall, 2013; Metzler and Woessmann, 2012), other studies support the hypothesis that teachers' unobservable characteristics might have a greater effect on student achievement (Hanushek *et al.*, 2005; Rivkin *et al.*, 2005). In this study, I take advantage of the detailed information provided by the OECD PISA database to define teacher quality in terms of those teacher characteristics that are thought to be conducive to educational achievement: teacher education, defined as the percentage of teachers holding a master's degree in each school; teacher certification, defined as the percentage of teachers in each school that are certified by the competent authority; and disciplinary climate, which after controlling for students and schools' characteristics, can be considered as a proxy for the teacher ability and incentives to create and maintain an effective learning environment in class.

References

Barankay, I. and Lockwood, B. (2007): "Decentralization and the productive efficiency of government: evidence from Swiss cantons", *Journal of Public Economics* 91, 1197-1218.

Bardhan, P. and Mookherjee, D. (2000): "Capture and governance at local and national levels", *American Economic Review* 90(2), 135-139.

Bardhan, P. and Mookherjee, D. (2006): "Decentralization, corruption and government accountability: an overview", in *International Handbook on the Economics of Corruption*, S. Rose-Ackerman (Ed.), Edward Elgar Publishing, Northampton.

Barro, R. J. and Sala-i-Martin, X. (2004): *Economic growth*, 2nd edition, MIT Press, Cambridge, MA.

Besley, T. and Coate, S. (2003): "Centralized versus decentralized provision of local public goods: a political economy approach", *Journal of Public Economics* 87, 2611-2637.

Bishop, J. (1992): "The impact of academic competences on wages, unemployment and job performance", *Carregie-Rochester Conference Series on Public Policy* 37, 127-194.

Blöchliger, H. and Rabesona, J. (2009): "The fiscal autonomy of sub-central governments: an update", OECD Working Papers on Fiscal Federalism 9.

Borge, L.E., Brueckner, J.K. and Rattso, J. (2014): "Partial fiscal decentralization and demand responsiveness of the local public sector: theory and evidence from Norway", *Journal of Urban Economics* 80, 153-163.

Bosch, N. and Suárez-Pandiello, J. (1993): "Tamaño del sector público y descentralización fiscal", *Revista de Economía Aplicada* 1(3), 181-193.

Brennan, D. and Buchanan, J. (1980): *The power to tax: analytical foundations of a fiscal constitution*, Cambridge University Press, Cambridge.

Brueckner, J.K. (2009): "Partial fiscal decentralization", *Regional Science and Urban Economics* 39, 23-32.

Díaz-Serrano, L. and Meix-Llop, E. (2012): "Do fiscal and political decentralization raise students' performance? A cross-country analysis", IZA Discussion Paper 6722.

Ebel, R.D. and Yilmaz, S. (2002): "On the measurement and impact of fiscal decentralization", WB Policy Research Working Papers 2809.

Falch, T. and Fischer, J.A.V. (2012): "Public sector decentralization and school performance: international evidence", *Economic Letters* 114, 276-279.

Fuchs, T. and Woessmann, L. (2007): "What accounts for international differences in student performance? A re-examination using PISA data", *Empirical Economics* 32, 433-464.

Galiani, S. and Schargrodsky, E. (2002): "Evaluating the impact of school decentralization on educational quality", *Economía* 2(2), 275-302.

Galiani, S., Gertler, P. and Schargrodsky, E. (2008): "School decentralization: helping the good get better, but leaving the rest behind", *Journal of Public Economics* 92, 2106-2120.

Hanushek, E.A., Kain, J.F., O'Brien, D.M and Rivkin, S.G. (2005): "The market for teacher quality", NBER Working Paper 11154.

Hanushek, E.A. and Kimko, D.D. (2000): "Schooling, labor-force quality and the growth of nations", *American Economic Review* 90, 1184-1208.

Hanushek, E.A. and Woessmann, L. (2007): "The role of education quality for economic growth", WB Policy Research Working Papers 4122.

Hanushek, E.A. and Woessmann, L. (2011): "The economics of international differences in educational achievement", in *Handbook of the Economics of Education*, E.A. Hanushek, S. Machin and L. Woessmann (Eds.), Vol. 3, Elsevier, Amsterdam.

Hindriks, J. and Lockwood, B. (2005): "Centralization and political accountability", CEPR Discussion Paper 5125.

Lago-Peñas, I. and Lago-Peñas, S. (2010): "Decentralization and electoral accountability", *Environment and Planning C: Government and Policy* 28, 318-334.

Lockwood, B. (2002): "Distributive politics and the costs of centralization", *Review of Economic Studies* 69, 313-337.

Lockwood, B. (2006): "Fiscal decentralization: a political economy perspective", in *Handbook of Fiscal Federalism*, E. Ahamad and G. Brosio (Eds.), Edward Elgar Publishing, Northampton.

Metzler, J. and Woessmann, L. (2012): "The impact of teacher subject knowledge on student achievement: evidence from within-teacher within-student variation", *Journal of Development Economics* 99, 486-496.

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

Oates, W.E. (2005): "Toward a second-generation theory of fiscal federalism", *International Tax and Public Finance* 12, 349-373.

OECD (2004): *Education at a glance 2004: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2008): *Education at a glance 2008: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2012): *Education at a glance 2012: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

Persson, T. and Tabellini, G. (2000): *Political economics: explaining economic policy*, MIT Press, Cambridge, MA.

Redoano, M. (2010): "Does decentralization affect the number and size of lobbies?", *Journal of Public Economic Theory* 12(3), 407-435.

Rivkin, S.G., Hanushek, E.A. and Kain, J.F. (2005): "Teachers, schools and academic achievement", *Econometrica* 73(2), 417-458.

Rodden, J. (2002): "The dilemma of fiscal federalism: grants and fiscal performance around the world", *American Journal of Political Science* 46(3), 670-687.

Rodden, J. (2003): "Reviving leviathan: fiscal federalism and the growth of government", *International Organization* 57(4), 695-729.

Rodden, J., Eskeland, G. and Litvack, J. (2001): *Decentralization and the challenge of hard budget constrains*, MIT Press, Cambridge, MA.

Romer, P.M. (1986): "Increasing returns and long run growth", *Journal of Political Economy* 94, 1002-1037.

Romer, P.M. (1990): "Endogenous technological change", *Journal of Political Economy* 98(5), 71-102.

Salinas-Jiménez, M.M., Artés, J. and Salinas-Jiménez, J. (2013): "How do educational attainment and occupational and wage-earner statuses affect life satisfaction? A gender perspective study", *Journal of Happiness Studies* 14(2), 367-388.

Seabright, P. (1996): "Accountability and decentralisation in government: an incomplete contracts model", *European Economic Review* 40, 61-89.

Weingast, B.R. (2009): "Second generation fiscal federalism: the implications of fiscal incentives", *Journal of Urban Economics* 65(3), 279-293.

Wildasin, D.E (1997): "Externalities and bailouts: hard and soft budget constraints in intergovernmental fiscal relations", WB Policy Research Working Papers 1843.

Wiswall, M. (2013): "The dynamics of teacher quality", *Journal of Public Economics* 100, 61-78.

Chapter 2

Partial Fiscal Decentralization Reforms and Educational Outcomes: a Difference-in-Differences Analysis for Spain

1. Introduction

In the last three decades Spain has been involved in a far-reaching process of decentralization, to the extent that today it is one of the most decentralized economies in Europe. As a result of this process important areas of expenditure, such as education, health or social welfare, are nowadays devolved to the regional governments (Solé-Ollé, 2010). Focusing on the education policy area, we find that while regions with a historic regional status and islands were able to accede to the educational powers not specifically assigned to the central government in the Spanish Constitution (1978) at the beginning of the eighties, the other regions did not receive these powers until the final years of the nineties. This fact provides a benchmark that allows us to identify the effects of the education decentralization reform by using the regions that had not received the educational powers in each time period as the comparison group for the regions that had received them.

Thus, the aim of this study is to evaluate the effects of the education decentralization reform in Spain on the efficiency of the educational policy. A characteristic of the decentralization reform in Spain at the beginning of the eighties is that it was a partial decentralization reform, that is, subnational governments were not granted any powers to raise their own revenues. Within this context, theory remains inconclusive regarding the effects of decentralization and empirical analyses are required (Weingast, 2009; Brueckner, 2009; Borge *et al.,* 2014). Despite this need, empirical studies on the effects of decentralization have, until recently, been virtually non-existent. The

general approach of the empirical literature to the analysis of the effects of decentralization on the *productive efficiency* in the provision of educational services has focused on estimating its effects on certain measures of policy outcomes in specific countries (Barankay and Lockwood, 2007; Galiani *et al.*, 2008). Since the degree of autonomy of subnational governments in the countries analyzed in these studies (Switzerland and Argentina, respectively) was not the same as that in Spain at the beginning of the eighties, the results of these studies might not be extrapolable to the case of Spain.

The effects of the decentralization reform in Spain in the educational sector have only been previously studied in Esteller-Moré and Solé-Ollé (2005), where the focus was specifically on the analysis of its effects on the *allocative efficiency* of education investment policies. That is, the authors analyze whether the decentralization reform in Spain had an impact on investment patterns and the extent to which these changes could be related to objective measures of needs. They concluded that the Spanish decentralization reform improved *allocative efficiency* in both education and road investment.

In this study, we analyze the effects of the education decentralization reform occurred at the beginning of the eighties on educational outcomes with a *difference-in-differences* approach, using the regions that did not receive their educational powers during this period as the comparison group. Since the decision to decentralize educational policy to these regions was made on historical grounds, and as part of a broader decentralization process affecting other areas of expenditure policy, we can consistently estimate the effects of the reform on educational outcomes with this approach.

We measure educational outcomes using the *promotion rate* by grade and educational programme in secondary (non-compulsory) education, defined as the proportion of students from a cohort enrolled in a given grade at a given school-year who study in the next grade in the following school-year (UNESCO, 2009). There are at least two reasons for our interest in the proportion of students who remain in full-time education after finishing compulsory education. First, in a country where enrolment rates in compulsory education are close to 100%, as it was the case in Spain, it seems appropriate to use a variable that measures the proportion of students that stay on at school after this period to measure educational outcomes. Second and most importantly, still nowadays each year a large number of young people in Spain fail to finish secondary education. As a consequence, upper-secondary

graduation rates in Spain remain low in international comparisons and raising them is one of the main objectives facing the educational policy in Spain, as it was during the eighties.

The evolution of the *promotion rate* can be explained both by the *repetition rate* and the *dropout rate* in each grade. Thus, in order to provide a full picture of the effects of the education decentralization reform in Spain, we also analyze the effects of decentralization on these two variables. *Dropout rates* might be understood as a process rather than the result of one single event, which might be influenced by socio-economic factors, but also by the performance of students at school. Although there is not clear evidence, grade repetition has often been signalled as one of the precursors to dropping out (Hunt, 2008). Thus, we find it interesting to analyze the effects of decentralization on these variables along the different grades and educational programmes of secondary education.

Our results show that decentralization in Spain was followed by an increase in the *promotion rates* in all grades of the general programme of secondary education. However, it was also followed by a decrease in the *promotion rates* of the vocational programme. We find, though, that these negative effects disappear for cohorts that have been under a decentralized regime for five years or more. We also find that the effects of decentralization in Spain highly depend on the level *public revenues* of the regions. More specifically, we find that the positive effects of decentralization on the *promotion rates* in the general programme disappear in regions with a low level of *public revenues*, and the negative effects of decentralization on the *promotion rates* in the vocational programme disappear in regions with a high level of *public revenues*. Thus, the results in this study are highly conditioned by the fact that we are analyzing a partial fiscal decentralization reform, where subnational governments did not have the decision-making autonomy to raise their own revenues if they needed to do so.

Finally, we find that variations in the *promotion rates* as a consequence of the decentralization reform are mostly explained by variations in the *dropout rates* and not in the *repetition rates*. We only observe a significant effect of decentralization on the *repetition rates* in the first grade, which is positive both in the general and the vocational programme. Thus, we can conclude that the observed increase in the *promotion rates* in the general programme was not achieved by means of decreasing educational standards. Given that the general

programme is the chosen avenue into university for most students, and that the attractiveness of vocational education in Spain is much lower than that of this general programme, differences in the effects of decentralization on educational outcomes in the general and the vocational programmes might reflect a better match between population preferences and educational policies consequent upon decentralization. Within a context where the resources were scarce and subnational governments had not been granted powers to raise their own revenues, regional governments might have concentrated their efforts and resources on improving the outcomes in the general programme.

To conduct the analysis, we constructed a panel data set containing information on the 50 provinces of Spain for the period 1977-1991, a period that includes the years before and after the education decentralization reform of the eighties. The reason to focus our study on this period is that a reform of the educational system that extended compulsory education from the age of 14 until the age of 16 was implemented at the same time that decentralization at the end of the nineties. In addition, during the nineties there was also a reform of the regional funding system, which implied a significant increase in the degree of taxing autonomy of regional governments (Bosch and Duran, 2005). As a consequence, it is difficult to disentangle the effects of the education decentralization reform during the nineties from the effects of the education and the funding system reforms.

The rest of this chapter is organized as follows. Section 2 offers a review of the literature that has examined the effects of decentralization, including both theoretical and empirical analyses. Section 3 describes the main features of the educational sector in Spain, with particular reference to the education decentralization reform. Section 4 describes the empirical strategy, including a description of the variables that we included in the analysis and our data sources. Sections 5 and 6 present the results we obtain from the analysis, including different tests to corroborate the robustness of our results and the validity of our comparison group. Finally, the last section reports the conclusions that can be drawn from the analysis.

2. Literature Review

2.1. Theoretical background

Fiscal federalism theory has traditionally presented decentralization movements as a trade-off between potential benefits, in terms of both *productive* and *allocative efficiency*, and possible drawbacks, that stem from the existence of *spillover* effects and economies of scale.

The *Decentralization Theorem* (Oates, 1972) claims that, in the absence of externalities and economies of scale, the decentralized provision of public goods will always be preferable in terms of social welfare to that of a centralized provision. This is because it is assumed that regional governments are better informed about local preferences and circumstances than the central government is, and this ensures that they are more responsive to local needs and are better placed to match local preferences with the provision of public goods and services (*preference-matching argument*). However, there is an implicit assumption in this proposition that should not be overlooked. These studies assume that governments are benevolent, in the sense that they act in the best interests of their citizens. This hypothesis, though, has been called into question by more than one author in recent years, as governments might very well prioritise their own interests (Oates, 2005; Weingast, 2009) or be under the sway of lobbies and rent-seeking groups, resulting in reduced *productive efficiency*.

Seabright (1996), for example, has modelled the way in which decentralization can affect a government's incentive to act in the best interests of its citizens. This author argues that government 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[1]. Since *political accountability* or the electoral control over incumbents is greater at the local level, decentralized governments will have more incentives than centralized authorities to act in accordance with the preferences of the population and, therefore, be less corrupt (*accountability argument*). Persson and Tabellini (2000) and Hindriks and Lockwood (2005) reach similar conclusions about the

[1] Despite this definition of *political accountability,* the literature usually considers this term in a broader sense as the electoral rules and other institutional mechanisms that constrain the rent-seeking activities of office holders, such as the taking bribes, favouring of particular interest groups and insufficient innovation and effort (Lockwood, 2006).

relationship between decentralization, political accountability and government behaviour. However, some authors argued that the electoral control over incumbents might diminish under a decentralized system, when the assignment of responsibilities between levels of government is not clear to the electorate (Lago-Peñas and Lago-Peñas, 2010). In addition, studies that have focused on the relationship between decentralization and lobbying conclude that the effects of decentralization on corruption are ambiguous and context-specific, indicating the need for empirical studies (Redoano, 2010; Bardhan and Mookherjee, 2000, 2006).

It has also been argued that the combination of the decentralization of expenditures and the centralization of tax collection means that subnational governments have an unclear perception of hard budget constraints, which causes them to overspend and to be inefficient (Bosch and Suárez-Pandiello, 1993; Wildasin, 1997). More recent studies, though, show that under such a partial decentralization setting the subnational provision of public goods and services can also be preferable to the central government provision (Brueckner, 2009; Borge *et al.*, 2014). Thus, theoretical analyses do not allow us to draw any definitive conclusions regarding the superiority of centralised or decentralised systems in terms of their respective economic efficiency. In addition, the net benefits of decentralization are likely to vary between policies and localities, and the choice between centralized and decentralized forms of government is highly sensitive and probably context-specific, which makes empirical studies necessary.

2.2. Related empirical studies

The empirical literature examining the effects of decentralization on both *allocative* and *productive efficiency* has, until recently, been virtually non-existent and, indeed, continues to be somewhat scarce. On the one side, Faguet (2004) and Esteller-Moré and Solé-Ollé (2005) examine the influence of decentralization on the *allocative efficiency* of the educational policy by determining whether the process has had an impact on investment patterns (across Bolivian municipalities in the first instance and Spanish provinces in the second), and the extent to which these changes could be related to objective measures of needs. Both studies conclude that decentralization has led to a better adjustment between investment patterns and needs, providing evidence that corroborates one of the main theories of fiscal federalism.

On the other side, the empirical literature analysing the impact of decentralization on the *productive efficiency* has not attempted to identify the particular channels discussed above. Rather, as discussed by Barankay and Lockwood (2007), the general approach has involved examining reduced-form equations, where educational outcomes are regressed on fiscal decentralization measures. For instance, Barankay and Lockwood (2007) analyze the effects of decentralization on educational attainment (measured using the *maturité rate,* defined as the ratio between the number of students obtaining the university entrance qualification and the number of 19 year olds in the population) in the Swiss cantons. The conclusion in this study is that decentralization is positively related to educational attainment, and that it is more beneficial when subnational governments have a low fiscal deficit. Likewise, Galiani and Schargrodsky (2002) and Galiani *et al.* (2008) report a positive impact of decentralization on educational outcomes in Argentina (measured using standardized test scores of Argentine students), but only in provinces that do not report a very large fiscal deficit and in schools in non-poor communities, respectively.

However, as noted above, the effects of decentralization might be context-specific, so that the results of these studies might not be extrapolable to the Spanish case. That is, the effects of decentralization are likely to depend on how subnational governments are financed and on the degree of political accountability in each country. The education decentralization reform in Spain was a partial fiscal decentralization reform, since subnational governments were not granted powers to raise their own revenues. In addition, democracy in Spain had just been established after a long period of dictatorship. Thus, we might not expect the effects of decentralization to be the same in this country than in Switzerland, with a long democratic tradition, or Argentina, where a far-reaching process of revenue decentralization had been implemented before educational competences were devolved to the provinces. Finally, the way in which the educational decentralization reform has evolved in Spain provides a unique benchmark where to consistently identify its effects. Given these arguments, and the fact that the case of Spain has only been analysed in Esteller-Moré and Solé-Ollé (2005)[2], and then solely in terms of *allocative*

[2] The effects of decentralization in Spain have been analyzed in other contexts than education. For instance, Carrion-i-Silvestre *et al.* (2008) analyze its effects on economic growth for the period 1965-2000, concluding that the effect was positive for those regions with the highest levels of fiscal decentralization, but negative for those regions with the lowest levels of competencies.

efficiency of investment, we consider an empirical analysis of the effects of decentralization on educational outcomes in Spain to be of great interest.

3. The main features of the education sector in Spain

3.1. Decentralization process

We can trace the process of decentralization in Spain back to 1978, when the Spanish Constitution was enacted. The 1978 Constitution clearly laid down the foundations that would enable Spain to become one of the most decentralized economies in Europe. That is, it established the grounds to create subnational autonomous regions (17 self-governing communities were formed) and specified the division of powers between the central government and the new regional governments. In the education sector, the Constitution upheld the central government's power to define the main structure of the education system, to regulate the requirements for the obtaining, issue and standardization of academic degrees and professional qualifications and to establish the basic rules to guarantee the unity of the Spanish education system. In practice, that meant that the central government kept the decision-making power to define the programmes of study, the subjects to be taught and most of the course content. All other responsibilities in the sector, however, were provided for being devolved to the regional governments. For instance, decisions about assignment of students to schools, teaching methods and personnel management (except decisions about salary levels) were not specifically assigned to the central government in the Constitution.

One of the main features of Spain's process of decentralization has been the asymmetrical manner in which it has been conducted (García-Milà and McGuire, 2002). While historic regions and islands were able to accede to all the powers not specifically assigned to the central government in the Constitution (section 149) following the approval of their Devolution Statutes (that is, Cataluña, País Vasco, Galicia, Andalucía, Comunidad Valenciana and Canarias), the other autonomous regions had to wait five years following the approval of their Devolution Statutes to be assigned the same powers. In practice, however, these non historic regions were not able to receive these educational powers until the approval of the *Acuerdos Autonómicos de ampliación de competencias* in 1992, and the transfers were not made effective until the final years of the nineties. As a result, the decentralization process has taken place over almost two decades, but today all the regions enjoy the same powers in

the education sector. Table 1 shows the year in which the individual Statutes of Autonomy were introduced in each region or Autonomous Community and the year in which educational powers were transferred to them.

Table 1. Statutes of Autonomy and educational transfer decrees.

Region	Statutes of Autonomy Constitutional Laws	Educational transfers decrees
Treated group		
País Vasco	3/1979	2808/1980
Cataluña	4/1979	2809/1980
Galicia	1/1981	1763/1982
Andalucía	6/1981	3936/1982
Canarias	10/1982	2091/1983
C. Valenciana	5/1982	2093/1983
Navarra	13/1982	1070/1990
Comparison group		
Baleares	2/1983	1876/1997
La Rioja	3/1982	1826/1998
Aragón	8/1982	1982/1998
Cantabria	8/1981	2671/1998
Madrid	3/1983	926/1999
Murcia	4/1982	938/1999
Castilla y León	4/1983	1340/1999
Extremadura	1/1983	1801/1999
Castilla La Mancha	9/1982	1844/1999
Asturias	7/1981	2081/1999

Source: Boletín Oficial del Estado (BOE).

During the first years following the decentralization reform at the beginning of the eighties, the central government had to guarantee to the subnational governments the resources that were necessary to provide all the services that had been decentralized with general transfers. In practice, though, the difficulties to compute the level of resources that were needed to provide these services has been argued to lead to a shortage of subnational revenues in some regions and to the existence of relevant unbalances between territories with regard to their level of public revenues as compared to their needs. It was not until 1986 when a new regional funding system was defined, which started to be applied in 1987. However, the new funding system did not implied a relevant change in the fiscal autonomy of regional governments and it did not correct the unbalances from the previous period (Bosch and Duran, 2005). Despite the decentralization reform was partial, during all the period we analyze in this study (1977-1991) subnational governments had the decision-

making power to freely allocate their resources among the different areas of expenditure.

3.2. Education system structure

When the Spanish Constitution was enacted in 1978, the education system in Spain was regulated by the *Ley General de Educación* (LGE) from the year 1970, which made education free and compulsory until the age of 14. In addition, with the aim of guaranteeing free education, a system of public subsidies to private schools was set in motion. This law also introduced vocational training into the education system as an alternative pathway to the general programme upon completion of compulsory education and to facilitate young people's entry into the labour market. Thus, after compulsory education, there was a secondary education *general programme,* which was a three years programme, plus one year of preparation for the entry to university. And a secondary education *vocational programme,* which was a five years programme, divided in two stages. After the first stage of the vocational programme (with a duration of 2 years) it was possible to change to the first course of the general programme, and after the second stage of the vocational programme (with a duration of 3 years) it was possible to change to the course of preparation for university. In 1978, the average gross enrolment rate in secondary education in Spain was 52.1 per cent, 36.1 per cent in the general programme and 16 per cent in the vocational programme.

In 1985, the *Ley Orgánica Reguladora del Derecho a la Educación* regulated the state-assisted schools, which combined free education in private schools with parental discretion regarding the school to which they could send their children, although these schools existed yet before this law. The basic structure of the education system was not altered until 1990, when the *Ley Orgánica de Ordenación General del Sistema Educativo* (LOGSE) extended compulsory education to the age of 16 and created advanced vocational training schools. Because of this reform, we focus our analysis on the period 1977-1991, before it started to be implemented[3]. In 1991, the average gross enrolment rate in secondary education was 89.1 per cent in Spain (61 per cent

[3] The LOGSE educational reform was approved in 1990, and it was progressively implemented between 1992 and 2003. Since this reform was not implemented at the same time in regions decentralized in the eighties than in regions decentralized in the nineties, an analysis of the effects of decentralization on educational outcomes at the end of the nineties would confound these effects with those of the educational reform. For an analysis of the effects of the LOGSE educational reform on *dropout rates* see Felgueroso *et al.* (2013).

in the general education programme and 28.1 per cent in the vocational training programme), although differences between regions were quite significant. Thus, during the eighties enrolment rates in secondary education in Spain experienced a significant growth.

4. Methodology

4.1. Empirical strategy

The aim of this study is to evaluate the effects of the decentralization reform in Spain on the country's educational outcomes. As it is well known in the public policy evaluation literature, the effect of decentralization in any region *s* is given by the difference between the outcomes in this region at time *t* after decentralization and the outcomes in this region had it not been decentralized:

$$\alpha_{st} = Y_{st}^{D} - Y_{st}^{ND} \tag{1}$$

where α_{st} denotes the individual-specific treatment effect, Y_{st}^{D} denotes the outcomes in the treated group of regions if decentralized, and Y_{st}^{ND} the outcomes in the treated group of regions had they not received educational powers (Blundell and Costa Dias, 2000, 2002). However, as it is not possible to observe what would have happened had decentralization not taken place in a particular region, Y_{st}^{ND} is non-observable and has to be estimated. When experimental data are available, the outcomes in the non-treated regions can be used to approximate Y_{st}^{ND}.

In our study, although we do not have any experimental data, we are fortunate that educational powers in Spain were devolved to the regions at different points in time in base to historical reasons. In addition, since the education decentralization reform in Spain was made within a broader process of decentralization, which implied both the creation of the regional level of government and the devolution of different public policies to the new regional governments, its implementation was not determined by the characteristics of the educational sector. Thus, we can use the outcomes in the non-decentralized regions to estimate what would have happened in the decentralized regions had they not been decentralized (Diamond and Robinson, 2010).

Despite these arguments, we estimate the effects of decentralization with a *difference-in-differences* method, which enables us to control for differences between regions in terms of the observable and non-observable time unvarying characteristics that might be related both to educational outcomes and the selection of regions that were granted powers in the field of education at the beginning of the eighties. For instance, it might be the case that the importance attached to education was different in historic regions, with a common culture and often with an own language, than in the other regions[4]. Thus, the equation we estimate is:

$$Y_{ist} = \Phi_s + \theta_t + d_{st}\alpha + \varepsilon_{ist} \qquad (2)$$

where Y_{ist} represents the educational outcomes in province *i* in region *s* in year *t;* Φ_s is a region-specific fixed effect, which controls for the unobservable or non-measurable characteristics of regions; θ_t is a common macro-economic effect (measured with year dummies), which allows us to control for the temporary shocks that affect the outcomes of all provinces equally (for instance, a central government reform or common economic shocks); d_{st} is the decentralization variable for region *s* in year *t;* and ε_{ist} is a temporary individual-specific effect. We estimate this model for the *promotion rate* in the different grades of the general and vocational secondary education programmes.

Decentralization is defined with a dummy variable that takes the values 1 if the region *s* is decentralized in year *t,* and 0 otherwise. We consider this variable to be appropriate in the case of Spain, where the decentralization of spending in education has also meant devolution in decision-making powers to the regions, and where educational powers were transferred by law at a specific point in time. However, we also define an additional measure of decentralization that allows testing whether the effects of decentralization depend on the length of time that a cohort has been exposed to a decentralized regime.

[4] If such differences were to exist and we did not control for them, a non-zero correlation between the decentralization variable and the error term in the outcome equation would appear, and our estimates of the impact of decentralization would be affected by a selection bias (Heckman and Hotz, 1989).

4.2. Estimation and identifying assumptions

The model presented above (equation 2) allows any kind of dependence between selection for treatment, d_{it}, and the region-specific component, Φ_s. Thus, we first need to take first differences to get rid of the regional fixed effects, and then to apply pooled ordinary least squares (POLS) to the differenced equation to estimate it (Wooldridge, 2002). We compute robust variance estimates and conduct our estimations by clustering the error term at the regional level, in order to adjust the standard errors for intra-group correlation (between provinces in the same region) and to obtain a variance covariance matrix which is consistent in the presence of any correlation pattern within regions over time (Bertrand *et al.*, 2004)[5].

