## ABSTRACT

Title of dissertation: DECENTRALIZATION AND EDUCATION:

AN EMPIRICAL INVESTIGATION

Felipe Barrera-Osorio, Doctor of Philosophy, 2003

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This thesis analyses, using a quasi-experimental approach, the relationship between decentralization and education in Colombia, where in 1991 decentralization of the State was implemented. The thesis focuses on two relationships: first, the relationship between decentralization and quality of education; and second, this relationship across individuals with different incomes.

Theoretically, decentralization may increase the efficiency in the provision of education, and therefore, we would expect an increment in educational quality in schools affected by decentralization. Furthermore, decentralization may create a more unequal distribution of educational quality, and therefore, we expect that the impact of decentralization is asym-

metric with respect to income.

The thesis makes use of a new dataset that comes from two sources. First, data from the Ministry of Education provide an important array of school characteristics. Second, data from the ICFES, the institute in charge of administering standardized tests in Colombia, provide test scores and characteristics of individuals.

We present three types of quasi-experimental models based on different control and treatment groups. First, we estimate the effect of decentralization on public schools, using private ones as a comparison group. Second, we restrict the estimation to public schools, but now the treatment group is comprised of schools in initially highly dependent departments, and the control group of schools in departments with initially highly independent relationship with the central government. Finally, the third model is a nested model of the first two. It is a more flexible model allowing nationwide effects and public school effects.

The empirical results are mixed. We find a positive impact of decentralization in the first two models. However, the third model presents a negative result. The results from the tests on an asymmetrical impact of decentralization, depending on income, are mixed as well. In the last two models, the results are symmetric. However, in the first model the results are asymmetric, and interestingly, in favour of low-income individuals. That is, decentralization increases the test scores for individuals at the left tail of the income distribution.

# DECENTRALIZATION AND EDUCATION: AN EMPIRICAL INVESTIGATION

by

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2003

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**Acknowledgements**

Several professors at Maryland helped me during my very happy years at the University. I would like to thank Darrell Hueth and Rudy Hommes. Darrell was brave enough to take the advice of Rudy to help me get an opportunity to study at Maryland. Robert Schwab was my teacher of microeconomics, at a moment in which I needed one like him. He read in detail my dissertation, allowing me to find mistakes and holes. His guidance was critical in the making of the thesis. Judith Hellerstein read the first drafts. Conversations with her were always an exercise of coherence that allowed me to build stronger arguments. The members of my committee not only provided very important comments to improve the thesis, but they also made my defense a very pleasant and challenging exercise. To Professors Oates, Rice and Sanders, my thankfulness.

Jonah Gelbach provided help not only with the ideas and technical problems, but also with detailed comments about the form and writing of the thesis. He provided ideas that, with boldness, I took as mine. He was able to combine the precise amount of hard criticism with valuable encouragement. Literally, without his help, I would not have been able to finish. He is a great teacher and, probably more important, a good friend. Jonah, thank you.

Vickie Fletcher, Mary Louise Snidow and Marie Speake helped me to make my transit through the university a very smooth experience. I hope that one day I can return all the favours that they did for me.

In the process of building the thesis, many people in Colombia gave me support at a

moment in which it was not abundant. Eduardo Lora gave me an opportunity, and friendship, that I will never forget. Juan Jose Echavarría brought me to Fedesarrollo the summer of 2000. During those two months I had the initial idea of the thesis. He paid me to think and he gave me for free his ideas and insights on the problem. A the Ministry of Education, Margarita López, Margarita Peña and Mauricio Castillo allowed me to get the necessary data in order to do the thesis, and Carlos Pardo did the same with the data at the ICFES. To all of them, my deepest gratitude.

The Central Bank of Colombia and Colciencias provided very important monetary support. José Darío Uribe and the committee of scholarships of the Central Bank was very generous with me. In Colciencias, I would like to thank Erin Dell and Juan Raúl Mendoza, the two people in charge of my case, and Hernán Jaramillo for believing in me. All of them helped me in a great way, although passive, to finish this journey.

Rocio Osorio, my mother, was widowed at the age of 36. She, alone, made true the dreams, whatever they were, of her three sons. She is always the most enthusiastic follower of our enterprises. Mother, I just finished one that is the start of several. Thank you.

My wife, Katja Vinha, did an enormous amount of this dissertation, in the real sense of the sentence. She read several times my drafts, correcting my poor English. She criticized weak arguments and she helped me preparing the defenses of the proposal and the thesis. On top of all this, she tolerated all my moods when things were not as bright as they are today. For all her intelligence, bravery and honesty, thanks. I will always fight to deserve you.

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# Chapter 1

# Introduction

In 1971, the State Court of California, United States, ordered a general equalization of expenditure on education in localities within the state. In simple terms, the state changed from a highly decentralized regime in which each locality decides its level of expenditures on education to a centralized one in which the state decides how much each locality should spend. The objective was to introduce equal expenditures across localities.

In 1991, the country of Colombia enacted a new Constitution that changed several aspects of the political, economic and administrative order in the country. One of the most fundamental changes was the transformation of the country's public sector from a highly centralized system to a more decentralized one in order to increase efficiency and coverage in the provision of local public goods.

The above two quasi-experiments may imply an implicit trade-off between equity and efficiency in the provision of services. Apparently, different degrees of decentralization are

used to accomplish different objectives. In California, the change from a decentralized system to a centralized one was made to promote equality, while in Colombia, the change from a centralized regime to a decentralized one was implemented to improve efficiency.

The problem analyzed in this thesis is a critical one in economics. Does a decentralized system deliver more efficiency than a centralized one? This question relies on several branches of economics: microeconomics and the formation of prices; public economics and the Tiebout hypothesis of voting with the feet; and human capital theory and the production of quality of education. The answer to the question is still open. Chapter 2 presents an overview of different theories on the topic, as well as some empirical results for the United States.

The primary objective of this dissertation is to investigate the impact of decentralization on education in Colombia, which implemented a decentralization reform during the nineties.

The two main hypotheses of the thesis are the following. First, that decentralization increases the efficiency in the provision of education, and therefore, has positively impacted standardized test scores. Second, that decentralization has impacted asymmetrically individuals with different incomes, and therefore, decentralization has impacted differently the scores of high- and low-income individuals.

The Colombian reform is discussed in Chapter 3. As argued in that chapter, Colombia decentralized in a limited way, transferring only some of the expenditure and tax functions to the localities. That chapter presents data on the impact of decentralization on inputs of the schools. As it argues, probably the most important change of decentralization is on the characteristics of the schools, such as teacher quality, and that change ultimately impacts

test scores.

Chapter 4 lays out the empirical strategy that is based on treatment and control estimations. Specifically, the chapter analyses changes in test scores in those schools that experienced decentralization and those that did not. Chapter 4 also presents estimation results. Chapter 5 discusses general conclusions.

# Chapter 2

# Literature Review

This chapter focuses on the theoretical and empirical literature about decentralization. The next part of the chapter analyses several theoretical papers that focus on the debate on the trade-off between inequality and efficiency. Under which conditions will decentralization deliver increased inequality? Under which conditions will decentralization induce efficiency? Is there any regime in which the trade off does not exist?

The third section of the chapter discusses the empirical evidence in the United States. Several states faced a court order for the equalization of expenditures, quasi-experiments that allow researchers to investigate the effects of such changes on efficiency and distribution. The empirical papers in the literature primarily investigate the effects on distribution, most likely because the reforms targeted reduction of inequality. These papers ask whether states that enacted equalization of educational expenditures were successful in reducing inequality and whether the court order was necessary for the change. Another question in the empirical

arena is whether expenditure equalization has caused convergence to the ex ante expenditure levels of localities with the lowest expenditure levels or the higher ones. Also, this part present evidence derived from general equilibrium models and simulation experiments that support parts of the empirical findings.

The fourth section of this chapter presents a discussion from the political economy view on how to break the apparent link between efficiency and inequality while preserving a decentralized regime. First, there is an extensive literature on vouchers, which can be used to induce equality in education expenditures by giving households the power to decide from where to consume educational services, so that decentralization of the educational system is preserved. Second, some papers discuss a system in which state taxes that are distributed in such a way as to effect equalization expenditures while preserving local jurisdiction over administration and the pattern of expenditure.

At this point, it is important to define decentralization. Decentralization is the transfer of several political and economical functions from the central government to the local governments. In the sphere of economics, these functions include the decisions on expenditure and revenues. For example, a central government will decide the amount of expenditure on education countrywide in a centralized regime, whereas in a decentralized system local governments (e.g. the municipal government) will decide the amount of expenditure on education for its own community. Likewise, in a central regime, the national government will decide tax rates and bases; in contrast, a decentralized regime will give this power to localities.

Clearly, there are several degrees of decentralizations, ones with more functions transferred to the localities, and others where the localities are more restricted in the expenditure and revenue decisions. Colombia, as the next chapter discusses in depth, has the characteristics of moderate decentralization. Part of the expenditure of localities is outlined by the national government, and taxation decisions are also limited by some central regulation.

## 2.1 The trade-off between efficiency and equality

The theoretical papers of this section present arguments on the potential effects of decentralization and centralization on efficiency and distribution. This section has three subsections: informational issues and sorting, supply-side considerations, and externalities and stratification.

In the first set of papers on informational issues the main conclusion is that the information held by local service providers suggest efficiency gains in the provision of the services in contrast with a central government, which presumably does not have complete information. The sorting argument on public service provision draws conclusions from several papers in which people vote with their feet to find their preferred consumption bundle for public services and taxes. Households will locate in those communities that provide their preferred consumption bundle and will pay the price (tax) charged for these services in the community. This type of efficiency argument embodies a correlation between high-income and high-level provision of services. The second set of papers on supply-side considerations looks into the problem of provision of services and the incentives that local suppliers have to give in order

to achieve the optimal level of services. The last set of papers on externalities and stratification argues in favor of centralization based on the presence of local externalities. There are efficiency gains from centralization if there are peer effects in education. There may, however, be general externalities that would favor decentralization on efficiency grounds. The section ends with a discussion of this dichotomy.

### 2.1.1 Informational issues and sorting

Behind the idea that decentralization induces a more efficient allocation of resources is the idea of F.A.Hayek [34] that a decentralized system will provided a better allocation of resources than a centralized system because agents at the micro level have more and better information than any central power. Therefore individual agents will make better decisions for themselves than the ones that the central power may take in their behalf. Clearly, some individuals are going to demand low levels of education and others high levels, depending on their preferences for education.

More recent literature (Tiebout [59], Oates [53] and the general overview in IDB [6] and Oates [52]) emphasizes the idea that a decentralized system will provide better public services because, in a Tiebout-type model, people choose the location that delivers the optimal set of taxes and expenditures, given their preferences. If the services or taxes are not the preferred ones, individuals will vote with their feet, leaving the location for another one that provides a preferred set of taxes and services. Given a population with heterogeneous preferences, there will be several different bundles of taxes and services in equilibrium, and households

will leave and enter communities according to their preferences. There will be high-service, high-tax and low-service, low-tax communities. In this case, efficiency refers to the concept of optimal choice (for services and taxes). People are maximizing utility subject to the set of taxes and services offered, so that in equilibrium people do not leave the communities.[1]

Hamilton [31] develops Tiebout's idea and incorporates housing price and local property taxes into the analysis. In a perfectly decentralized system, housing prices implicitly reflect local taxes and the type of services that each community receives. Owners of houses will see increases in house prices as the quality of services provided in the community increases, holding constant tax bills. On the other hand, low-income people will live in low rent places with low levels of services. In these localities, tax rates may be high and the total revenue from taxes low since the tax base is smaller than in rich communities. Therefore, there is a link between services, taxes and prices of houses. Communities with high levels of services probably will pay a larger amount of dollars in taxes, with housing prices reflecting the high level of services and taxes. Owners will be compensated for the high tax payments with higher housing prices and better quality of services.

Sonstelie and Portney [57] show that, if a community allocates resources to the provision of local public goods such that it maximizes the value of the property within its boundaries, the allocation is Pareto optimal. The implication is that a decentralized system, in which the local community decides expenditures and taxes for local public goods, is efficient in a Pareto sense since people internalize the effect of expenditures and taxes through the prices

[1]Even in the case of low level migration, as Oates [52] argues, decentralization may induce a higher level of efficiency because the information arguments still hold.

of property.

The trade off between efficiency and inequality is implicitly present in the two previous arguments. People choose taxes, services and rents to maximize their utility, a fact that implies efficiency. There is, however, a correlation between income and the chosen levels of services, taxes and rent. High-income families will be in high quality localities, with high rents and high collection of taxes, and the contrary for low-income people.[2]

It is important to point out that even if decentralization, based on the information arguments, brings theoretical efficiency gains some authors argue that in practice decentralization faces important problems, including technical constraints and corruption. Local authorities may have a lower technical capacity than the central government in deciding expenditure, assignation of resources, collection of taxes, etc.[3] If this is true, it is possible to observe a dip in the quality of services immediately after the decentralization starts.

With respect to corruption, local governments with new resources may be prone to this problem. But, the decentralization can give more instruments to the community to exercise checks and balances. Since local service providers control the resources and programs to be implemented they also can be held responsible for the results. Moreover, under the decentralized system the relationship between the units providing services and the community receiving them is direct. Therefore, the local community can "demand" better services from

[2]However, if the model incorporates not only people but also companies, the apparent correlation may vanish. Firms tend to locate in places in which rents are low. If this is the case, the tax rate and the tax collection over firms can compensate for the low taxes of individuals. The community may be low-income with a high total tax base and a high level/quality of services (Fischel [27]).

[3]For precisely that reason, however, decentralization will force local governments to increase their technical capacities via learning by doing.

suppliers.

### 2.1.2 Supply-side considerations

So far, the three models reviewed until now present the hypothetical situations of a world that either has or does not have perfect decentralization. However, it is quite different to analyze a country that changes from one regime to another, say from a decentralized one to a centralized one. In terms of North [51], a system that is in place may have some institutions that are difficult to change. Once the regime changes, old institutions may remain and create certain dynamics that are important to analyze. For instance, decentralization creates dynamics in the price of property as we saw above. Once the system changes from a decentralized regime to a centralized one, and since taxes somehow reflect previously the quality (expenditure) of services, the change in the system decouples the relationship between taxes and services. This fact is precisely the starting point of Hoxby [41], Fischel [28] and Fischel [26]

Hoxby [41] uses the notion that behind a certain quality and amount of expenditure on education there is an implicit cost, which is the tax that provides the revenues for the expenditure. Hoxby calculates this implicit tax price for several states. In some states, for which the court ordered a strong equalization of expenditures, the local authorities have to raise more than one dollar in revenue to spend a dollar. In these states, actual expenditure is discouraged because equalization favors the localities within the state that have low expenditure in education.