The only assumption that we need so as to identify the effect of decentralization on educational outcomes, α, is that selection into treatment is independent of the temporary individual-specific effect. This ensures that the evolution of the outcomes in non-decentralized regions is the same as they would have been in decentralized regions had the latter not been decentralized:

$$\left(Y_{t_1}^{D} - Y_{t_0}^{D}\right), \left(Y_{t_1}^{ND} - Y_{t_0}^{ND}\right) \perp D \tag{3}$$

where $\left(Y_{t_0}^{D}, Y_{t_1}^{D}\right)$ denote the outcomes for the treated group of regions before and after the reform, respectively, and $\left(Y_{t_0}^{ND}, Y_{t_1}^{ND}\right)$ the outcomes of the comparison group of regions also before and after the reform. Thus, in order to ensure the consistent estimation of the effect of the decentralization reform in Spain on educational outcomes (Y), we need to corroborate that the common trend assumption (3) is accomplished in our setting (Angrist and Pischke, 2009). We conduct different analyses to test the identifying assumption –that absent decentralization the treated group of regions would have experienced similar trends in the outcomes to the comparison ones- is accomplished.

The advantage of the *difference-in-differences* estimation method is that it accounts for any time unvarying characteristic of the regions which may determine both student outcomes and the desire of regional governments to be granted powers in the field of education. However, differences in the time varying

[5] We compute a bias corrected cluster-robust variance matrix to account for the small number of clusters.

characteristics of the regions might cause the evolution of the outcomes to be different in decentralized and non-decentralized regions. Thus, first, we assess the importance of the non-random selection in base to the observable characteristics of the regions by simple comparison of these characteristics in the two groups of regions before decentralization was initiated. In this way, we can test whether inclusion within the decentralization reform depended on these variables, so that their omission in the outcomes equation might bias the estimated decentralization parameter. In addition, balance in pre-treatment characteristics is always a good feature in this context, since if the treated and non-treated groups look equal, it is more likely that they would behave in a similar way absent decentralization.

Second, we analyze whether the treated and comparison groups display the same secular trends in their outcome variables before decentralization. We conduct this analysis graphically, and by estimating the following equation for the years before the decentralization process was started,

$$Y_{ist} = \Phi_s + \theta_t + \gamma_1 \cdot t \cdot DC_s^{80} + \gamma_2 \cdot t \cdot DC_s^{90} + \varepsilon_{ist} \qquad (4)$$

where DC_s^{80} is a dummy variable that takes the values 1 if region *s* receives education responsibilities during the eighties, and 0 otherwise; and DC_s^{90} is a dummy variable that takes the values 1 if region *s* receives education responsibilities during the nineties, and 0 otherwise; t represents a trend variable, and the rest of variables are defined as before. We estimate this equation in first differences for the years before decentralization takes place, that is, for the period 1977-1980, and then we test if the difference between γ_1 and γ_2 is statistically significant.

4.3. Robustness checks

We conduct three additional analyses that allow us to relax the common trend assumption needed for the *difference-in-differences* estimator to be consistent. First, we include in the regression equation (2) a set of variables that control for time varying characteristics of regions that might be considered as being associated with the dynamics of the outcome variable. In line with previous evidence on education production functions (Hanushek, 1986, 2003), we consider the potential determinants of educational attainment in Spain to be the *schooling* level of the active population and the *per capita income*, as measures

of family background and inputs; the *unemployment rate,* as being representative of the broader context of the educational sector; and the level of *public revenues* related to the regions' GDP, as a measure the economic capacity of subnational governments. By including these control variables in the regression we ensure that we are comparing the outcomes of decentralized regions with the outcomes in non-decentralized regions that have similar observable characteristics, and thus, which would respond in the same way to the decentralization policy.

However, if the omitted time varying characteristics of regions were non-observable, or they were not included in our set of regressors, we might still be obtaining biased results. By including the lagged dependent variable in the regression equation we can control for all those omitted characteristics. In addition, since the educational process is cumulative, by including the first lag of the outcomes variable we might be controlling for past educational inputs and avoiding any kind of correlation between the error term and the past, present and future values of the explanatory variables (Todd and Wolpin, 2003). Thus, second, we estimate equation (2) by including the lagged dependent variable within the set of control variables. We estimate this equation within a Differences GMM procedure to account for the endogeneity of the lagged dependent variable in the differenced equation, using as instruments the third and deeper lags of the dependent variable[6].

Third, as an additional check of the *difference-in-differences* identification assumption, we add region-specific time trends to the regression equation. The main advantage of this alternative specification is that each region is allowed to have its own time trend, which allows us to relax the more restrictive assumption of the *difference-in-differences* model of common macroeconomic effects. In order to consistently estimate the decentralization coefficient in this specification we apply least squares to the double differenced equation. Finally,

[6] As the number of units was limited (50 provinces) we had to restrict the number of lags to be used as instruments to be less than 50 (Roodman, 2009). We conducted the analyses with different sets of instruments, in order to select the best specification in base to the Hansen test for the whole set of instruments and by groups of instruments. Estimations in base to a system-GMM procedure were also conducted, although we found that the lagged dependent variables in first differences were weak instruments for the level equation in most cases. Despite that, the coefficient of the decentralization variable in the different models and specifications was very similar to the coefficients we obtained with the Differences-GMM procedure. The results of these sensitive analyses are available upon request to the authors.

in order to corroborate that the results are not driven by any particular region, I repeat the estimation eliminating one region at a time.

4.4. Data

We constructed a panel data set containing information on the 50 provinces of Spain for the period 1977-1991, a period that covers the entire process of decentralization of the eighties. In this way, we include observations for the years before and after the decentralization process was implemented. Although the educational powers were transferred to the regional governments, our data are measured at the provincial level in order to increase the precision of our estimates.

Several variables have been proposed in the literature to measure educational attainment, including net enrolment rates (Mahal *et al.*, 2000), average test scores in Language and Maths (Galiani and Schargrodsky, 2002) and the ratio between the number of students obtaining the university entrance qualification and the number of 19 year olds in the population (Barankay and Lockwood, 2007). Here, we measure educational attainment by using the *promotion rate* by grade and educational programme in secondary education, defined as the proportion of students from a cohort enrolled in a given grade at a given school-year who study in the next grade in the following school-year (UNESCO, 2009). We additionally present the results that we obtain when analyzing the effects of decentralization on the *repetition* and *dropout rates*, as they are the main explanatory factors of variations in the *promotion rates*. More specifically, the *dropout rate* plus the *repetition rate* equal one minus the *promotion rate*.

The *promotion rate* by grade is computed by dividing the number of new enrolments in a given grade in school-year $t+1$ by the number of students from the same cohort enrolled in the preceding grade in the previous school-year t. We distinguish between the *promotion rates* in the first, second and third grades of the general programme and the vocational programme[7]. Thus, for instance, the *promotion rate* for the first grade in year t is defined as the proportion of students enrolled in the first grade in year t who study in the

[7] As explained above, secondary education in Spain during the eighties was a four years programme for the general programme and a five years programme for the vocational programme. The theoretical entrance age to secondary education was 14 or 15, depending on the month each student was born, and it was non-compulsory.

second grade in the year *t+1*. We include students in public and private schools. This is done for two reasons: first, because we can expect decentralization to affect education outcomes in private schools too, since state-assisted schools are included in this group. Second, if we restrict the measurement of the *promotion rate* to public schools, the variable will be affected by students transferring from private schools to public schools or viceversa.

The *decentralization* variables were constructed from the legislative acts providing for the transfer of educational powers from the central to the regional governments, and published in the *Boletín Oficial del Estado* (BOE). The decentralization dummy variable takes the values 1 if region *s* is decentralized in year *t*, and 0 otherwise. We additionally define a dummy variable that takes the values 1 if region *s* has been decentralized for at least five years. This variable allows us to test whether the effects of decentralization depend on the number of years that a cohort has been exposed to decentralization.

The data describing the number of students enrolled in each grade were obtained from the Education Annuals published by the *National Statistics Institute* until 1985 and by the *Ministry of Education and Science* for all years after that date. The *schooling* variable, defined as the average years of education of the active population, is calculated from data of the *Economically Active Population Survey* provided by the *National Statistics Institute*. The *per capita income* series, measured in thousands of euros at 1990, is constructed from data published by the *Fundación BBVA* (period 1978-1986) and from the *Regional Accounts* published by the *National Statistics Institute* (period 1986-1991). The *unemployment rate* that we use to obtain the results presented in this paper is the overall unemployment rate, which is also obtained from the *Economically Active Population Survey*. Finally, the amount of *public revenues* at the disposal of the regional governments, measured as a percentage of the regional GDP, includes all the revenues (excepting transfers for specific services other than education). A descriptive analysis of all the variables included in the analysis is presented in Table A.1 in the annex of this chapter.

5. Empirical findings

5.1. Comparison group validation

In this section we test the validity of the identifying assumption, which implies that absent decentralization the treated group of regions would have experienced similar trends in the outcomes to the comparison ones. First, in Table A.2 we compare the characteristics of the two groups of regions that might influence the evolution in their educational outcomes. The comparison is conducted for the years before the decentralization process was set in motion, that is, for the years 1978, 1979 and 1980. As it can be observed, no statistically significant differences can be appreciated for the variables being compared, except for the *unemployment rate*, for which we find a low difference for some years. Despite this difference, we can conclude that selection into treatment does not seem to have been influenced by these observable characteristics of the regions. In addition, as we find out later, the *unemployment rate* does not have a significant effect on educational outcomes, so that we can neglect the difference in this variable.

In Table 2 we present the results of estimating equation (4). We show the estimated coefficient of the secular trend of the *promotion rate* by grade and educational programme for the treated and comparison groups (in columns 1 and 3, respectively) and the estimated difference between them (in column 5). As it can be observed, this difference is non-significant in all cases, except for the third grade's *promotion rate* when students in all programmes are considered. In this case, it presents a low statistical significance. Figure A.1 in the annex of this chapter represents the evolution of the *promotion rates* by grade and educational programme for the treated and the comparison group, for the period 1977-1980. As it can be observed, the evolution of these variables presents a similar pattern in both groups of regions.

Thus, the three analyses conducted above seem to confirm that the *common trend* assumption can be considered a valid hypothesis in this setting. As the education decentralization reform in Spain was made within a broader process of decentralization, which implied both the creation of the regional level of government and the devolution of different public policies to the new governments, its implementation was not determined by the characteristics of the educational sector. In addition, since the selection of the regions that received these competences during the eighties was made on historical

grounds, we do not observe relevant differences between the two groups of regions regarding their observable characteristics. Thus, we can consistently estimate the effects of decentralization without including any control variables in the regression, that is, by using the *difference-in-differences* estimation method. With this approach, we control for the time unvarying non-observable characteristics of regions that might have driven the decentralization process.

Table 2. Comparison of secular trends in promotion rates. Period 1977-1980.

	Treated		Comparison		Difference	
	Coeff.	**s.e.**	**Coeff.**	**s.e.**	**Coeff.**	**s.e.**
	(1)	(2)	(3)	(4)	(5)	(6)
First grade						
All programmes	0.359	0.394	0.241	0.417	0.118	0.312
General programme	-0.476	0.590	-0.446	0.603	-0.030	0.315
Vocational programme	2.056***	0.664	1.577**	0.735	0.479	0.586
Second grade						
All programmes	-0.214	0.473	0.047	0.456	-0.261	0.403
General programme	-0.187	0.649	0.125	0.478	-0.313	0.437
Vocational programme	2.560***	0.946	2.795***	0.949	-0.236	0.710
Third grade						
All programmes	3.846***	0.672	4.839***	0.531	-0.992*	0.540
General programme	4.212***	0.866	5.263***	0.718	-1.051	0.669
Vocational programme	2.795*	1.524	4.040**	1.584	-1.245	1.439

Notes: estimation of equation (4) in first differences by POLS for the 50 provinces in Spain and the period 1977-1980. The dependent variable is the *promotion rate* by grade and educational programme. Year dummies are included in all the specifications, being statistically significant in all of them, except for the second and third grades of the vocational programme. The error terms are clustered at the regional level and the covariance matrix estimate is robust. *** p<0.01, ** p<0.05, * p<0.1.

5.2. The effects of decentralization on promotion rates

In what follows we present the *difference-in-differences* estimator of the effects of decentralization on educational outcomes in Spain, which are measured using the *promotion rate* by grade and by educational programme. Thus, for each grade we estimate three equations with three alternative dependent variables. The first one includes students in the general and the vocational programmes (GP&VP), the second one includes only students in the general programme (GP) and the third one includes only students in the vocational programme (VP). Since the first wave of the decentralization process in Spain began in 1980 and terminated in 1983, we use a panel data set comprising the 50

provinces of Spain for the period 1977-1991. In this way, we include observations both before and after decentralization, as required when applying the *difference-in-differences* estimation method. Table 3 presents the results we obtained with this analysis.

As we can observe in this table, the effect of the decentralization reform on the *promotion rate* in the three grades is non-significant when we consider students in the general and the vocational programme (GP&VP). However, once we separate the students according with their educational programme, we observe that the decentralization reform has a positive and significant effect on the *promotion rates* in the three grades of the general programme and a negative effect on the *promotion rates* in the second and third grades of the vocational programme.

Table 3. The effect of decentralization on promotion rates.

	(A) First grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	1.025	2.365**	-1.233
	(1.165)	(1.176)	(1.645)
R^2	0.074	0.075	0.067
	(B) Second grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	-0.025	1.877**	-3.243**
	(0.745)	(0.874)	(1.419)
R^2	0.146	0.234	0.097
	(C) Third grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	0.350	1.969***	-5.959**
	(0.822)	(0.687)	(2.751)
R^2	0.218	0.271	0.078
Provinces	50	50	50
Regions	17	17	17
Observations	700	700	700

Notes: estimation of equation (2) in first differences by POLS for the 50 provinces in Spain and the period 1978-1991. The dependent variable is the *promotion rate* by grade and educational programme. Year dummies are included in all the specifications, being statistically significant in all of them. Robust standard errors adjusted for clustering at the regional level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Thus, based on these results, the decentralization reform increased the *promotion rates* by an average of 2.4 percentage points in the first grade, 1.9 percentage points in the second grade and 2.0 percentage points in the third grade of the general programme (column 2). That is, the increase of the *promotion rates* in the general programme ranges between a 32 and a 47 per cent of a standard deviation. In the vocational programme, though, decentralization decreased the *promotion rate* by an average of 3.2 percentage points in the second grade and 6.0 percentage points in the third grade (column 3), that is, a 39 and a 43 per cent of a standard deviation, respectively. The effect on the *promotion rate* in the first grade of the vocational programme is also negative, but statistically non-significant.

When interpreting these results we need to bear in mind that enrolment rates are higher in the general programme (around 45 per cent in mid-eighties) than in the vocational programme (around 24 per cent in mid-eighties), so that we cannot directly compare the magnitudes of the effects in the general and vocational programmes in terms of how many students are affected by the reform. Rather, what these effects are telling us is that the proportion of students enrolled in a grade of the general programme who promotes to the next grade significantly increases following decentralization. However, the proportion of students enrolled in the second and third grades of the vocational programme who promote to the next grade decreases following decentralization.

Table A.3 in the annex presents the results that we obtain when we allow the effects of decentralization to depend on the number of years that a cohort has been exposed to a decentralized educational system. As it can be observed in this table, when a cohort has been under a decentralized system for five years or more the effect of decentralization is positive both in the general and in the vocational programme. These effects are only significant for the third grade when the general and vocational programmes are considered separately, but the effect is statistically significant in the three grades when we consider students in all programmes. Thus, although decentralization has an immediate negative effect on the *promotion rates* in the vocational programme, this effect turns out positive after five years of decentralization.

5.3. Robustness checks

Different analyses are conducted in this section in order to corroborate the robustness of the results above. For each dependent variable, we estimate three different specifications. The first one includes the set of variables defined above as being potential determinants of educational outcomes; the second one also includes the lagged dependent variable as a control for the time varying characteristics of regions; and the third one includes region-specific time trends. Table A.4 in the annex presents the results of these analyses when we consider students in all programmes; Table A.5 presents the results for students in the general programme; and Table A.6 presents the results for students in the vocational programme[8]. As we can observe in these tables, the results of the previous section are highly robust.

The first specification for each dependent variable presents almost the same value of the parameter of the decentralization variable than the *difference-in-differences* specification. Rather, the specification that includes the lagged dependent variable and the specification that allows for specific regional time trends provide us with slightly different parameter values. However, as pointed out by Heckman and Hotz (1989), we should not expect exactly the same estimated parameter from alternative non-experimental methods, since they are based on different assumptions.

Thus, the key point here is that alternative methods lead us to the same conclusions regarding the beneficial effects of the decentralization reform for the *promotion rates* in the general programme and detrimental effects for the *promotion rates* in the vocational programme, and that the estimated effects in base to the different models are quantitatively similar. When we estimate these models allowing the effects of decentralization to depend on the number of years that a cohort has been under a decentralized system, we also corroborate

[8] The effects of the different control variables are not presented in this table, but they can be observed in Tables A.7 to A.9. We use a Differences-GMM approach to estimate the model which includes the lagged dependent variable as a regressor. The lags of the dependent variable that we use as instruments and the total number of instruments are presented in Tables A.4 to A.6 for each specification. As the number of units was limited (50 provinces) we restricted the number of lags to be used as instruments.

the results presented in the section above. The results are also robust to the elimination of regions from the estimation equation[9].

6. Additional findings

6.1. The effect of decentralization on dropout and repetition rates

As discussed above, variations in the *promotion rates* can be explained by variations in the *dropout rates* or in the *repetition rates*. In order to obtain a full picture of the effects of the education decentralization reform in Spain, in this section we analyze its effects on these additional educational outcomes variables. The results of conducting this analysis for each grade and educational programme are presented in Table 4. As it can be observed in this table, variations in the *promotion rates* as a consequence of decentralization are mostly explained by variations in the *dropout rates*.

The positive effect of decentralization on the *promotion rate* in the first grade of the general programme is mostly explained by a diminution of the *dropout rate* (Panel A, column 2), although this effect is partially compensated by a slight increase of the *repetition rate* (Panel A, column 5). This finding is meaningful, since the increase of the *repetition rate* means that the increase of the *promotion rates* in the general programme following decentralization was not achieved by means of decreasing the qualification requirements for a student to promote. In the vocational programme, decentralization has also a positive effect on the *repetition rate* in the first grade (Panel A, column 6), and the effect on the *dropout rate* is positive and non-significant (Panel A, column 3). Thus, the decrease of the *promotion rate* in the first grade of the vocational programme as a consequence of decentralization (which was non-significant) is partly explained by an increase of the *repetition rate*. Again, these results seem to point to the hypothesis that following decentralization there was an increase in the qualification requirements for students to promote. Alternatively, they might be the result of the retention of students in the educational system that otherwise might have gave up.

For the second and the third grades (Panels B and C), we can observe that the effects of decentralization on the *promotion rates* are uniquely explained by its effects on the *dropout rates,* since the effects on the *repetition rates* are non-

[9] These results are not presented here, although they are available upon request to the authors.

significant. That is, we can observe a diminution of the *dropout rates* in the general programme (column 2) and an increase of the *dropout rates* in the vocational programme (column 3) following decentralization. However, when we allow the effect of decentralization to depend on the number of years that a cohort has been under a decentralized system, the effect on the *dropout rates* in the vocational programme turns out to be negative after 5 years of the implementation of the decentralization reforms[10]. Thus, it might be the case that following decentralization regional governments decided to introduce stricter rules within the educational system in vocational programmes, with a negative impact on the retention rates in the first years, but positive thereafter.

Table 4. The effect of decentralization on dropout and repetition rates.

	(A) First grade					
	Dropout rate			***Repetition rate***		
	GP&VP	**GP**	**VP**	**GP&VP**	**GP**	**VP**
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	-1.645	-2.950**	0.551	0.621***	0.583***	0.682*
	(1.200)	(1.221)	(1.826)	(0.229)	(0.202)	(0.414)
R^2	0.067	0.084	0.057	0.140	0.132	0.084
	(B) Second grade					
	Dropout rate			***Repetition rate***		
	GP&VP	**GP**	**VP**	**GP&VP**	**GP**	**VP**
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	0.213	-1.739*	3.305*	-0.188	-0.139	-0.063
	(0.942)	(0.979)	(1.733)	(0.314)	(0.274)	(0.505)
R^2	0.165	0.254	0.118	0.172	0.149	0.111
	(C) Third grade					
	Dropout rate			***Repetition rate***		
	GP&VP	**GP**	**VP**	**GP&VP**	**GP**	**VP**
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	-0.264	-2.115***	6.213**	-0.085	0.146	-0.254
	(0.840)	(0.678)	(3.053)	(0.314)	(0.385)	(0.407)
R^2	0.204	0.240	0.090	0.187	0.154	0.107
Provinces	50	50	50	50	50	50
Regions	17	17	17	17	17	17
Observations	700	700	700	700	700	700

Notes: see Table 3.

[10] These results are not presented here, although they are available upon request to the authors.

A different explanation is that, since vocational programmes are generally less attractive to students than the general programmes, these results might reflect a better match between public preferences and education policy. Regional governments might have concentrated their efforts and resources on improving the latter programmes, which at the same time could have had a negative impact on vocational programmes. As we discussed above, subnational governments might have scarce resources to finance educational services following decentralization. Since they had no fiscal autonomy to raise their own revenues, they might have to choose where to allocate the amount of resources that were available to them. We give an insight into this question in the next section.

6.2. Heterogeneous effects of decentralization on promotion rates

We should bear in mind that the effects of the decentralization reform in Spain presented in the previous sections represent average impacts across regions, while decentralization would have had heterogeneous effects. As discussed above, following decentralization regional governments might have different levels of public revenues to respond to their needs and demands, which were determined at the central level of government. Although we cannot identify the effects of the decentralization reform in every region, in this section we do analyse whether the effects of decentralization depended on their *per capita income* and *public revenues*, by including interaction terms between *decentralization* and these variables in equation (2), along with covariates.

The results of this analysis are presented in Table 5. The decentralization coefficient in this table can be interpreted as the effect of the decentralization reform in regions with an average level of *per capita income* and *public revenues,* since we centred these variables[11]. As we can observe in this table, the effect of the decentralization reform is significantly positive for *promotion rates* in the three grades of the general programme, being the coefficients even higher than before (column 2); for the vocational programme this effect is negative, although it is only significant for the *promotion rate* in the third grade (Panel C, column 3); and the effect is positive for *promotion rates* in the three grades when we consider students in all programmes, although non-significant (column 1).

[11] The *per capita income* variable has been centred with respect to the overall mean, and the *public revenues* variable has been centred with respect to its annual mean for the treated regions. Thus, the *public revenues* variable will be zero in regions that have a level of public resources equal to the corresponding annual mean.

Table 5. Heterogeneous effects of decentralization on promotion rates.

	(A) First grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	1.380	2.778**	-0.820
	(1.221)	(1.356)	(1.673)
Per capita income x Decent.	-0.328	-0.415	-0.252
	(0.423)	(0.604)	(0.314)
Public revenues x Decent.	0.533	0.658	0.572
	(0.416)	(0.421)	(0.731)
R^2	0.084	0.078	0.079
	(B) Second grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	0.668	2.375***	-2.352
	(0.803)	(0.904)	(1.432)
Per capita income x Decent.	-0.922***	-1.002**	-0.826
	(0.332)	(0.451)	(0.745)
Public revenues x Decent.	1.067***	0.843**	1.307*
	(0.312)	(0.380)	(0.722)
R^2	0.179	0.260	0.113
	(C) Third grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	1.177	2.824***	-4.531*
	(0.879)	(0.889)	(2.646)
Per capita income x Decent.	-0.903*	-0.847	-1.085
	(0.493)	(0.537)	(0.772)
Public revenues x Decent.	1.263***	1.319**	1.924**
	(0.417)	(0.537)	(0.980)
R^2	0.191	0.220	0.092
Provinces	50	50	50
Regions	17	17	17
Observations	700	700	700

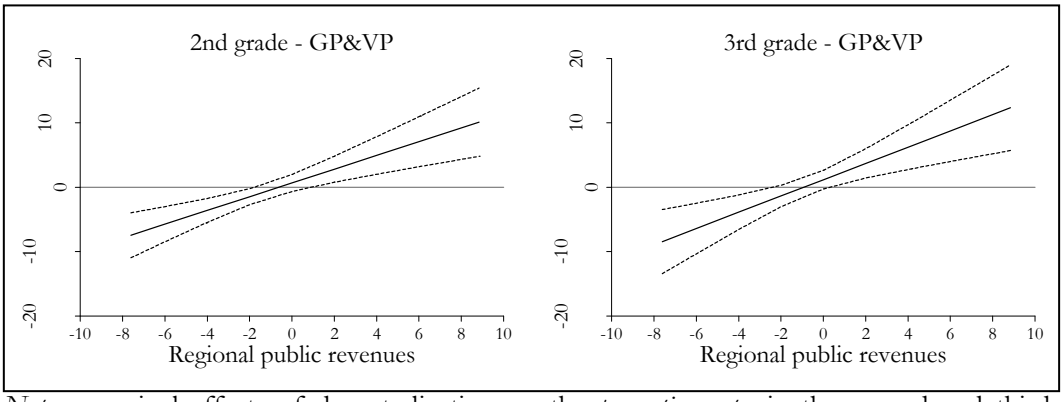
Notes: see Table 3. The complete estimation results are presented in Tables A.7 to A.9. Table A.7 presents the results when we consider the *promotion rates* of students both in the general and the vocational programmes; Table A.8 presents the results for the *promotion rates* in the general programme; and Table A.9 presents the results for the *promotion rates* in the vocational programme. Robust standard errors adjusted for clustering at the regional level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The effects of decentralization, however, are expected to be higher in regions with a higher level of *public revenues* and in regions with a lower level of *per*

capita income, although these differences are not always significant. The interaction term between *decentralization* and *public revenues* is significant for the promotion rates in the second and third grades (Panels B and C), both in the general and the vocational programmes, and non significant for the first grade (Panel A). The interaction term between *decentralization* and *per capita income* is significant for the second grade, when we consider pupils in all programmes or in the general programme (Panel B, columns 1 and 2); and for the third grade, when we consider students in all programmes (Panel C, column 1).

When we do take into account these heterogeneous impacts, we can observe that the effect of decentralization on the *promotion rates* of the general programme is not expected to be positive in all the regions, and that the effect of decentralization on the *promotion rates* of the vocational programme is not expected to be negative in all the regions. To see this clearly, in Figure 1 we plot the effects of *decentralization* on the *promotion rates* in the second and third grades for students in all programmes as a function of the regional *public revenues*, considering that the level of *per capita income* is equal to its mean. As we can observe in this figure, the effects of the education decentralization reform on the *promotion rates* in the second and third grades highly depend on the level of regional *public revenues*[12].

Figure 1. The effect of decentralization on the promotion rates.



Notes: marginal effects of decentralization on the *promotion rates* in the second and third grades of secondary education, as a function of regional public revenues, when per capita income is set to the mean. The regional public revenues variable is expressed in relation to its annual mean. The corresponding coefficients are presented in Table 5.

[12] We do not represent the effects of decentralization on *promotion rates* in all programmes for the first grade because they are non-significant for all levels of *public revenues*. Figure A.2. in the annex represents the effects of decentralization on *promotion rates* by grade and educational programme as a function of the regional public revenues. As we can observe, both for the general and the vocational programme the differences between regions with different levels of public revenues are quantitatively significant.

Based on these results, in regions where *public revenues* are below the mean we can observe a negative impact of decentralization on the represented *promotion rates*, since the effect of decentralization in these regions is negative for the vocational programme and non-significant for the general programme; and, in regions where *public revenues* are over the mean, we can observe a positive impact on the *promotion rates*, since the effect of *decentralization* in these regions is positive for the general programme and non-significant for the vocational programme. More specifically, the effect of the *decentralization* reform on the *promotion rate* in the second grade range from minus 7.45 percentage points (when *public revenues* are eight points below the mean) to 10 percentage points (when *public revenues* are eight points above the mean); and in the third grade, these effects range from minus 8.4 percentage points (when *public revenues* are eight points below the mean) to 12.3 percentage points (when *public revenues* are eight points above the mean). It can be observed that the effects are non significant for regions with a level of public revenues around the mean.

7. Summary and concluding remarks

The effects of decentralization on the efficiency of governments at providing public goods and services remain unclear in the theoretical literature, which tends to emphasise the trade-offs between potential benefits and drawbacks. However, until recently, very few empirical studies had attempted to examine these trade-offs. At a time when decentralization policies are on the agenda of many countries and figure among the main recommendations emanating from international organizations, we considered it timely to offer some insights into this problem. Specifically, we have focused on analyzing the impact on educational outcomes of the partial fiscal decentralization reform in Spain at the beginning of the eighties.

As we have seen, the decentralization reform in education started at the beginning of the eighties, when educational powers were devolved to Cataluña, País Vasco, Galicia, Andalucía, Comunidad Valenciana and Canarias. The fact that the other regions had to wait until the end of the nineties to receive the same powers enables us to use these non-decentralized regions as the comparison group and so estimate the effects of decentralization. Although it is our belief that the selection process was not influenced by regional characteristics, which in turn might also have influenced the evolution of educational outcomes, we use the *difference-in-differences* method to estimate the effects of decentralization. In this way, we are able to control not only for

the temporary shocks that affect the outcomes of all regions equally, but also for the non-observable characteristics of the regions that may influence the evolution of their educational outcomes and which could result in differences between the treatment and comparison groups before decentralization. We additionally corroborate the robustness of our results by using three alternative models that enable us to relax some of the assumptions needed for the *difference-in-differences* estimator to be consistent.

According to our analysis, the decentralization reform in Spain increased the *promotion rates* in all grades of the general programme by more than 1.9 percentage points on average. When we allow the effects to differ in accordance with the observable characteristics of the regions, we see that this effect is higher in regions with a higher level of *public revenues* and in regions with a lower level of *per capita income*. However, the decentralization reform also had a negative impact on the *promotion rates* in the second and third grades of the vocational programmes. This negative impact, though, is only significant in regions with a low level of *public revenues* and for the first years following decentralization. For cohorts that were under a decentralized regime for five years or more the effects turn out to be positive.

As we have discussed above, increasing the number of students completing secondary education was one of the main challenges facing the Spanish education system. Thus, these results point to the conclusion that the partial decentralization reform of the eighties contributed to this objective, especially in the general programme where the positive results were felt immediately following decentralization. Since variations of the *promotion rates* are mostly explained by variations of the *dropout rates*, while *repetition rates* even increased in the first grade, we can conclude that decentralization does not seem to have been followed by a decrease in the qualification requirements to promote and complete the secondary education programme.

These results might be interpreted as evidence of a better match between the preferences of the population and educational policies under a partial fiscal decentralization reform, where subnational resources were scarce and subnational governments faced a trade-off in the allocation of these resources. Given that the general programme is the chosen avenue into university for most students, and that the attractiveness of vocational education in Spain is much lower than that of this general programme, regional governments might

have concentrated their efforts and resources on improving the outcomes in the general programme.

References

Angrist, J.D. and Pischke, J.S. (2009): *Mostly harmless econometrics: an empiricist's companion,* Princeton University Press, Princeton.

Barankay, I. and Lockwood, B. (2007): "Decentralization and the productive efficiency of government: evidence from Swiss cantons", *Journal of Public Economics* 91, 1197-1218.

Bardhan, P. and Mookherjee, D. (2000): "Capture and governance at local and national levels", *American Economic Review* 90(2), 135-139.

Bardhan, P. and Mookherjee, D. (2006): "Decentralization, corruption and government accountability: an overview", in *International Handbook on the Economics of Corruption*, S. Rose-Ackerman (Ed.), Edward Elgar Publishing, Northampton.

Bertrand, M., Duflo, E. and Mullainathan, S. (2004): "How much should we trust difference-in-differences estimates?", *The Quarterly Journal of Economics* 119(1), 249-275.

Blundell, R. and Costa Dias, M. (2000): "Evaluation methods for non-experimental data", *Fiscal Studies* 21(4), 427-468.

Blundell, R. and Costa Dias, M. (2002): "Alternative approaches to evaluation in empirical microeconomics", *Portuguese Economic Journal* 1, 91-115.

Borge, L.E., Brueckner, J.K. and Rattso, J. (2014): "Partial fiscal decentralization and demand responsiveness of the local public sector: theory and evidence from Norway", *Journal of Urban Economics* 80, 153-163.

Bosch, N. and Duran, J.M. (2005): "Evolución del sistema de financiación de las CCAA en los últimos 25 años y perspectivas de reforma", in *La financiación de las Comunidades Autónomas: políticas tributarias y solidaridad interterritorial*, N. Bosch and J.M. Duran (Eds.), Publicacions i Edicions UB, Barcelona.

Bosch, N. and Suárez-Pandiello, J. (1993): "Tamaño del sector público y descentralización fiscal", *Revista de Economía Aplicada* 1(3), 181-193.

Brueckner, J.K. (2009): "Partial fiscal decentralization", *Regional Science and Urban Economics* 39, 23-32.

Carrion-i-Silvestre, J.L., Espasa, M. and Mora, T. (2008): "Fiscal decentralization and economic growth in Spain", *Public Finance Review* 36(2), 194-218.

Diamond, J. and Robinson, J.A. (2010): *Natural experiments of history*, Harvard University Press, Cambridge, MA.

Esteller-Moré, A. and Solé-Ollé, A. (2005): "Does decentralization improve the efficiency in the allocation of public investment? Evidence from Spain", IEB Working Paper 2005/5.

Faguet, J.P. (2004): "Does decentralization increase government responsiveness to local needs? Evidence from Bolivia", *Journal of Public Economics* 88, 867-893.

Felgueroso, F., Gutiérrez-Domènech, M. and Jiménez-Martín, S. (2013): "Dropout trends and educational reforms: the role of the LOGSE in Spain", FEDEA Working Papers 2013-04.

Galiani, S. and Schargrodsky, E. (2002): "Evaluating the impact of school decentralization on educational quality", *Economía* 2(2), 275-302.

Galiani, S., Gertler, P. and Schargrodsky, E. (2008): "School decentralization: helping the good get better, but leaving the rest behind", *Journal of Public Economics* 92(10-11), 2106-2120.

Garcia-Milà, T. and McGuire, T.J. (2002): "Fiscal decentralization in Spain: an asymmetric transition to democracy", mimeo.

Hanushek, E.A. (1986): "The economics of schooling: production and efficiency in public schools", *Journal of Economic Literature* 24, 1141-1177.

Hanushek, E.A. (2003): "The failure of input based schooling policies", *Economic Journal* 113, 64-98.

Heckman, J.J. and Hotz, V.J. (1989): "Choosing among alternative non-experimental methods for estimating the impact of social programs: the case of manpower training", *Journal of the American Association* 84(408), 862-874.

Hindriks, J. and Lockwood, B. (2005): "Centralization and political accountability", CEPR Discussion Paper 5125.

Hunt, F. (2008): "Dropping out from school: a cross-country review of literature", *CREATE Pathways to Access* 16, University of Sussex.

Lago-Peñas, I. and Lago-Peñas, S. (2010): "Decentralization and electoral accountability", *Environment and Planning C: Government and Policy* 28, 318-334.

Lockwood, B. (2006): "Fiscal decentralization: a political economy perspective", in *Handbook of Fiscal Federalism*, E. Ahamad and G. Brosio (Eds.), Edward Elgar Publishing, Northampton.

Mahal, A., Srivastava, V. and Sanan, D. (2000): "Decentralization and public sector delivery of health and education services: the Indian experience", ZEF Discussion Paper 20.

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

Oates, W.E. (2005): "Toward a second-generation theory of fiscal federalism", *International Tax and Public Finance* 12, 349-373.

Persson, T. and Tabellini, G. (2000): *Political economics: explaining economic policy*, MIT Press, Cambridge.

Redoano, M. (2010): "Does decentralization affect the number and size of lobbies?", *Journal of Public Economic Theory* 12(3), 407-435.

Roodman, D. (2009): "How to do xtabond2: an introduction to difference and system GMM in Stata", *The Stata Journal* 9(1), 86-136.

Seabright, P. (1996): "Accountability and decentralisation in government: an incomplete contracts model", *European Economic Review* 40, 61-89.

Solé-Ollé, A. (2010): "Decentralization and service delivery: the Spanish case" in *Does decentralization enhance service delivery and poverty reduction?*, G. Brosio and E. Ahamad (Eds.), Edward Elgar Publishing, Northampton.

Todd, P.E. and Wolpin, K.I. (2003): "On the specification and estimation of the production function for cognitive achievement", *The Economic Journal* 113, 3-33.

UNESCO (2009): *Education indicators: technical guidelines*, United Nations Education, Scientific and Cultural Organization, Paris.

Weingast, B.R. (2009): "Second generation fiscal federalism: the implications of fiscal incentives", *Journal of Urban Economics* 65(3), 279-293.

Wildasin, D.E (1997): "Externalities and bailouts: hard and soft budget constraints in intergovernmental fiscal relations", WB Policy Research Working Papers 1843.

Wooldridge, J.M. (2002): *Econometric analysis of cross section and panel data*, Cambridge, MA.

Annex

Figure A.1. Comparison of secular trends of *promotion rates*. Period 1977-1980.

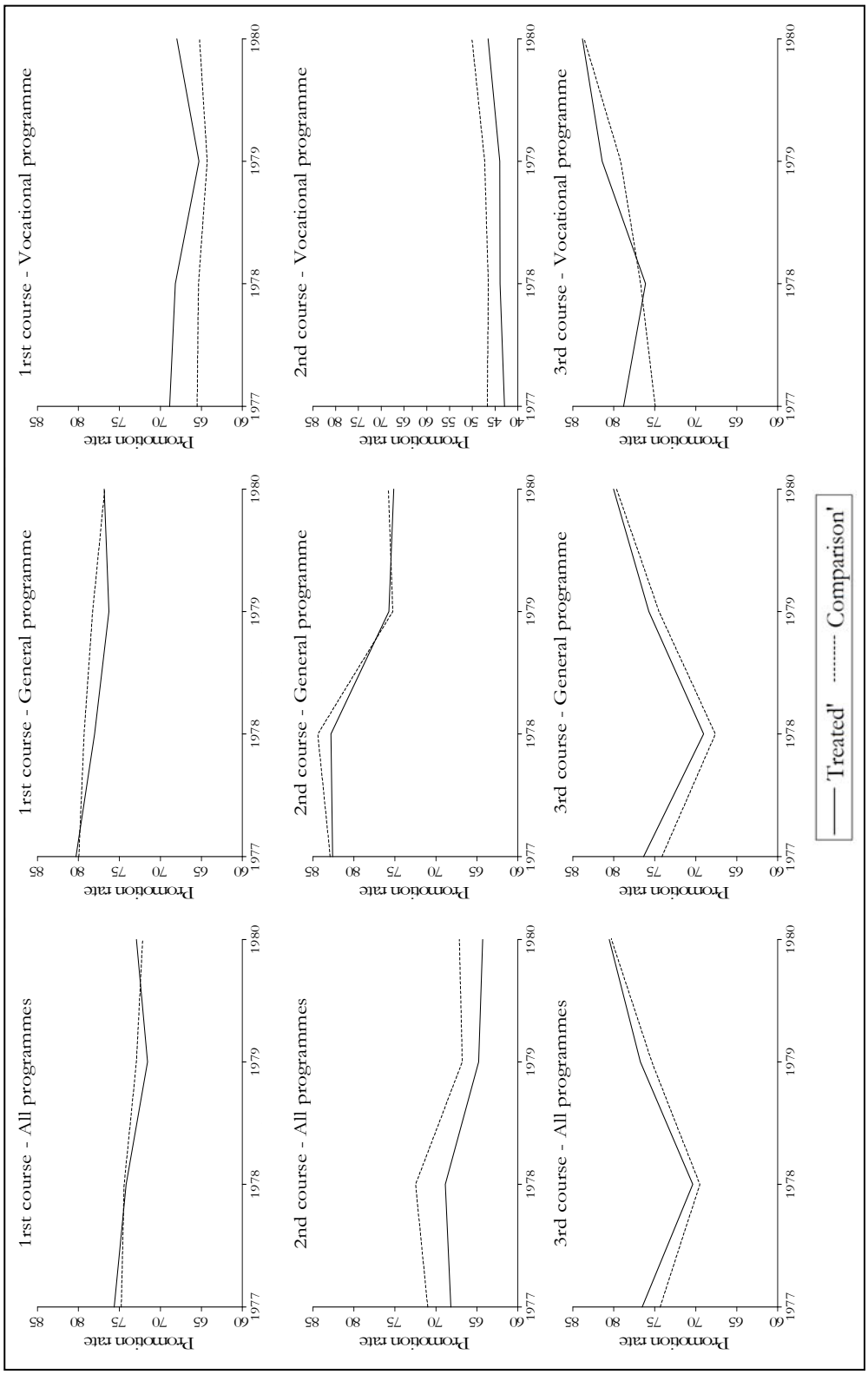
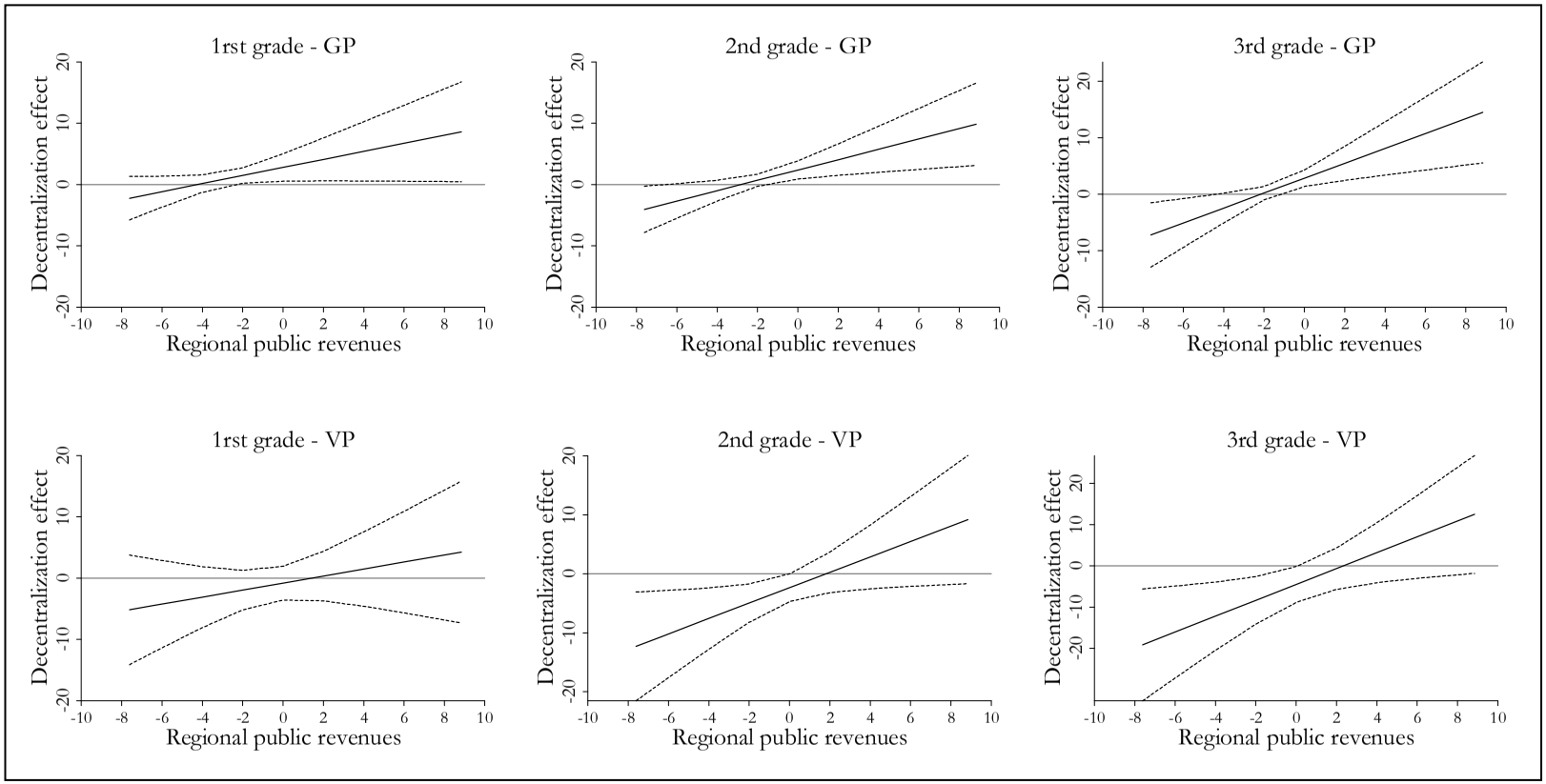


Figure A.2. Effects of decentralization on the promotion rates in the general and vocational programmes.



Notes: marginal effects of decentralization on the promotion rates by grade and educational programme, as a function of regional public revenues, when per capita income is set to the mean. The corresponding coefficients are presented in Table 5.

Table A.1. Descriptive analysis.

Variable	Mean	Std. Dev.	Min	Max
Promotion rate 1rst course - All programmes	72.51	5.44	53.92	88.54
Promotion rate 1rst course - General prog.	76.64	5.60	55.61	91.04
Promotion rate 1rst course - Vocational prog.	66.26	8.55	38.26	99.78
Promotion rate 2nd course - All programmes	67.90	5.36	54.17	88.51
Promotion rate 2nd course - General prog.	76.55	4.85	61.91	92.42
Promotion rate 2nd course - Vocational prog.	53.22	13.45	23.64	87.40
Promotion rate 3rd course - All programmes	79.60	6.35	57.66	96.48
Promotion rate 3rd course - General prog.	77.11	6.18	55.31	96.84
Promotion rate 3rd course - Vocational prog.	87.55	15.52	40.17	135.36
Dropout rate 1rst course - All programmes	15.42	4.22	0.59	30.45
Dropout rate 1rst course - General prog.	9.96	4.34	-5.12	25.86
Dropout rate 1rst course - Vocational prog.	23.82	7.48	-12.31	56.11
Dropout rate 2nd course - All programmes	15.99	6.13	-0.61	32.53
Dropout rate 2nd course - General prog.	7.71	4.27	-12.03	24.20
Dropout rate 2nd course - Vocational prog.	30.16	16.30	-13.13	72.80
Dropout rate 3rd course - All programmes	7.44	6.44	-10.42	37.76
Dropout rate 3rd course - General prog.	8.58	5.93	-8.84	38.74
Dropout rate 3rd course - Vocational prog.	3.68	15.86	-40.71	53.65
Repetition rate 1rst course - All programmes	12.08	4.10	4.67	31.09
Repetition rate 1rst course - General prog.	13.40	3.13	6.42	24.78
Repetition rate 1rst course - Vocational prog.	9.92	7.21	0.00	47.69
Repetition rate 2nd course - All programmes	16.11	4.46	8.39	32.96
Repetition rate 2nd course - General prog.	15.74	3.28	7.21	26.60
Repetition rate 2nd course - Vocational prog.	16.61	8.41	1.01	48.58
Repetition rate 3rd course - All programmes	12.95	3.58	4.22	26.77
Repetition rate 3rd course - General prog.	14.30	3.29	4.09	24.36
Repetition rate 3rd course - Vocational prog.	8.77	6.83	0.00	54.14
Schooling	6.04	0.76	4.53	8.23
Per capita income	8.17	1.94	4.55	20.43
Unemployment rate	14.63	7.10	1.41	35.01
Public revenues	3.64	3.53	0.00	18.17

Source: own made

Table A.2. Comparison of characteristics for the treated and the comparison groups.

Variables	Treated Group		Comparison Group		Difference	
	Mean	**s.e.**	**Mean**	**s.e.**	**Mean**	**s.e.**
Panel A. Year 1978.						
Schooling	5.15	0.08	5.14	0.09	0.01	0.12
Schooling - women	4.86	0.08	4.87	0.07	-0.01	0.11
Schooling - men	5.45	0.10	5.42	0.11	0.03	0.14
Per capita income	7.79	0.30	7.65	0.28	0.14	0.42
Unemployment rate	7.09	0.87	5.34	0.47	1.75**	0.98
Panel B. Year 1979.						
Schooling	5.26	0.08	5.29	0.09	-0.03	0.12
Schooling - women	4.97	0.07	5.02	0.08	-0.05	0.11
Schooling - men	5.57	0.10	5.56	0.10	0.01	0.14
Per capita income	7.92	0.29	7.74	0.28	0.18	0.41
Unemployment rate	8.35	0.93	6.98	0.58	1.37	0.54
Panel C. Year 1980.						
Schooling	5.39	0.09	5.41	0.09	-0.02	0.12
Schooling - women	5.09	0.07	5.17	0.07	-0.07	0.10
Schooling - men	5.71	0.11	5.67	0.10	0.05	0.15
Per capita income	7.84	0.29	7.59	0.29	0.25	0.41
Unemployment rate	11.04	1.12	9.05	0.62	1.99*	1.28

Source: own made

Table A.3. The effect of decentralization on promotion rates.

	(A) First grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	1.025	2.365**	-1.233
	(1.166)	(1.177)	(1.647)
Decentralized >5 years	2.743**	1.831	3.646
	(1.369)	(1.596)	(2.583)
R^2	0.087	0.079	0.073
	(B) Second grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	-0.025	1.877**	-3.243**
	(0.745)	(0.875)	(1.420)
Decentralized >5 years	2.255*	1.505	3.632
	(1.291)	(1.293)	(2.406)
R^2	0.154	0.237	0.103
	(C) Third grade		
	GP&VP	**GP**	**VP**
	(1)	(2)	(3)
Decentralization	0.350	1.969***	-5.959**
	(0.822)	(0.688)	(2.753)
Decentralized >5 years	5.349***	3.634*	10.591**
	(1.965)	(2.068)	(5.108)
R^2	0.242	0.282	0.095
Provinces	50	50	50
Regions	17	17	17
Observations	700	700	700

Notes: estimation of equation (2) in first differences by POLS for the 50 provinces in Spain and the period 1978-1991. The dependent variable is the *promotion rate* by grade and educational programme. Year dummies are included in all the specifications, being statistically significant in all of them. Robust standard errors adjusted for clustering at the regional level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4. The effect of decentralization on promotion rates by grade. All programmes.

	First grade			Second grade			Third grade		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decentralization	1.023	0.815	1.803	-0.011	0.175	-0.744	0.347	0.012	0.418
	(1.158)	(1.295)	(1.722)	(0.748)	(0.996)	(1.232)	(0.799)	(1.078)	(1.424)
Control variables	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*
Lagged dep. variable	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*Yes*	*No*
Regional Time Trend	*No*	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Estim. Method	*FD-OLS*	*Diff-GMM*	*SD-OLS*	*FD-OLS*	*Diff-GMM*	*SD-OLS*	*FD-OLS*	*Diff-GMM*	*SD-OLS*
Number Instruments	-	43	-	-	39	-	-	39	-
Lags	-	3, 4	-	-	3, 4	-	-	3, 4	-
Hansen test	-	26.55			15.44			19.82	
R^2	0.081	-	0.058	0.166	-	0.127	0.181	-	0.166
F	-	8.10^{***}			19.52^{***}			25.64^{***}	
Provinces	50	50	50	50	50	50	50	50	50
Regions	17	17	17	17	17	17	17	17	17
Observations	650	650	700	650	650	700	650	650	700

Notes: for each grade, the first specification corresponds to the estimation of equation (2) with covariates in first differences by POLS; the second specification corresponds to the estimation of equation (2) with covariates and the lagged dependent variable, by differences-GMM; and the third specification corresponds to the estimation of equation (2) with a specific-time trend for each region, by applying POLS to the double-differenced equation. The analysis is conducted for the 50 provinces in Spain and the period 1978-1991. Year dummies are included in all the specifications, being statistically significant in all of them. The error terms in the first and third specifications for each dependent variable are clustered at the regional level and the covariance matrix estimate is robust. In the second specification, the Hansen test is non significant, as it is non significant the Hansen test by groups of instruments (which is not presented in this table). Standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A.5. The effect of decentralization on promotion rates by grade. General programme.

	First grade			Second grade			Third grade		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decentralization	2.338**	1.803*	3.532*	1.875**	1.960*	2.664*	1.944***	1.882*	2.815**
	(1.182)	(0.955)	(1.813)	(0.881)	(1.041)	(1.344)	(0.703)	(1.130)	(1.115)
Control variables	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*
Lagged dep. variable	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*Yes*	*No*
Regional Time Trend	*No*	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Estim. Method	*FD-OLS*	*Diff-GMM*	*SD-OLS*	*FD-OLS*	*Diff-GMM*	*SD-OLS*	*FD-OLS*	*Diff-GMM*	*SD-OLS*
Instruments number	-	31	-	-	39	-	-	39	-
Lags	-	3	-	-	3, 4	-	-	3, 4	-
Hansen test	-	15.37			21.82			35.60	
R^2	0.075	-	0.058	0.252	-	0.127	0.211	-	0.166
F	-	8.99***			50.48***			23.78***	
Provinces	50	50	50	50	50	50	50	50	50
Regions	17	17	17	17	17	17	17	17	17
Observations	650	650	700	650	650	700	650	650	700

Notes: see Table A.4

Table A.6. The effect of decentralization on promotion rates by grade. Vocational programme.

	First grade			Second grade			Third grade		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decentralization	-1.217	-1.263	-1.070	-3.225**	-5.768**	-5.782**	-5.835**	-6.828**	-8.805*
	(1.644)	(1.505)	(2.500)	(1.439)	(2.761)	(2.313)	(2.676)	(3.398)	(4.682)
Control variables	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*
Lagged dep. variable	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*Yes*	*No*
Regional Time Trend	*No*	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Estim. Method	*FD-OLS*	*Diff-GMM*	*SD-OLS*	*FD-OLS*	*Diff-GMM*	*SD-OLS*	*FD-OLS*	*Diff-GMM*	*SD-OLS*
Number Instruments	-	43	-	-	39	-	-	48	-
Lags	-	3, 4	-	-	3, 4	-	-	3, 5	-
Hansen test	-	27.63			24.78			25.02	
R^2	0.078	-	0.058	0.109	-	0.127	0.089	-	0.166
F	-	5.85***			14.69***			8.14***	
Provinces	50	50	50	50	50	50	50	50	50
Regions	17	17	17	17	17	17	17	17	17
Observations	650	650	700	650	650	700	650	650	700

Notes: see Table A.4

Table A.7. The effect of decentralization on promotion rates by grade. All programmes.

	First grade		Second grade		Third grade	
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	1.023	1.380	-0.011	0.668	0.347	1.177
	(1.158)	(1.221)	(0.748)	(0.803)	(0.799)	(0.879)
Schooling	1.678	1.694	1.088	1.185	1.613	1.682
	(1.400)	(1.408)	(1.528)	(1.514)	(1.826)	(1.801)
Per capita income	-0.077	0.237	-0.114	0.752**	0.187	1.044**
	(0.137)	(0.403)	(0.145)	(0.369)	(0.393)	(0.496)
Per capita income x		-0.328		-0.922***		-0.903*
Decent.		(0.423)		(0.332)		(0.493)
Unemployment rate	-0.084	-0.083	0.028	0.034	-0.129	-0.125
	(0.090)	(0.088)	(0.064)	(0.059)	(0.204)	(0.198)
Public revenues	0.263	-0.032	0.628**	0.044	0.615**	-0.081
	(0.259)	(0.207)	(0.253)	(0.158)	(0.289)	(0.245)
Public revenues x		0.533		1.067***		1.263***
Decent.		(0.416)		(0.312)		(0.417)
R^2	0.081	0.084	0.166	0.179	0.181	0.191
Provinces	50	50	50	50	50	50
Regions	17	17	17	17	17	17
Observations	650	650	650	650	650	650

Notes: for each grade, the first specification corresponds to the estimation of equation (2) with covariates in first differences by POLS; and the second specification corresponds to the estimation of equation (2) with covariates and interaction terms between *decentralization* and the *public revenues* and the *per capita income* variables. The analysis is conducted for the 50 provinces in Spain and the period 1978-1991. Year dummies are included in all the specifications, being statistically significant in all of them. Robust standard errors adjusted for clustering at the regional level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.8. The effect of decentralization on promotion rates by grade. General programme.