In a similar argument, Fischel [28] and Fischel [26] argue that an equalization of expenditures will fracture the link between services, taxes and capitalization of houses and therefore individuals will want to introduce limits on property taxes.

Campbell and Fischel [16] study the particular case of New Hampshire's 1992 elections in which a candidate proposed property tax limits and a state income tax earmarked for education. The political basis for this proposal was that the political system did not provide the most preferred reforms for the average citizen, because some people who did not want these reforms had a considerable amount of power in the political process. However, the candidate who proposed the reforms did not win the election. This fact implies that the median voter was against the reforms, and by a transitivity argument, the median voter was against the court orders as well. Campbell and Fischel find that the fiscal proposal was an important factor deciding the individuals' vote among various other campaign issues.

In summary, when individuals choose localities, they are implicitly choosing a set of taxes and services. If the taxes are local taxes (mainly taxes on property), the tax works as a fee for the public local services. House prices and taxes will reflect quality of public services. These relationships induce a potential positive correlation between income and quality of services that is at the heart of the trade off between equality and efficiency.

It is important to notice that the demand side drives the previous arguments. The efficiency argument is that individual will be maximizing utility in the consumption of education. However, it is not clear that the local provider of the services will in fact deliver the optimal demand of services. Hanushek [33], Hanushek [32], Manski [47] and Hoxby [40]

present a fundamental critique of the empirical literature on education that treats quality as the output of an educational production function whose inputs are individual and schools characteristics. These articles argue that the objective function of the school is not clear. For instance, it is possible that among several objectives of a public school are the "integration" of different groups of society, creating civic conscience, or job stability for teachers, just to mention a few candidates.[4]

Therefore, it is important to know what induces the local provider of the services to deliver the "right" level of services, e.g. the one demanded by the community. Decentralization can open space for the active and direct participation of each locality's individuals in school decisions. The clearest example of this is the board system in which parents of children in the school can actively make decisions such as to change the principal, remove bad teachers, etc. In contrast, in a centralized system, central actors (usually the minister of finance and the teachers unions) make decisions and local authorities are simply instruments in fulfilling these decisions. In a centralized system one problem is that the central government is unlikely to make decisions that accommodate the requirements of each locality, since it generally does not have adequate information.[5] Moreover, decisions at the central level can reflect the preferences of the people making them rather than the preferences of the general population. For instance, the teachers union may be interested in introducing job stability for teachers in each locality.

Hoxby [40] stresses the importance of the supply side of education in the efficiency dis-

[4]A more detailed discussion is undertaken in the empirical chapter.
[5]This argument was made by Hayek [34].

cussion. Decentralization provides the means for individuals to enforce the optimal provision of services. The providers will, under this system, deliver the optimal level of services for the locality based on its collective preferences.

Hoxby [40] presents a principal-agent model in which the principal is the community and the agent is the local school. The essential insight of the model is that the principal (the board of directors of the school) can induce the optimal quality (and minimization of cost by the school) in the presence of incomplete observation due to the Tiebout-Hamilton mechanism of capitalization. In a (perfect) Tiebout world, cost-minimizing schools prevail. However, the model assumes that characteristics are verifiable by the board of directors of the school, which may or may not be the case. Hoxby assumes that the board cannot observe either some parameter in the cost function of the school or the effort of the schools, but that Tiebout capitalization allows the board to infer the effort that the school is making to minimize costs. Black [14] presents an estimation that is in line with this argument. She infers the value that parents place on the quality of education by looking at housing prices. She compares the prices of houses in the same neighborhood (i.e. across the street from each other) but in different school districts. In this way she is able to isolate the impact of school quality from other sources of variation like differences in tastes, characteristics of the neighborhood, etc.

As we saw, capitalization is the key link between quality of services and prices of houses. Individuals will pay higher taxes in return for better services and higher property values. People who own houses will be willing to invest in better services since the value of their

property increases with service quality. People who want better services will pay for them through taxes and higher rents. Under perfect decentralization, the board of directors can infer the type of services that the school is providing by means of property values.[6]

When there is not perfect decentralization and the Tiebout mechanism does not hold (for instance when a court orders an equalization of expenditures), the link between services, taxes and housing prices is broken, and the local community cannot infer the level of effort by the school, inducing a loss in efficiency.[7]

As in the previous papers in which the emphasis is on the demand side, in Hoxby's paper the trade off between equity and efficiency is present. Decentralization can give the community instruments to induce efficiency from part of the provider of the services. However, quality is higher in those places in which the tax base is higher.

In conclusion, there are several theoretical reasons why a decentralized system may induce a higher level of efficiency than a centralized one. First, people will be able to consume the optimal quality and quantity of education. Second, decentralization allows people to induce the local provider of the services to deliver the preferred amount. By contrast, in a centralized system the authority will target spending to match the preferences of some agent (presumably the median voter). The rest of the people will need to accommodate their demands to this level. Moreover, local providers will not have any interaction with local communities: they will receive mandates from a central government and will not have

[6]One problem of the argument is the fact that property values reflect a complete vector of several local amenities, and not only local quality of education.

[7]If education has, however, a positive externality, and education of the whole society enters in the utility function of each locality, then there may be a case for equalization of expenditures on the grounds of efficiency if the equalization actually increases the overall education of society. More discussion on this issue above.

any incentive to deliver the optimal choices of the local community. Furthermore, in the worst-case scenario the objective function of the decision makers may not match the median voter's at all, but rather be that of their own group.[8] However, the gains in efficiency from decentralization come with a cost in general cases. Rich communities will spend more on services than poor ones. If quality of education depends on expenditure, then a perpetual circle of inequality is created.

### 2.1.3 Externalities and stratification

Despite the apparent conflict between equity and efficiency and levels of decentralization, some theoretical models that include local educational externalities predict that the trade-off will not exist in equilibrium. Moreover, these types of models (mainly Benabou [10], Benabou [9] and Benabou [11]) present theoretical arguments in favor of a centralized regime since it can theoretically deliver both efficiency and equity.

Benabou [10] presents a model with human capital and financial asset accumulation that allows the analysis of distributional aspects. The main aim of the paper is to see the impact of funding sources (state or local) on the over overall economic surplus, student achievement and equality of opportunity for education. In the model, individuals make three main decisions: location, capital accumulation and consumption (which is correlated with expenditure on the public good). The model consists of a simple individual maximization

[8]Clearly, under decentralization the local decision makers can also try to enforce their own objective function. However, in this case the community may have more instruments to induce decisions towards the best interest of the locality than in a centralized regime.

problem in which utility depends directly on the quality of education. The model explicitly includes a positive externality of education, since the individual's education quality depends on the quality of education of the community where the individual lives. In other words, the community's stock of human capital impacts positively the individual's accumulation of education. Hoxby [39] presents a strong case in favor of peer effect externalities. She uses gender and race changes in adjacent cohorts as the source of variation to identify the externality. She finds that the achievement of classmates has an important effect on the achievement of individuals.

Equilibrium conditions specify the distribution of people across the city. There are two cases, a stratified equilibrium in which the rich and the poor individuals live in different areas, and an integrated equilibrium in which the rich and the poor live in both communities. If there are complementarities between families' human capital and the quality of education of the community, there will be stratification. If there are (small) imperfections in the capital market, so that the opportunity cost of funds for poor families is higher (for instance, different interest rates for poor people), there will also be stratification. In addition, small differences in lifetime resources are sufficient to cause stratification. Given stratification, wealth increases in rich communities and decreases in poor communities. This stratification creates a dynamic force in favor of segregation.

Inequality in this model increases over time under general conditions. Rich parents invest more in education, live in wealthier localities and live in communities with high human capital. Under local externalities, this combination will induce increases in the human capital

of the individuals, creating a virtuous cycle within the rich community. The contrary will occur in the poor community. However, capitalization has an effect in the income distribution between poor and rich communities. Since rent, or the price of property, in the rich community is higher than in the poor community, the poor neighborhood faces low prices that induce an income effect in favor of the poor. Also, assuming that rich people own all houses, the lower price of rent in the poor community will decrease the income of rich people. Despite these effects, they are not strong enough to break the stratified, stable equilibrium.

Benabou presents a measure of efficiency in the presence of segregation that depends on three margins. First, who benefits more from an increase in the level of community quality? Presumably, it benefits more the rich families. Second, who benefits more on the margin from increases in quality? Given that quality is high in rich communities, and that presumably the utility function is concave with respect to quality, the effect of segregation is quite small for rich communities and it implies an important loss for poor communities. Third, in what type of community will a highly-educated family contribute more to increase the level of education of the community? Presumably, in a poorer community. Therefore, under certain conditions, segregation can induce losses in efficiency since the losses of the poor may be greater than the gains of the rich.

Three main conclusions result from the different ways to finance education. First, since stratification is inefficient in the presence of local externalities, and decentralization may induce stratification, decentralization may be inefficient. Moreover, decentralization also induces inequality when expenditure on the public good and the mean level of human capital

of the community are complements because rich communities will spend more than poor ones. Second, forced equalization of expenditure on schools may leave stratification intact, while reducing wealth since equalization brings efficiency costs. In this case, the movement to a more centralized system will level the field by bringing down the rich rather than raising the poor. Despite this, inequality will decrease in this scenario. Third, in the case where the individual human capital and the community human capital level are negatively related in the production function of education, equalization of expenditures may lead to integration and there will be gains in efficiency and overall student achievement.

Benabou [9] presents another perspective on the same problem. In this model, education is a public good. There are two types of skills, high-quality and low-quality. The cost of acquiring high-quality skills depends on the proportion of people with high-quality skills in the community: the greater the proportion of high-skill people in the community, the lesser the cost of acquiring high-quality skills. The dynamic of the problem is as follows. Suppose the economy starts in a symmetric equilibrium, i.e. both communities with the same number of high-skill individuals. Now assume that, for some exogenous reason, the proportion of high-skilled people increases by a small amount in one community. This community becomes more attractive for all agents, so rents increase there. But as soon as rents increase, only those who can bid for higher rents will do it. If there is a positive correlation between skills and income, only high-skill individuals would be able to move to the community with a greater proportion of high-skilled people. The only stable equilibrium is one in which the high-ability individuals are concentrated in one place.

The previous two models center their analyses on the demand side and leave aside supply considerations. Specifically, expenditure on education depends directly on household consumption. However, it is argued above that optimal educational spending depends not only on the individual's maximization problem, but also on the interaction between the community and the local supplier of education. The objective function of the local service providers is not clear, and in the two models optimal provision of services is taken as given.

Another key issue in the two models is the presence of local externalities, not only among individual human capital levels and the average community level of human capital, but also between educational expenditures and human capital.[9] However, it is possible to argue that both local and general externalities are important in the accumulation of human capital. A general externality is one that enhances the productivity of all agents, independent of the type and location of the agent. One example is computers. Once the stock of knowledge in a society reaches a certain level, individuals start producing new technologies such as computers. Computers then reach, via schools, all of society, enhancing productivity of all individuals independent of location.

Another example is education. It is possible to argue that education has a general positive externality, affecting the whole population. A more educated teacher can provide better education to individuals, independent of the skill level of these individuals. An increase in the stock of education will lead to increases in the education of everyone in the community,

[9]The way in which the human capital accumulation function is modeled plays a critical role: the marginal productivity of human capital is decreasing, but the total productivity has increasing returns on mean human capital of the community.

including future teachers as well current ones.[10]

In the case at hand, suppose that decentralization, via efficiency gains, increases the average level of human capital by comparison to a centralized regime. If human capital presents positive general externalities, decentralization makes everyone better off, even though inequality can increase or stay constant.

## 2.2 Equalization of Expenditures

Several states in the United States have been experimenting with the equalization of expenditures in education. These experiments have drawn strong attention from several researchers. The literature on this topic includes empirical work with actual data and general equilibrium models that try to analyze the potential impacts of these types of measurements.

The empirical evidence is crucial in understanding the effects of decentralization or centralization. In principle it is possible to use the experiments in US to answer several questions. First, does a court order for the equalization of expenditures across localities actually deliver equalization? Second, if it does induce equalization, what type of equalization is it? For instance, do all localities spend the same amount as the one that was spending the least under perfect decentralization or does equalization raise expenditures in localities that previously had low expenditures? Third, what is the impact of equalization on income distribution? Finally, what is the impact of equalization on the quality of education?

[10]Some educational externalities are local. For example, a community of scientists with very specialized knowledge will have positive spillover effects at the cutting edge of their field only among equally prepared colleagues.

This section has three subsections. The first discusses the experience in California where strong equalization was enacted; the second considers equalization in general; and the third discusses simulation and general equilibrium models.

The first section presents empirical evidence based on the first case of court order equalization in California. The strong equalization of expenditure caused several results such as the lowering in the mean expenditure per pupil in the state. The second set of articles on equalization in general shows that the general conclusion may be different from those observed in California. Finally, the last section presents some general equilibrium models and simulations that corroborates some of the empirical conclusion of the previous part.

### 2.2.1 The California case: strong equalization

California was one of the first states to which a court ordered equalization of expenditures on education, and much of the empirical literature focuses on this case. Silva and Sontelie [55], in their empirical work of the California case, point out that two effects are present when a court orders equalization of educational expenditures: an income effect and a price effect. The income effect tends to reduce expenditure when median income is less than the mean income. The price effect can be positive or negative, depending on whether state taxes are more progressive than local taxes. If so, then the "price" for education decreases, inducing increased expenditure.

Silva and Sontelie [55] find an overall decrease in the per-capita expenditure across localities in California. They argue that the reduction in expenditure can be explained by

two factors: the court ordered equalization and an increase in enrollment. With respect to equalization, the authors find that the income effect (which induced a lower expenditure) dominates the price effect (which is positive and induced an increase in expenditure). The other part of the explanation in expenditure reduction is due to the high increases in enrollment in California over the last decades. If enrollment increases, for any given amount of expenditure, per-capita expenditure decreases.

In the already mentioned article by Hoxby [41], the author finds that California had a strong equalization scheme. Strong equalizations are ones in which the implicit ex post price of one dollar of educational expenditure is greater than one. This induces reduction in average per-pupil expenditure because the reduction in local expenditure is more than the increase in state expenditure. For this reason, in California the equalization was towards to bottom of the expenditure distribution. In other words, rich localities reduced their expenditures, converging to the expenditures of poor localities.

### 2.2.2 Equalization considered more generally

Evans, Murray and Schwab [23] and Evans, Murray and Schwab [24] (henceforth referred to as EMS) present a general overview of the literature on education and court decisions across several states in the USA. The authors stress the tension between the goal of equalization and local control of public schools since local control has led to significant differences in education spending. Basically poor school districts have little property wealth that they can

tax, so they impose a higher tax rate in order to compensate for the base.[11] Despite this, poorer districts spend less per student than wealthier ones.

The first empirical finding of EMS is that, including all states that ordered equalization of expenditures, real resources per student grew for the period 1972-92. Second, the amount of money spent directly by localities from local revenues in education was possibly crowded out by money that the locality received from the state. It is possible that the court orders were a form of tax relief for low-income localities. A third empirical finding of EMS is that several measures of district spending inequality decreased between 1972 and 1992 for the states that mandated equalization of expenditure. Moreover, the convergence in education spending is not towards the bottom, since spending rose in the low spending districts.

On another front, recalling the argument of Fischel [26], if there exists equalization of expenditures, the link between spending and preferences will be broken. Families will put children in private schools, and the political support for public education will decline, leading to lower spending in schools, tax revolts and even further decline in the quality of public education. Empirically this implies that the causality runs from court mandates to tax limitation. However, EMS find the contrary: in almost all states with court ordered equalizations, tax limitations occurred before the court mandates.

EMS review some studies with respect to the impact of court mandates on education outcomes. First, there is no clear relationship between expenditures and student performance. Second, greater equality in spending was not accompanied by greater equality in

[11] Notwithstanding the argument, some inner cities have an important amount of capital which implies an important tax base, as argued by Fischel [27].

measured student performance. In other words, the change towards a centralized regime did not imply losses in efficiency, or at least, the evidence is not clear on the point. The previous section of this chapter presented theoretical arguments why decentralization is more efficient in the provision of services. By symmetry, it is then conceivable that the equalization of expenditure would induce reduction in efficiency. The presented evidence does not support this claim.

### 2.2.3 Simulation and general equilibrium models

Loeb [45] enriches the previous discussion with a political view of the problem. First, political support for public education in a centralized regime declines because people may not be consuming their preferred bundle. Second, rich districts do not have any incentive to support a common pool of resources. In her model, changing from a decentralized system to a centralized one will have two effects. The first is the price effect discussed above: if the tax rate of the central government is higher than the one at the local level, individuals will be paying a higher price for services. Second, since people are not consuming their preferred bundles, individuals are worse off with a centralized system than with a decentralized one. Therefore, in a vote for a centralized system versus a decentralized one, the latter will win.

Loeb uses data on education and income from Michigan to calculate the tax price by locality. Based on these prices, and assuming some elasticities of income and price, she simulates what would happen under different scenarios of expenditure financing. The result of Loeb's paper is that a system of state grants with unlimited local supplementation does

not provide equalization across districts, and average spending per student may go down. By contrast, a system of state grants with limited supplementation leads to smaller variance in spending, while providing some room for localities to be providing preferred bundles for their communities.

Fernández and Rogerson [25], using a general equilibrium model, present evidence that is consistent with the evidence in EMS. The model is a two-period model in which agents make three main decisions. Income of old people is determined by education obtained when young. Given income, individuals decide where to live and then they decide public expenditure on education in that community. This expenditure determines the level of education of the young people. A key characteristic of the model is the presence of capital market imperfections that constrain the expenditure on education more for poor individuals than for rich ones. Two important parameters of the model are the elasticity of mean earnings with respect to the quality of education and the cross elasticity of community public-education expenditure with respect to community mean income. When the first elasticity is high, gains from smoothing expenditures are outweighed by efficiency gains from local expenditure. The main result of simulating the model is that the average income and education expenditure as a fraction of consumption increases under central government control. The simulation shows that local expenditures do not decrease.

In short, the empirical evidence is mixed, with two main conclusions. First, equalization of educational expenditures decreases the variance of expenditures across localities. Second, strong equalizations may induce a lowering of mean expenditure in the state.

## 2.3 Solving the equity-efficiency trade off

An important aspect to address is, if the trade-off between efficiency and equality actually holds in a (perfectly) decentralized system, how is it possible to induce a better distribution of expenditures across localities without breaking the potential control that local communities have over education decisions? This section is divided in two parts. The first part discusses vouchers and the second state taxes and redistribution.

Vouchers are a system in which people have the option to consume services from other localities, mainly from those that offer better-quality services than provided in their own community. Grants, which are moneys distributed to localities from statewide taxes, can also change the quality of services provided. Localities that are bound by budget restriction to supply low-quality services, can with the aid of the grants supply better services. Localities that are not bound by their budget constraint, will deliver the same level of services as before.

### 2.3.1 Vouchers

A potential solution to the equity-efficiency trade-off of decentralization is to subsidize educational expenses via demand vouchers so that people can choose their preferred school, regardless of the location of the household. One of the first essays to advocate this market-oriented solution is Friedman [29]. He argues that vouchers give individuals the option to pick schools according to their abilities, breaking the link between income and services in the different localities, at least for those individuals that decide to change schools with the voucher. On top of this effect, vouchers increase the competition between schools, mainly

public ones, and therefore they also induce efficiency gains.[12]

The voucher solution has a potential problem with respect to the distribution of abilities. Parents who actually exercise the option of the voucher likely will be either high-ability or highly-motivated who may leave the public school system to attend private school or better public ones. Under the presence of local externalities (like peer effects), public schools that are losing people will retain only lower-ability individuals, reducing the potential of positive externalities in public schools.

This type of argument is examined in Epple and Romano [22]. Their model has two important characteristics. First, students differ in abilities and income. Second, achievement of students depends not only on their own ability, but also on the ability of their peers. Again, as in the Benabou model, local externalities drive the model's dynamics. The model incorporates private and public schools, but it does not model the potential efficiency gains from vouchers via competition among schools. The equilibrium is characterized by a strict order of qualities across schools, with the public schools having the lowest quality of education and quality in private schools ranked in ascending order by income (and perhaps by ability). Vouchers pull out high-ability individuals from public schools, drawing down the mean ability of people that stay in the public schools. High-income individuals subsidize low-income, high-ability people. The overall welfare consequences of vouchers may be significant, since, despite increases in low-income, high-ability individuals' gains, the majority of people in public schools lose due to the introduction of vouchers. This implies important distributional

[12]However, this solution does not address the problem of voucher financing, and may imply another type of inefficiency.

changes as well.

Manski [47] presents a review of recent reform proposals in the USA using a general equilibrium model. One diagnosis of the problem is that "it is widely held that decision making in (the public schools) is too concentrated in school district administrations and that teachers and principals lack the incentives and authority to perform their jobs effectively." In other words, more decentralization is needed. Other reforms are "choice", in the sense that vouchers correct incentives and give opportunities to people.

In a model with micro fundamentals, the author simulates the effects of several programs, among them vouchers. The benchmark scenario yields the following equilibrium characteristics. First, expenditures are almost always higher in the private sector than in the public one. Second, the fraction of highly-motivated students is higher in the private schools than in the public ones. Third, within each community there exists a negative relationship between public enrollment and income.

When a system of vouchers is introduced, tuition in the private schools falls as value of vouchers increases. As a consequence of this relative price effect, the fraction of people in public schools decreases. Moreover, the fraction of highly-motivated people falls in both types of schools, private and public since the people moving from public to private schools have lower motivation than those already in private schools, but higher motivation than those left in the public schools.

One recent study shows some evidence in favor of a voucher system. Paul Peterson [54] takes advantage of three randomized programs in New York City, Dayton, Ohio and Wash-

ington, D.C. The experiment was similar in the three cities. The government announced provision of a certain amount of vouchers for low-income people. All interested people could apply, with the government using a lottery to pick the experimental group to whom the vouchers were given. The control groups consist of the people who did not receive the voucher. Since the vouchers were given randomly, presumably the treatment effect can be estimated consistently using difference by treatment status. The most important empirical result of the paper is that after two years of the program, African American students who switched from public to private schools improved their standardized test scores more than their contra-parts who remain in the public system.

An important limitation of the study is that, while a population treatment is estimable, it is only the effect for those who applied to the experiment. On top of this, the study has some statistical problems. First, the program's rate of attrition was very large (e.g., around 40% of people in the control and treatment group did not report results in the follow up interview). Second, it seems that all the result are driven by a small group of students in a specific wave in New York that score higher than any other African-Americans in the sample.

### 2.3.2 State taxes and redistribution

Loeb [45] discusses another potential solution to the trade-off, where each locality attains their preferred bundle for education with optimal local taxes and a state wide tax that is distributed to localities progressively. This solution has the benefit that rich communities consume their preferred levels of education and that poor communities will be able to increase

their expenditure on education. It is important to notice that this solution will not receive political support from communities that will not enjoy transfers from the state. However, if the choice is between a centralized system in which each community has to spend the same amount in education and a decentralized system with a state tax distributed in a progressive way, people may vote for the second option. Clearly, agenda-setting power is critical.

The combination of a state grant with vouchers can be quite complex. Nechyba [48], Nechyba [49] and Nechyba [50] analyze not only a voucher system but also different financial arrangements under decentralization within a general equilibrium framework. On one hand, vouchers may increase efficiency (primarily in public schools), but on the other, this creates an expected equity loss since highly motivate students will leave public schools for private ones. The main aim of the papers is to see if, in fact, this tension exists. The main features of Nechyba's model are:

1. Parental perceptions of school output are a function of per-pupil expenditure and average peer quality of the school

2. Quality enters directly into parents' utility function;

3. There are local educational externalities (i.e. peer effects)

4. Local public schools are funded by local property taxes, chosen by majority rule vote among local residents

5. There are block grants per pupil based on state income tax

6. Private schools are profit maximizing institutions that set a minimum standard for peer quality

7. There is perfect correlation between peer quality and income

8. There is housing capitalization

In the model's equilibrium, higher-income communities tend to have higher spending levels for schools, lower property tax rates with high-value bases, and property values are increasing with the community wealth. High-income individuals will use vouchers to attend private schools in low-income communities to avoid high property taxes in the high-income communities.[13] This migration has two main effects. On one hand, spending per pupil increases in public schools because fewer students attend the public sector. On the other hand, vouchers induce a lower peer quality in public schools in low-income areas. However, the expenditure effect may outweigh the second effect (the drop in peer quality) in which case public schools in poor areas are made better off. In this model, the introduction of a voucher system breaks educational stratification by income and wealth.

Now, if education is funded by states (the central government), expenditures per pupil are equalized across communities, and peer effects matter. Then, capitalization of education quality into housing prices breaks down. People have to pay the same tax, regardless of where they live. For this reason, the voucher system does not induce the migration effect, e.g., rich people moving to areas with lower taxes but good private schools. In this scenario,

[13]In this model everyone can have access to the vouchers. It is a universal program, in contrast to one targeted to low-income people.

the equilibrium effect of vouchers on housing prices is very limited.

Now consider the combination of local taxes with state grants. In this case, all measures of school quality in the public sector deteriorate. The key driving force behind the result is that the transfer via the grant is not binding the expenditure that localities may want to implement. Because of this, the per student expenditures can remain the same as before the grant, and high-ability individuals will migrate from poor, public schools to good, private ones. In other worlds, the negative peer effect is present and the expenditure per pupil in the public school does not change.

Notice that in this model the principal gainers are the high-ability individuals who migrate. In a mean tested program, however, the main gainers would be high-ability low-income people who take advantage of the program, changing from public schools in poor localities to private (or public) schools in high-income localities.

## 2.4 A conclusion

There are some reasons to think that decentralized schools might perform better than centralized ones. First, localities have better information than the central government. Second, decentralization may induce a process of checks and balances on the local provider of the service, increasing efficiency on the provision of services. Despite this, there are some reasons to think that decentralization might imply efficiency losses on the ground of segregate localities, local externalities, and economies of scale in the provision of certain services.

Two main conclusions can be draw from the empirical studies. On one hand, some studies

actually find that court orders induce equalization and increase expenditure in education for poor districts (Evans, Murray and Schwab [23] and Evans, Murray and Schwab [24]), findings that are supported within a General Equilibrium framework (Fernández and Rogerson [25]). On the other hand, other studies that look at particular cases (such as California) find that equalization occurs towards the district with lowest expenditure; that rich districts are induced to spend less; and that several localities will be receiving educational services that are not equal to their preferred bundles of consumption (Silva and Sontelie [55] and Hoxby [41]), evidence that is supported by the simulations of Loeb [45]. The households that have not been able to consume their preferred levels of education are paying local taxes that do not correspond to the services they would like to recieve (Fischel [26] and Campbell and Fischel [16]).

In conclusion, the direction of impact of decentralization on test scores is thus an empirical question. The main task of this dissertation is, therefore, to estimate an empirical model of education to examine this impact.

# Chapter 3

# Decentralization in Colombia

## 3.1 Introduction

Like other several developing countries in South America, Colombia undertook decentralization programs during the 1980's and 1990's.[1] In July 1991, Colombia enacted a new Constitution. This Constitution gave a new push to a process of decentralization that had started some years earlier.[2] In fact, the major decentralization reform in 1991 followed an incipient one in 1986. The "quasi-reform" of 1986 created some space for local governments (specifically, municipalities) to create and promote their own programs. It did not, however, give the necessary financial resources to implement such programs. The purpose of this chapter is to describe the general characteristics of Colombia's decentralization reforms and their implications for education. This section follows heavily Ahmad and Baer [2]; Alesina,

[1]The majority of the processes are described in Ter-Minassian [58] and Bird and Vaillancourt [13]. For a general description of other macroeconomic changes across South America, see Lora and Barrera [46].

[2]Bird [12] presents some of the early ideas and proposals for the case of Colombia.

Carrasquilla, and Echavarria [3]; and Borjas and Acosta [15]. A recent set of papers prepared for an Income Mission for Colombia were very helpful, specially Acosta and Bird [1] and Smart, Zapata and Chaparro [56].

The first part of this Chapter presents the most relevant laws and data on decentralization in Colombia. The second part describes in more detail the implication of decentralization on education and concentrates on the allocation of teachers and the administration of public education. The third part presents the data used in the empirical strategy. The last part sets out changes in the school characteristics before and after decentralization. It allows us to have a first indicator of whether anything has actually changed as result of the reforms.

Two important results emerge in this Chapter. First, the new system gives an important amount of broadly specified resources, such as education or health, to the local government (e.g. departments and municipalities). Second, the local governments, with the new set of rules, have the opportunity to raise new taxes. Relatively few local governments have increased local taxation, either because of the new resources they are receiving or because local governments can borrow against these resources.

Decentralization gave more functions and power in the provision of education to the subnational levels of government. It also provided significant resources to the departmental and municipal governments. An important share of this increase went to increased wages for teachers. Decentralization of education, however, was only partial. According to Borjas and Acosta [15], the power of the central union of teachers is still strong, and the union still affects many critical educational decision at all levels.

It is important to stress that Colombia's decentralization did not give full power to localities either in expenditure decisions or in tax collection. Significant increases in subnational expenditure powers, however, did occur. Colombia's decentralization thus provides an important opportunity to study the effects of decentralization, if only a partial one.