	First grade		Second grade		Third grade	
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	2.338**	2.778**	1.875**	2.375***	1.944***	2.824***
	(1.182)	(1.356)	(0.881)	(0.904)	(0.703)	(0.889)
Schooling	0.347	0.370	1.806	1.949	1.500	1.550
	(1.788)	(1.846)	(2.125)	(2.162)	(2.185)	(2.176)
Per capita income	-0.476**	-0.079	-0.510***	0.419	-0.102	0.708
	(0.208)	(0.581)	(0.175)	(0.514)	(0.246)	(0.516)
Per capita income x Decent.	-	-0.415	-	-1.002**	-	-0.847
		(0.604)		(0.451)		(0.537)
Unemployment rate	-0.051	-0.049	-0.008	0.001	-0.170	-0.166
	(0.085)	(0.089)	(0.070)	(0.073)	(0.159)	(0.157)
Public revenues	0.073	-0.291	0.468	0.012	0.430	-0.299
	(0.368)	(0.314)	(0.390)	(0.313)	(0.373)	(0.295)
Public revenues x Decent.	-	0.658	-	0.843**	-	1.319**
		(0.421)		(0.380)		(0.537)
R^2	0.075	0.078	0.252	0.260	0.211	0.220
Provinces	50	50	50	50	50	50
Regions	17	17	17	17	17	17
Observations	650	650	650	650	650	650

Notes: see Table A.7

Table A.9. The effect of decentralization on promotion rates by grade. Vocational programme.

	First grade		Second grade		Third grade	
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	-1.217	-0.820	-3.225**	-2.352	-5.835**	-4.531*
	(1.644)	(1.673)	(1.439)	(1.432)	(2.676)	(2.646)
Schooling	3.718**	3.712**	-0.140	-0.094	3.865	3.901
	(1.810)	(1.776)	(1.880)	(1.891)	(4.139)	(4.191)
Per capita income	0.353	0.601	0.386	1.176	1.101	2.146
	(0.262)	(0.427)	(0.576)	(1.140)	(1.231)	(1.428)
Per capita income x Decent.		-0.252		-0.826		-1.085
		(0.314)		(0.745)		(0.772)
Unemployment rate	-0.189	-0.190	0.026	0.029	0.159	0.161
	(0.172)	(0.169)	(0.138)	(0.134)	(0.315)	(0.305)
Public revenues	0.361*	0.043	0.897**	0.175	0.927**	-0.139
	(0.219)	(0.413)	(0.364)	(0.652)	(0.390)	(0.777)
Public revenues x Decent.		0.572		1.307*		1.924**
		(0.731)		(0.722)		(0.980)
R^2	0.078	0.079	0.109	0.113	0.089	0.092
Provinces	50	50	50	50	50	50
Regions	17	17	17	17	17	17
Observations	650	650	650	650	650	650

Notes: see Table A.7

Chapter 3

The Effect of Decentralization on Educational Outcomes: Real Autonomy Matters!

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.

[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

[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.

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 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:

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

where Y_{ijk} is the test score of student *i* in school *j* in country *k*; β_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 ε_{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

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

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 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

[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.

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 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 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

[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.

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 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

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

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.

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

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

extent to 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).

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).

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

[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.

for the responsibility of subnational governments to carry out the educational services and their decision-making autonomy.

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*

[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.

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 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

[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.

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. 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

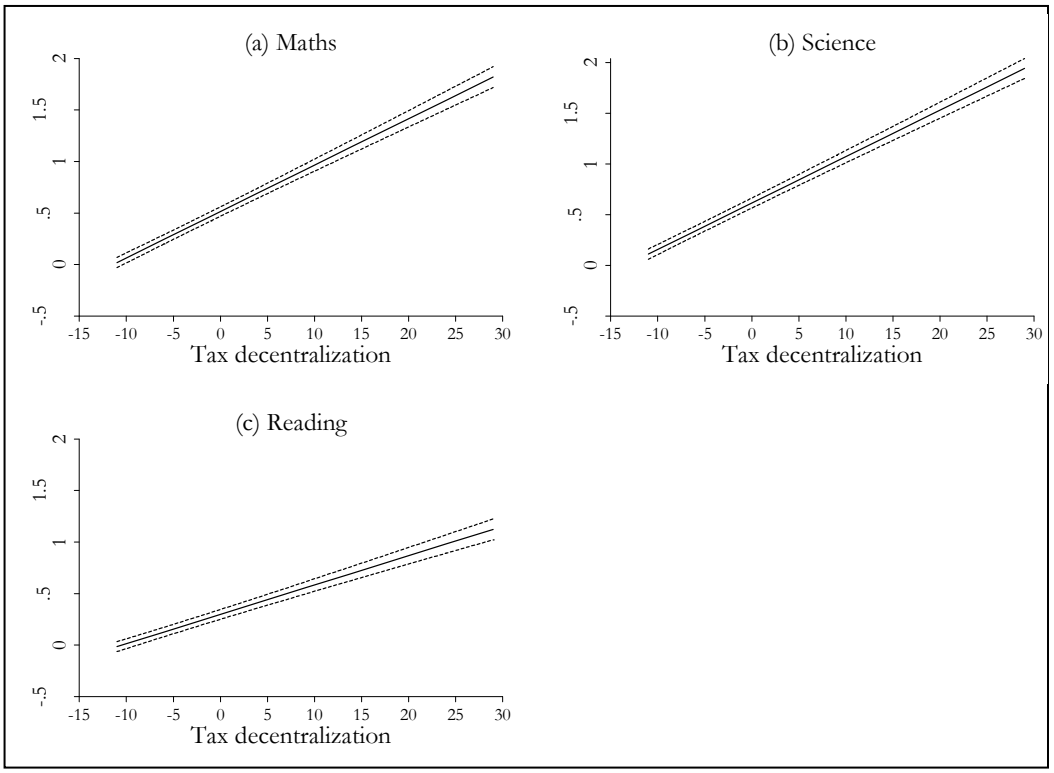
Notes: see Table 4.

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.

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.

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.

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].

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).

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

[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.

[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.

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).

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.

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.

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.

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***	-	0.442***	-	0.268***	-
	(0.022)		(0.024)		(0.021)	
Local decision-making decentralization	0.440***	-	0.478***	-	0.378***	-
	(0.023)		(0.026)		(0.025)	
Regional expenditure decentralization	-	0.188***	-	0.126***	-	0.026**
		(0.013)		(0.014)		(0.013)
Local expenditure decentralization	-	0.197***	-	0.145***	-	0.168***
		(0.012)		(0.012)		(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

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.

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.

References

Barankay, I. and Lockwood, B. (2007): "Decentralization and the productive efficiency of government: evidence from Swiss cantons", *Journal of Public Economics* 91, 1197-1218.

Bardhan, P. and Mookherjee, D. (2000): "Capture and governance at local and national levels", *American Economic Review* 90(2), 135-139.

Bardhan, P. and Mookherjee, D. (2006): "Decentralization, corruption and government accountability: an overview", in *International Handbook on the Economics of Corruption*, S. Rose-Ackerman (Ed.), Edward Elgar Publishing, Northampton.

Bishop, J. (1991): "Achievement, test scores and relative wages", in *Workers and their Wages*, M.H. Kasters (Ed.), The A.E.I. Press, Washington.

Bishop, J. (1992): "The impact of academic competences on wages, unemployment and job performance", *Carregie-Rochester Conference Series on Public Policy* 37, 127-94.

Blöchliger, H. and Rabesona, J. (2009): "The fiscal autonomy of sub-central governments: an update", OECD Working Papers on Fiscal Federalism 9.

Borge, L.E., Brueckner, J.K. and Rattso, J. (2014): "Partial fiscal decentralization and demand responsiveness of the local public sector: theory and evidence from Norway", *Journal of Urban Economics* 80, 153-163.

Bosch, N. and Suárez-Pandiello, J. (1993): "Tamaño del sector público y descentralización fiscal", *Revista de Economía Aplicada* 1(3), 181-193.

Brueckner, J.K. (2009): "Partial fiscal decentralization", *Regional Science and Urban Economics* 39, 23-32.

Deaton, A. (1997): *The analysis of household surveys: a microeconomic approach to development policy,* Johns Hopkins University Press, Baltimore.

De Mello, L.R. (2000): "Fiscal decentralization and intergovernmental fiscal relations: a cross-country analysis", *Wold Development* 28(2), 365-380.

Díaz-Serrano, L. and Meix-Llop, E. (2012): "Do fiscal and political decentralization raise students' performance? A cross-country analysis", IZA Discussion Paper 6722.

Ebel, R.D. and Yilmaz, S. (2002): "On the measurement and impact of fiscal decentralization", WB Policy Research Working Papers 2809.

Falch, T. and Fischer, J.A.V (2012): "Public sector decentralization and school performance: international evidence", *Economic Letters* 114, 276-279.

Fuchs, T. and Woessmann, L. (2007): "What accounts for international differences in student performance? A re-examination using PISA data", *Empirical Economics* 32, 433-464.

Galiani, S. and Schargrodsky, E. (2002): "Evaluating the impact of school decentralization on educational quality", *Economía* 2(2), 275-314.

Galiani, S., Gertler, P. and Schargrodsky, E. (2008): "School decentralization: helping the good get better, but leaving the rest behind", *Journal of Public Economics* 92, 2106-2120.

Gallego, F.A. (2010): "Historical origins of schooling: the role of democracy and political decentralization", *Review of Economics and Statistics* 92(2), 228-243.

Habibi, N., Huang, C., Miranda, D., Murillo, V., Ranis, G., Sarkar, M. and Stewart, F. (2001): "Decentralization in Argentina", Yale Economic Growth Center Discussion Paper 825.

Hanushek, E.A. (1986): "The economics of schooling: production and efficiency in public schools", *Journal of Economic Literature* 24, 1141-1177.

Hanushek, E.A. (1989): "The impact of differential expenditures on school performance", *Educational Researcher* 18(4), 45-62.

Hanushek, E.A. (2003): "The failure of input based schooling policies", *Economic Journal* 113, 64-98.

Hanushek, E.A. and Kimko, D.D. (2000): "Schooling, labor-force quality and the growth of nations", *American Economic Review* 90, 1184-1208.

Hanushek, E.A. and Woessmann, L. (2007): "The role of education quality for economic growth", WB Policy Research Working Paper 4122.

Hindriks, J. and Lockwood, B. (2005): "Centralization and political accountability", CEPR Discussion Paper 5125.

Hunter, J.S.H. (1974): "Vertical intergovernmental financial imbalance: a framework for evaluation", *FinanzArchiv* 32(2), 481-492.

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

Oates, W.E. (2005): "Toward a second-generation theory of fiscal federalism", *International Tax and Public Finance* 12, 349-373.

OECD (2004): *Education at a Glance 2004: OECD Indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2008): *Education at a glance 2008: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2009): *PISA data analysis manual, SPSS second edition*, Organization for Economic Co-operation and Development, Paris.

OECD (2012a): *Education at a glance 2012: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2012b): *PISA 2009 technical report*, PISA, Organization for Economic Co-operation and Development, Paris.

Persson, T. and Tabellini, G. (2000): *Political economics: explaining economic policy*, MIT Press, Cambridge.

Prud'homme, R. (1995): "The dangers of decentralization", *The World Bank Research Observer* 10 (2), 201-220.

Redoano, M. (2010): "Does decentralization affect the number and size of lobbies?", *Journal of Public Economic Theory* 12(3), 407-435.

Rodden, J. (2002): "The dilemma of fiscal federalism: grants and fiscal performance around the world", *American Journal of Political Science* 46(3), 670-687.

Seabright, P. (1996): "Accountability and decentralisation in government: an incomplete contracts model", *European Economic Review* 40, 61-89.

Shah, A. and Shah, S. (2006): "The new vision of local governance and the evolving roles of local governments" in *Local governance in developing countries,* A. Shah (Ed.), World Bank, Washington D.C.

Sharma, C.K. (2012): "Beyond gaps and imbalances: re-structuring the debate on intergovernmental fiscal relations", *Public Administration* 90(1), 99-128.

Strumpf, K.S. and Oberholzer-Gee, F. (2002): "Endogenous policy decentralization: testing the central tenet of economic federalism", *Journal of Political Economy* 110(1), 1-36.

Todd, P.E. and Wolpin, K.I. (2003): "On the specification and estimation of the production function for cognitive achievement", *The Economic Journal* 113, 3-33.

Weingast, B.R. (2009): "Second generation fiscal federalism: the implications of fiscal incentives", *Journal of Urban Economics* 65(3), 279-293.

Wildasin, D.E. (1997): "Externalities and bailouts: hard and soft budget constraints in intergovernmental fiscal relations", WB Policy Research Working Papers 1843.

Woessmann, L. (2001): "Why students in some countries do better?", *Education matters* 1(2), 67-74.

Annex

Figure A.1. Decentralization in OECD countries.

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

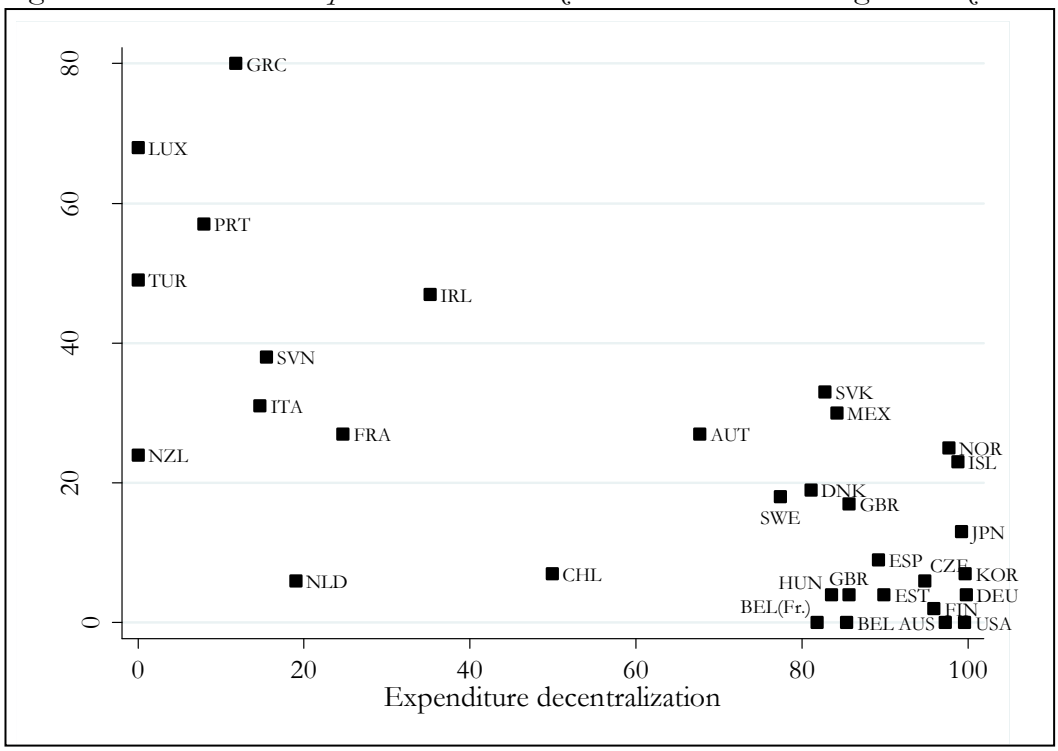


Figure A.1.b. Education expenditure decentralization and conditioned expenditure.

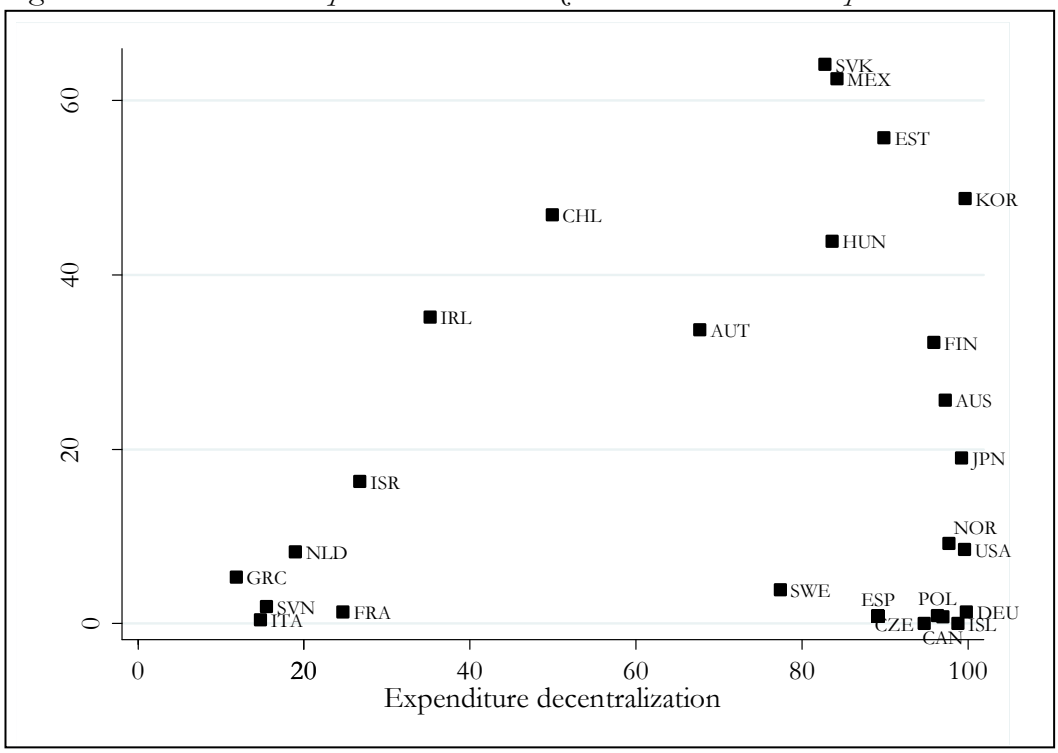
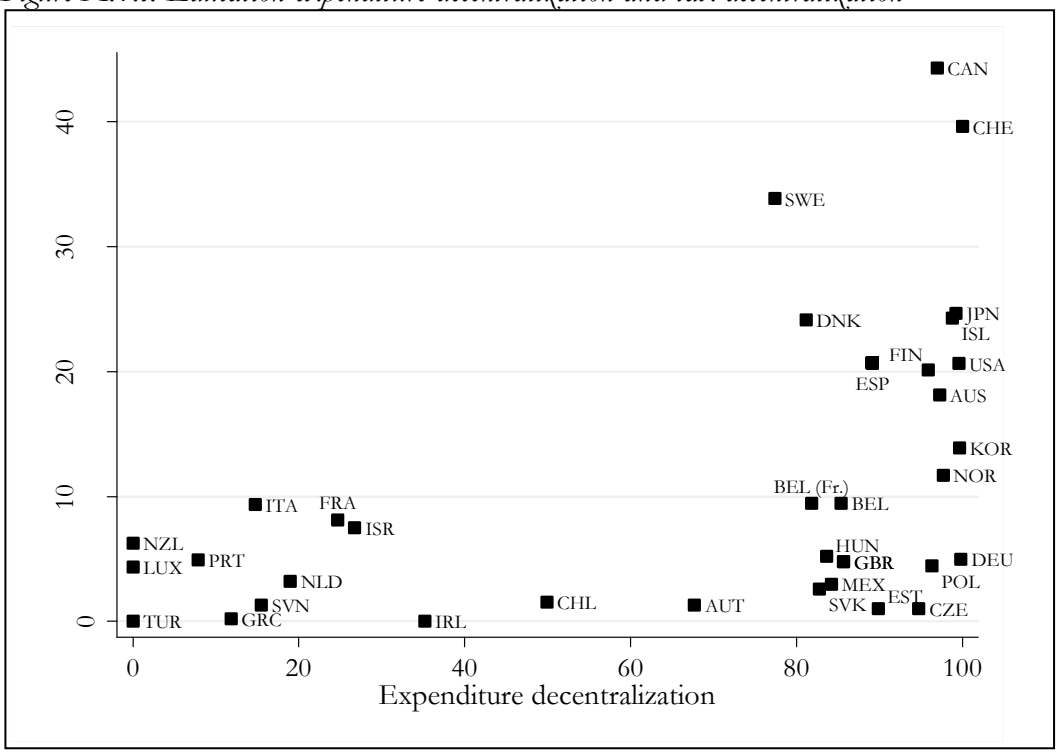


Figure A.1.c. Education expenditure decentralization and tax decentralization



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.

Chapter 4

The Role of Teacher Quality as a Mediator of the Relationship between Decentralization and Educational Attainment

1. Introduction

Fiscal federalism theory identifies a number of mechanisms via which decentralization may lead to improved levels of efficiency in the provision of public goods and services (Oates, 1972, 2005; Weingast, 2009). The empirical literature analyzing the relationship between decentralization and efficiency, though, has typically estimated reduced-form equations, in which the dependent variable is an indicator of the efficiency with which subnational governments provide public services or the outcome of a specific policy[1]. In the education sector, the general conclusion of the empirical literature that adopts this approach is that expenditure decentralization is positively related to educational attainment (Barankay and Lockwood, 2007; Falch and Fischer, 2012), and that the benefits are greater when subnational governments have a low fiscal deficit (Barankay and Lockwood, 2007; Galiani and Schargrodsky, 2002). Additionally, the autonomy of subnational governments to make decisions in education and to raise their own revenues has been shown to play a central role in determining the effects of decentralization on educational attainment (Chapter 3).

However, these studies have not analyzed the process via which decentralization can affect educational attainment, that is, how it can affect

[1] To the best of our knowledge, the only attempts at conducting an empirical analysis of a specific mechanism via which decentralization impacts the education sector are Faguet (2004) and Esteller-Moré and Solé-Ollé (2005), who empirically tested the *preference-matching argument* of fiscal federalism theory by analyzing investment patterns and the way in which they were affected by decentralization.

educational inputs, which at the same time have an impact on educational attainment. This study seeks to go more deeply into the analysis of the effects of decentralization in the education sector, by focusing on one of the most relevant determinants of educational attainment in schools: teacher quality. More specifically, I analyze the role of teacher quality in a decentralization process – that is, how teacher quality might be affected by decentralization and the extent to which this explains decentralization effects on educational attainment. In addition, in order to take into account the possibility that the effect is dependent on the size of the labour market in which subnational governments can hire teachers, I determine if these effects vary according to whether educational policy is decentralized to the regional or local level of government.

The main conclusion to be drawn from this analysis is that a relevant part of the effect of education decentralization on educational attainment is mediated through its effects on teacher quality. That is, decentralization of education has a positive and significant effect on teacher quality, which at the same time has a positive effect on educational attainment. These indirect effects account for 30 per cent of the overall effects of education decentralization on educational attainment. These results are robust to the various analyses conducted to ensure they are not driven by either the endogeneity of decentralization or the endogeneity of the teacher quality variables in the education production function.

Moreover, the indirect effects of decentralization mediated through teacher quality are more relevant when the educational policy is decentralized to the regional level of government than when the policy is decentralized to the local level of government. The explanation to this is that the effects of decentralization on teacher quality will not be as great when the labour market in which governments can hire teachers is smaller, both because teacher supply should be lower in this case and because we would expect the power of the teachers' unions to be greater the shorter the distance between policy-makers and school-based interest groups.

The analysis of the determinants of teacher quality is a relevant question not only for education policy, since teacher quality has been identified as being of great importance in explaining differences in achievement (Hanushek and Rivkin, 2010a; Harris and Sass, 2011), but also for economic policy, since teaching quality has been identified in the empirical literature as a relevant

factor for student outcomes in adulthood (Hanushek, 2011; Chetty *et al.*, 2013) and for long-run economic growth (Hanushek and Kimko, 2000; Hanushek and Woessmann, 2007)[2]. Given this evidence, the development of policies seeking to improve teacher quality and to ensure that all students receive quality teaching is on the agenda of the OECD countries (OECD, 2011). Substantial policy initiatives have been taken in a range of areas that have been outlined in the literature as means of improving teacher quality, including reforming initial teacher education and professional development; reforming teacher recruitment and supply; and, strengthening leadership in schools.

The relationship between decentralization and teacher quality has received little attention in the literature and in educational reforms. However, various arguments raised by fiscal federalism theory, which are summarized in this study, serve to explain the ways in which teacher quality can be influenced by fiscal decentralization policies. These arguments do not allow us, though, to draw any definitive conclusions regarding the beneficial or detrimental effects of decentralization, and empirical analyses are needed. Despite the importance of this question for policy making, to the best of my knowledge, the relationship between fiscal decentralization and teacher quality has yet to be analyzed empirically.

Since there is considerable variation in the OECD countries both in the distribution of educational responsibilities between the different tiers of government and in their teachers' characteristics, they provide a good benchmark against which to analyze the effect of decentralization on teacher quality. Improving our understanding of how a decentralization process affects teacher quality should help us to predict its effects on educational attainment in different countries, and to design future decentralization processes.

Although the effects of teacher quality on educational attainment have been widely analyzed in the empirical literature, evidence regarding which characteristics of teachers are relevant for teacher quality is mixed. In this study, I take advantage of the detailed information provided by the OECD PISA 2009 database to define *teacher quality* in terms of some of the teacher

[2] It is important to distinguish between teacher quality and teaching quality. The latter is not only dependent on the former (i.e., teacher quality), but also on the level of instructional resources available, staffing levels, support from administrators and parents, etc. If schools are not well organized and supportive, and they do not have the necessary educational resources, it is possible that even good teachers will not be successful.

characteristics that are thought to be conducive to educational achievement: *teacher education,* defined as the percentage of teachers holding a master's degree in a given school; *teacher certification*, defined as the percentage of teachers at a given school that are certified by the competent authority; and *disciplinary climate*, an index that measures the disciplinary climate in language lessons in each school. Once differences in student and school characteristics are controlled for in the specified model, variations in the disciplinary climate in language classes can be considered the result of variations in the ability and incentives of language teachers to create and sustain an effective learning environment. Since the disciplinary climate variable is defined only for language lessons, educational attainment is defined in terms of the students reading test scores on PISA 2009. This information is available for 294,156 students, in 10,871 schools, belonging to 33 OECD countries (France is the only OECD country which was excluded from the dataset, because of missing data for some relevant variables).

Education decentralization is defined here as the percentage of educational decisions that are taken at the subnational level of government. In Chapter 3 I show that the decision-making autonomy of subnational governments is what really matters in explaining the effect of decentralization on educational attainment, since its explanatory power is much higher than that of the most commonly used measure of decentralization, that is, expenditure decentralization. In addition, as I discuss later, the capacity of subnational governments to improve teacher quality depends greatly on their autonomy to regulate the factors that impact teacher decisions, including teachers' salaries and their working conditions.

Following on from this introduction, the rest of the chapter is organized as follows. Section 2 provides the rationale for the analysis, describing why teacher quality is an important factor of the education process and how it can be affected by decentralization. Section 3 describes the methodology and discusses the main empirical questions of the analysis. Section 4 presents the main empirical findings and section 5 presents additional results that allow for heterogeneous effects of education decentralization. Section 6 summarizes and presents the conclusions that can be derived from the analysis.

2. Educational attainment, teacher quality and decentralization

2.1. The relationship between teacher quality and educational attainment

The aim of this study is to analyze the role played by teacher quality in a decentralization process, that is, how teacher quality might be affected by decentralization and the extent to which this effect accounts for the impact of decentralization on educational attainment. In this section, I review the literature that has examined the importance of teacher quality for educational achievement, in order to determine the teacher characteristics that can be considered relevant in defining teacher quality. There is a broad consensus among researchers concerning the importance of teacher quality for explaining differences in achievement, but the debate concerning the specific characteristics of teachers that are relevant for teacher quality remains open and the evidence is mixed[3].

The reason for this lack of consensus is that the identification of the effect of teacher characteristics on student achievement is hampered by the problems of endogeneity affecting these variables. Teachers with higher qualifications might be matched in some systematic way with students exhibiting characteristics that, if not fully controlled for in the model, might introduce biases in the estimated results (Krueger, 2003; Todd and Wolpin, 2003). Early empirical evidence, which did not control for this endogeneity, concluded that teaching quality had little to do with differences in student performance (Hanushek, 1986, 1989).

The more recent literature has sought to overcome the endogeneity problems generated by the non-random assignment of students to teachers through the value-added specification of the education production function, which controls for lagged student achievement (Hanushek, 2003). In addition, the availability of detailed datasets for the United States during the last decade allowed researchers to improve such value-added empirical analyses, by also including fixed effects for schools, students or teachers, depending on the data

[3] The most widely accepted way of defining *teacher quality* is in terms of student learning. That is, teachers are considered to be effective when there is evidence that their students have acquired adequate knowledge and skills. However, measuring teacher quality in terms of their students' learning requires very detailed datasets, with students matched to their teachers and repeated observations of each. Such datasets are only available for certain regions or cities in the United States, and thus such measures cannot be used to analyse the effects of decentralization.

that were available (Rockoff, 2004; Rivkin *et al.*, 2005). The general conclusion presented by these studies is that differences in teacher effectiveness are quite significant (Hanushek and Rivkin, 2010a), although there is some disagreement as to just how much of this variation can be explained by the teachers' observable characteristics.