Regarding the changes in inputs, all the statistics indicate that the relative teacher quality improved in public schools after decentralization, which is in line with the expectation that decentralization increases the quality of education.

## 3.2 Decentralization in Colombia

Colombia was been divided politically, even before decentralization, into three levels of power: central government, departments, and municipalities. The main objective of decentralization was to shift from a system in which all the main decisions were made by the central government to one in which some important decisions are left to departments and municipalities. The reform of 1991 gave substantial expenditure responsibilities to municipalities and departments and increased the amount of resources available for them from both central revenues and from taxes collected at the local levels. However, general policies are still determined by the central government.

For example, the majority of the transfers from the central government are earmarked, mainly for education and health. Laws enacted in 1993 and 1994 complemented the Constitution by describing the actual mechanisms and capacities of taxation available to different levels of government. In some sense, the Colombian decentralization is similar to the recently

implemented welfare reform in the United States, in which the States have more capacity to design and implement programs but with specific designation of certain funds from the Federal government (for instance, see Baicker [5]).

In addition, the new Constitution dictates some rules on revenue sharing, and these were implemented by Law 60 of 1993 (see Table 3.1). There are four main systems of revenue sharing: two funds with specific destinations, a system of co-financing funds, and a fund from royalties. Transfers from the central government to the departments and municipalities made through these four systems have increased from 2.4% of the GDP in 1990 to over 5.6% by the end of the 90's.

The first fund, the *situado fiscal*, or SF, provides transfers to the departments for education and health. Fifteen percent of the fund is distributed equally among the departments, and the rest is distributed according to the population of each department. The law was implemented in 1993 with a minimum obligation of 22.5% of the central government's total current revenues for the fund, increasing to 24.5% by 1996.

The *participacion municipal*, or PM, fund is for the municipalities, to be used mainly for education, health and water programs. This fund was implemented in 1993 as well, and its share of total revenues from the central government increased from 14% to 21% by 2000. 60% of the fund's resources are to be distributed according to the number of poor people in the municipality and 40% according to the population, fiscal and administrative efficiency, and progress in reducing poverty in the local region.

The system of *cofinancing funds*, or CF, started in the eighties as a way to induce in-

vestment in social and infrastructure projects. After the new Constitution, there was an explosion in the number of these funds that by 1996 accounted for almost 40% of all transfers to the municipalities.

Finally, the central government imposed a tax on natural resources such as coal and oil, with 60% of the revenues going to the departments and municipality in which the resources are, (47.5% to department and 12.5% to the municipalities), 8% to the municipalities in which there are ports that are used for exporting the resources, and 32% to the *National Royality Fund*, or NRF. The NRF distributes its revenues to the rest of the departments and municipalities. In principle, these resources have to be invested into priority projects, including development plans made by the departmental and municipal governments.

On the tax front, the central government collects the majority of taxes, although there is some space for the local government to impose and collect their own taxes. Major taxes, such as the VAT, international trade, personal and corporate income taxes, are collected by the national government. The departments tax alcoholic drinks, cigarettes and vehicles. The municipalities' taxes include a property tax, a business tax, and a vehicle tax.

Local taxes (departments and municipalities) account for 20% of all taxes, while the central government collects the other 80%. The major taxes at the central level are the income taxes, VAT, and payroll taxes. At the department level, 65% of tax revenue comes from the sale of liquor and beer, and the rest from other sources such as taxes on vehicles and tobacco. In total, the Industry and Commerce Tax and the Property Tax represent 84% of municipal taxes (Alesina, Carrasquilla, and Echavarria [3]).

Some local governments took the opportunities generated by decentralization to extend their tax base and impose new taxes. The technical capacity of departments and municipalities in collecting and administrating taxes, however, ranges from very low to quite high, depending on the region. Major cities have modern systems of collection, tracking and punishment for evasion. By contrast, small and poorer municipalities generally do not have high technical capacity.

Table 3.3 presents overall data on transfers, taxes and expenditures, before and after decentralization. The purpose of this table is to address an important question: Has there been any impact from decentralization in the country? As described above, local governments began to have, at least on paper, more expenditure functions, and the central government, again on paper, was obligated to transfer more resources to the localities. It could be the case that the program was only a "list of intentions", without any actual changes in the system in reality. The data show, however, a clear and important effect from decentralization on transfers, taxes, and expenditures at local level.

The amount of transfers between 1990 and 1999 increased rapidly, from 2.4% of GDP in 1990 to 5.5% in 1999. With respect to taxes, the changes have been different at the municipal and departmental levels. At the municipal level taxes increased from 0.8% of GDP in 1990 to 1.8% in 1999, whereas departmental taxes stayed at the same level, between 0.8% and 1% during the same period. Finally, expenditures at both levels show an important increase: at the municipal level, from 2.55% of GDP in 1990 to 6.82% in 1999, and at the departmental level, from 1.64% in 1990 to 4.2% in 1999.

Overall, the data show a clear fact: transfers to local governments have increased in a significant way, taxes at the municipal level have doubled since the beginning of decentralization and expenditures by the local government have experienced an important increment as well. The data are evidence that decentralization has occurred in the country.

### 3.2.1 Deepening of decentralization and community role

Regardless of the important amount of resources transferred to the municipalities and departments from the central government, the question of how decentralization has altered the decisions at the community level has not yet been answered. Has decentralization *reached* the communities?

Before decentralization, the President used to appoint the mayors and governors nationwide. In 1986, as one of the first measures of decentralization, the popular election of mayors was established. The Constitution of 1991 increased community participation in the election of municipal mayors and departmental governors, for example, by allowing for the possibility of recall.[3] These instruments, along with the increased amount of resources commanded by each lower governmental level, have given the community one of the most important mechanisms for participation. Currently, the community can interact with the local government in several ways. For instance, there are community meetings in which the community can discuss with the authorities topics ranging from the quality of schools and public services to

[3]El Tiempo, the main newspaper in the country, has in its archives five cases of recall of mayors. These recalls may induce a deterrence effect in that other mayors are more aware of the consequences of not fulfilling their campaign promises. In this case, decentralization may yield additional benefits due to the more active community participation.

problems of corruption in the government.

In terms of the power of the municipalities, even though the majority of the transfers are earmarked for education and health (approximately 80% of the transfers), municipalities still have some decision power over them. For instance, the law does not specify in which specific items the municipality has to spend the money for education.[4] Moreover, around 20% of the transfers are at the free disposal of the municipality, giving them more decision power.

Finally, as Acosta and Bird [1] argue, the departments loses with the implementation of decentralization. Before decentralization, departments used to have several important roles, especially with regard to the realization of large infrastructure projects and the provision of security for the country. Now, the two important decision makers are the Nation, which took some of the functions of the departments, and the municipality, which is the unit of expenditure for public services.

In sum, there is evidence that decentralization has implied a more active role for the community in the decision making process, not only in terms of electing mayors but also in the discussion of policies. Municipalities now, along with the National government, determine the policies of the country.

[4]Nonetheless, an important amount is designated for the operation expenditures, a designation that is quite inflexible.

## 3.3 Education

The two key laws concerning decentralization and education are Law 60 of 1993 and Law 115 of 1994. These two laws have different objectives. The law of 1993 gave more responsibilities to the municipalities, whereas the law of 1994 assigned a greater role to the departments. These two Laws are conflicting with each other to some degree in the sense that Law 60 gave more power to municipalities, while Law 115 took away some of this power and gave it to the departments.

### 3.3.1 Functions across jurisdictions

As Borjas and Acosta [15] points out, the distribution of functions across the three levels of government (municipal, departmental and national) is not well defined. Each of the three levels of government has a role in the administration of public education, as established by Law 60 and Law 115 (see Table 3.2 reproduced from Borjas and Acosta). In the central government, the Ministry of Education is in charge of educational issues. In theory the central government is in charge of technical, curricular and pedagogical norms to be used by the other levels. However, it also makes some decisions about the number of "national teachers" and their wages, their pensions, and some infrastructure investments.

The Departmental Secretaries of Education are the agencies in charge of the educational area at the departmental level. They plan, administer and coordinate teaching services, and they decentralize these functions to the municipalities. The Secretaries prepare teachers, administer the co-financing funds, and invest in school infrastructure.

The municipalities administer the three levels of education, which are kindergarten, primary and secondary. They also maintain infrastructure and investment in schools, and they inspect and supervise the provision of education.

In sum, there exist several duplications in the responsibilities among the different levels of government. For instance, investment in infrastructure is decided by the three levels of government, without a clear assignation of responsibilities of each one. Borjas and Acosta [15] point out other problems in the system as well, such as poor mechanisms for monitoring and the lack of appropriate data to evaluate performance of the local schools.

### 3.3.2 Teachers and wage allocation

The process of teacher allocation has experienced several changes during the last decade. Before decentralization, the teachers' union ("FECODE") used to have an important say in the location of teachers across the national territory. For instance, they influenced the decisions on the number of teachers in a municipality. After decentralization, the decisions process is influenced both by the power of the union and by that of the municipalities. First, there are "national teachers", who are allocated to departments and municipalities according to negotiations between FECODE and the Ministry. Second, despite this, departments and municipalities can also hire teachers, but the new teachers cannot replace the ones allocated by the negotiations between FECODE and the Ministry. In short, the union still has some power in the hiring and allocation of teachers. However, the localities have started to have some level of autonomy in the process since they can hire additional teachers besides the

ones allocated by central decisions.

In terms of teacher wages, Law 115 gave the teachers' union an important role in the determination of wages. This power was counter-balanced by Law 60, which gave municipalities an important role in determining wages. At present, the bulk of teachers' wages is determined in a negotiation between FECODE and the Ministry of Education, and it is implicitly fixed according to the level of the teacher. As it is presented below, teachers have can be classified in 17 different ranks, where each rank is determined by experience and education. Wages increases with rank. The table of wage by rank is the one determined by negotiation between the union and the Ministry of Education.

A potential reason for Law 115 of 1994 was pressure from the teachers' union ("FECODE") to try to centralize education decisions as much as possible (Borjas and Acosta [15] and Duarte [20]). The teachers' union has opposed decentralization from the beginning, arguing that decentralization implies fewer resources for education. However, the evidence clearly suggests the opposite. As mentioned above, the bulk of the transfers that decentralization mandates are allocated to education and health. Public expenditure on education grew from 3.1% of the GDP in 1991 to over 4.5% at the end of the 1990's. An important component of this increase has been due to increases in teachers' wages (real wages for public teachers grew at a rate of 3%) (Borjas and Acosta [15]). Clearly, another hypothesis of why the union opposes decentralization is that the process itself implies a loss of union power.

At the beginning of 2002, the Congress of Colombia approved Law 120, which reforms the Laws 60 and 115. This law gives more functions and clear control to the municipalities

in the provision of education, especially in the hiring and wage determination of teachers. In several articles in El Tiempo [60], the most important newspaper of the country, FECODE has strongly opposed decentralization, arguing again that decentralization implies fewer resources for education and that decentralization implies more control for municipalities in the provision of education. Evidently, the union sees increased local control as a bad implication of decentralization. In addition, the union claims that with the passing of power from central to local government education will lose financial resources.

### 3.3.3 Studies of decentralization and education in Colombia

The majority of studies on decentralization in Colombia address the relationship between local finances and the fiscal deficit.[5] According to these studies, two features in the design of the decentralization contributed to the sharp deterioration of Colombia's fiscal conditions during the 1990's. First, tasks were not clearly assigned to the different levels of government. As presented above, education is a clear example. Second, the debt rules facing the local governments were extremely flexible. This induced over-spending by the local governments, financed by unsustainable loans, and leading in several cases to bailouts by the central government.

With respect to education and decentralization, Borjas and Acosta [15], use data from National Household Surveys to provide some trends on education before and after decentralization. They analyze four main variables by comparing the pre-decentralization period

[5]The most relevant ones are Alesina, Carrasquilla, and Echavarria [3]; Echavarria, Renteria and Steiner [21] and Alonso, Olivera and Fainboim [4]

(1990-94) to the post-decentralization period (1995-97). They find a significant increase in wages for teachers versus other workers, especially for public school teachers. Second, Borjas and Acosta find an increase in enrollment rates, mainly among younger children (5 to 6 years old), precisely the population that is most likely affected by the decentralization. However, it is difficult to disentangle the effect of decentralization from an overall trend that started in the 80s according to their data. Third, the authors observe a low migration rate among teachers. Teachers migrated less frequently, with this difference shrinking after decentralization. According to these authors, decentralization should affect relative teachers salaries across the country. This effect should induce migration until salaries are equalized. Fourth, they show some convergence in some educational variables (for instance, enrollment) across some cities, but again it is difficult to disentangle the effect of decentralization from an overall trend.

In conclusion, these authors find mixed evidence concerning decentralization and educational variables. A clear impact is found in the increase in teachers' wages. The improvement on the others variables that Borjas and Acosta study may be explained by a prior tendency and not necessarily by the decentralization.

The data that Borjas and Acosta use are aggregate data that come from household surveys. The data are derived from the questions on the occupation of the person, and using other data in the survey they derive income and migration patterns for different occupations. The contribution of this thesis is to investigate the impact of decentralization on education using another source of information that is richer than the data used previously since it

directly measure educational outcomes.

## 3.4 Educational data

The data come from two sources. First, the C600 and C100 is a general survey administered to schools. It provides data on the characteristics of the schools inputs. Second, data from the national institute for higher education (in Spanish, the ICFES, "Instituto Colombiano para el Fomento de la Educacion Superior") provide standardized test scores and data on characteristics of individuals, beside school identifiers. This section will describe in a high degree of detail the construction of the final data set.

### 3.4.1 The survey of schools

The C600 and the C100 surveys provide general data on schools. The Ministry of Education collects the data directly via a questionnaire to schools. The purpose of this survey is to have educational data for evaluation purposes. However, the data have not been used in a systematic way and until now have only been serving as the source of specific statistics. Data are available for the years 1990-1994 and 1996-1999. Data for 1995 are not available, due to technical problems in the compilation at the Ministry of Education. Two main computer formats of the data are available; presentation of the content of the data will follow the two types of format.

**1990-1994**

For the period 1990-1994, the data are divided into four levels of schools, kindergarten, primary, new primary, and secondary. Every level has four main sections.

New primary is a type of primary, except that a teacher has students for several grades in the same classroom. The primary objective of this arrangement is to cope with small cohorts in rural areas, where there are not many teachers.