While some studies conclude that experience is not significantly related to achievement after the first few years working in the profession (Hanushek *et al.*, 2005; Rivkin *et al.*, 2005), others report that the returns to experience are quantitatively significant, even after the initial period dedicated to teaching (Clotfelter *et al.*, 2007, 2010; Harris and Sass, 2011; Wiswall, 2013). Conclusions regarding the relationship between teacher qualifications and student achievement vary widely depending on the specific measure that is used. For instance, teacher subject knowledge measured with test scores has been found to exert a statistically and quantitatively significant impact on student achievement (Metzler and Woessmann, 2012). By contrast, the attainment of advanced degrees has been reported as not being significant in improving teacher productivity (Rivkin *et al.*, 2005; Hanushek *et al.*, 2005; Aaranson *et al.*, 2007), and even as having negative effects (Clotfelter *et al.*, 2007). In-service professional development has been found to have mixed effects on educational attainment, depending on the grade level and the subject (Harris and Sass, 2011). Finally, the results are also mixed for teacher credentials in the form of certification (Hanushek *et al.*, 2005; Clotfelter *et al.*, 2007; Kane *et al.*, 2006).

Some of these studies support the hypothesis that teachers' unobservable characteristics might have a greater effect on student achievement (Hanushek *et al.*, 2005; Rivkin *et al.*, 2005). For instance, the ability of teachers to create and sustain an effective learning environment, their ability to communicate effectively, their sense of caring and responsibility for helping their students to learn and become good people or their dedication to the goals of teaching have been identified in other branches of the literature as important characteristics that good teachers might have (Darling-Hammond, 2000). However, some of these characteristics are difficult to measure and, therefore, only a few studies have attempted to include them in their analyses of student learning. Instead, researchers tend to use measures that are proxies of these non-observable characteristics, such as parent-teacher conferences, assignment

of homework or teacher school attendance to measure teacher effort and commitment (Glewwe *et al.*, 2010).

An alternative method for analyzing the effects of teacher quality on student achievement is based on a contemporaneous specification of the education production. This method was the most widely adopted in early studies (Hanushek, 1986) and has been used in recent studies based on international student achievement survey data (Woessmann, 2003; Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007). International achievement survey data allow researchers to conduct cross-national analyses, controlling for a wide set of country characteristics and institutional settings. In addition, an extended set of school, teacher and student-level variables can also be included in the analysis, which should ameliorate omitted variables bias (Clotfelter *et al.*, 2006). Although teacher quality has not received as much attention in this branch of the literature, the general conclusion is that the effect of teacher education on student educational attainment is positive and significant.

In this study, I take advantage of the detailed information provided by the PISA 2009 database to define three different variables that account for the dimensions of teacher quality. The first variable is *teacher education,* which measures the percentage of teachers in a school that hold a master's degree. The second variable is *teacher certification*, which measures the percentage of teachers in a school that are certified by the competent authority. Obtaining a certificate generally means that a teacher has been prepared on an accredited teacher education programme. In some countries it might also imply that teachers have passed a national teacher examination or have acquired some teaching experience. The third variable, aimed at proxying the non-observable or non-measured characteristics of teachers, is *disciplinary climate.* Once differences in student and school characteristics are controlled for in the specified model, variations in the disciplinary climate in language classes can be considered the result of variations in the ability and incentives of language teachers to create and sustain an effective learning environment. These different dimensions of teacher quality are liable to be affected by decentralization in different ways, which I analyze in the next section.

2.2. The relationship between decentralization and teacher quality

Different arguments might serve to identify the different channels through which teacher quality can be affected by fiscal decentralization. Fiscal

federalism theory identifies a number of mechanisms via which decentralization may lead to improved levels of efficiency in the provision of public goods and services, both in terms of allocative and productive efficiency[4]. Thus, it has been claimed that subnational governments have a better knowledge than that held by central government of their citizens' preferences and needs so that, in the absence of economies of scale and externalities, decentralization can ensure a better match between political decisions and these preferences and needs (Oates, 1972).

Evidence for the OECD countries suggests that some schools are facing difficulties in recruiting teachers in computer sciences, mathematics, technology, foreign languages and sciences, skills that are in high demand in other professions besides education. As a consequence, the proportion of teachers teaching subjects for which they are not fully qualified is strikingly high in some key areas, and attrition and turnover rates have increased in recent years in these fields. Evidence for the OECD countries also suggests that students in disadvantaged areas find themselves in classes with the least experienced and least qualified teachers (OECD, 2004a), because of attrition from the profession and the movement of teachers to other schools. Since subnational governments will be better informed as to whether schools face a shortage of teachers in specific fields (such as, special education, computer sciences or foreign languages), and whether they need better trained teachers to offset the worse conditions that low income, disabled, language minority and other vulnerable students may face in specific regions, it can be argued that such a situation can be improved under a decentralized system. The better information available to subnational governments about student and school needs in their jurisdictions enables them to match their education policies more effectively with these requirements.

The shortened distance between policy-makers and citizens implied by the decentralization of education policy may also increase the voice of parents. Parental/citizen control and political participation might be enhanced, which in turn should ensure that subnational governments are more responsive to their demands than the central government tends to be (Shah, 1998). Closely related to this, decentralization is thought to increase the degree of political accountability of the government (Seabright, 1996), especially when

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

subnational governments are not highly dependent on intergovernmental fiscal grants to finance their expenditures (De Mello and Barensteinl, 2001; Rodden, 2003; Oates, 2005; Weingast, 2009). As a consequence, subnational governments might have more incentives than the central government to improve teacher labour force quality by increasing the number of teachers with the desirable characteristics (in terms of qualification, ability and motivation). Similarly, policies aimed at improving teacher incentives might be enhanced under a decentralized system. The incentives for a school's principal and teachers to work harder and to use the educational resources available to maximize student performance might also be enhanced under a decentralized system, since they are more accountable to both the government that is responsible for managing the educational system and to the parents, who can more effectively demand better education for the taxes they pay (Healey and Crouch, 2012; Winkler and Yeo, 2007).

However, the better information that subnational governments might have regarding their schools' needs and enhanced citizen control and political participation will only result in an improvement in teacher quality under certain circumstances. First, subnational governments need to be responsible for taking decisions in relation to the various factors that determine the supply of good quality teachers in the different fields, that is, individuals' decisions to enter and stay in the teaching profession. Factors that have been identified as being important determinants of teacher quality include *working conditions*, such as the availability of administrative support and educational resources, class sizes, teaching load or safety; *accountability methods*, since schools that fail to meet performance standards can affect teacher morale and lead to teacher exodus, especially in more disadvantaged communities; *teacher preparation*, since the evidence suggests that better prepared teachers stay in the profession and in disadvantaged schools longer; *location*, since areas where the supply of teachers is lower than the demand are likely to recruit less qualified teachers, unless compensatory incentives are in place; and *salaries*, since higher salaries would attract better prepared teachers (Darling-Hammond and Sykes, 2003). Thus, the capacity of subnational governments to improve teacher quality will depend upon their decision-making power to influence these factors.

Second, even if subnational governments have the proper decision-making power to be able to improve teacher quality, their capacity to do so might be limited because of the power of the teachers' unions. Thus, they might find

their power to introduce reforms in the education sector and in the teaching labour market is restricted. Salaries and levels of employment are typically determined through a process of collective bargaining involving governments and teachers' unions. Thus, even if subnational governments have the power to fix teachers' salaries and to hire and fire teachers, their room for manoeuvre will be limited by the presence of powerful teachers' unions. For instance, entry from outside the profession or mechanisms of reward linked to teaching performance or teaching fields might be restricted in such a setting, and has been shown to be related to the loss of the more talented teachers (Gilpin and Kaganovich, 2012). Likewise, Pritchett and Filmer (1997) argue that inputs directly or indirectly benefiting teachers, such as wage increases or smaller class sizes, are disproportionately favoured in public education in many countries because of the lobbying power of teachers and teachers' unions, despite the fact that alternative inputs are frequently found to be more cost-effective in improving student learning. However, evidence regarding the relationship between teachers' unions, teacher quality and student achievement is mixed (Hoxby, 1996; Murillo *et al.*, 2002; Zegarra and Ravina, 2003), and might be context specific.

An important issue to consider is the fact that the power of the teachers' unions could depend on the level of government that is responsible for the delivery of educational services. Some authors have argued that decentralization might make school-based interest groups more influential, resulting in an increase in the level of corruption in the education sector (Prud'homme,1995; Woessmann, 2001)[5]. Despite these theories, a number of studies that have analyzed the relationship between decentralization and lobbying in other sectors conclude that the effects of decentralization on corruption are ambiguous and context-specific, indicating the need for empirical studies (Redoano, 2010; Bardhan and Mookherjee, 2000; 2006).

Finally, the supply of good quality teachers also depends on the level of government that has responsibility for delivering educational services since this will determine the size of the labour market in which governments can hire teachers (Darling-Hammond and Sykes, 2003). That is, if there is no national labour market or there are interstate barriers to mobility,

[5] Corruption in the education sector can take different forms, such as the diversion of resources from effective uses to uses that benefit particular purposes (such as increasing salaries, teacher hiring, etc.) or teacher absenteeism. In any case, it will have an impact on the availability and quality of educational goods and services (Hallak and Poisson, 2005).

decentralization will reduce the supply of teachers that can be hired by governments. Thus, we would expect the effects of decentralization to depend on the size of the jurisdictions that receive educational decision-making power, since both the relationship between decentralization and lobbying and between decentralization and the supply of teachers might depend on this size.

To sum up, decentralized governments may enhance policies aimed at improving teacher labour force quality, both because they have a better knowledge of their population and their schools' needs and because they are more accountable, and thus they will have more incentives to act in the best interests of their citizens than is the case of the central government. However, these effects will depend on their autonomy to take decisions, as well as on the bargaining power of the teachers' unions and the size of the labour market in which decentralized governments can hire teachers. Thus, empirical analyses are needed to determine whether the decentralization of education policy has beneficial or detrimental effects on teacher quality.

Despite the importance of these effects in determining the impact of decentralization on educational attainment, and the relevant policy implications that might be derived from such analyses, to the best of our knowledge the relationship between decentralization and teacher quality has not been empirically analyzed. Thus, this study represents the first attempt to analyze the role of teacher quality in a decentralization process, that is, how teacher quality can be affected by decentralization and the extent to which this effect accounts for the impact of decentralization on educational attainment.

3. Methodology

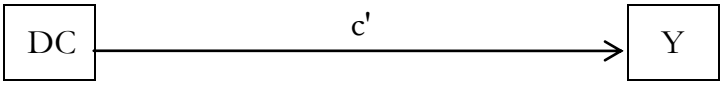
3.1. Methodological framework

When educational attainment (Y) is regressed on education decentralization (DC) without controlling for either teacher quality or other variables liable to be affected by decentralization and to have an effect on educational attainment, the *total effect* of decentralization on educational attainment is obtained (represented by c' in Panel A of Figure 1). In this study, however, I am interested in analyzing the process that leads to these effects. More

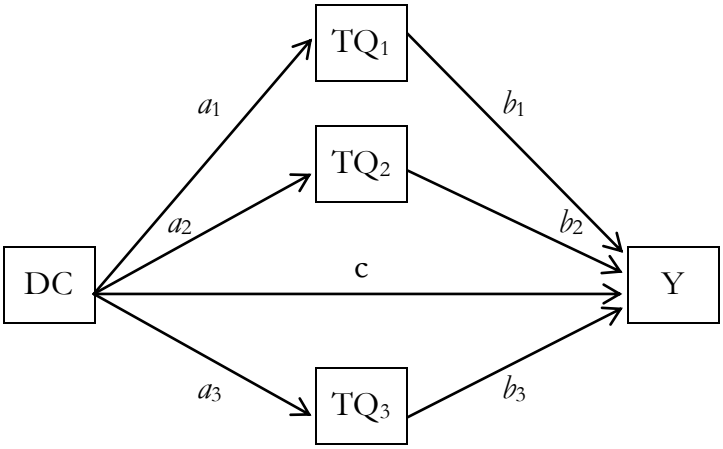
specifically, the objective of this study is to decompose the *total effect* into a *direct effect* and an *indirect effect* as mediated through teacher quality[6].

Figure 1. Relationship between decentralization and educational outcomes.

Panel A. Total Effects of Decentralization on Educational Attainment.



Panel B. Direct and Indirect Effects of Decentralization on Educational Attainment.



Notes: DC represents *education decentralization*; Y represents *educational attainment*; TQ_m represents teacher quality variable *m*; c' in Panel A represents the total effect of decentralization on educational attainment; c in Panel B represents the direct effect of decentralization on educational attainment; and a_m and b_m represent the first and second stage, respectively, of the effect of decentralization on educational attainment mediated though teacher quality variable *m*.

Panel B in Figure 1 represents the relationship between decentralization, teacher quality and educational attainment in this setting, where teacher quality is measured in terms of the three variables defined above (TQ_m, m = 1, 2, 3). The line between decentralization and educational attainment represents the *direct effect* (c), which can be obtained by regressing Y on DC, controlling for the teacher quality variables. The *specific indirect effects,* that is, the effects of decentralization on educational attainment mediated through each teacher quality variable *m*, are also represented in Figure 1. They are defined as the

[6] For an overview of the analytical strategies for evaluating indirect effects in multiple mediation models see Preacher and Hayes (2008).

product of the two paths linking DC and Y via each teacher quality variable ($a_m \cdot b_m$). The first path (a_m), which represents the effect of DC on TQ_m, corresponds to the *first stage* of the *specific indirect effect m* of decentralization. The second path (b_m), which represents the effect of TQ_m on Y, corresponds to the *second stage* of the *specific indirect effect m*. The total *indirect effect* of decentralization on educational attainment is defined as the sum of the *specific indirect effects* ($\sum a_m \cdot b_m$), and the *total effect* of decentralization on educational attainment can then be estimated as the sum of the total *indirect effect* and *direct effect*.

In order to conclude that teacher quality variables are mediators of the relationship between decentralization and educational attainment, quite straightforward conditions must be met (Baron and Kenny, 1986). First, decentralization must be significant in explaining educational outcomes, that is, the *total effect* must be significant ($c' \neq 0$)[7]. Second, decentralization must also be significant in explaining teacher quality ($a_m \neq 0$). Finally, teacher quality must be significant in explaining educational outcomes after controlling for decentralization ($b_m \neq 0$). These conditions can be tested within a regression framework, which requires the estimation of a system of four different equations: one equation for each teacher quality variable, which enables me to estimate the effects of decentralization on each (a_m); and one equation for educational attainment, which enables me to estimate the effect of each teacher quality variable on educational attainment (b_m) and the direct effect of decentralization on educational attainment (c). I present the specification of these equations in the next section.

3.2. Empirical strategy

As explained above, teacher quality is measured in terms of three different variables. The first variable is *teacher education,* which is defined as the percentage of teachers holding a master's degree in a given school. The second variable is *teacher certification*, which is defined as the percentage of teachers at a given school that are certified by the competent authority. And the third variable, designed to proxy the non-observable characteristics of teachers, is *disciplinary climate,* which is an index that measures the disciplinary climate in the classroom during language lessons. In order to identify the effect of decentralization on these teacher quality variables, controls for those factors

[7] Although this is quite an intuitive condition, some authors argue that it is not necessary for mediation to occur (MacKinnon *et al.*, 2000). However, in Chapter 3 we have seen that this effect is statistically significant.

that lie outside the control of governments (or at least are not likely to be influenced by decentralization) but which are likely to affect the decisions of teachers and schools and, thus, to have an influence on teacher quality, need to be included in the model.

Thus, in line with the above discussion, we need to control for a school's characteristics, including size and location, as these might be determinants of both the attractiveness of the school for teachers and the possibility of the school's finding good teachers (that is, the supply of good quality teachers); and, for the aggregate student characteristics, since these will drive a teacher's choice of school (for instance, a teacher might very well prefer to work in a school with non-poor students). In addition, these variables are also likely to have a relevant impact on the disciplinary climate in the classroom, which might lie outside the control of the teachers themselves. Once these factors have been controlled for, variations in disciplinary climate can be interpreted as the result of the ability or incentives of teachers to create and sustain an effective learning environment in class.

Finally, the equation for educational attainment is defined as a contemporaneous education production function where student educational attainment is regressed on a set of variables that measure the inputs of the educational process. These inputs include teacher quality and decentralization, and a set of variables that control for the schools' characteristics, family inputs (such as home educational resources and family background variables) and student characteristics. This system of equations can be represented as follows[8]:

$$Educ_{jk} = \alpha_{01} + \alpha_{11} DC_k + \alpha_{21} Sc_{jk} + \alpha_{31} St_{jk} + \varepsilon^1_{jk} \quad (1)$$

$$Cert_{jk} = \alpha_{02} + \alpha_{12} DC_k + \alpha_{22} Sc_{jk} + \alpha_{32} St_{jk} + \varepsilon^2_{jk} \quad (2)$$

$$Clima_{jk} = \alpha_{03} + \alpha_{13} DC_k + \alpha_{23} Sc_{jk} + \alpha_{33} St_{jk} + \varepsilon^3_{jk} \quad (3)$$

$$Y_{ijk} = \beta_0 + \beta_1 Educ_{jk} + \beta_2 Cert_{jk} + \beta_3 Clima_{jk} + \beta_4 DC_k + \beta_5 Sc_{jk} + \beta_6 St_{jk} + \beta_7 F_{ijk} + \beta_8 St_{ijk} + \varepsilon^4_{ijk} \quad (4)$$

[8] The quality of educational resources, the characteristics of the school's principal and the school's accountability might also affect teacher quality and educational attainment, but they are also likely to be affected by decentralization. Thus, I do not include these additional variables in the analysis. In this way, the total effect of decentralization on teacher quality is identified in equations (1) to (3) and the effect of decentralization on educational outcomes in equation (4), which is interpreted here as the *direct effect*, might also include indirect effects via this kind of omitted input.

where $Educ_{jk}$ represents *teacher education* in school *j* in country *k*; $Cert_{jk}$ represents *teacher certification* in school *j* in country *k*; $Clima_{jk}$ represents the *disciplinary climate* in language classes in school *j* in country *k*; Y_{ijk} is the reading test score of student *i* in school *j* in country *k*; DC_k represents *education decentralization* in country *k*; Sc_{jk} represents the characteristics of school *j* in country *k* ; St_{jk} represents the aggregate student characteristics in school *j* in country *k;* F_{ijk} represents the family inputs of student *i* in school *j* in country *k;* St_{ijk} represents the characteristics of student *i* in school *j* in country *k*; and ε^n represents the error term in each equation *n*. Individual and school level data were obtained from the OECD PISA 2009 database, described in Annex I. Table 1 in Annex I defines all the variables included in the model and the expected sign of their coefficients in the education production function according to the theoretical background and previous empirical evidence.

The coefficients of decentralization in equations (1) to (3), α_{1m}, represent the *first stage* of the *specific indirect effects* of decentralization (a_m); the coefficients of the teacher quality variables in equation (4), β_m, represent the *second stage* of the *specific indirect effects* of decentralization (b_m)*;* and the coefficient of decentralization in equation (4), β_4, represents the *direct effect* of decentralization on educational attainment (c). Thus, the *specific indirect effect* mediated through each teacher quality variable *m* can be estimated as the product $\alpha_{1m} \cdot \beta_m$; the total *indirect effect* as the sum of the *specific indirect effects* ($\sum \alpha_{1m} \cdot \beta_m$); and the *total effect* as the sum of the *indirect* and the *direct effects* ($\sum (\alpha_{1m} \cdot \beta_m) + \beta_4$).

I conduct the analysis at the student level, for which proper weights are available in the PISA database. I estimate equations (1) to (4) using the weighted least-squares method, with the weights being equal to the students sampling probability, normalized to give an equal weight to each country. In addition, since students are grouped by school, and schools are grouped by country, I use balanced repeated replication (BRR) with Fay's modification to compute estimates of the sampling variance. In this way, I am able to recognize the clustering structure of student-level data 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. The standard errors of the indirect and the total

effects are computed by bootstrapping, and their significance is set in base to bias corrected confidence intervals[9].

3.3. Identification strategy

3.3.1. Potential endogeneity of teacher quality

The specification problems identified in the literature as being likely to affect the estimation of education production functions (Todd and Wolpin, 2003) are unlikely to affect the coefficient of *education decentralization*, since the state of decentralization is unlikely to change over a student's school life or to be correlated with a student's non-observable characteristics, such as his or her innate ability. However, these biases are likely to affect the coefficients of teacher quality variables (β_m), if teachers with stronger qualifications are matched in some systematic way with students exhibiting characteristics that are not fully controlled for in the model (Krueger, 2003; Todd and Wolpin, 2003).

For instance, students with family backgrounds and other factors conducive to higher achievement tend to seek out better schools with higher quality teachers. In addition, administrative decisions regarding teacher and student classroom assignments may amplify or dampen the correlations introduced by such family choices. A further source of correlation between teacher quality and student performance lies in the matching of teachers with schools. Teacher preferences for schools with non-poor students or students with a higher level of achievement potentially introduce a positive correlation between teacher quality and a family's contribution to learning (Hanushek *et al.*, 2004; Hanushek and Rivkin, 2010b)[10]. If the coefficients of teacher quality were biased in equation (4), the estimated *indirect effect* of decentralization on

[9] This method has been found to be preferable to the more common method for testing mediation hypotheses, the *Sobel test,* which requires the assumption of a normal distribution (Preacher and Hayes, 2004; MacKinnon *et al.*, 2002; Williams and MacKinnon, 2008). In addition, bootstrapped confidence intervals do not depend on the choice to free or constrain residual covariances of the different equations, which represents an additional advantage of this method.

[10] The systems of teacher and student assignments to schools in each country will determine this relationship. Evidence for the United States suggests that teachers with stronger qualifications are matched to students who are educationally more advantaged along dimensions that are hard to control for, and that most of this positive matching occurs at the school rather than at the classroom level (Clotfelter *et al.*, 2006). Thus, within this context, the coefficients of the teacher variables when non-random selection is not taken into account would be upward biased.

educational attainment mediated via teacher quality would also be biased. However, as several variables were included that control for the student and school characteristics that could be driving the non-random sorting processes of students and teachers to schools, I do not expect the estimated coefficients to be biased for this reason. In addition, since teacher quality variables are measured at the school level, their coefficients should not be affected by within school sorting processes of students and teachers.

The estimated *indirect effect* of decentralization might also be biased if there were a causal dependence between the different teacher quality variables, which is not taken into account in the estimation method proposed above. For instance, teachers' ability to create and sustain an effective learning environment in class might depend on whether they have a master's degree or certification. If this is the case, the coefficient of decentralization in equation (3) might include both the effect of decentralization on the abilities and incentives of teachers, and its effect on the other teacher quality variables.

I conduct two additional analyses to corroborate that the estimated *indirect effect* of decentralization mediated through teacher quality is not biased for these reasons. First, I estimate the *indirect effect* of decentralization on educational attainment with an alternative method, which involves estimating it as the difference between the *total effect* and the *direct effect* of decentralization (c'-c)[11]. This measure of the *indirect effect* of decentralization on educational attainment depends neither on the coefficients of the teacher quality variables in equation (4) nor on the coefficients of decentralization in equations (1) to (3), so that potential biases in these coefficients should not affect it. Second, I conduct an additional analysis which includes teacher quality variables as regressors in equations (1) to (3), and simultaneously estimate the system of equations. In this way, I take into account the causal relations between teacher quality variables, avoiding biases in the coefficients of decentralization in equations (1) to (3) for this reason.

[11] Although in a multilevel setting these two methods for computing the indirect effects are not algebraically equivalent, Krull and MacKinnon (1999) show that the discrepancy between them is equal to zero, and that for very large samples the two estimates would be equivalent. However, the *specific indirect effects* mediated through each teacher quality variable cannot be estimated with this alternative method.

3.3.2. Potential endogeneity of decentralization

A different source of bias in the estimated effects of decentralization on teacher quality and educational attainment originates from the potential endogeneity of decentralization in equations (1) to (4) (Strumpf and Oberholzer-Gee, 2002). If there were observable or non-observable characteristics of countries that were liable to affect both decentralization decisions and the levels of teacher quality 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 or lower teacher quality are more likely to be centralized or decentralized than countries with higher levels of these variables, decentralization coefficients might also be biased because of reverse causality. Thus, I conduct additional analyses to corroborate that such endogeneity problems are not affecting the estimated effects of decentralization on teacher quality and educational attainment.

First, I include fixed effects that account for the region to which each country belongs. These *region fixed effects* seek to capture the observable and non-observable characteristics of countries that might be common in countries that are close geographically[12]. For instance, we might expect the importance attached to education to be similar in Asiatic countries, in Nordic countries or in the South of Europe countries. If these common characteristics were related both to teacher quality and education decentralization policies, and their effects were not captured by the variables included in the model, their omission from equations (1) to (3) might bias the estimated effects of decentralization. In the same way, if they were related both to educational attainment and education decentralization policies, their omission from equation (4) might also bias the decentralization coefficient.

Second, I run additional regressions controlling for countries' observable characteristics that might also be liable to correlate with teacher quality, 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

[12] 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.

International Corruption Perception Index, which ranges between 10, if the country is highly clean, and 0, if the country is highly corrupt). If the likelihood of a country decentralizing depends on its level of development or corruption, and these variables are also related to teacher quality and educational attainment, their omission from the regression equations might cause the effect of decentralization to be biased. International evidence shows that the education sector is especially prone to corruption, since large amounts of resources are often transferred through many administrative tiers without proper controls being exercised. In addition, the importance attached to education policies also means interests groups tend to be more powerful in this sector (TI, 2013). However, just how decentralization relates to these variables is not entirely clear in the literature. Finally, in order to corroborate that the results are not driven by any particular country in the sample, I repeated the estimations eliminating one country at a time.

3.4. Allowing for heterogeneous effects of education decentralization

As discussed above, we would expect the effects of education decentralization in particular countries to depend on the level of government that is awarded responsibility for education, since this can be expected to be related both to the power of the teachers' unions and teacher labour supply. As we have seen above, the theory is not conclusive about how these variables will modify the effects of decentralization on teacher quality and educational attainment, since opposite forces are in play. Thus, in order to provide an insight into these questions, I analyze whether the relationship between decentralization, teacher quality and educational attainment depends on the level of government with responsibility for education policy.

To analyze the heterogeneous effects of decentralization that are dependent on the level of government which holds the education competences, I re-estimate equations (1) to (4) including two different variables of decentralization. One of these measures the percentage of education decisions that is decentralized to the regional government, and the other, the percentage of decisions decentralized to the local government.

3.5. Data

I estimate the above equations by using a huge dataset, which contains personal and academic information of 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 decentralization,* which is defined as the percentage of educational decisions that are taken at the subnational level of government (OECD, 2004b, 2008, 2012). 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.

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 is also provided at the regional level, the number of independent observations to estimate the decentralization effects is increased to 35 observations. Each country's average *teacher education, teacher certification, disciplinary climate* and reading test scores are also included in this table.

Average *teacher education* and *certification* in the OECD countries is quite high. The average percentage of teachers in schools holding a master's degree is 73.2%, and the average percentage of certified teachers is 84.7%. However, notable differences between the different countries exist with regard to these variables. As we can observe in Table 3 in Annex I, standard deviation is 37 points for *teacher education* and 27 points for *teacher certification*. Differences between countries are also observed for the *disciplinary climate* variable, although these differences cannot be directly interpreted in terms of teacher quality. As this variable was scaled to have an average mean equal to 0 and a standard deviation equal to 1 in the OECD countries, we can observe that it ranges from minus 0.40 in Greece to 0.75 in Japan. Average reading test scores also present wide variation between countries, ranging from 425.27 in Mexico to 539.27 in Korea, with an overall mean for OECD countries equal to 493.38. Although an important part of the variability in test scores can be explained by student, family and school factors, the countries' institutional factors are also relevant for explaining differences between countries (Fuchs and Woessmann, 2007).