Kindergarten generally has three grades and primary (New and regular) five. Every entry in all sections of the data indicates the department and the municipality in which the school operates, the type of zone (rural or urban), the sector of the school (private or public), the schedule of the school (complete, morning, afternoon and night) and a seven-digit code that identifies the school (the DANE code.) Every schedule within the school is treated as a school itself (e.g., one school that provides primary in the morning and secondary in the afternoon is like two schools)

The first section in the kindergarten level has data about number of registered children in the school by sex, number of dropouts by sex, and number of children who pass to the next grade by sex. All of these variables are by grade within the level, e.g., kindergarten, grade 1.[6] From these variables, three main variables are constructed: the total number of registered children (which is the sum of registered students by grade and by sex), the total number of dropouts (the sum of dropout by grade and by sex) and the total number of children who pass (the sum of passing children by grade and by sex).

[6]From now on, level refers to kindergarten, primary (regular and new) and secondary.

The second section in the kindergarten level has the number of students by grade, age and sex. For instance, it records female children age four in grade 2. Also, it presents two variables that are the number of requested places by grade and number of actual available places by grade. From this section, two key variables are extracted: the total number of male students (the sum of male students by grade), and the total number of female students. Also, each record indicates the department, the municipality, the zone, the sector, the schedule and the DANE code of the school.

The third section presents information about teachers. Colombia has a system of teachers' seniority that depends on experience, education and specific courses that the teachers can take to ascend in the ranking. There are 17 ranks: without rank, rank A, rank B and ranks 1 through rank 14. This section contains data on the number of teachers, by sex and by ranking. From these data, seven variables are constructed: total number of teachers without ranking (the sum of female and male teachers without rank), total number of teachers with rank A and B (the sum of female and male teachers with ranks A or B), total number of teachers with rank 1 through rank 14 (analogously), the total number of female teachers, the total number of male teachers and the total number of teachers (sum of female and male teachers). Again, each entry indicates the department, the municipality, the zone, the sector, the schedule and the DANE code of the school. Rank gives a proxy for experience of the teacher, given that higher rank means higher experience.

Finally, the last section at the kindergarten level contains information about education of teachers. The data distinguish education of teachers by whether the teacher finished each

of four levels; primary, secondary, college, and graduate studies. All variables are available by sex. From these variables, five other are constructed: total number of teachers with only primary, total number of teachers with secondary studies, total number of teachers with college studies, total number of teachers with graduate studies and finally total number of teachers. These four sections were merged, using the DANE code and the schedule of the school, in a single Stata dataset.

The first section for primary records the total number of students admitted, not passed and dropouts, each broken down by sex. The second section includes number of students by sex, grade and age. From these variables, three variables were constructed: total number of male students, total number of female students and total number of students. The third and fourth sections give teachers by rank and level of education in an identical way as to the respective sections for kindergarten. These four sections of primary education were merged, again using DANE code and schedule, to create a Stata file for each year.

For new primary, the data are also divided into four sections that are identical to the sections in the kindergarten and primary categories. From these data, variables were analogously constructed and compiled into a single Stata dataset.

There are two types of secondary education in Colombia: "short" and regular secondary. In general, short secondary programs are technical schools in which the students prepare for specific careers, such as electrician or farmer. These programs can last for four or five years. The duration of regular secondary is six years. The regular secondary school programs have general courses like mathematics, physics, biology, etc. The aim of this type of secondary

school is to prepare individuals for college programs.

As with kindergarten and primary, the first section of the data provides information on the total number of students, the total number of dropouts and the total number of students who did not pass to the next grade in the short type of secondary. These variables are available by sex. It is also possible to know the type of short secondary program in which the students are enrolled: industrial, farming, social promotion, business, pedagogic, arts, science, and others.

The second section presents data for the regular secondary schools (six grades). It contains information on the total number of registered students, the total number of dropouts and the total number of students who did not pass to the next grade, distinguished by sex. The third section presents information on the total number of students by age. Sections three and four are exactly the same as the respective sections for the other three levels. They give information about education and rank of teachers. Finally, another section provides number of teachers by area of teaching and sex. The fifteen areas are mathematics, Spanish, sciences, religion, aesthetics, physical training, language, philosophy, industrial class, commerce class, farming, social promotion, systems and others. As in the other three levels, all the sections in the secondary data were compile in a Stata file.

Finally, for each year, the school level data were merged into a single data set including all variables by school and by schedule.

**1996-1999**

In contrast to the 1990-1994 data, the 1996-1999 data are presented in sections by variable. For example, one archive contains the data for the number of students by school, with an identifier of the level and the schedule of the school. It is important to stress that the separation by levels (e.g. kindergarten, primary, secondary) is an important feature of the data work since it allows the identification of changes of inputs by level of school. As in the previous section, the description of the data will follow the original format in which the data were given. The following sections are identical for the years 1996-1999.

In the first section of the data, each school has a school DANE code (these codes do not change over the 1990-1999 period), and the schedule of the school. This section of the data is important because it allows the merger of the 1990-1994 data with the 1996-1999 data using the DANE code and schedules.

The second section of the data presents, by school-level, data on the department, municipality, zone (rural or urban), name of the school, address, phone number, calendar (whether the school runs from February-November (calendar A) or September-June (calendar B)), sector (private or public), type of provision of energy, and information on the water and sewer system of the school (no provision, private provision or public provision.) Each entry has a DANE code.

The third section presents data on administrative personnel and teachers. The data are presented by school (DANE code) and by schedule. Seven main variables can be extracted from this section; the number of headmasters that are teachers, the number of teachers,

the number of administrative personnel, the number of doctors and dentist, the number of advisory personnel (including psychologists) and the number of people dedicated to special education. From these variables the total number of teachers is constructed (the sum of headmasters and teachers).

The next section of the data presents information on the total number of students in the school and the number of students who did not pass to the next grade. These two figures are discriminated by sex, grade and schedule. Since each entry in the dataset is by school, by schedule and by grade, in order to get the data by level, the data are collapsed by grade, schedule, and school.

The information in the fifth section of the data refers to level of education of teachers. Each line of data has the code of the school, the schedule, the level (kindergarten, primary or secondary), and the number of teachers with complete or incomplete education in each of primary, secondary, college, and graduate studies. The same type of data as described for 1990-1994 were extracted from this section.

The next section gives secondary teachers' data by area of education. This section provides the number of teachers by area of teaching and sex for the secondary level. The fifteen areas in which the data are presented are mathematics, Spanish, sciences, religion, aesthetics, physical training, language, philosophy, industrial class, commerce class, farming, social promotion, systems and others. These data are identified by school code and schedule.

Finally, the last section of the data provides information about physical characteristics of schools. The main variables are: furniture in the school (chairs and desks); support

materials such as computers and so; number of computers for teaching purposes exclusively; number of laboratories; laboratories for physics, chemistry and biology; laboratories for specific education (construction, farming, etc); number of rooms; number of classrooms; number of libraries; number of food facilities and dorms; number of sports locations (soccer and basketball fields); and number of other rooms.

All the above sections for the years 1996-99 were merged using the DANE code and the school's schedule to create a dataset for each year.

**Common data and main variables of schools**

As we have described, there are several variables that are available for both time periods. Some variables are available, however, in only one of the periods. In particular, the number of dropouts is available only for the 1990-94 period, while the physical characteristics of the schools and the administrative personnel are available only for the 1996-99 period. The rest of the variables are available for both periods. Given that the data are presented by DANE code and schedule for both periods 1990-94 and 1996-99, it is possible to have a sub-group of schools common to the period 1990-99. The number of schools that are observed over the entire period is 10.481.

Altogether, 10 variables were used in the estimation, following the empirical literature (Hanushek [33], Hanushek [32]). First, two variables are included to capture students characteristics of the school: the total number of students per school and the fraction of students that failed to pass the academic year, separated by kindergarten, primary and secondary.

Second, three sets of variables that capture teacher characteristics are included: number of teachers per schools; primary teachers fraction (teachers with only primary/total number of teachers), secondary teachers fraction (teachers with secondary/total number of teachers), college teacher fraction (teachers with college/total number of teachers), and graduate teachers fraction (teachers with graduate studies/total number of teachers); average years of teachers schooling; finally, math, language, and science teachers fraction (math, language and science teachers/total number of teachers). Finally, the last variable is the student-teacher ratio (total number of students/total number of teachers). All of these variables are calculated within level of education.

### 3.4.2 Individual test and characteristics

The data on test scores and student characteristics are from the ICFES. The test score data come from a general test that is administered to all students who are finishing their secondary education. Again, following the format of the data, the description will follow the files as they were given. It is important to note two points with respect to these data. First, the data are available for the years 1990, 1991, 1992, 1995 and 1999. Therefore, three years before decentralization are available to be merged with the data of the schools (1990, 1991 and 1992), and only one year in the post decentralization regime (1999) since school data for 1995 are not available (though it is possible to merge the 1995 individual data and the 1996 school data). Second, detailed information on the characteristics of individuals is only available for 1999. However, some individual characteristics are available for the other years.

The data for August and March 1989, March 1990, August 1991, March 1992 and August and March 1995 include several variables: a 7-digit individual identifier; gender; a variable indicating whether the person is currently enrolled; a school code[7]; the city where the test was taken (which is a combination between the Department code and the Municipality code); a variable indicating whether the person is married or not; the university that the individual wants to attend; the schedule of the school that the individual attended; the calendar of the school (A, which is from February to November, or B, which goes from September to June); the type of secondary school that the individual attended (mainly, academic or technical); and whether the person has migrated from the original town of birth.

The data for the exam scores are in a separate file. The data have the individual identifier (a seven-digit number) and total score in the test and score by areas of the exam (mainly, mathematics, physics, chemistry, biology, language, and others).

The data for August and March 1999 are divided by date of exam administration. Typically, students from schools with calendar A (February-November) take the August exam, and schools with calendar B (September-June) take the March exam. The data provide the seven-digit individual identifier; a variable indicating whether the students is "validating" or not (usually, validaters are people who dropped out and later decided to take some classes to finish school); gender; whether the person is studying at the moment or not; a National Test Service school code; the city where the test was taken (which is a combination of the

[7]This code is not the DANE code, but another code of the National Test Service. However, in another section of the data this code is matched with the DANE code, allowing the merging between the individual and school data sources.

Department code and the Municipality code); the address and telephone of the person; the day, month and year of birth; the age; year in which the person finished or is finishing high school; the schedule of the school that the individual attended; the calendar of the school (A or B); the type of secondary school that the individual attended (regular or short); plans for next year (work, study or both); number of people in the family; whether the family owns a house; whether the family has a mortgage; number of people contributing to the income of the family; range of family income (there are 10 categories given as a ration to the minimum wage); occupation of father; occupation of mother; number of siblings; number of siblings with high school; position of individual among siblings; whether the person is married; and the university that the individual want to attend. The data on exam scores are in a separate file. These data have the individual identifier, the total score, and the score by area of the exam.

Finally, the ICFES data have some information on the school characteristics. The school data include both school codes - the National Test Service and the DANE code. They allow the merging of data on individuals and data on schools. Besides these two codes, the data also include the schedule of the school, the sector of the school (private or public schools), department of the schools, municipality of the school, calendar of the school, whether the school is bilingual, and the population attending the school attend by gender.

## 3.5 Changes in characteristics of school inputs before and after decentralization: Inside the Black Box

For the whole study period (1990-1999) around 40% of the schools are located in urban areas. However, location varies substantially across public and private schools: 70% of all public schools are located in rural areas, whereas only 5% of private schools are in rural areas. In terms of school schedules (morning, afternoon or both), the distribution of schools is the same in both the public and private groups.

As described in the data section, the focus of this part will be on three sets of school-level variables. The first set describes the student composition of a school, the second set describes the teacher characteristics at the schools, and the third set compares the number of students to teachers. Table 3.4 to Table 3.9 present these school level characteristics. In the tables, the observations are divided into three school levels; kindergarten, primary, and secondary.

The tables provide averages before and after decentralization, as well as differences in the averages. There are three years that are important to consider when constructing the before-after decentralization periods. The new constitution was enacted in July of 1991, giving major resources to departments and municipalities from 1992 onwards. The 1993 and 1994 laws delimited the scope of decentralization and organized tasks across the three levels of government.

Three different calculations were performed to derive the pre- and post-decentralization

period variables. The simplest one was to take 1991 as the pre-decentralization period and 1999 as post-decentralization. Second, the average of values in 1991 and 1992 as pre-decentralization and the average of the values for 1996 and 1999 as post-decentralization were used. Third, the average of values in 1991 and 1994 was used for the pre-decentralization period and the same average (1996 and 1999) as in the second method was used for the post-decentralization period. Sensitivity analyses were carried out to see if the results change with these three definitions of the pre- and post-decentralization period. The results are robust to the years chosen for the calculations.

Several interesting and some surprising results can be seen in Table 3.4 regarding changes in kindergartens. The top pane of the Table pools public and private schools. The number of students per school stayed constant during the period of consideration: 55.32 students in the pre-decentralization period versus 55.09 students in the post-decentralization period. In terms of the percent of students who did not advance to the next academic year ("non-pass" students), the average number decreases from 0.17% before decentralization to zero percent after decentralization.

In general, the proportion of teachers with secondary and graduate studies increased, whereas the proportion with college education decreased. On average, the number of years of education of teachers remains stable at around 14.5-15 years. Presumably, a decentralization process that has a positive impact on education will induce teachers to be more highly educated. It is, therefore, expected that the proportion of teachers with just primary (or secondary) school education will decrease and that the other categories will increase. This

expectation is not fully borne out, however. The proportion of teachers with secondary schooling increased slightly (from 0.269 to 0.280), whereas the proportion of teachers with primary stayed constant (around 0.004); the proportion of teachers with a college decreased from 0.711 to 0.572, while the proportion of teachers with graduate studies increased from 0.016 to 0.143. Finally, when both types of schools are considered, the teacher-student ratio increases from 0.054 teachers per student to 0.061.

When the kindergarten sample is divided by sector, several interesting findings emerge. First, on average public schools have fewer students in kindergarten, with the number of students enrolled in public kindergarten increasing with decentralization (from 40.023 to 51.610); by contrast, the average number of students in private kindergarten decreases over the decentralization period (67.070 versus 57.756). The proportion of failing students in both public and private schools decrease dramatically from 0.138 to 0.005 and from 0.186 to 0.004 students, respectively.

Before decentralization, the distribution of teachers' educational attainment was very similar across sectors. However, college-educated teachers in public schools dropped after decentralization from 0.693 to 0.503, with the proportion of teachers having done graduate studies increased from 0.027 to 0.304. By contrast, in private schools the proportion of teachers with only a secondary degree increased with the number of teachers having a college education dropping. The average years of education increased in public schools from 14.66 to 15.916 and decreased in privates ones from 14.654 to 14.263.