4. Empirical findings

4.1. Direct and indirect effects of decentralization on educational attainment

In this section I present the results obtained when estimating the *direct effect* of education decentralization on educational attainment, the *indirect effect* of education decentralization on educational attainment mediated through teacher quality and the *total effect* of education decentralization. Panel A in Table 1 presents the *specific indirect effect* for each teacher quality variable. The first and the second stages of these *specific indirect effects*, obtained directly from the estimation of equations (1) to (4), are also presented in this panel. Panel B in Table 1 presents the *indirect effect* of education decentralization on educational attainment, computed as the sum of the *specific indirect effects;* the *direct effect* of decentralization on educational attainment, corresponding to the estimated parameter of decentralization in equation (4); and the *total effect*, which is the sum of the *indirect* and *direct effects*. Table A.1 in the annex of this chapter reports the estimated coefficients for the whole set of variables included in the model.

As can be observed in Panel A in Table 1, e*ducation decentralization* has a positive and significant effect on teacher quality, independent of whether it is measured with the *teacher education*, *teacher certification* or *disciplinary climate* variables (*first stage effect*). Based on these results, if we compare a country in which all educational decisions have been decentralized to the subnational level of government and a country in which all the decisions are centralized, we could expect an average difference in *teacher education* equal to 5.8 percentage points, an average difference in *teacher certification* equal to 15 percentage points, and an average difference in *disciplinary climate* equal to 0.338, that is, 84.5 per cent of an international standard deviation, a quite relevant effect. Taking into account the fact that the percentage of teachers with a master's degree or certification is high in most countries, the effect of decentralization on these variables can also be considered a quantitatively significant effect.

The effects of the teacher quality variables on the students' test scores are also positive and significant (*second stage effect*). In line with previous findings, however, the effect of the percentage of teachers holding a master's degree is quantitatively moderate. Based on these results, a 10 per cent difference in *teacher education* would imply an average difference of 0.62 points on the reading assessment scores; a 10 per cent point difference in *teacher certification* an

average difference of 1.70 points; and a difference in *disciplinary climate* equal to 0.10 would imply an average difference in the reading assessment equal to 1.84 points.

Table 1. Decomposition of the effects of education decentralization on reading test scores.

Panel A. Specific indirect effects	**First stage effect**	**Second stage effect**	**Specific indirect effect**
Teacher education	0.058***	6.212***	0.360**
	(0.016)	(1.053)	(0.162)
Teacher certification	0.150***	16.951***	2.543***
	(0.010)	(1.634)	(0.408)
Disciplinary climate	0.338***	18.359***	6.205***
	(0.024)	(0.861)	(0.732)
Panel B. Decomposition of the total effects			
Indirect Effect	-	-	9.108***
			(0.850)
Direct Effect	-	-	21.679***
			(1.979)
Total Effect	-	-	30.787***
			(2.885)

Notes: decomposition of the *total effect* of decentralization on reading test scores, in base to the estimated coefficients of equations (1) to (4). The complete estimation results are presented in Table A.1 in the annex. The *first stage effect* corresponds to the effect of education decentralization on each teacher quality variable in equations (1) to (3). The *second stage effect* corresponds to the effect of each teacher quality variable on educational attainment in equation (4). The *specific indirect effect* mediated through each teacher quality variable is the product of the *first* and *second stage effects*; the *indirect effect* is the sum of the *specific indirect effects;* the *direct effect* corresponds to the effect of decentralization on educational attainment in equation (4) and the *total effect* is the sum of the *direct* and the *indirect effects*. Equations (1) to (4) are estimated by least-squares weighted by students' sampling probability, normalised to give an equal weight to each country. For coefficients from equations (1) to (4) robust standard errors adjusted for clustering at the country level and school level are in parentheses; for the *indirect effects* and the *total effect* of decentralization bootstrapped standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As a result, it can be observed that the *specific indirect effects* are also positive and significant for the three teacher quality variables. Based on these results, a country in which all the educational decisions are taken at the subnational level can be expected to score 0.36 points more on the reading assessment than a country in which all the decisions are centralized due to differences in *teacher education;* 2.54 points more due to differences in *teacher certification;* and 6.21

points more due to differences in *disciplinary climate*[13]. Thus, the *indirect effect* of decentralization on educational attainment mediated through these measures of teacher quality is 9.108 points (Panel B in Table 1). That is, if we compare a country operating an educational policy completely decentralized to the subnational level of government and a country with a completely centralized education policy, we could expect an average difference in reading test scores equal to 9.108 points due to differences in *teacher education*, *certification* and *disciplinary climate* as a result of decentralization.

The *direct effect* of decentralization on educational attainment is also positive and significant. Based on these results, a country in which all the educational decisions are taken at the subnational level of government can be expected to score 21.68 points more than a country in which all the decisions are centralized. Finally, the *total effect* of decentralization on students' test scores is 30.79 points. Based on these results, the indirect effect mediated through teacher quality might account, therefore, for 29.6% of the overall effects of decentralization on educational attainment in reading.

4.2. Robustness checks

Table 2 presents additional results that corroborate the robustness of the conclusions reported above. Column (1) presents the results obtained when estimating the *indirect effect* of decentralization on educational attainment mediated through teacher quality as the difference between the *total effect* and the *direct effect*. Column (2) presents the results obtained when estimating the model that includes the teacher quality variables as regressors in equations (1) to (3), and which is simultaneously estimated. Finally, columns (3) to (5) present the results obtained when controlling for country characteristics, the omission of which might bias the estimated effects of decentralization and the teacher quality variables. These include the *region fixed effects* in column (3), *per capita GDP* in column (4) and *per capita GDP* and *corruption* in column (5).

As can be observed in column (1), the estimated *indirect effect* is slightly lower than before, which might be due to an overestimation of the teacher quality

[13] 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 18 points on the reading assessment. 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 mean and standard deviation for OECD countries of 500 and 100, respectively, these effects can also be interpreted in terms of percentage points of an international standard deviation.

parameters in equation (4), reflecting the non-random assignment of students and teachers to schools, or to an overestimation of the decentralization parameter in equations (1) to (3), owing to the failure to take into account the relationship between the different teacher quality variables. When this relationship is taken into account, by including each teacher quality variable as a regressor in the other equations of teacher quality (column 2), the estimated *indirect effect* is very similar to the one obtained in column (1). Thus, the *estimated effect* of teacher quality on educational attainment does not seem to be biased because of the non-random assignment problem. It can also be observed that the *specific indirect effect* of decentralization mediated through *teacher education*, which was very low in the original model, becomes non-significant in this model.

Table 2. Robustness analysis.

Panel A. Specific indirect effects					
	(1)	(2)	(3)	(4)	(5)
Teacher education	-	0.212	0.705***	0.319*	1.269***
		(0.152)	(0.245)	(0.191)	(0.299)
Teacher certification	-	1.974***	0.819***	2.304***	3.156***
		(0.381)	(0.286)	(0.442)	(0.574)
Disciplinary climate	-	5.645***	6.360***	6.347***	6.433***
		(0.694)	(0.773)	(0.717)	(0.759)
Panel B. Decomposition of the total effects					
Indirect Effect	8.246***	7.831***	7.884***	8.970***	10.858***
	(0.746)	(0.752)	(0.826)	(0.863)	(0.990)
Direct Effect	21.679***	21.679***	13.663***	24.150***	19.140***
	(1.979)	(1.979)	(2.107)	(2.027)	(2.344)
Total Effect	29.925***	29.510***	21.547***	33.120***	29.998***
	(2.780)	(2.817)	(3.521)	(2.692)	(2.711)

Notes: In column (1) the *indirect effect* is estimated as the difference between the *total effect* and the *direct effect* (c'-c); in column (2) the system of equations (1) to (4) is simultaneously estimated, including teacher quality variables as regressors in equations (1) to (3); in column (3) r*egion fixed effects* are included in the model; in column (4) *per capita GDP* is included in the model; and in column (5) *per capita GDP* and *corruption* are included in the model. In columns (3) to (4) equations (1) to (4) are estimated by least squares, weighted by students' sampling probability. Weights are normalized to give an equal weight to each country. The *indirect effect* is the sum of the *specific indirect effects;* the *direct effect* corresponds to the effect of decentralization on educational attainment in equation (4); and the *total effect* is the sum of the *direct* and the *indirect effects*. For the *direct effect* robust standard errors adjusted for clustering at the country and school level are in parentheses; for the *indirect effects* and the *total effect* of decentralization, bootstrapped standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In columns (3) to (5) slight differences can be observed in the magnitude of the coefficients depending on the specific model applied; yet, the results do not change the above conclusions concerning the positive and significant *direct* and *indirect effects* of decentralization on educational attainment. These changes in magnitude of the coefficients do not affect the *specific indirect effects* mediated through the *disciplinary climate* variable, which remain unchanged in the different models. As for the other coefficients, in column (3), where *region fixed effects* are included, it can be seen that the *specific indirect effect* mediated through *teacher education* increases, while the specific indirect effect mediated through *teacher certification* decreases. As a result, the *specific indirect effects* mediated through *teacher education* and *certification* are very similar in this model, and equal to 0.71 and 0.82, respectively. Despite this change, the *indirect effect* in this model is very similar to the *indirect effect* in columns (1) and (2). However, the *direct effect* in this model falls to 13.66 points, so that the total effect in this model is also lower, and equal to 21.55 points.

When *per capita GDP* is included in the regression equation in column (4), we observe that the *specific indirect effects* mediated through each teacher quality variable remain the same as in the original model in Table 1. However, the *direct effect* increases to 24.15 points, which at the same time implies an increase in the *total effect* of decentralization, which is now equal to 33.12 points. However, when corruption is also included in the regression equation in column (5), jointly with the *per capita GDP* variable, it can be seen that the *specific indirect effects* mediated through *teacher education* and *teacher certification* increase to 1.27 and 3.16 points, respectively. The *indirect effect* in this model is 10.86 points, which represents 36.2 per cent of the overall effect of decentralization on reading assessment.

Thus, these results show that corruption is likely to be a relevant omitted factor in the relationship between decentralization and teacher quality. In this model, corruption can be assumed to be measuring the effect of the quality of institutions, as well as governance and democratic quality in OECD countries. However, these results do not change the conclusions reported above concerning the effects of decentralization on educational attainment, in the sense that it presents a positive and significant overall effect. The direct effect and the indirect effect mediated through teacher quality are also positive and significant in all the specifications estimated in this section, although their relative importance might depend on specific country characteristics. For

example, when countries with a similar level of perceived corruption are compared, the estimated indirect effects of decentralization mediated through teacher quality are higher.

5. Comparison of regional and local decentralization

In this section I analyze whether the decomposition of the effect of education decentralization on educational attainment into a *direct* and an *indirect effect* mediated through teacher quality differs depending on the level of government awarded responsibility for education. I conduct the analysis by controlling for the countries' *per capita GDP* and *corruption*, as it has been shown above that these variables are likely to influence the relationship between decentralization and teacher quality. Table 3 presents the *specific indirect effects* of education decentralization mediated through each teacher quality variable for each level of government, and Table 4 presents the (total) *indirect effect*, the *direct effect* and the *total effect* of decentralization on educational attainment for each level of government.

As can be observed in Table 3, the effect of education decentralization on teacher quality (*first stage effect*) differs depending on whether the educational decision-making power is decentralized to the regional or the local tier of government. On the one hand, we observe that the effect of education decentralization on *teacher education* is higher when educational decisions are decentralized to the local level of government (0.20 percentage points for each additional percentage point of decentralization) than to the regional level (0.09 percentage points for each additional percentage point of decentralization). By contrast, the effect of education decentralization on *teacher certification* is higher at the regional level of government (0.27 percentage points for each additional percentage point of decentralization) than at the local level of government (0.20 percentage points for each additional percentage point of decentralization). The effect of education decentralization on *disciplinary climate* is also higher at the regional level than at the local level.

The effects of each teacher quality variable on educational attainment (*second stage effects*) are slightly different to those obtained above because we are now controlling for the countries' *per capita GDP* and *corruption*. Based on these results, we can observe that the *specific indirect effect* of decentralization mediated through *teacher education* is 0.81 points at the regional level and 1.75 points at the local level of government; the *specific indirect effect* of decentralization

mediated through *teacher certification* is 3.57 points at the regional level and 2.65 points at the local level of government; and the *specific indirect effect* of decentralization mediated through *disciplinary climate* is 7.58 points at the regional level and 5.14 points at the local level of government.

Table 3. Specific indirect effects of education decentralization on test scores by level of government.

	First Stage Effect	Second Stage Effect	Specific Indirect effect
Teacher education			
Regional decentralization	0.094***	8.594***	0.808***
	(0.021)	(1.033)	(0.277)
Local decentralization	0.203***		1.745***
	(0.021)		(0.364)
Teacher certification			
Regional decentralization	0.266***	13.431***	3.573***
	(0.012)	(1.653)	(0.649)
Local decentralization	0.197***		2.646***
	(0.013)		(0.529)
Disciplinary climate			
Regional decentralization	0.394***	19.231***	7.577***
	(0.031)	(0.857)	(0.816)
Local decentralization	0.267***		5.135***
	(0.037)		(0.857)

Notes: see Table 1.

Thus, as can be observed in Table 4, the *indirect effect* of decentralization on educational attainment mediated through teacher quality is 11.96 points when education is decentralized to the regional level of government, and 9.53 score points when education is decentralized to the local level of government. That is, given a certain level of local decentralization, the expected difference in educational attainment due to differences in teacher quality for each additional percentage point of decentralization to the regional level is 0.119 score points. Similarly, given a certain level of regional decentralization, the expected difference in educational attainment due to differences in teacher quality for each additional percentage point of decentralization to the local level is 0.095 score points.

It can be observed in Table 4 that the difference between these effects is statistically significant. Thus, the *indirect effect* of decentralization mediated through teacher quality is higher when education is decentralized to the

regional level of government than when it is decentralized to the local level of government. This result was expected, since the effects of decentralization on teacher quality will not be as great when the labour market in which governments can hire teachers is smaller, both because teacher supply should be lower in this case and because we would expect the power of the teachers' unions to be greater the shorter the distance between policy-makers and school-based interest groups. By contrast, the *direct effect* of decentralization on educational attainment is greater at the local level than at the regional level, the difference being above 10 assessment points. Thus, the *total effect* of decentralization on reading test scores is 26.73 points when education is decentralized to the regional level of government, and 35.58 points when education is decentralized to the local level of government.

Table 4. Decomposition of the effects of education decentralization on test scores.

	Indirect effect	**Direct effect**	**Total effect**
	(1)	(2)	(3)
Regional decentralization	11.958***	14.774***	26.732***
	(1.078)	(2.213)	(2.873)
Local decentralization	9.526***	26.058***	35.584***
	(1.075)	(2.902)	(3.302)
Difference	2.432***	-11.284***	-8.852***
	(0.846)	(2.697)	(2.842)

Notes: see Table 1.

Interestingly, we observe that while the effect of decentralization on *teacher education* is higher at the local level of government, the effect of decentralization on *teacher certification* is higher at the regional level of government. A possible explanation for these differences might be that selection processes and standards depend on whether they are determined at the regional or at the local level of government. For instance, regional governments might be in a better position to provide certification programmes for teacher preparation and qualification: first, because their technical and economic capacity might be greater than that of the local level of government; and, second, because if the power of the teachers' unions is lower at the regional than at the local level of government, it might be easier for the former to fix certification requirements and standards for entry into the profession. This might also help to explain why the effect of education decentralization on *disciplinary climate* is greater when education is decentralized to the regional level. If the power of the teachers' unions is lower at this level, it might also be

easier for regional governments to introduce mechanisms of motivation, such as, rewards tied to teaching performance.

An alternative explanation for these results is that, as local labour markets might be smaller than regional markets, it could be the case that when education responsibilities are transferred to the local level of government national mechanisms designed to avoid barriers to mobility are activated, while they are less likely to be operative when education responsibilities are transferred to the regional level. Since the labour markets in which local governments can hire teachers might in this case be bigger, it would be easier for them than for their regional counterparts to find teachers with a master's degree.

6. Summary and concluding remarks

The effects of decentralization have been widely analyzed, both empirically and theoretically. However, in the education sector, the literature analyzing the effects of decentralization is limited, focusing above all on its impact on educational attainment. The general conclusion of these studies is that expenditure decentralization is positively related to educational attainment (Barankay and Lockwood, 2007; Falch and Fischer, 2012). The autonomy of subnational governments to take decisions in relation to education and to raise their own revenues has also been shown to play a central role in determining the effects of decentralization on educational outcomes (Chapter 3). This study has taken one step further in the analysis of the effects of decentralization in the education sector, by focusing on one of the most relevant determinants of educational attainment in schools: teacher quality. More specifically, my focus has been on the way in which teacher quality might be affected by decentralization and the extent to which this effect explains the impact of decentralization on educational attainment.

In this study, I take advantage of the detailed information provided by PISA to define three variables of teacher quality: *teacher education,* which measures the percentage of teachers that hold a master's degree in a given school; *teacher certification*, which measures the percentage of teachers that are certified by the competent authority in a given school; and, *disciplinary climate*, which provides information on the level of discipline in the classroom, and as such can be considered the result of the teachers' ability or their incentives to create and sustain an effective learning environment (having first controlled for student

characteristics and other relevant factors). These dimensions of teacher quality are liable to be affected by decentralization in distinct ways. On the one hand, applying fiscal federalism theory to the context of education, decentralization is expected to lead to political decisions being taken in relation to educational inputs that provide a better match to population preferences and student needs than those that might otherwise be taken under a centralized system. A direct effect of decentralization might, therefore, be to improve teacher labour force quality by increasing the number of teachers with the desirable characteristics, in terms of qualification, ability and motivation, or by providing the right incentives to improve teacher quality.

On the other hand, decentralization is expected not only to affect government incentives to act in the best interests of their citizens (as predicted by fiscal federalism theory), but also to increase the incentives of schools and teachers alike to work harder and to use educational resources to maximize student performance, since they are made more accountable both to the government with responsibility for managing the educational system and to parents, who can more effectively demand better education for the taxes they pay (Healey and Crouch, 2012; Winkler and Yeo, 2007). However, these positive effects may be undermined if the labour market in which the decentralized government can hire teachers is small, hampering their ability to find "good" teachers (Darling-Hammond and Sykes, 2003), or if the shortened distance between policy-makers and schools makes school-based interest groups more influential, resulting in an increase in the level of corruption in the education sector (Woessmann, 2001). Thus, theoretical analyses do not allow us to predict how decentralization might affect teacher quality, making empirical analyses necessary.

Based on the results obtained in this analysis, education decentralization has been shown to have a positive and significant effect on teacher quality. As a consequence, a sizable proportion of the effect of education decentralization on educational attainment can be explained by the indirect effect mediated through teacher quality. More specifically, this indirect effect accounts for 30 per cent of the overall effects of education decentralization on reading test scores. These results are robust to the various analyses conducted to ensure they are not driven by either the endogeneity of decentralization or the endogeneity of the teacher quality variables in the education production function.

In addition, I find that these effects are greater when educational powers are decentralized to the regional level of government than when the educational policy is decentralized to the local level of government. Since teacher supply should be lower when the labour market in which governments can hire teachers is smaller and the power of the teachers' unions is expected to be greater the shorter the distance between policy-makers and school-based interest groups, this result was expected. Additionally, regional governments might be in a better position to provide certification programmes for teacher preparation and qualification.

References

Aaronson, D., Barrow, L. and Sander, W. (2007): "Teachers and student achievement in the Chicago public high schools", *Journal of Labor Economics* 25(1), 95-135.

Barankay, I. and Lockwood, B. (2007): "Decentralization and the productive efficiency of government: evidence from Swiss cantons", *Journal of Public Economics* 91, 1197-1218.

Bardhan, P. and Mookherjee, D. (2000): "Capture and governance at local and national levels", *American Economic Review* 90(2), 135-139.

Bardhan, P. and Mookherjee, D. (2006): "Decentralization, corruption and government accountability: an overview", in *International Handbook on the Economics of Corruption*, S. Rose-Ackerman (Ed.), Edward Elgar Publishing, Northampton.

Baron, R.M. and Kenny, D.A., (1986): "The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations", *Journal of Personality and Social Psychology* 51(6), 1173-1182.

Chetty, R., Friedman, J.N., Rockoff, J.E. (2013): "Measuring the impacts of teachers II: teacher value-added and student outcomes in adulthood", NBER Working Paper 19424.

Clotfelter, C.T., Ladd, H.F., Vidgor, J.L. (2006): "Teacher-student matching and the assessment of teacher effectiveness", *Journal of Human Resources* 41(4), 778-820.

Clotfelter, C.T., Ladd, H.F., Vidgor, J.L. (2007): "How and why do teacher credentials matter for student achievement?", NBER Working Paper 12828.

Clotfelter, C.T., Ladd, H.F., Vidgor, J.L. (2010): "Teacher credentials and student achievement in high school: a cross-subject analysis with student fixed effects", *Journal of Human Resources* 45(3), 655-681.

Darling-Hammond, L. (2000): "Teacher quality and student achievement: a review of state policy evidence", *Education Policy Analysis Archives* 8(1), 1-44.

Darling-Hammond, L. and Sykes, G. (2003): "Wanted: a national teacher supply policy for education: the right way to meet", *Education Policy Analysis Archives* 11(33), 1-55.

Deaton, A. (1997): *The analysis of household surveys: a microeconomic approach to development policy,* Johns Hopkins University Press, Baltimore.

De Mello, L.R. and Barensteinl, M. (2001): "Fiscal decentralization and governance: a cross-country analysis", IMF Working Paper 01/71.

Esteller-Moré, A. and Solé-Ollé, A. (2005): "Does decentralization improve the efficiency in the allocation of public investment? Evidence from Spain", IEB Working Paper 2005/5.

Faguet, J.P. (2004): "Does decentralization increase government responsiveness to local needs? Evidence from Bolivia", *Journal of Public Economics* 88, 867-893.

Falch, T. and Fischer, J.A.V. (2012): "Public sector decentralization and school performance: international evidence", *Economic Letters* 114, 276-279.

Fuchs, T. and Woessmann, L. (2007): "What accounts for international differences in student performance? A re-examination using PISA data", *Empirical Economics* 32, 433-464.

Galiani, S. and Schargrodsky, E. (2002): "Evaluating the impact of school decentralization on education quality", *Economía* 2(2), 275-314.

Gilpin, G. and Kaganovich, M. (2012): "The quantity and quality of teachers: dynamics of the trade-off", *Journal of Public Economics* 96, 417-429.

Glewwe, P. Nauman-Ilias, P. and Kremer, M. (2010): "Teacher incentives", *American Economic Journal: Applied Economics* 2(3), 205-227.

Hallak, J. and Poisson, M. (2005): Ethics and corruption in education: an overview. *Journal of Education for International Development* 1(1), 1-16.

Hanushek, E.A. (1986): "The economics of schooling: production and efficiency in public schools", *Journal of Economic Literature* 24, 1141-1177.

Hanushek, E.A. (1989): "The impact of differential expenditures on school performance", *Educational researcher* 18(4), 45-62.

Hanushek, E.A. (2003): "The failure of input based schooling policies", *Economic Journal* 113, 64-98.

Hanushek, E.A. (2011): "The economic value of higher teacher quality", *Economics of Education Review* 30(3), 466-479.

Hanushek, E.A., Kain, J.F. and Rivkin, S.G. (2004): "Why public schools loose teachers", *Journal of Human Resources* 39(2), 326-354.

Hanushek, E.A., Kain, J.F., O'Brien, D.M. and Rivkin, S.G. (2005): "The market for teacher quality", NBER Working Paper 11154.

Hanushek, E.A. and Kimko, D.D. (2000): "Schooling, labor-force quality and the growth of nations", *American Economic Review* 90, 1184-1208.

Hanushek, E.A. and Rivkin, S.G. (2010a): "Generalizations about using value-added measures of teacher quality", *American Economic Review: Papers and Proceedings* 100, 267-271.

Hanushek, E.A. and Rivkin, S.G. (2010b): "Constrained job matching: does teacher job search harm disadvantaged urban schools?", NBER Working Paper 15816.

Hanushek, E.A. and Woessmann, L. (2007): "The role of education quality for economic growth", WB Policy Research Working Paper 4122.

Harris, D.N. and Sass, T.R. (2011): "Teacher training, teacher quality and student achievement", *Journal of Public Economics* 95, 798-812.

Healey, F.H. and Crouch, L. (2012): "Decentralization for high-quality education: elements and issues of design", Research Report, RTI Press Publication.

Hoxby, C.M. (1996): "How teachers' unions affect education production", *Quarterly Journal of Economics* 111(3), 671-718.

Kane, T.J., Rockoff, J.E. and Staiger, D.O. (2006): "What does certification tell us about teacher effectiveness", NBER Working Paper 12155.

Krueger, A.B. (2003): "Economic considerations and class size", *The Economic Journal* 113(485), 34-63.

Krull, J.L. and Mackinon, D.P. (1999): "Multilevel mediation modeling in group-based intervention studies", *Evaluation Review* 23(4), 418-444.

Mackinnon, D.P., Krull, J.L. and Lockwood, C.M. (2000): "Equivalence of the mediation, confounding and suppression effect", *Prevention Science* 1, 173-181.

Mackinnon, D.P., Lockwood, C.M., Hoffman, J.M., West, S.G. and Sheets, V. (2002): "A comparison of methods to test mediation and other intervening variable effects", *Psychological Methods* 7, 83-104.

Metzler, J. and Woessmann, L. (2012): "The impact of teacher subject knowledge on student achievement: evidence from within-teacher within-student variation", *Journal of Development Economics* 99, 486-496.

Murillo, M.V., Tommasi, L., Ronconi, L. and Sanguinetti, J. (2002): "The economic effects of unions in Latin America: teachers' unions and education in Argentina", IDB Research Network Working Paper R-463.

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

Oates, W.E. (2005): "Toward a second-generation theory of fiscal federalism", *International Tax and Public Finance* 12, 349-373.

OECD (2004a): "The quality of the teaching workforce", OECD Policy Brief February 2004.

OECD (2004b): *Education at a glance 2004: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2008): *Education at a glance 2008: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2011): *Building a high-quality teaching profession: lessons from around the World,* Organization for Economic Co-operation and Development, Paris.

OECD (2012): *Education at a glance 2012: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

Preacher, K.J. and Hayes, A.F. (2004): "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods, Instruments and Computers* 36, 717-731.

Preacher, K.J. and Hayes, A.F. (2008): "Asymptotic and re-sampling strategies for assessing and comparing indirect effects in multiple mediator models", *Behavior Research Methods* 40(3), 879-891.

Pritchett, L. and Filmer, D. (1997): "What education production functions really show: a positive theory of education spending", WB Policy Research Working Paper 1795.

Prud'homme, R. (1995): "The dangers of decentralization", *The World Bank Research Observer* 10(2), 201-220.

Redoano, M. (2010): "Does decentralization affect the number and size of lobbies?", *Journal of Public Economic Theory* 12(3), 407-435.

Rivkin, S.G., Hanushek, E.A. and Kain, J.F. (2005): "Teachers, schools and academic achievement", *Econometrica* 73(2), 417-458.

Rockoff, J.E. (2004): "The impact of individual teachers on student achievement: evidence from panel data", *American Economic Review: Papers and Proceedings* 92(2), 247-252.

Rodden, J. (2003): "Reviving leviathan: fiscal federalism and the growth of government", *International Organization* 57(4), 695-729.

Seabright, P. (1996): "Accountability and decentralisation in government: an incomplete contracts model", *European Economic Review* 40, 61-89.

Shah, A. (1998): "Balance, accountability and responsiveness. Lessons about decentralization", WB Policy Research Working Paper 2021.

Strumpf, K.S. and Oberholzer-Gee, F. (2002): "Endogenous policy decentralization: testing the central tenet of economic federalism", *Journal of Political Economy* 110(1), 1-36.

TI (2013): *Global corruption report: education*, Transparency International, Berlin.

Todd, P.E. and Wolpin, K.I. (2003): "On the specification and estimation of the production function for cognitive achievement", *The Economic Journal* 113, 3-33.

Weingast, B.R. (2009): "Second generation fiscal federalism: the implications of fiscal incentives", *Journal of Urban Economics* 65(3), 279-293.

Williams, J. and Mackinnon, D.P. (2008): "Re-sampling and distribution of the product methods for testing indirect effects in complex models", *Structural Equation Modeling* 15, 23-51.

Winkler, D. and Yeo, B.L. (2007): "Identifying the impact of education decentralization on the quality of education", EQUIP2 Working Paper.

Wiswall, M. (2013): "The dynamics of teacher quality", *Journal of Public Economics* 100, 61-78.

Woessmann, L. (2001): "Why students in some countries do better?", *Education matters* 1(2), 67-74.

Woessmann, L. (2003): "Schooling resources, educational institutions and student performance: the international evidence", *Oxford Bulletin of Economics and Statistics* 65(2), 117-170.

Woessmann, L., Ludemann, E., Schütz, G., West, M.R. (2007): "School accountability, autonomy, choice and the level of student achievement. International evidence from PISA 2003", OECD Education Working Papers 13.

Zegarra, E. and Ravina, R. (2003): "Teacher unionization and the quality of education in Peru: an empirical evaluation using survey data", IDB Research Network Working Paper 474.

Annex

Table A.1. Estimation results for equations (1) to (4).

	Teacher education	Teacher certification	Disciplinary climate	Test scores
	(1)	(2)	(3)	(4)
Decentralization				
Education decentralization	0.058**	0.150***	0.338***	21.729***
	(0.016)	(0.010)	(0.024)	(1.977)
Teacher quality				
Teacher education	-	-	-	6.212***
				(1.053)
Teacher certification	-	-	-	16.951***
				(1.634)
Disciplinary climate	-	-	-	18.359***
				(0.861)
School characteristics				
Public school	-0.027	0.008	-0.213***	-4.278
	(0.021)	(0.019)	(0.028)	(2.186)
Private govern. depend. school	-0.060**	-0.068***	-0.182***	1.058
	(0.022)	(0.020)	(0.031)	(2.604)
Location - Small town	0.007	-0.011	-0.026	2.571
	(0.016)	(0.008)	(0.018)	(1.373)
Location - Town	0.030*	-0.022**	-0.051**	4.484***
	(0.015)	(0.008)	(0.019)	(1.162)
Location - City	0.091***	-0.015	-0.055**	7.640***
	(0.016)	(0.010)	(0.020)	(1.368)
Location - Large city	0.134***	-0.008	-0.075***	5.135***
	(0.017)	(0.014)	(0.024)	(1.625)
Availability of other schools	0.020*	0.030***	0.047***	2.311*
	(0.010)	(0.007)	(0.012)	(0.879)
Schools decision-making power	-0.418***	0.304***	0.165***	35.161***
	(0.020)	(0.016)	(0.030)	(2.490)
School size	0.019***	-0.082***	0.054***	-
	(0.005)	(0.006)	(0.008)	
Grades 7 to 13	0.117***	-0.005	0.034**	-
	(0.007)	(0.007)	(0.013)	
Ungraded school	-0.532***	0.042**	0.189***	-
	(0.022)	(0.015)	(0.023)	

Table A.1. Estimation results for equations (1) to (4) *(continued).*

	Teacher education	Teacher certification	Disciplinary climate	Test scores
	(1)	(2)	(3)	(4)
Student characteristics (measured at the school level)				
Immigrants - 0%	0.110***	-0.071***	0.012	-
	(0.015)	(0.011)	(0.020)	
Immigrants - 0%-10%	0.056***	-0.007	-0.030	-
	(0.015)	(0.010)	(0.018)	
Immigrants - 10%-20%	0.019	-0.007	-0.010	-
	(0.019)	(0.013)	(0.024)	
Immigrants - >60%	0.037	-0.010	-0.063**	-
	(0.019)	(0.015)	(0.020)	
General programme	0.076***	-0.023***	0.020	-
	(0.007)	(0.006)	(0.012)	
Wealth	-0.110***	0.132***	-0.022**	-
	(0.005)	(0.005)	(0.009)	
Cultural possessions	0.051***	-0.036***	0.118***	-
	(0.007)	(0.005)	(0.012)	
Family inputs				
Family resources				
Mother full-time	-	-	-	2.471***
				(0.415)
Mother part-time	-	-	-	4.721***
				(0.545)
Father full-time	-	-	-	0.484
				(0.607)
Father part-time	-	-	-	-10.912***
				(0.698)
Out-of-school lessons 0h	-	-	-	17.207***
				(0.790)
Out-of-school lessons 2-4h	-	-	-	-5.005***
				(0.955)
Out-of-school lessons 4-6h	-	-	-	-17.259***
				(1.345)
Out-of-school lessons more 6h	-	-	-	-28.173***
				(1.763)
Home educational resources	-	-	-	5.298***
				(0.261)
Wealth index	-	-	-	-0.510
				(0.306)

Table A.1. Estimation results for equations (1) to (4) *(continued).*

	Teacher education	Teacher certification	Disciplinary climate	Test scores
	(1)	(2)	(3)	(4)
Family background				
Parents' education	-	-	-	1.512***
				(0.082)
Parents' job white high skilled	-	-	-	22.992***
				(0.771)
Parents' job white low skilled	-	-	-	8.949***
				(0.757)
Parents' job blue high skilled	-	-	-	2.515***
				(0.743)
Books 11-25	-	-	-	7.126***
				(0.751)
Books 26-100	-	-	-	18.809***
				(0.701)
Books 101-200	-	-	-	28.371***
				(0.746)
Books 201-500	-	-	-	37.430***
				(0.901)
Books more 500	-	-	-	33.072***
				(1.052)
Living with both parents	-	-	-	36.083***
				(1.515)
Living with single mother	-	-	-	35.975***
				(1.491)
Living with single father	-	-	-	31.525***
				(1.890)
Living with siblings	-	-	-	-1.292***
				(0.482)
Living with grandparents	-	-	-	-8.269***
				(0.623)
Native students	-	-	-	4.341***
				(0.836)
Speak test language	-	-	-	8.828***
				(0.800)

Table A.1. Estimation results for equations (1) to (4) *(continued).*

	Teacher education	Teacher certification	Disciplinary climate	Test scores
	(1)	(2)	(3)	(4)
Student characteristics (measured at the student level)				
Female	-	-	-	16.575***
				(0.388)
Grade 7	-	-	-	-90.105***
				(3.879)
Grade 8	-	-	-	-58.152***
				(1.605)
Grade 9	-	-	-	-21.568***
				(1.248)
Grade 10	-	-	-	-3.568***
				(1.169)
Age (months)	-	-	-	0.239***
				(0.058)
General programme	-	-	-	21.893***
				(0.870)
Pre-primary educ. no	-	-	-	-8.499***
				(0.772)
Pre-primary educ. less 1 year	-	-	-	-1.017*
				(0.510)
Expected university	-	-	-	31.343***
				(0.514)
Enjoyment of reading	-	-	-	25.636***
				(0.232)
Library use	-	-	-	-9.504***
				(0.198)
Constant	0.654***	0.870***	0.140***	382.965***
	(0.029)	(0.023)	(0.039)	(3.726)
R^2	0.288	0.206	0.127	0.486
Students	294,156	294,156	294,156	294,156
Schools	10,871	10,871	10,871	10,871
Regions	35	35	35	35

Notes: equations (1) to (4) are estimated by least-squares weighted by students' sampling probability, normalised to give an equal weight to each country. All the regressions include missing dummy variables. 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.

Chapter 5
Concluding Remarks

This dissertation examines the effects of decentralization on the efficiency of educational policies, with a particular concern for how these effects depend on the autonomy of subnational governments (Chapters 2 and 3) – both on the expenditure and revenue sides of decentralization, and for the process via which decentralization can impact educational attainment (Chapter 4). The three studies reveal that the effects of decentralization on the outcomes of the educational system are positive and, in line with theoretical prescriptions, that these effects depend on the autonomy of subnational governments and on the level of government awarded educational competences. Additionally, an important share of the overall effect of decentralization on educational outcomes is mediated through its effects on teacher quality.

The analysis presented in Chapter 2, in which the effects of the partial fiscal decentralization reform in Spain at the beginning of the eighties are studied, reveals that the effects of decentralization on the *promotion rates* in secondary education were on average non-significant. However, when I differentiate between the promotion rates in the general and in the vocational programmes, I find that decentralization had a positive impact on the promotion rates in the general programme and a negative impact on those in the vocational programme. However, this negative impact disappears for cohorts that have been under a decentralized regime for five years or more. In addition, these effects are found to depend on the level of public revenue made available to the regional governments. More specifically, the positive effects of decentralization on the promotion rates in the general programme disappear in regions with low levels of public revenue. Similarly, the negative effects of decentralization on the promotion rates in the vocational programme

disappear in regions with high levels of public revenue. Thus, the effects of decentralization on the overall promotion rates in Spain were positive in regions with high levels of public revenue and negative in regions with low levels of public revenue.

Finally, I find that variations in the promotion rates as a consequence of the decentralization reform can be explained mainly by variations in dropout rates but not by those in rates of repetition. A significant effect of decentralization on repetition rates can only be observed in the first grade, where the impact is positive both for the general and the vocational programmes. Thus, it can be concluded that the increase observed in the promotion rates in the general programme was not achieved at the cost of decreasing educational standards. These findings might reflect the fact that following decentralization regional governments opted to introduce stricter rules within the educational system, which had a negative impact on the promotion rates in vocational programmes during the first few years of implementation. This would explain why the impact becomes positive for cohorts that have been under a decentralized system for five years or more.

These results need to be interpreted in a context in which the revenues of subnational governments were fixed and determined by the central government. This might mean that regional governments concentrated their efforts and resources on improving promotion rates in the general programme, given that this represents the traditional path for those wishing to gain entry to university and the attractiveness of Spain's vocational education programmes is not as great as that of the general programme. Differences in the effects of decentralization on promotion rates in the general and the vocational programmes, therefore, seem to represent a better match between population preferences and educational policies consequent upon decentralization. This finding is in line with the predictions of Borge *et al.* (2014), who argue that spending discretion under a partial fiscal decentralization regime, when granted to localities, allows public-good levels to adjust to suit local demands; and with previous empirical evidence for Spain regarding the beneficial effects of decentralization on the allocative efficiency of educational investment (Esteller-Moré and Solé-Ollé, 2005).

The possibility of generalizing these results across the OECD countries is explored in Chapter 3, in which I analyze the effects of decentralization on educational attainment (measured with the PISA test scores), and the way in

which different structures of expenditure and revenue decentralization have a differential impact on the efficiency of public education policies. The analysis in this chapter is conducted within the education production function framework, and uses information for 294,156 students, grouped in 10,871 schools and belonging to 33 OECD countries. 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.

More specifically, in Chapter 3 I find that the decentralization of education expenditure responsibilities has a positive effect on educational attainment, thus corroborating previous empirical evidence on this question (Barankay and Lockwood, 2007; Falch and Fischer, 2012). However, this effect depends on whether subnational governments have the autonomy to decide where to allocate their resources. When subnational education expenditures are financed using conditional grants from upper levels of government (with the implication that their autonomy to decide on the allocation of funds might be undermined), the effect of expenditure decentralization is lowered. I also find that the estimated effect of education decentralization is much higher when it is measured as the percentage of educational decisions that are taken at the subnational level of government. Thus, the autonomy of subnational governments to decide on the main features of their education systems and the allocation of funds is what determine the effects of decentralization. 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 can be explained by the fact that under a decentralized educational system, educational policies can be better matched with citizen preferences and needs. For instance, subnational governments can be expected to be better informed as to whether schools face shortages of teachers in specific fields or of instructional material or problems related to teachers' effort and motivation. Thus, when the right incentives are in place, subnational governments can be expected to match their resources more closely with the most needed inputs in the educational process and, in this way, to improve educational outcomes.

In addition, government accountability might also be increased under a decentralized system, especially when subnational governments are responsible for raising their own revenues, as this should improve their incentives to act in

the best interests of their citizens and, thus, to be less corrupt. For this reason, I find that the effects of education decentralization are positively dependent on whether subnational governments are responsible for making their own tax decisions. Although the effects of decentralizing educational decision-making power is positive or non-significant even when there is no decentralization of tax decisions, thus corroborating the theoretical prescriptions in Brueckner (2009) and Borge *et al.* (2014), increasing subnational tax autonomy, and therefore reducing the dependence of subnational governments on intergovernmental grants to finance their expenditures, has a positive effect on the efficiency with which educational services are provided by subnational governments.

Although I do not analyze whether improvements in educational attainment are achieved by enhancing allocative or productive efficiency, in Chapter 4 I do analyze one of the channels via which educational outcomes might be improved under a decentralized system: teacher quality. More specifically, in Chapter 4 I analyze the effects of education decentralization on teacher quality, and the extent to which these effects might explain the overall effect of decentralization on educational attainment. That is, I decompose the total effect of decentralization on educational attainment into a direct and an indirect effect mediated through teacher quality.

The main conclusion to be drawn from this analysis is that an important share of the overall effect of education decentralization on educational attainment is mediated through its effects on teacher quality. In other words, education decentralization is found to have a positive and significant effect on teacher quality, which at the same time has a positive effect on educational attainment. This indirect effect accounts for 30 per cent of the overall effect of education decentralization on educational attainment. Moreover, this effect is more marked when the educational policy is decentralized to the regional level of government than when it is decentralized to the local level of government. However, the opposite is true for the direct effects of decentralization.

The results in Chapter 4 seem to point to the hypothesis that teacher selection processes and standards depend on whether they are determined at the regional or the local level of government. For instance, regional governments might be in a better position to provide certification programmes for teacher preparation and qualification, since their technical and economic capacity is likely to be greater than that of the local level of government. In addition, if

the power of the teachers' unions is not as great at the regional level as it is at the local level of government, it might be easier for the regional governments to establish certification requirements and standards for entry into the profession, as well as mechanisms of motivation, such as, rewards tied to teaching performance.

Although I have not addressed these questions here, future research could usefully examine which of these explanations accounts for the differences between the effects of decentralizing to the regional tier, on the one hand, or to the local level of government, on the other. It could also be of interest to examine whether the improvement recorded in the quality of teachers in decentralized systems is achieved at the expense of other educational inputs, that is, by reallocating educational resources; by increasing the level of resources that are devoted to education; by improving the efficiency with which educational resources are used; or as the result of a mix of these options.

Finally, an issue that has not been analyzed in this dissertation, and which might be deserving of further attention in the empirical literature, is that of the analysis of the effects of decentralization on the equality of the educational system. It would be interesting to analyze the effects of decentralization on the equality of educational outcomes among students of the same region (a matter of increasing concern in most countries and one that is the focus of most policy recommendations emanating from international organisms) and the equality of educational outcomes of students in different regions. The potentially negative effects of decentralization on the equality between regions are emphasized in studies conducted in line with the First Generation Theory of Fiscal Federalism, especially when subnational governments are financed with their own taxes or when effective equalisation mechanisms have yet to be introduced. However, this issue has not received much attention in recent studies, which have tended to focus on other aspects of decentralization, such as its effects on government incentives and political accountability (Oates, 2005; Weingast, 2009).

References

Barankay, I. and Lockwood, B. (2007): "Decentralization and the productive efficiency of government: evidence from Swiss cantons", *Journal of Public Economics* 91, 1197-1218.

Borge, L.E., Brueckner, J.K. and Rattso, J. (2014): "Partial fiscal decentralization and demand responsiveness of the local public sector: theory and evidence from Norway", *Journal of Urban Economics* 80, 153-163.

Brueckner, J.K. (2009): "Partial fiscal decentralization", *Regional Science and Urban Economics* 39, 23-32.

Esteller-Moré, A. and Solé-Ollé, A. (2005): "Does decentralization improve the efficiency in the allocation of public investment? Evidence from Spain", IEB Working Paper 2005/5.

Falch, T. and Fischer, J.A.V. (2012): "Public sector decentralization and school performance: international evidence", *Economic Letters* 114, 276-279.

Oates, W.E. (2005): "Toward a second-generation theory of fiscal federalism", *International Tax and Public Finance* 12, 349-373.

Weingast, B.R. (2009): "Second generation fiscal federalism: the implications of fiscal incentives", *Journal of Urban Economics* 65(3), 279-293.

Annex I

PISA 2009 Database

The dataset used in chapters 3 and 4 contains personal and academic information for 294,156 students, grouped in 10.871 schools and belonging to 33 OECD countries. These data were obtained from the OECD PISA 2009 database, which provides internationally comparable information about students' achievement and the relevant inputs to the educational process. PISA 2009 provides information about 65 participant countries, although I restricted the analysis to the OECD countries, for which detailed measures of the degree of decentralization in the education sector were available. In addition, France was excluded from the analysis because of missing data for some relevant variables.

The PISA survey dataset is based on a two-stage stratified sample. The first-stage sampling units consist of individual schools with 15-year-old students. The second-stage sampling units are the students within sampled schools. A sample of 35 students is selected from each school with equal probability and, for schools with less than 35 15-year-old students all of them are selected. Thus, survey weights must be incorporated into the analysis in order to make valid estimates and inferences of the population (OECD, 2009).

Students' performance on PISA is denoted with five plausible values in each of the tested domains. That is, instead of directly estimating a point estimate of student ability, a range of possible values for a student's ability, with an associated probability for each of these values, is estimated. Plausible values are random draws from this estimated distribution for a student's ability. They are defined in such a way that the mean and standard deviation on reading scores are 500 and 100, respectively, for the equally weighted 27 OECD countries that participated in PISA 2000; the mean and standard deviation on

maths scores are 500 and 100, respectively, for the 30 OECD countries that participated in PISA 2003; and the mean and standard deviation on science scores are 500 and 100, respectively, for the 30 OECD countries that participated in PISA 2006 (OECD, 2009).

Table 1 defines all the variables of the PISA 2009 dataset included in the analyses of chapters 3 and 4, as well as the expected sign of their coefficients in the education production function according to theoretical background and previous empirical evidence. Table 2 provides information about the number of students and schools sampled in each country. Each country's average test scores in the subject areas of mathematics, science and reading and each country's average level of teacher quality in schools are also presented in this table.

Finally, Table 3 provides the main descriptive statistics for the whole set of explanatory variables included in the model. Although the missing rate is not high for most of the variables, deleting all the observations that have a missing value for at least one variable would have reduced the sample size considerably. Thus, missing values of the different variables were imputed in order to include the maximum number of cases in the analysis, following the method proposed by the OECD (2009)[1]. It is known that this imputation method generally produces biased estimates of coefficients, and that standard errors of those variables that contain missing values are underestimated since they do not account for the uncertainty introduced through imputation. However, given that the percentage of data with missing values was very low, this bias can be considered negligible. In addition, all the estimations include one dummy for each variable, which takes a value of 1 for observations with missing and, thus, imputed data, and 0 for observations with original data. In this way I account for the possibility of non-randomly missing observations and I ensure that the results are not driven by imputed data.

[1] For continuous variables, missing values were replaced by the weighted school average of the variables; if all data on the respective variable were missing in one school such that the weighted school mean could not be computed, the weighted country mean was imputed. For dichotomous variables missing values were replaced by 0.

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment.

Variable	Definition	Expected effect
Outcome variables		
Mathematical literacy	Literacy is concerned with the capacity of students to apply knowledge and skills in key subject areas (Mathematics, Science and Reading) and to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations. Thus, PISA seeks to assess not merely whether students can reproduce what they have learned, but also to examine how well they can extrapolate from what they have learned and apply their knowledge in novel settings, both in school and non-school contexts.	-
Scientific literacy		-
Reading literacy		-
Teacher quality [1]		
Teachers' education	This variable measures the proportion of teachers that hold a master's degree in each school.	Students in schools whose teachers have on average a higher level of education are expected to perform better than otherwise. This is true for degrees in pedagogy, in specific subjects and for specific teacher certificates (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007).
Teachers' certification	This variable measures the proportion of teachers that are fully certified in each school.	
Disciplinary climate	Index constructed from students' responses concerning the disciplinary climate in language lessons. Positive scores on this index indicate a better disciplinary climate. This variable was averaged at the school level.	The atmosphere created by students and teachers is expected to have measurable positive effects on students' performance (OECD, 2012).

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment *(continued).*

Variable	Definition	Expected effect
School characteristics		
Type of school	Set of dummy variables that indicates if the school is *public* (baseline category); *private, government dependent* (defined as those private schools that receive more than 50% of their core funding from government agencies); or *private, government independent* (defined as those private schools that receive less than 50% of their core funding from government agencies), the latter being the baseline category.	Once demographic and socio-economic factors have been taken into account, students in schools that are privately operated are not expected to perform any differently from students in schools that are publicly operated (OECD, 2012).
School location	Set of dummy variables that indicates if the school is located in a *village* or rural area (fewer than 3,000 inhabitants), *small town* (3,000-15,000 inhabitants), *town* (15,000-100,000 inhabitants), *city* (100,000-1,000,000 inhabitants) or *big city* (>1,000,000 inhabitants). *Village* is the baseline category.	Performance differences by community location of the schools are expected to be relatively modest (Fuchs and Woessmann, 2007).
Availability of other schools	Dummy variable that takes a value of 1 if there is another school in the area, and 0 otherwise.	Students in schools in competition with other schools are expected to perform better than those in schools without.
School size [1]	Number of students enrolled in the school (measured in thousands). This variable has been centred with respect to the mean.	-
Grades offered [1]	The grades offered in school are measured with two variables: a dummy variable that indicate if the school offers *grades 7 to 13* or not; and a dummy variable that indicate if the school is an *ungraded* school or not.	-

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment *(continued).*

Variable	Definition	Expected effect
Family inputs (measured at the student level)		
Family resources		
Parents' work status	Set of dummy variables that indicates if the student's mother and father work full time (*Mother full-time, Father full-time*), part time (*Mother part-time, Father part-time*) or do not work (baseline category).	Previous studies use a different set of variables that does not differentiate between the effect of the mother and father's work status (neither working, at least one half time, at least one full time, both full time), and find mixed results (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007).
Out-of-school lessons	Set of dummy variables that indicates how much time students spend on *out-of-school lessons* in the specific subject (*zero hours, between 0 and 2 hours, between 2 and 4 hours, between 4 and 6 hours, and more than 6 hours*). The baseline category is *between 0 and 2 hours.*	Students that do not attend out-of-school lessons are expected to perform better, since they might be good students. This variable may be endogenous, as it might be correlated to the student's innate ability.
Home educational resources	Index constructed from student responses concerning the availability at home of a desk, a quiet place to study, a computer to use for school work, educational software, textbooks, technical books and a dictionary. Defined so that positive scores indicate higher levels of educational resources.	We would expect this variable to influence educational outcomes positively. Previous studies do not always obtain significant coefficients of the expected sign for family resource variables (Woessmann, 2003; Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007).
Wealth index	Index constructed from student responses concerning the availability at home of their own room, an internet link, a dishwasher and a DVD player, and about how many cellular phones, televisions, computers, cars and bathrooms they have. Defined so that positive scores indicate higher levels of family possessions.	Previous studies do not always obtain significant coefficients of the expected sign for family resource variables once they control for family background characteristics and educational resources (Fuchs and Woessmann, 2007).

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment *(continued).*

Variable	Definition	Expected effect
Family background		
Parents' education	Estimated years of schooling, computed from student responses to the highest level of education of his parents (primary education or less, lower secondary, upper secondary and university education). The mapping of the level of education to years for each country can be found in OECD (2012).	Students whose parents have a higher level of education are expected to perform better than students whose parents have a lower level of education (Fuchs and Woessmann, 2007).
Parents' job	Set of dummy variables that classify parents' jobs into *white collar high skilled* (ISCO 1-3), *white collar low skilled* (ISCO 4-5), *blue collar high skilled* (ISCO 6-7) and *blue collar low skilled* (ISCO8-9), the latter being the baseline category.	Students whose parents are white collar high skilled workers are expected to perform better than white collar low skilled workers and better than blue collar low skilled workers. Students whose parents are blue collar high skilled workers are also expected to perform better than blue collar low skilled workers (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007).
Books at home	Set of dummy variables that indicates how many books there are in the student home (*between 0 and 10, between 11 and 25, between 26 and 100, between 101 and 200, between 201 and 500, more than 500*). The baseline category is *between 0 and 10 books*.	*Books at home* is considered a measure of the educational and social background of the family. Students are expected to perform better the more books there are in the home (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007).

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment *(continued).*

Variable	Definition	Expected effect
Family structure	Set of dummy variables that indicates if the student is *living with a single father, a single mother, with both parents* or *no parents*, the latter being the baseline category. I also include a dummy variable that indicates if the student has brothers or sisters or not (*Living with siblings*), and a dummy variable that indicates if the student is *living with grandparents*.	Students who live with both parents are expected to perform better than students who live with a single mother, the latter to perform better than students who live with a single father, and the latter to perform better than students who do not live with either parent (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007).
Immigration status	Dummy variable that indicates if the student was born in the country of assessment or had at least one parent born in the country (*Native students*).	Native students are expected to perform better than second-generation students and non-native students (Woessmann *et al.*, 2007).
Language at home	Dummy variable that indicates if the student speaks the test language at home or not (*Speak test language*).	Students that speak the test language at home are expected to perform better than the rest of the students (Woessmann *et al.*, 2007).
Students' characteristics (measured at the student level)		
Female	Dummy variable that takes a value of 1 if student is female, and 0 otherwise.	Girls are expected to perform worse in maths and science, and better in reading (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007)
Grade	Set of dummy variables that indicates which grade the student is attending (grades 7 to 11, the latter being the baseline category).	Students in higher grades are expected to perform better than students in lower grades (Fuchs and Woessmann, 2007; Woessmann *et al.*, 2007)
Age	Student age, measured in months. This variable has been centred with respect to the mean.	Older students are expected to perform better after controlling for grade and grade repetition (Woessmann *et al.*, 2007).

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment *(continued).*

Variable	Definition	Expected effect
Education programme	Dummy variable that indicates if the student is enrolled on a general programme designed to give access to the next programme level, or not (*General programme*).	Students enrolled on a general programme are expected to perform better than students enrolled on a pre-vocational programme, a pre-labour market programme or a modular programme. (There is no previous evidence for this variable).
Pre-primary education	Set of dummy variables that indicates if the student did not attend pre-primary education, attended for less than 1 year or attended for more than 1 year, which is the baseline category.	Students that did not attend pre-primary education or attended for less than one year are expected to perform worse than students who attended for more than one year (Woessmann *et al.*, 2007).
Expected level of education	Dummy variable that indicates if the student expects to finish university studies.	Students who expect to finish a university degree are expected to perform better than students that do not.
Enjoyment of reading	Index constructed from questions about student's enjoyment of reading, defined so that positive scores indicate higher levels of enjoyment of reading.	Those students who are habitual readers and who enjoy reading are more likely to perform better, at least, on the reading assessment.
Library use	Index defined such that a higher value is indicative of the subject's greater use of libraries.	We expect the effect of this variable to be positive if time spent in a library is more productive than time spent studying at home, and negative if the opposite is true.

Table 1. Definition of variables of the PISA 2009 dataset and expected effect on educational attainment *(continued).*

Variable	Definition	Expected effect
Student characteristics (measured at the school level) [1]		
Percentage of immigrant students	Set of dummy variables that indicates if the percentage of immigrants in the school is *equal to 0%; between 0% and 10%; between 10% and 20%; between 20% and 60%* (baseline category); or *more than 60%.*	-
Wealth	Schools' average of the *wealth index* measured at the student level.	-
Cultural Possessions	Schools' average of the cultural possessions index, constructed from student responses concerning the availability at home of classical literature books, books of poetry and works of art.	-

[1] Variables included only in the analysis of Chapter 4.

Table 2. Sampled students and schools, teacher quality and educational attainment in OECD countries.