In terms of teacher-student ratio, another asymmetry between public and private schools

is evident: the ratio, which was lower for public schools in the pre-decentralization period (0.043 in public schools versus 0.062 for private schools) remained constant for public schools and increased for private ones. Differences across the decentralization period varied significantly across sector for 7 out of 8 variables describing kindergartens (Table 3.5). In summary, the number of students increased more during the pre- to post-decentralization period in the public schools. The proportion of teachers with graduate studies increased more in the public schools than in the private ones, and the average years of education per teacher also increased more in the public schools. Finally, the student-to-teacher ratio decreased more for the public schools than for the private ones.

Table 3.6 shows the same set of variables but for primary-level schools. Pooling the pubic and private schools, the number of primary students decreased from an average of 123 to 117 students per school. The ratio of non-passing students also declined during the pre-post decentralization period, from 0.205 to 0.018.

The proportion of teachers with secondary education decreased, and the proportion of teachers with graduate studies increased. Teachers' educational attainment increased by one year. Finally, during the study period there was an increment in the ratio of teachers to students, from 0.046 to 0.053.

Looking at primary education by type of school, we see that private schools have more primary students. However, for both types of schools the number of students per school fell, with the decline being more pronounced in the private schools (from 180 to 161) than in public schools (from 112 to 108). The ratio of non-passing students fell significantly in both

types of schools.

The table shows an increase in teachers' education: the proportion of teachers with college education falls, while the proportion with a graduate education increases. This trend is especially pronounced in the public schools. The average year of education increased for public schools, while decreasing for private ones. Lastly, there is a small increment in the teacher- student ratio for both types of schools.

In terms of the difference in difference (DD) estimates without covariates, 7 of the 8 are statistically significantly different from zero. In summary, teachers' education levels increased more for public schools. Class size as measured by the teacher-to-student ratio rose in both sectors, with greater increments in private schools (Table 3.7).

Table 3.8 reports summary statistics for the same set of variables at the secondary-school level. Pooling the public and private schools, the number of secondary students increased across the two periods, from 439 to 478 students per school. The ratio of non-passing students fell significantly, from 0.26 to 0.03. The proportion of teachers with graduate studies and the average years of teachers' education increased. Lastly, the teacher- student ratio decreased, slightly, and the proportion of teachers who were physics, chemistry, biology and languages teachers remained almost the same.

Comparing across sectors, we find results similar to those for kindergarten and primary schools. The number of students in the public schools increased, while the number in private schools decreased. In both periods, the number of secondary students attending public schools was greater than the corresponding number in private schools.

With respect to teachers' education, the same pattern as in the previous two levels arises: the proportion of teachers with secondary and college levels of education falls, while the number of teachers with graduate studies rises and years of teachers' education increased more in the public sector. In fact, average years of teachers' education were greater in private schools before decentralization (15.10 versus 15.36), but greater in public schools after decentralization (16.69 versus 15.95).

The ratio of teachers-to-students decreased for both public schools (from 0.0642 to 0.0529) and private ones (from 0.0845 to 0.0715). The ratio of "science" teachers (physics, biology, chemistry and language), which is higher in the public schools, fell for both types of schools over the two periods.

In conclusion, 8 out of the 9 variables showed a statistically significant change for secondary schools (Table 3.9). In all 8 of these cases, the changes occurred in a direction suggesting that decentralization improved the relative quality of education in public schools. The number of students increased more in the public schools; the ratio of non-passing students decreased more in public schools; the number of teachers increased more in the public schools; the proportion of teachers with graduate studies increased more in public schools; the number of years of education of teachers increased in public schools; and the proportion of science teachers increased in public schools (relative to private schools).

It is worth noting that, for all levels of education, teachers education in the public sector preserves first-order stochastic dominance: $\Delta Pr[$ teachers education$= E] < 0$ for all $E < E_{max}$. In other words, everyone prefers the dominant, after decentralization distribution

over the dominated, before decentralization distribution. This property holds for the public schools, whereas it does not apply for the private ones. This is an important property that supports the argument of an improvement in the quality of public teachers after the decentralization.

Across all three levels of education, three principal characteristics emerge concerning teachers. First, the number of teachers increased more in public than in private schools. Second, the proportion of teachers with graduate studies increased, with the fraction having secondary- and college-education falling. Third, the average number of years of education of teachers increased more in the public sector than in the private one. All in all, a reasonable case can be made that relative teacher quality improved in public schools.

Table 3.1: Main Laws in the Nineties

| **Year** | **Law** | **Changes** |
|---|---|---|
| 1991 | New Constitution | Decentralization is implemented:<br>increment in expenditure functions by local government |
| 1993 | Law 60 | Development of decentralization;<br>organization of transfers |
| 1994 | Law 115 | Empowerment of departments in the education decisions;<br>more resources to education, specially wages of teachers |

Table 3.2: Functions by level of government

| **Level** | **Activity** |
|---|---|
| National | General norms to be implemented by other levels:<br>curriculum, pedagogic and technical orientation |
| Departments | Administration, coordination and preparation of teachers<br>Administration of co-financing funds<br>Schools infrastructure, investment and maintenance |
| Municipalities | Administration of kindergarten, primary and secondary education<br>Schools infrastructure, investment and maintenance<br>Inspection of the provision of education |

Adapted from Borjas and Acosta.

Table 3.3: Decentralization in numbers

| (% of GDP) | 1990 | 1994 | 1997 | 1999 |
|---|---|---|---|---|
| **Tranfers to localities** | 2.4 | 3.5 | 4.3 | 5.6 |
| **Taxes** | | | | |
| **Municipalities** | 0.8 | 1.2 | 1.5 | 1.8 |
| **Departments** | 1.0 | 0.8 | 0.9 | 0.9 |
| **National** | 8.8 | 10.2 | 11.1 | 10.9 |
| **Expenditure** | | | | |
| **Municipalities** | 2.55 | 3.85 | 5.9 | 6.82 |
| **Departments** | 1.64 | 1.98 | 3.82 | 4.2 |

Source: Income Mission, several papers

Table 3.4: Kindergarten

**Pool sample**
**Number of Observations: 1830**

| Label | Pre-decentr. | | Post-decentr. | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 55.320 | 1.318 | 55.086 | 1.263 |
| Number of no-pass students | 0.165 | 0.004 | 0.004 | 0.001 |
| Prop. of teacher with primary | 0.004 | 0.001 | 0.004 | 0.001 |
| Prop. of teacher with secondary | 0.269 | 0.009 | 0.280 | 0.009 |
| Prop. of teacher with college | 0.711 | 0.009 | 0.572 | 0.010 |
| Prop. of teacher with graduate std. | 0.016 | 0.003 | 0.143 | 0.007 |
| Avg. years of education of teachers | 14.656 | 0.049 | 14.981 | 0.059 |
| Ratio Student/Teacher | 0.054 | 0.001 | 0.061 | 0.001 |

**Public Sector**
**Number of observations: 795**

| Label | Pre-decentr. | | Post-decentr. | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 40.023 | 1.156 | 51.610 | 1.441 |
| Number of no-pass students | 0.138 | 0.005 | 0.005 | 0.001 |
| Prop. of teacher with primary | 0.004 | 0.002 | 0.006 | 0.003 |
| Prop. of teacher with secondary | 0.276 | 0.015 | 0.187 | 0.013 |
| Prop. of teacher with college | 0.693 | 0.015 | 0.503 | 0.016 |
| Prop. of teacher with graduate std. | 0.027 | 0.005 | 0.304 | 0.015 |
| Avg. years of education of teachers | 14.660 | 0.080 | 15.916 | 0.093 |
| Ratio Student/Teacher | 0.043 | 0.001 | 0.044 | 0.001 |

Table 3.4: Kindergarten, cont.

**Private Sector**
**Number of observations: 1035**

| **Label** | **Pre-decentr.** | | **Post-decentr.** | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 67.070 | 2.082 | 57.756 | 1.937 |
| Number of no-pass students | 0.186 | 0.006 | 0.004 | 0.001 |
| Pro. of teacher with primary | 0.005 | 0.002 | 0.003 | 0.002 |
| Prop. of teacher with secondary | 0.263 | 0.012 | 0.352 | 0.013 |
| Prop. of teacher with college | 0.725 | 0.012 | 0.625 | 0.013 |
| Prop. of teacher with graduate std. | 0.007 | 0.002 | 0.020 | 0.003 |
| Avg. years of education of teachers | 14.654 | 0.062 | 14.263 | 0.067 |
| Ratio Student/Teacher | 0.062 | 0.002 | 0.074 | 0.002 |

Table 3.5: Kindergarten. DD estimator

| **Label** | **Dif. in dif.** | | |
|---|---|---|---|
| | Mean | St.Err | t stat |
| Number of students | 20.69 | 2.05 | 10.12 |
| Number of no-pass students | 0.048 | 0.008 | 5.85 |
| Prop. of teacher with primary | 0.003 | 0.004 | 0.84 |
| Prop. of teacher with secondary | -0.18 | 0.022 | -8.15 |
| Prop. of teacher with college | -0.085 | 0.26 | -3.36 |
| Prop. of teacher with graduate std. | 0.27 | 0.014 | 19.10 |
| Avg. years of education of teachers | 1.68 | 0.13 | 12.88 |
| Ratio Student/Teacher | -0.011 | 0.003 | -4.17 |

Table 3.6: Primary

**Pool sample**
**Number of Observations: 7786**

| Label | Pre-decentr. | | Post-decentr. | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 123.1376 | 2.5137 | 116.8260 | 1.5420 |
| Number of no-pass students | 0.2054 | 0.0111 | 0.0180 | 0.0004 |
| Prop. of teacher with primary | 0.0060 | 0.0008 | 0.0097 | 0.0010 |
| Prop. of teacher with secondary | 0.6047 | 0.0044 | 0.4319 | 0.0046 |
| Prop. of teacher with college | 0.3803 | 0.0043 | 0.4086 | 0.0043 |
| Prop. of teacher with graduate std. | 0.0090 | 0.0006 | 0.1498 | 0.0030 |
| Avg. years of education of teachers | 12.9377 | 0.0228 | 14.1832 | 0.0298 |
| Ratio Student/Teacher | 0.0460 | 0.0003 | 0.0529 | 0.0005 |

**Public Sector**
**Number of observations: 6570**

| Label | Pre-decentr. | | Post-decentr. | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 112.5610 | 2.7961 | 108.6204 | 1.5939 |
| Number of no-pass students | 0.2367 | 0.0131 | 0.0203 | 0.0005 |
| Prop. of teacher with primary | 0.0057 | 0.0008 | 0.0082 | 0.0010 |
| Prop. of teacher with secondary | 0.6129 | 0.0048 | 0.4182 | 0.0051 |
| Prop. of teacher with college | 0.3725 | 0.0047 | 0.4024 | 0.0047 |
| Prop. of teacher with graduate std. | 0.0090 | 0.0007 | 0.1713 | 0.0035 |
| Avg. years of education of teachers | 12.9002 | 0.0251 | 14.3331 | 0.0329 |
| Ratio Student/Teacher | 0.0453 | 0.0003 | 0.0513 | 0.0004 |

Table 3.6: Primary, cont.

**Private Sector**
**Number of observations: 1216**

| **Label** | **Pre-decentr.** | | **Post-decentr.** | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 180.2821 | 5.2560 | 161.1604 | 4.6275 |
| Number of no-pass students | 0.0364 | 0.0080 | 0.0054 | 0.0004 |
| Prop. of teacher with primary | 0.0076 | 0.0021 | 0.0179 | 0.0035 |
| Prop. of teacher with secondary | 0.5606 | 0.0102 | 0.5063 | 0.0107 |
| Prop. of teacher with college | 0.4227 | 0.0100 | 0.4420 | 0.0104 |
| Prop. of teacher with graduate std. | 0.0090 | 0.0013 | 0.0338 | 0.0031 |
| Avg. years of education of teachers | 13.1401 | 0.0537 | 13.3731 | 0.0634 |
| Ratio Student/Teacher | 0.0496 | 0.0010 | 0.0618 | 0.0028 |

Table 3.7: Primary. DD estimator

| **Label** | **Dif. in dif.** | | |
|---|---|---|---|
| | Mean | St.Err | t stat |
| Number of students | 15.374 | 5.604 | 2.74 |
| Number of no-pass students | -0.195 | 0.031 | -6.26 |
| Prop. of teacher with primary | -0.008 | 0.003 | -2.25 |
| Prop. of teacher with secondary | -0.141 | 0.015 | -9.55 |
| Prop. of teacher with college | 0.010 | 0.015 | 0.68 |
| Prop. of teacher with graduate std. | 0.138 | 0.008 | 16.83 |
| Avg. years of education of teachers | 1.203 | 0.086 | 13.94 |
| Ratio Student/Teacher | -0.006 | 0.001 | -4.49 |

Table 3.8: Secondary

**Pool sample**
**Number of Observations: 665**

| **Label** | **Pre-decentr.** | | **Post-decentr.** | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 439.0842 | 12.8440 | 478.4045 | 12.5026 |
| Number of no-pass students | 0.1831 | 0.0102 | 0.0318 | 0.0019 |
| Prop. of teacher with primary | 0.0001 | 0.0001 | 0.0005 | 0.0002 |
| Prop. of teacher with secondary | 0.2946 | 0.0071 | 0.0944 | 0.0043 |
| Prop. of teacher with college | 0.7509 | 0.0076 | 0.5987 | 0.0079 |
| Prop. of teacher with graduate std. | 0.0544 | 0.0039 | 0.3064 | 0.0080 |
| Avg. years of education of teachers | 15.1897 | 0.0391 | 16.4420 | 0.0364 |
| **Ratio Student/Teacher** | 0.0710 | 0.0045 | 0.0591 | 0.0017 |
| Propor. of science teachers | 0.5299 | 0.0048 | 0.5095 | 0.0043 |

**Public Sector**
**Number of observations: 443**

| **Label** | **Pre-decentr.** | | **Post-decentr.** | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 460.8939 | 16.8139 | 531.0293 | 16.1686 |
| Number of no-pass students | 0.2060 | 0.0115 | 0.0366 | 0.0024 |
| Prop. of teacher with primary | 0.0001 | 0.0001 | 0.0006 | 0.0003 |
| Prop. of teacher with secondary | 0.2130 | 0.0091 | 0.0818 | 0.0045 |
| Prop. of teacher with college | 0.7299 | 0.0094 | 0.5698 | 0.0098 |
| Prop. of teacher with graduate std. | 0.0569 | 0.0044 | 0.3678 | 0.0100 |
| Avg. years of education of teachers | 15.1046 | 0.0496 | 16.6879 | 0.0419 |
| Ratio Student/Teacher | 0.0642 | 0.0026 | 0.0529 | 0.0011 |
| Prop. of science teachers | 0.5466 | 0.0064 | 0.5256 | 0.0054 |

Table 3.8: Secondary, cont.