Country	Students	Schools	Mean test scores						Teacher quality					
			Maths		Science		Reading		Teacher education		Teacher certification		Disciplinary climate	
			Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Australia	14,251	353	514.34	94.0	527.27	101.5	514.90	98.9	94.6%	14.7	98.4%	8.4	-0.08	0.4
Austria	6,590	282	495.91	96.1	494.33	101.8	470.28	100.1	46.6%	37.4	89.2%	17.2	0.11	0.5
Belgium	8,501	278	515.27	104.2	506.58	105.0	505.95	101.8	36.7%	17.2	91.1%	16.7	-0.07	0.4
Belgium (Fl.)	4,596	158	536.72	99.5	526.11	98.0	518.57	93.8	37.7%	17.8	96.8%	8.7	-0.11	0.3
Belgium (Fr.)	3,905	120	488.78	103.7	482.44	108.4	490.34	108.9	35.4%	16.4	84.2%	20.9	-0.01	0.4
Canada	23,207	978	526.81	87.5	528.70	89.9	524.24	90.4	91.7%	23.4	91.0%	26.1	-0.08	0.3
Chile	5,669	200	421.06	80.1	447.47	81.4	449.37	82.7	93.3%	10.5	15.3%	17.0	-0.11	0.3
Czech Republic	6,064	261	492.81	93.2	500.50	97.3	478.19	92.3	86.6%	15.9	87.8%	16.1	-0.18	0.5
Denmark	5,924	285	503.28	87.0	499.34	91.9	494.92	83.6	3.4%	9.4	91.6%	15.7	0.01	0.4
Estonia	4,727	175	512.10	81.1	527.83	84.2	500.96	83.3	90.8%	20.0	90.8%	20.0	0.05	0.5
Finland	5,810	203	540.50	82.5	554.08	89.2	535.88	86.4	91.1%	12.3	91.1%	12.3	-0.29	0.4
France [2]	4,298	168	496.78	100.9	498.23	102.6	495.62	105.5	-		-		-0.20	0.3
Germany	4,979	226	512.78	98.4	520.41	100.6	497.31	95.7	92.8%	17.9	92.8%	17.9	0.25	0.4
Greece	4,969	184	466.10	89.5	470.12	91.6	482.78	95.2	93.9%	12.5	96.4%	9.3	-0.40	0.3
Hungary	4,605	187	490.17	92.1	502.64	86.5	494.18	90.2	95.5%	15.9	95.5%	15.9	-0.02	0.4
Iceland	3,646	131	506.67	91.0	495.60	95.4	500.28	96.0	66.8%	30.2	85.1%	14.7	-0.06	0.3
Ireland	3,937	144	487.14	85.6	507.98	97.0	495.64	95.2	94.8%	18.5	97.5%	7.6	-0.03	0.4
Israel	5,761	176	446.86	104.1	454.85	106.7	473.99	111.5	90.3%	12.8	78.5%	29.3	0.07	0.4
Italy	30,905	1,097	482.91	93.0	488.83	96.6	486.05	95.9	76.7%	28.7	87.6%	20.9	0.03	0.5
Japan	6,088	186	528.99	94.1	539.43	99.7	519.86	100.4	98.1%	4.5	97.9%	8.7	0.75	0.5
Korea	4,989	157	546.23	89.2	537.99	82.2	539.27	79.2	98.1%	8.5	97.8%	10.6	0.38	0.3
Luxembourg	4,622	39	489.07	97.6	483.93	104.5	472.17	103.7	90.4%	12.0	72.1%	20.7	-0.21	0.3

Table 2. Sampled students and schools, teacher quality and educational attainment in OECD countries *(continued)*.

Country	Students	Schools	Mean test scores						Teacher quality					
			Maths		Science		Reading		Teacher education		Teacher certification		Disciplinary climate	
			Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Mexico	38,250	1,535	418.51	78.9	415.91	77.2	425.27	84.6	89.4%	19.0	47.0%	36.9	0.11	0.3
Netherlands	4,760	186	525.84	89.1	522.22	96.1	508.40	88.7	25.9%	22.3	82.9%	20.0	-0.28	0.3
New Zealand	4,643	162	519.30	96.2	532.01	107.3	520.88	102.9	91.0%	13.1	96.2%	8.8	-0.12	0.3
Norway	4,660	197	497.96	85.4	499.88	89.6	503.23	91.2	17.4%	19.9	90.2%	19.4	-0.24	0.4
Poland	4,917	185	494.80	88.4	508.07	86.9	500.48	89.2	94.1%	21.8	98.8%	5.3	0.07	0.4
Portugal	6,298	214	486.89	91.4	492.95	93.4	489.33	86.8	7.4%	10.2	92.6%	9.7	0.19	0.3
Slovak Republic	4,555	189	496.68	96.1	490.27	95.4	477.44	90.2	21.5%	22.7	76.7%	23.4	-0.02	0.4
Slovenia	6,155	341	501.47	95.3	511.76	94.2	483.08	90.9	87.5%	17.4	95.3%	6.6	-0.11	0.6
Spain	25,887	888	483.49	90.6	488.25	87.5	481.04	87.5	100.0%	0.0	100.0%	0	0.08	0.4
Sweden	4,567	189	494.24	93.8	495.11	99.8	497.45	98.6	78.8%	28.9	90.9%	11.2	-0.04	0.3
Switzerland	11,812	426	533.96	99.2	516.57	95.9	500.50	93.5	61.8%	32.8	85.5%	19.9	0.09	0.4
Turkey	4,996	170	445.45	93.4	453.91	80.7	464.19	81.9	96.5%	14.6	3.5%	14.6	0.03	0.3
United Kingdom	12,179	482	492.41	87.2	513.71	98.8	494.18	95.4	9.6%	24.4	96.0%	9.8	0.11	0.4
England [1]	9,548	384	491.84	86.7	513.67	99.1	493.66	95.5	2.9%	5.0	95.9%	9.7	0.12	0.4
Scotland	2,631	98	499.02	92.6	514.23	95.7	500.11	94.2	86.5%	26.8	97.7%	9.7	0.03	0.3
United States	5,233	165	487.40	90.8	502.00	97.6	499.83	96.6	96.2%	15.5	94.5%	14.7	0.16	0.3
OECD	**298,454**	**11,039**	**495.68**	**96.3**	**500.92**	**98.3**	**493.38**	**95.7**	**73.2%**	**36.8**	**84.7%**	**27.5**	**0.01**	**0.3**

[1] PISA data include England, Wales and Northern Ireland

[2] France is not included in the analyses, since the variables on the school questionnaire were not available for this country.

[3] The OECD mean is computed without France, giving an equal weight to each country.

Table 3. Description of variables.

Variable	% missing	Mean	Std. Dev.
Teacher quality [2]			
Teacher education	12.4%	0.73	0.37
Teacher certification	13.2%	0.85	0.27
Disciplinary climate	2.0%	0.01	0.40
School characteristics			
Public school	3.7%	0.81	0.40
Private government dependent school	3.7%	0.12	0.32
Private government independent school [1]	3.7%	0.04	0.20
Location - Village [1]	2.0%	0.09	0.29
Location - Small town	2.0%	0.21	0.41
Location - Town	2.0%	0.33	0.47
Location - City	2.0%	0.23	0.42
Location - Large city	2.0%	0.12	0.32
Availability of other schools	2.0%	0.74	0.44
School size [2]	3.7%	0.73	0.57
Grades 7 to 13 [2]	5.2%	0.28	0.45
Ungraded school [2]	55.1%	0.04	0.19
Family inputs			
Family resources			
Mother full-time	4.1%	0.50	0.50
Mother part-time	4.1%	0.19	0.39
Mother looking for job [1]	4.1%	0.05	0.22
Mother other [1]	4.1%	0.22	0.42
Father full-time	6.8%	0.76	0.43
Father part-time	6.8%	0.07	0.26
Father looking for job [1]	6.8%	0.04	0.19
Father other [1]	6.8%	0.07	0.25
Out-of-school maths lessons 0 hours	22.5%	0.51	0.50
Out-of-school maths lessons 0-2 hours [1]	22.5%	0.12	0.33
Out-of-school maths lessons 2-4 hours	22.5%	0.09	0.28
Out-of-school maths lessons 4-6 hours	22.5%	0.04	0.19
Out-of-school maths lessons more 6 hours	22.5%	0.02	0.13
Out-of-school science lessons 0 hours	24.3%	0.59	0.49
Out-of-school science lessons 0-2 hours [1]	24.3%	0.08	0.27
Out-of-school science lessons 2-4 hours	24.3%	0.05	0.23
Out-of-school science lessons 4-6 hours	24.3%	0.02	0.15
Out-of-school science lessons more 6 hours	24.3%	0.01	0.10
Out-of-school language lessons 0 hours	23.1%	0.60	0.49
Out-of-school language lessons 0-2 hours [1]	23.1%	0.08	0.27
Out-of-school language lessons 2-4 hours	23.1%	0.05	0.23
Out-of-school language lessons 4-6 hours	23.1%	0.02	0.15
Out-of-school language lessons more 6 hours	23.1%	0.01	0.10
Home educational resources	1.1%	0.01	1.00
Wealth index	0.9%	0.00	1.00

Table 3. Description of variables *(continued)*.

Variable	% missing	Mean	Std. Dev.
Family background			
Parents' education	3.3%	13.31	3.01
Parents' job white collar high skilled	4.6%	0.54	0.50
Parents' job white collar low skilled	4.6%	0.22	0.42
Parents' job blue collar high skilled	4.6%	0.12	0.32
Parents' job blue collar low skilled [1]	4.6%	0.08	0.27
Books 1-10 [1]	1.9%	0.12	0.32
Books 11-25	1.9%	0.16	0.36
Books 26-100	1.9%	0.30	0.46
Books 101-200	1.9%	0.18	0.38
Books 201-500	1.9%	0.14	0.35
Books more 500	1.9%	0.08	0.27
Living with both parents	6.3%	0.02	0.13
Living with single mother	6.3%	0.11	0.31
Living with single father	6.3%	0.79	0.41
Living with neither parent [1]	6.3%	0.02	0.15
Living with siblings	20.7%	0.79	0.41
Living with grandparents	22.8%	0.12	0.32
Native students	2.1%	0.88	0.33
Speak test language	3.9%	0.87	0.33
Student characteristics (measured at the student level)			
Female	0.0%	0.49	0.50
Grade 7	0.4%	0.01	0.07
Grade 8	0.4%	0.05	0.22
Grade 9	0.4%	0.35	0.48
Grade 10	0.4%	0.51	0.50
Grade 11[1]	0.4%	0.08	0.27
Age (months)	0.0%	189.17	3.49
General programme	0.2%	0.80	0.40
Pre-primary education no	2.2%	0.08	0.28
Pre-primary education less 1 year	2.2%	0.20	0.40
Pre-primary education more 1 year [1]	2.2%	0.70	0.46
Expected university	58.1%	0.20	0.40
Enjoyment of reading	2.7%	0.00	0.99
Library use	2.1%	0.00	0.99
Student characteristics (measured at the school level) [2]			
Immigrants - 0%	12.3%	0.25	0.43
Immigrants - 0%-10%	12.3%	0.42	0.49
Immigrants - 10%-20%	12.3%	0.09	0.28
Immigrants - 20%-40% [1]	12.3%	0.05	0.22
Immigrants - 40%-60% [1]	12.3%	0.02	0.14
Immigrants - >60%	12.3%	0.05	0.23
Wealth	0.9%	0.00	0.64
Cultural possessions	0.9%	0.00	0.46

[1] Baseline category.

[2] Included only in the analysis in Chapter 4.

References

Fuchs, T. and Woessmann, L. (2007): "What accounts for international differences in student performance? A re-examination using PISA data", *Empirical Economics* 32, 433-464.

OECD (2009): *PISA data analysis manual, SPSS second edition*, Organization for Economic Co-operation and Development, 2009.

OECD (2012): *PISA 2009 technical report*, PISA, Organization for Economic Co-operation and Development, Paris.

Woessmann, L. (2003): "Schooling resources, educational institutions and student performance: the international evidence", *Oxford Bulletin of Economics and Statistics* 65(2), 117-170.

Woessmann, L., Ludemann, E., Schütz, G., West, M.R. (2007): "School accountability, autonomy, choice and the level of student achievement. International evidence from PISA 2003", OECD Education Working Papers 13.

References

Aaronson, D., Barrow, L. and Sander, W. (2007): "Teachers and student achievement in the Chicago public high schools", *Journal of Labor Economics* 25(1), 95-135.

Angrist, J.D. and Pischke, J.S. (2009): *Mostly harmless econometrics: an empiricist's companion,* Princeton University Press, Princeton.

Barankay, I. and Lockwood, B. (2007): "Decentralization and the productive efficiency of government: evidence from Swiss cantons", *Journal of Public Economics* 91, 1197-1218.

Bardhan, P. and Mookherjee, D. (2000): "Capture and governance at local and national levels", *American Economic Review* 90(2), 135-139.

Bardhan, P. and Mookherjee, D. (2006): "Decentralization, corruption and government accountability: an overview", in *International Handbook on the Economics of Corruption*, S. Rose-Ackerman (Ed.), Edward Elgar Publishing, Northampton.

Baron, R.M. and Kenny, D.A., (1986): "The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations", *Journal of Personality and Social Psychology* 51(6), 1173-1182.

Barro, R. J. and Sala-i-Martin, X. (2004): *Economic growth*, 2nd edition, MIT Press, Cambridge, M.A.

Bertrand, M., Duflo, E. and Mullainathan, S. (2004): "How much should we trust difference-in-differences estimates?", *The Quarterly Journal of Economics* 119(1), 249-275.

Besley, T. and Coate, S. (2003): "Centralized versus decentralized provision of local public goods: a political economy approach", *Journal of Public Economics* 87, 2611-2637.

Bishop, J. (1991): "Achievement, test scores and relative wages", in *Workers and their Wages*, M.H. Kasters (Ed.), The A.E.I. Press, Washington.

Bishop, J. (1992): "The impact of academic competences on wages, unemployment and job performance", *Carregie-Rochester Conference Series on Public Policy* 37, 127-194.

Blöchliger, H. and Rabesona, J. (2009): "The fiscal autonomy of sub-central governments: an update", OECD Working Papers on Fiscal Federalism 9.

Blundell, R. and Costa Dias, M. (2000): "Evaluation methods for non-experimental data", *Fiscal Studies* 21(4), 427-468.

Blundell, R. and Costa Dias, M. (2002): "Alternative approaches to evaluation in empirical microeconomics", *Portuguese Economic Journal* 1, 91-115.

Borge, L.E., Brueckner, J.K. and Rattso, J. (2014): "Partial fiscal decentralization and demand responsiveness of the local public sector: theory and evidence from Norway", *Journal of Urban Economics* 80, 153-163.

Bosch, N. and Duran, J.M. (2005): "Evolución del sistema de financiación de las CCAA en los últimos 25 años y perspectivas de reforma", in *La financiación de las Comunidades Autónomas: políticas tributarias y solidaridad interterritorial*, N. Bosch and J.M. Duran (Eds.), Publicacions i Edicions UB, Barcelona.

Bosch, N. and Suárez-Pandiello, J. (1993): "Tamaño del sector público y descentralización fiscal", *Revista de Economía Aplicada* 1(3), 181-193.

Brennan, D. and Buchanan, J. (1980): *The power to tax: analytical foundations of a fiscal constitution*, Cambridge University Press, Cambridge.

Brueckner, J.K. (2009): "Partial fiscal decentralization", *Regional Science and Urban Economics* 39, 23-32.

Carrion-i-Silvestre, J.L., Espasa, M. and Mora, T. (2008): "Fiscal decentralization and economic growth in Spain", *Public Finance Review* 36(2), 194-218.

Chetty, R., Friedman, J.N., Rockoff, J.E. (2013): "Measuring the impacts of teachers II: teacher value-added and student outcomes in adulthood", NBER Working Paper 19424.

Clotfelter, C.T., Ladd, H.F., Vidgor, J.L. (2006): "Teacher-student matching and the assessment of teacher effectiveness", *Journal of Human Resources* 41(4), 778-820.

Clotfelter, C.T., Ladd, H.F., Vidgor, J.L. (2007): "How and why do teacher credentials matter for student achievement?", NBER Working Paper 12828.

Clotfelter, C.T., Ladd, H.F., Vidgor, J.L. (2010): "Teacher credentials and student achievement in high school: a cross-subject analysis with student fixed effects", *Journal of Human Resources* 45(3), 655-681.

Darling-Hammond, L. (2000): "Teacher quality and student achievement: a review of state policy evidence", *Education Policy Analysis Archives* 8(1), 1-44.

Darling-Hammond, L. and Sykes, G. (2003): "Wanted: a national teacher supply policy for education: the right way to meet", *Education Policy Analysis Archives* 11(33), 1-55.

Deaton, A. (1997): *The analysis of household surveys: a microeconomic approach to development policy,* Johns Hopkins University Press, Baltimore.

De Mello, L.R. (2000): "Fiscal decentralization and intergovernmental fiscal relations: a cross-country analysis", *Wold Development* 28(2), 365-380.

De Mello, L.R. and Barensteinl, M. (2001): "Fiscal decentralization and governance: a cross-country analysis", IMF Working Paper 01/71.

Diamond, J. and Robinson, J.A. (2010): *Natural experiments of history*, Harvard University Press.

Díaz-Serrano, L. and Meix-Llop, E. (2012): "Do fiscal and political decentralization raise students' performance? A cross-country analysis", IZA Discussion Paper 6722.

Ebel, R.D. and Yilmaz, S. (2002): "On the measurement and impact of fiscal decentralization", WB Policy Research Working Paper 2809.

Esteller-Moré, A. and Solé-Ollé, A. (2005): "Does decentralization improve the efficiency in the allocation of public investment? Evidence from Spain", IEB Working Paper 2005/5.

Faguet, J.P. (2004): "Does decentralization increase government responsiveness to local needs? Evidence from Bolivia", *Journal of Public Economics* 88, 867-893.

Falch, T. and Fischer, J.A.V. (2012): "Public sector decentralization and school performance: international evidence", *Economic Letters* 114, 276-279.

Felgueroso, F., Gutiérrez-Domènech, M. and Jiménez-Martín, S. (2013): "Dropout trends and educational reforms: the role of the LOGSE in Spain", FEDEA Working Papers 2013-04.

Fuchs, T. and Woessmann, L. (2007): "What accounts for international differences in student performance? A re-examination using PISA data", *Empirical Economics* 32, 433-464.

Galiani, S. and Schargrodsky, E. (2002): "Evaluating the impact of school decentralization on educational quality", *Economía* 2(2), 275-302.

Galiani, S., Gertler, P. and Schargrodsky, E. (2008): "School decentralization: helping the good get better, but leaving the rest behind", *Journal of Public Economics* 92, 2106-2120.

Gallego, F.A. (2010): "Historical origins of schooling: the role of democracy and political decentralization", *Review of Economics and Statistics* 92(2), 228-243.

Garcia-Milà, T. and McGuire, T.J. (2002): "Fiscal decentralization in Spain: an asymmetric transition to democracy", mimeo.

Gilpin, G. and Kaganovich, M. (2012): "The quantity and quality of teachers: dynamics of the trade-off', *Journal of Public Economics* 96, 417-429.

Glewwe, P. Nauman-Ilias, P. and Kremer, M. (2010): "Teacher incentives", *American Economic Journal: Applied Economics* 2(3), 205-227.

Habibi, N., Huang, C., Miranda, D., Murillo, V., Ranis, G., Sarkar, M. and Stewart, F. (2001): "Decentralization in Argentina", Yale Economic Growth Center Discussion Paper 825.

Hallak, J. and Poisson, M. (2005): Ethics and corruption in education: an overview. *Journal of Education for International Development* 1(1), 1-16.

Hanushek, E.A. (1986): "The economics of schooling: production and efficiency in public schools", *Journal of Economic Literature* 24, 1141-1177.

Hanushek, E.A. (1989): "The impact of differential expenditures on school performance", *Educational researcher* 18(4), 45-62.

Hanushek, E.A. (2003): "The failure of input based schooling policies", *Economic Journal* 113, 64-98.

Hanushek, E.A. (2011): "The economic value of higher teacher quality", *Economics of Education Review* 30(3), 466-479.

Hanushek, E.A., Kain, J.F. and Rivkin, S.G. (2004): "Why public schools loose teachers", *Journal of Human Resources* 39(2), 326-354.

Hanushek, E.A., Kain, J.F., O'Brien, D.M and Rivkin, S.G. (2005): "The market for teacher quality", NBER Working Paper 11154.

Hanushek, E.A. and Kimko, D.D. (2000): "Schooling, labor-force quality and the growth of nations", *American Economic Review* 90, 1184-1208.

Hanushek, E.A. and Rivkin, S.G. (2010a): "Generalizations about using value-added measures of teacher quality", *American Economic Review: Papers and Proceedings* 100, 267-271.

Hanushek, E.A. and Rivkin, S.G. (2010b): "Constrained job matching: does teacher job search harm disadvantaged urban schools?", NBER Working Paper 15816.

Hanushek, E.A. and Woessmann, L. (2007): "The role of education quality for economic growth", WB Policy Research Working Paper 4122.

Hanushek, E.A. and Woessmann, L. (2011): "The economics of international differences in educational achievement", in *Handbook of the Economics of Education*, E.A. Hanushek, S. Machin and L. Woessmann (Eds.), Vol. 3, Elsevier, Amsterdam.

Harris, D.N. and Sass, T.R. (2011): "Teacher training, teacher quality and student achievement", *Journal of Public Economics* 95, 798-812.

Healey, F.H. and Crouch, L. (2012): "Decentralization for high-quality education: elements and issues of design", Research Report, RTI Press Publication.

Heckman, J.J. and Hotz, V.J. (1989): "Choosing among alternative non-experimental methods for estimating the impact of social programs: the case of manpower training", *Journal of the American Association* 84(408), 862-874.

Hindriks, J. and Lockwood, B. (2005): "Centralization and political accountability", CEPR Discussion Paper 5125.

Hoxby, C.M. (1996): "How teachers' unions affect education production", *Quarterly Journal of Economics* 111(3), 671-718.

Hunt, F. (2008): "Dropping out from school: a cross-country review of literature", *CREATE Pathways to Access* 16, University of Sussex.

Hunter, J.S.H. (1974): "Vertical intergovernmental financial imbalance: a framework for evaluation", *FinanzArchiv* 32(2), 481-492.

Kane, T.J., Rockoff, J.E. and Staiger, D.O. (2006): "What does certification tell us about teacher effectiveness", NBER Working Paper 12155.

Krueger, A.B. (2003): "Economic considerations and class size", *The Economic Journal* 113(485), 34-63.

Krull, J.L. and Mackinon, D.P. (1999): "Multilevel mediation modeling in group-based intervention studies", *Evaluation Review* 23(4), 418-444.

Lago-Peñas, I. and Lago-Peñas, S. (2010): "Decentralization and electoral accountability", *Environment and Planning C: Government and Policy* 28, 318-334.

Lockwood, B. (2002): "Distributive politics and the costs of centralization", *Review of Economic Studies* 69, 313-337.

Lockwood, B. (2006): "Fiscal decentralization: a political economy perspective", in *Handbook of Fiscal Federalism*, E. Ahamad and G. Brosio (Eds.), Edward Elgar Publishing, Northampton.

Mackinnon, D.P., Krull, J.L. and Lockwood, C.M. (2000): "Equivalence of the mediation, confounding and suppression effect", *Prevention Science* 1, 173-181.

Mackinnon, D.P, Lockwood, C.M., Hoffman, J.M., West, S.G. and Sheets, V. (2002): "A comparison of methods to test mediation and other intervening variable effects", *Psychological Methods* 7, 83-104.

Mahal, A., Srivastava, V. and Sanan, D. (2000): "Decentralization and public sector delivery of health and education services: the Indian experience", ZEF Discussion Paper 20.

Metzler, J. and Woessmann, L. (2012): "The impact of teacher subject knowledge on student achievement: evidence from within-teacher within-student variation", *Journal of Development Economics* 99, 486-496.

Murillo, M.V., Tommasi, L., Ronconi, L. and Sanguinetti, J. (2002): "The economic effects of unions in Latin America: teachers' unions and education in Argentina", IDB Research Network Working Paper R-463.

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

Oates, W.E. (2005): "Toward a second-generation theory of fiscal federalism", *International Tax and Public Finance* 12, 349-373.

OECD (2004a): "The quality of the teaching workforce", OECD Policy Brief February 2004.

OECD (2004b): *Education at a glance 2004: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2008): *Education at a glance 2008: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2009): *PISA data analysis manual, SPSS second edition*, Organization for Economic Co-operation and Development, Paris.

OECD (2011): *Building a high-quality teaching profession: lessons from around the World,* Organization for Economic Co-operation and Development, 2011.

OECD (2012a): *Education at a glance 2012: OECD indicators*, Organization for Economic Co-operation and Development, Paris.

OECD (2012b): *PISA 2009 technical report*, PISA, Organization for Economic Co-operation and Development, Paris.

Persson, T. and Tabellini, G. (2000): *Political economics: explaining economic policy*, MIT Press, Cambridge, MA.

Preacher, K.J. and Hayes, A.F. (2004): "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods, Instruments and Computers* 36, 717-731.

Preacher, K.J. and Hayes, A.F. (2008): "Asymptotic and re-sampling strategies for assessing and comparing indirect effects in multiple mediator models", *Behavior Research Methods* 40(3), 879-891.

Pritchett, L. and Filmer, D. (1997): "What education production functions really show: a positive theory of education spending", WB Policy Research Working Paper 1795.

Prud'homme, R. (1995): "The dangers of decentralization", *The World Bank Research Observer* 10(2), 201-220.

Redoano, M. (2010): "Does decentralization affect the number and size of lobbies?", *Journal of Public Economic Theory* 12(3), 407-435.

Rivkin, S.G., Hanushek, E.A. and Kain, J.F. (2005): "Teachers, schools and academic achievement", *Econometrica* 73(2), 417-458.

Rockoff, J.E. (2004): "The impact of individual teachers on student achievement: evidence from panel data", *American Economic Review: Papers and Proceedings* 92(2), 247-252.

Rodden, J. (2002): "The dilemma of fiscal federalism: grants and fiscal performance around the world", *American Journal of Political Science* 46(3), 670-687.

Rodden, J. (2003): "Reviving leviathan: fiscal federalism and the growth of government", *International Organization* 57(4), 695-729.

Rodden, J., Eskeland, G. and Litvack, J. (2001): *Decentralization and the challenge of hard budget constrains*, MIT Press, Cambridge, MA.

Romer, P.M. (1986): "Increasing returns and long run growth", *Journal of Political Economy* 94, 1002-1037.

Romer, P.M. (1990): "Endogenous technological change", *Journal of Political Economy* 98(5), 71-102.

Roodman, D. (2009): "How to do xtabond2: an introduction to difference and system GMM in Stata", *The Stata Journal* 9(1), 86-136.

Salinas-Jiménez, M.M., Artés, J. and Salinas-Jiménez, J. (2013): "How do educational attainment and occupational and wage-earner statuses affect life satisfaction? A gender perspective study", *Journal of Happiness Studies* 14(2), 367-388.

Seabright, P. (1996): "Accountability and decentralisation in government: an incomplete contracts model", *European Economic Review* 40, 61-89.

Shah, A. (1998): "Balance, accountability and responsiveness. Lessons about decentralization", WB Policy Research Working Paper 2021.

Shah, A. and Shah, S. (2006): "The new vision of local governance and the evolving roles of local governments" in *Local governance in developing countries,* A. Shah (Ed.), World Bank, Washington D.C.

Sharma, C.K. (2012): "Beyond gaps and imbalances: re-structuring the debate on intergovernmental fiscal relations", *Public Administration* 90(1), 99-128.

Solé-Ollé, A. (2010): "Decentralization and service delivery: the Spanish case" in *Does decentralization enhance service delivery and poverty reduction?*, G. Brosio and E. Ahamad (Eds.), Edward Elgar Publishing, Northampton.

Strumpf, K.S. and Oberholzer-Gee, F. (2002): "Endogenous policy decentralization: testing the central tenet of economic federalism", *Journal of Political Economy* 110(1), 1-36.

TI (2013): *Global corruption report: education*, Transparency International, Berlin.

Todd, P.E. and Wolpin, K.I. (2003): "On the specification and estimation of the production function for cognitive achievement", *The Economic Journal* 113, 3-33.

UNESCO (2009): *Education indicators: technical guidelines*, United Nations Education, Scientific and Cultural Organization, Paris.

Weingast, B.R. (2009): "Second generation fiscal federalism: the implications of fiscal incentives", *Journal of Urban Economics* 65(3), 279-293.

Wildasin, D.E. (1997): "Externalities and bailouts: hard and soft budget constraints in intergovernmental fiscal relations", WB Policy Research Working Papers 1843.

Williams, J. and Mackinnon, D.P. (2008): "Re-sampling and distribution of the product methods for testing indirect effects in complex models", *Structural Equation Modeling* 15, 23-51.

Winkler, D. and Yeo, B.L. (2007): "Identifying the impact of education decentralization on the quality of education", EQUIP2 Working Paper.

Wiswall, M. (2013): "The dynamics of teacher quality", *Journal of Public Economics* 100, 61-78.

Woessmann, L. (2001): "Why students in some countries do better?", *Education matters* 1(2), 67-74.

Woessmann, L. (2003): "Schooling resources, educational institutions and student performance: the international evidence", *Oxford Bulletin of Economics and Statistics* 65(2), 117-170.

Woessmann, L., Ludemann, E., Schütz, G., West, M.R. (2007): "School accountability, autonomy, choice and the level of student achievement. International evidence from PISA 2003", OECD Education Working Papers 13.

Wooldridge, J.M. (2002): *Econometric analysis of cross section and panel data*, MIT Press, Cambridge, MA.

Zegarra, E. and Ravina, R. (2003): "Teacher unionization and the quality of education in Peru: an empirical evaluation using survey data", IDB Research Network Working Paper 474.