**Private Sector**
**Number of observations: 222**

| **Label** | **Pre-decentr.** | | **Post-decentr.** | |
|---|---|---|---|---|
| | Mean | Std.Err | Mean | Std.Err |
| Number of students | 395.5631 | 18.5360 | 373.3919 | 16.9880 |
| Number of no-pass students | 0.1375 | 0.0199 | 0.0220 | 0.0029 |
| Prop. of teacher with primary | 0.0000 | 0.0000 | 0.0003 | 0.0003 |
| Prop. of teacher with secondary | 0.1578 | 0.0108 | 0.1194 | 0.0088 |
| Prop. of teacher with college | 0.7928 | 0.0123 | 0.6964 | 0.0109 |
| Prop. of teacher with graduate std. | 0.0495 | 0.0075 | 0.1839 | 0.0090 |
| Avg. years of education of teachers | 15.3594 | 0.0610 | 15.9512 | 0.0575 |
| Ratio Student/Teacher | 0.0845 | 0.0123 | 0.0715 | 0.0045 |
| Prop. of science teachers | 0.4966 | 0.0065 | 0.4773 | 0.0065 |

Table 3.9: Secondary. Difference in difference

| **Label** | **Dif. in dif.** | | |
|---|---|---|---|
| | **Mean** | **St.Err** | **t stat** |
| **Number of students** | 77.744 | 12.140 | 6.40 |
| **Number of no-pass students** | -0.041 | 0.019 | -2.19 |
| **Proport. of teacher with primary** | 0.003 | 0.001 | 2.11 |
| **Proport. of teacher with secondary** | -0.115 | 0.013 | -9.03 |
| **Proport. of teacher with college** | -0.076 | 0.016 | -4.69 |
| **Proport. of teacher with graduate std.** | 0.170 | 0.015 | 11.10 |
| **Average years of education of teachers** | 1.114 | 0.078 | 14.32 |
| **Ratio Student/Teacher** | 0.005 | 0.008 | 0.60 |
| **Proportion of science teachers** | 0.007 | 0.007 | 1.08 |

# Chapter 4

# Empirical Strategy and Estimations

## 4.1 Introduction

The empirical literature on educational quality can be divided into two categories. The first investigates the determinants of the quality of education (for a comprehensive survey, see Hanushek [32] and Hanushek [33]), whereas the second one links quality of education to labor income (Behrman and Birdsall [8], Card and Krueger [18] and Card and Krueger [17].)

In the first strand of literature, the quality of education is seen as a product of two inputs, characteristics of schools and characteristics of individuals. Measurement of quality usually is done through standardized tests. School inputs include the ratio of teachers to students or the average experience of teachers. Individual characteristics are significant covariates of education performance, since family background, genetics, etc, play an important role in the acquisition of education and in the ability to perform on standardized exams.

In the second strand, a measure of quality (usually, test scores) is linked to labor income through human capital theory. Quality of education enhances future wages because the higher the quality of education, the more valuable are the skills individuals develop. Thus, there is a theoretical link between quality of education and wages that can be estimated empirically.

Given the data available, the thesis follows the first strand of the literature. The first step in the estimation is to replicate the results of the previous chapter, only for the schools that are going to be used in the regression analysis.[1] The second step is the estimation of a quality of education equation (Equation 4.1, below), using a treatment-control methodology.

As it is clear from the literature review, an important aspect of the relationship between different degrees of decentralization is the trade off between quality and equity. In the last part of the chapter we estimate Equation 4.1 for different households, according to their income, and in this manner, shed some light onto the trade off between quality and equity.

The remainder of this chapter consists of three sections. The next section develops the theoretical foundations for the production function for quality of education. Section 4.3 incorporates this theory within a quasi-experimental estimation framework. Section 4.4 presents the characteristics of the schools used in the estimation and their changes through time as well as the main results of the estimation. The section also presents the result of the estimation when the sample is partitioned by household income.

[1] In Chapter 3 we estimated the changes in inputs using all the schools available in the school level dataset. When merging these data with the student data, some schools are not represented. Therefore, the first step of the estimation is to replicate the results obtained for all the schools with the sub-sample that remains for the subsequent estimations.

## 4.2 Quality of education: Production Function

The common model in the literature of quality of education ($Q$) is a function of observable individual characteristics ($X$), school characteristics ($Z$) and an unobservable component ($U$)

$$Q = f(X, Z, U) \tag{4.1}$$

The typical approach to constructing a measure of education's quality is to use a standardize test ($S$). In theory these types of exams are designed to measure the capacity to reason and to solve non-mechanical problems, capacity that is enhanced by high quality education. Therefore, such tests provide information on the quality of education that individuals have.

The characteristics of the school, like the teacher/student ratio, wages of professors, education of professors, etc, as well as other unobservable characteristics like the relationship between the school and the community, affect the quality of education that individuals receive. On the other hand, the characteristics of the individual taking the exam are important. These characteristics include family background (like income, size of the family, education of parents, etc) and the demographic characteristics (like sex, race, etc.)

The first group of studies, including Coleman et. al. [19], picked a functional form of the production function and estimated several specifications of Equation 4.1. One surprising result of the Coleman et. al. study was that school characteristics seem to play a very small role in determining test scores, whereas individual characteristic play a decisive one.

Later studies also showed this regularity (again, the key references are Hanushek [32] and Hanushek [33]).[2]

These results induced two lines of research. In the first researchers started to depart from the notion of perceiving education as analogous to a production of an output in a firm, and therefore began to build upon a notion of a more complex production function of education. Second, others researchers started work more in the quality of data and techniques of estimation of the "simple" production function.

In production theory, a firm tries to maximize profits through the selection of inputs, given a production function and a cost structure. In the case of schools, it is not clear that the objective is quality maximization. For instance, a recent poll in Colombia asked "Of the next functions, which one is the most important objective of the education in Colombia?" In response, 34% of the people answered "learning how to live in the community," 26% said "learning to make the country better," 16% said "the objective of self-realization," 14% said "a better economic future for people," 9% said "learning of tools to make Colombia more competitive" and 1% answered "none of the above" (newspaper El Tiempo, April 7 of 2002). Clearly this is the opinion of "individuals in the street", and may not reflect the opinion of principals or teachers. It is significant, however, that a plurality considers civic values the principal objective of schooling, rather than better preparation or enhanced skills. Hanushek [32] and [33], Manski [47] and Hoxby [41] forcefully make this point.

[2] A study by Heynaman and Loxley [37] divides poor countries from rich ones. They find that for high-income countries, individual inputs are more important than school inputs, with the converse true for low-income countries.

On the other hand, it is possible that the production function approach is valid, but affected by data, specification or estimation problems. Omitted variable bias can be present in the estimation of Equation 4.1. For instance, the score of an individual may depend on unobservable characteristics like ability, and these characteristics may be correlated with socioeconomic factors. For example, higher levels of income are correlated with better nutrition, and nutrition may be correlated with ability. In this case, the coefficients on individual characteristics $X$ are going to be upwardly biased.

In order to obtain consistent estimates it is possible to use instrumental variables techniques or to implement randomized experiments. Both approaches are quite difficult: finding instrumental variables can be as difficult as finding the unobservable variables that are the source of the problem, and randomized experiments are expensive and quite uncommon to find.

Another type of problem is measurement. For example, the typical variables used to capture the relevant inputs of the school may not be the right ones. Hanushek [32] and [33] identified three variables extensively used in the empirical literature: the experience and education of teachers and the ration of students to teachers. In a comprehensive review of empirical studies, Hanushek found that none of these three variables plays a statistically significant role in explaining scores on standardized tests.[3] Hanushek advance the hypothesis that the critical variable in explaining scores is, for example, ability in teachers, which in turn is combined with some characteristic of the school (small classrooms, good facilities,

[3]In several studies, the sign of the coefficient of the variables is not the expected one and when the sign is the expected one, very often it is not significant.

etc) to produce good results in tests. In other words, the typical included variables are neither necessary nor sufficient variables in explaining test results.

In two recent articles, Krueger [42] and Hoxby [38] try to capture the effect of class size on standardized tests using exogenous variations in class size. Krueger [42] uses an experiment implemented in the United States, in which, in a randomized way, children were allocated in three different sizes of classrooms. In this way, and thanks to the fact that neither children nor parents were allowed to pick the classroom, the effect of class size on test was in principle estimable. The empirical results were that size does matter: children in small classrooms had higher test scores than children in big classrooms. However, the experiments were partially contaminated, since some individuals changed classrooms from big to small sizes.

Hoxby [38] points out another potential problem in the above experiment. It is possible that teachers in small classrooms implemented more effort because they want the evidence to show that size matters, and therefore, the results may be biased upward in favor of small class size. Hoxby used another source of external variation. There exist small demographic variations in the size of birth cohorts. Hoxby uses this variation as an instrument to estimate the effect of class size on test scores and finds no effect.

## 4.3 A framework for estimation: Quasi-experiments

### 4.3.1 A general model

One of the most important quests in modern economics is to find the effect of specific programs, like job training, on an outcome of interest, like income (Heckman and Robb [36], Heckman [35], Heckman, LaLonde and Smith [44] and LaLonde [43]). Quasi-experiments are a way to circumvent the problem of not having a control group randomly chosen by the researcher: in a quasi-experiment, an external shock affects some individuals but not others in a way that is plausibly not subject to self-selection. In the present context, the institutional change from a centralized system to a decentralized one provides the potentially exogenous source of variation that separates schools into the treatment and into comparison groups. Hence, the treatment, in this case, is decentralization. In the comparison group are students attending schools to which the decentralization does not apply. As discussed in detail below, three sets of models, based on different treatment and control groups, are used in the estimation.

The institutional change, however, does not mean that the problem of self- selection into the type of school by an individual is not present: it may be the case that better (or worse) students may be more likely to attend schools in the control group, for instance. The literature in program evaluations (which is summarized in Heckman, LaLonde and Smith [44]) studies the impact of individual outcomes that only depend on the personal characteristics of "one" individual (or at least, they are modeled in this way). In the case

of quality of education, it is necessary to take into account the decisions of the two agents simultaneously, the schools and the children.

Assuming a linear relationship, Equation 4.1 can be rewritten as

$$S = \beta * X + \gamma * Z + U \tag{4.2}$$

where $S$ denotes test scores, the proxy for quality of education, $Q$.

Suppose now that decentralization is undertaken at time $k$, $t = 0 < k < t = 1$, and only certain schools are affected. Letting $Tr$ denote students in treated schools and $Co$ denote students in control schools, test scores before the program for both groups can be represented as[4]

$$S_0^{Tr} = \beta * X_0^{Tr} + \gamma * Z_0^{Tr} + U_0^{Tr}$$

$$S_0^{Co} = \beta * X_0^{Co} + \gamma * Z_0^{Co} + U_0^{Co}$$

and the after post-test score can be represented as

$$S_1^{Tr} = \alpha + \beta * X_1^{Tr} + \gamma * Z_1^{Tr} + U_1^{Tr}$$

$$S_1^{Co} = \beta * X_1^{Co} + \gamma * Z_1^{Co} + U_1^{Co}$$

[4]The vector X includes a variable equal to 0 in the pre-reform period and 1 in the post-reform period

The objective of the researcher is to estimate $\alpha$, $\beta$ and $\gamma$. $\alpha$ measures the impact of decentralization, holding schools inputs constant. The proposed estimator is essentially a difference-in-differences estimator, since we have information on school and individual characteristics both before and after treatment. The estimator is the following. In the first place, the previous equations can be summarized as

$$S_1 = D * S_1^{Tr} + (1 - D) * S_1^{Co} \tag{4.3}$$

$$S_0 = D * S_0^{Tr} + (1 - D) * S_0^{Co} \tag{4.4}$$

where $D = 1$ for the treated group and $D = 0$ for the control one.

These two equations yield the basic equation to be estimated:

$$S_t^g = \beta_0 + \alpha_0 * T_t + \alpha_1 * D^g + \alpha_2 * D^g * T_t + \beta_1 * X_t^g + \gamma * Z_t^g + U_t^g \tag{4.5}$$

where $g = Tr, Co$, treated $(Tr)$ and control $(Co)$ schools.

One important condition has to hold in order to have consistent estimators for Equation 4.5: the unobservable characteristics for both groups have to evolve in the same way. The last condition includes unobservable characteristics in the production function for quality of education. Clearly, these can be unobservable characteristics of the individuals, such as ability, or they can be unobservable characteristics of the school, such as motivation of teachers. In this sense, $U$ can be decomposed in two terms, one reflecting the individual part

and the other the school part: $U = U^{Schools} + U^{Individuals}$.

At least two factors can contaminate the experiment, each of which may induce bias in the estimation of the effect of the program. The first can be described as general equilibrium effects and the second is a problem with the selection of individuals.

The problem of general equilibrium effects can best be described with an example. Suppose that, based on the idea that decentralization directly affects public schools and not private ones, the treated group consists of the public schools and the control includes the private ones. Further suppose that, on average, the skills of individuals in the private schools were higher than those in the public schools before decentralization.[5] Now, suppose that after decentralization a significant portion of the population decides to move from private education to public education. In this case, it may be that the quality of education in the public school increases, not because of decentralization itself, but because of this movement of better students between the two types of schools. Continuing with the same example, suppose that the movement of students from the private to public schools is drawn from the lower, left tail of the ability distribution of students in private schools. In this case, the level of educational outcomes will increase in the private schools, which implies problems with the measurement of the direct impact of decentralization on the quality of education.

The second problem can be very severe in the context of education. Presumably public school students differ from private school students in significant ways; income is one example. In the case in which public education is cheaper than private education, family incomes will

[5]For instance, if nutrition is better in private schools than in public ones and better health is reflected in better school performance.

differ across school types. Again, a proper comparison group is important in order to avoid potential contamination of the experiment.

The estimation of Equation 4.5 captures two potential channels of the program's impact: the impact through the changes in the characteristics of the schools because of the program, $\gamma * [(Z_1^{Treatment} - Z_0^{Treatment}) - (Z_1^{Control} - Z_0^{Control})]$, and a "inputs-constant treatment effect", $\alpha_2$.

The economic interpretation of the change in the characteristics of the school is an interesting one. Following with the example in which the treatment group is composed of the public schools and the control of the private ones, before the decentralization process, public schools were constrained by the decisions of the central government, and thus potentially the allocation of resources were not optimal. Once the system was decentralized, public schools could start changing internal characteristics since decentralization provided more autonomy to the public schools. The results of the previous chapter indicate that indeed decentralization induced increases in the mean level of teacher education.

The economic interpretation of the "inputs-constant treatment effect" of decentralization is also an interesting one. Decentralization can have some positive unobservable effects like a better relationship between the local community and the school. For instance, after the decentralization the school may have more power to change certain practices to better accommodate certain parental demand in the community. Presumably, the "inputs-constant treatment effect" will capture these effects.

### 4.3.2 Specific models for estimation

At this moment, it is important to explain in detail the three different sets of treatment and control groups. Table 4.1 summarizes the models used in the estimations.

#### Model 1

In the first model, the treatment group consists of the public schools and the control group of the private schools. In this sense, the treated are the students who are in schools affected by decentralization, namely in the public ones. A natural option for the control group is the private schools.

In mathematical terms, the general model of the previous sections is applied to this specific one:

$$S_1 = D^g * S_1^{Pu} + (1 - D^g) * S_1^{Pr} \tag{4.6}$$

$$S_0 = D^g * S_0^{Pu} + (1 - D^g) * S_0^{Pr} \tag{4.7}$$

where $D = 1$ for public schools $(Pu)$ and $D = 0$ for private ones $(Pr)$.

Given these two equations, the basic equation to be estimated is

$$S_t^g = \beta_0 + \alpha_0 * T_t + \alpha_1 * D^g + \alpha_2 * D^g * T_t + \beta_1 * X_t^g + \gamma * Z_t^g + U_t^g \tag{4.8}$$

where $g = Pu, Pr$, public $(Pu)$ and private $(Pr)$ schools.

In order to gain an intuition of the model, suppose that the treated group, public schools, observed two types of shocks: the effect of decentralization and an external, nationwide event like a recession. A recession can affect education outcomes in several ways. The most direct one is the reduction of resources to schools. If we were analysing test scores only for public schools, before and after decentralization we will capture not only the effect of the decentralization but also the effect of the negative shock in the economy. In this case, the control, that is, private schools, will observe the effect of the nationwide shock, but not the effect of decentralization. By taking the difference in the test scores before and after, for the public and private schools we can find the effect of decentralization.

In more formal terms, Table 4.2 presents the argument by making use of Equation 4.8.[6] In this case, $\alpha_0$ is the common shock that affects both private and public schools after decentralization; $\alpha_1$ is the coefficient of the dummy that identifies the public schools; $\alpha_2$ is the coefficient that captures the "inputs-constant treatment effect," the parameter of interest. Again, if we take test scores before and after decentralization for public schools, we will capture both the effect of decentralization and the nationwide shock, $\alpha_0 + \alpha_2$. If we take the difference in the test scores for private schools only, before and after decentralization, we will get the effect of the nationwide shock, $\alpha_0$. Taking the difference of these two differences, we find the parameter of interest: $\alpha_2 = (\alpha_0 + \alpha_2) - (\alpha_0)$.

[6]The table is a simpler model as it assumes constant the covariates $X$ and $Z$.

**Model 2**

While institutional change provides a potentially exogenous variation, there may have been differences among public schools in their degree of decentralization. For instance, we would expect that schools in departments with less initial political and administrative autonomy would have experienced greater effects of decentralization than schools in departments with higher initial autonomy. The impact of any decentralization would be greater in the localities that were highly dependent on the central government prior to decentralization, and which became more independent after decentralization.

Gonzalez [30] and Vergara and Simpson [61] evaluate the administrative performance of departments during the nineties by constructing an index that shows their relative position in the country.[7] This index places Bogota, Antionquia and Valle at a higher initial point of decentralization than the other departments. Administratively these departments were more autonomous than others in the beginning of decentralization. The major cities of the country and their respective departments - Bogota (Capital District), Medellin (capital of the department of Antioquia) and Cali (capital of Valle) - were able to prior to decentralization make local decisions that did not depend on the central government and had more resources of their own to implement local policies.

For these reasons, Model 2 places schools in departments with an initially low degree of decentralization into the treatment group, and as controls schools in the three abovemen-

[7]Vergara and Simpson [61] rank the autonomy of localities according to four conditions: (1) possibility of community participation in decisions, (2) a well-organized information system on the administrative aspects, (3) an organizational structure that can meet the new responsibilities of decentralization, and (4) a distribution of resources that meets the new responsibilities (Vergara and Simpson [61], page 18).

tioned departments. The hypothesis in this case is that the departments that were more dependent on the central government prior to decentralization had more benefits from decentralization than the departments that were already highly autonomous at the beginning of decentralization.

In mathematical terms, Model 2 is as follows:

$$S_1 = D^l * S_1^{HD} + (1 - D^l) * S_1^{HI} \tag{4.9}$$

$$S_0 = D^l * S_0^{HD} + (1 - D^l) * S_0^{HI} \tag{4.10}$$

where $D = 1$ for schools in departments initially highly dependent from the central government ($HD$) and $D = 0$ for schools in departments initially highly independent from the central government ($HI$).

Given these two equations, the basic equation to be estimated is

$$S_t^l = \beta_0 + \alpha_0 * T_t + \alpha_3 * D^l + \alpha_4 * D^l * T_t + \beta_1 * X_t^l + \gamma * Z_t^l + U_t^l \tag{4.11}$$

where $l = HD, HI$, treated ($HD$) and control ($HI$) schools.

Intuitively, there are some common shocks that affect all public schools and that are independent of decentralization. A clear example is a change in the curriculum that affects all public schools, which may have an impact on test scores. In theory, schools in initially highly dependent departments ($HD$) will have the effect of decentralization $\alpha_4$ and of the

change in curriculum $\alpha_0$ (see Table 4.3) Schools in initially highly independent departments ($HI$) will observer only the effect of the change in the curriculum $\alpha_0$, and therefore, we can infer the effect of decentralization by the second difference, across schools and time.

**Model 3**

Model 3 is derived from Models 1 and 2: it is a difference in difference in difference (DDD) model. Retaking the notation of the difference in difference estimator (Equations 4.4), we have now four basic equations:

$$S_0^g = D^g * S_0^{Pu} + (1 - D^g) * S_0^{Pr} \tag{4.12}$$

$$S_1^g = D^g * S_1^{Pu} + (1 - D^g) * S_1^{Pr} \tag{4.13}$$

$$S_0^l = D^l * S_0^{HD} + (1 - D^l) * S_0^{HI} \tag{4.14}$$

$$S_1^l = D^l * S_1^{HD} + (1 - D^l) * S_1^{HI} \tag{4.15}$$

where $l$ indicates if the school is in a department initially highly dependant on the central government ($HD$) or in an initially highly decentralized department ($HI$) and $g$ indicates whether the school is public ($Pu$) or private ($Pr$). These four equations can be restated as

$$S_t^{g,l} = \beta_0 + \alpha_0 * T_t + \alpha_1 * D^g + \alpha_2 * D^g * T_t + \alpha_3 * D^l + \alpha_4 * D^l * T_t + \alpha_5 * D^g * D^l + \alpha_6 * D^g * D^l * T_t + \beta_1 * X_t^{g,l} + \gamma * Z_t^{g,l} + U_t^{g,l} \quad (4.16)$$

where $g = Pu, Pr$ and $l = HD, HI$.

This equation describes the triple difference estimator, an extension of the difference in difference estimator (Equation 4.5). The triple difference estimator is a more flexible model than the previous two. Model 1 does not allow for changes that will affect all public schools (e.g. curriculum changes), or in other words, it assumes $\alpha_3 = 0$. Model 2 does not allow for general shocks in the economy that will affect both private and public schools; it assumes that $\alpha_1 = 0$. In contrast, Model 3 allows both types of shocks, events affecting only public schools and events affecting both public and private schools, allowing us to recover the effect of decentralization ($\alpha_6$) after controlling for these types of effects (see Table 4.4).

## 4.4 Estimation

All the estimations are based on the same basic equation (Equation 4.5). Two years are used. 1991 represents the pre-decentralization period and 1999 represents the post-decentralization period. There are three reasons for choosing only these two years for the estimation. First, for 1990 the number of school observations is significantly lower than in any other year. Second, taking the extreme points ensures that the data truly represents the pre- and post-

decentralization periods. As presented in the description of decentralization in Colombia, the new constitution was enacted at the end of 1991 and Laws of 1993 and 1994 developed decentralization. The transfers from the central government to the localities started in 1992, and therefore, the impact of decentralization began that year. Third, the effects of decentralization may take several years to become apparent. Using the extreme points ensures that due to the slow nature of the changes, the process of adjustment will have had enough time to operate. In any case, own sensitivity analysis, found no significant differences in the results when other years were included.

It is important to emphasize that the estimation employs as data a test taken by prospective college applicants. Despite the fact that almost everyone graduating from high school takes the ICFES exam, it is not a requirement to get a high school diploma.

### 4.4.1 Changes in School Characteristics

The previous Chapter showed evidence on the impact of decentralization on the characteristics of schools. This section replicates the same procedure but limiting the data to those schools that are in the estimation of Equation 4.5. Following Hanushek [32] and [33], three school variables were include in the estimation of Equation 4.5: one variable that captures the quality of the teachers, or teachers' years of education; a variable that captures the size of the school, or the total number of teachers; and finally, one that captures the average size of the classroom, or the ratio of teachers to students.

Table 4.5 presents the summary statistics for these variables in the public and private

schools used in the estimation of Model 1. Consistent with the previous Chapter, the same basic results hold: first, education of teachers increased more in public schools than in private ones; second, the number of teachers in public schools increased more than in private ones; finally, the ratio of teachers to students decreased more in public schools than in privates ones.

It is important to stress one result from Table 4.5. It shows the same pattern as seen in the previous Chapter, indicating that the sub-sample of schools used preserve the same characteristics as the whole sample.

Table 4.6 presents the same evidence as the previous table, but for Model 2. Consistent results emerge from this table. In the treatment group, schools in the initially less autonomous departments, the quality of the teachers increased more than the quality of teachers in the control group. The same pattern occurs with the number of teachers. Finally, the ratio of teachers to students declines more in the treatment group than in the control group.

Overall, the main argument of the previous Chapter still holds: the quality of teachers increased more in the treated group.[8]

### 4.4.2 Test scores and decentralization: regression analysis

To recapitulate, the objective is the estimation of Equation 4.5. Only schools with information in both periods are used. The dependent variable is the test score for a student, and

[8]However, under the specification of Model 3, we do not observe this trend. In Model 3 quality of the treatment group teachers decreases through time relative to the control group teachers.

the right hand side variables consist of school characteristics ($Z$), individual characteristics ($X$), a dummy variable for time ($T_t$), which is zero for the pre-decentralization period and one for the post-decentralization period, a dummy variable for the treatment group, which is one for the treated group and zero for the control group ($D^g$), and the interaction term between ($D^g$) and ($T_t$), which is the variable that captures the "inputs-constant treatment effect" of decentralization. We used as characteristics of the schools the years of education of teachers, the number of teachers and the ratio teachers / students. As for the variables capturing characteristics of students taking the exam, three variables were included: income of the head of the household (in number of minimum wages), and the sex and age of the student.[9]

One important aspect of the estimation that needs to be discussed is the fact that it uses test results and intrinsic individual characteristics from the same year as the school inputs. Hanushek [32] discuses the issue of timing in this class of models. According to the author, contemporaneous measures of inputs with contemporaneous test scores can lead to measurement and specification errors. Education of individual $i$, who went to school from 1989 to 1999, depends on the inputs that he / she received during all the years of schooling. However, we are matching inputs of a specific year (1999) with the educational outcome of individual $i$ of the same year. Therefore, if the set of inputs used in the estimation is not the relevant set for the education of the individual, we are facing a measurement error problem.

The assumption about timing is that decentralization induces changes in inputs of the

[9]In this case, other controls, such as the marital status and migration status, were also used but they were not statistically significant nor did the results reported here change upon their inclusion.

schools and that those changes are cumulative through time. An individual who started school in 1988 began to benefit from these changes in inputs from 1991 onwards. In effect, the levels seen in 1999 reflect the cumulative changes induced by decentralization from 1990 onwards. As discussed in the previous chapter, the changes in inputs are invariant to the years taken: the same pattern emerge if we take the average inputs between 1991 and 1992 as pre-decentralization and 1996 and 1999 as post-decentralization or 1991 as pre-decentralization and 1999 as post decentralization.

The summary statistics of the individual characteristics used in the estimation of Equation 4.5 are presented in Table 4.5 and Table 4.6. In the sample, 55% of the population is female. This percentage is constant across time and the two groups (treatment and control.) On average, students in public schools are slightly older than the students in private schools. The mean fluctuates around 18 years. Finally, and probably as a reflection of the 1999 recession in Colombia, the income of the individuals decreased on average of 3% between the before- and the after-decentralization periods. However, the pattern is quite different in the treatment and control groups; for the treated the average income declined, and for the control it increased. One potential reason for this pattern can be compositional: if more people are going into college, then it is possible that the sample reflects people in the left tail of the distribution for the after-decentralization sample. Barrera and Higuera [7] present preliminary statistics on college enrolment that are in line with this hypothesis.

As presented in the table, there is an important increase in the sample size between the two periods. Moreover, the increase occurs in both public and private schools, although it

is more pronounced, in relative terms, in the public ones. Given that the span of time is 10 years, and the fact that through time more people are getting primary, secondary and tertiary education in the country, it is possible that the increase reflects an increase in the overall educational enrolment.

This relative increase in public schools, however, may raise concerns about selection problems. In short, if the program is successful in increasing the quality of education, it is reasonable to expect migration from private to public schools of certain types of individuals (for instance individuals with a higher ability). A simple and direct way to see if the problem is a serious one is the generation of CDFs for tests scores for both public and private schools. Sharp differences in the DCFs may indicate the presence of selection problems in the two samples. Graphing the two distributions one observes that the density functions look very similar for both types of schools, and for both time periods. At least this evidence does not support the suggestion of selection problems.

The first results presented are the difference in difference estimates without covariates (Table 4.5, DD for Mean scores) from Model 1. The DD estimator is -4.72, and it is statistically significantly different from zero. As the Table shows, test scores for private schools were, before decentralization, higher than the public ones. For both types of schools, the mean test score increases through time, but it increases more for the private schools.

The analogous estimation for Model 2 (Table 4.6), shows a different picture. The treatment group, which consists of the public schools in departments with initially less autonomy, had lower test scores than the control group. For both groups the mean test score increased,

but more for the treated group. For this reason, the DD estimation in this case is positive (3.426) and statistically significant.

Summing up, these first sets of estimators are showing two preliminary results: first, for both Models 1 and 2, treatment mean scores increased between pre-decentralization and post-decentralization periods; second, mean scores for the control group in Model 1 increased more and in Model 2 increased less than for their respective treatment groups.

Table 4.7 presents the results from the regressions of test scores against individual characteristics, school characteristics, a time dummy, a treatment dummy, and the interaction of the last two variables (DD estimation), for the case of Models 1 and 2, and all the combinations of dummies of treatment and control groups for Model 3 (2 to the power of 3). All the results presented are controlled for fixed effects by departments. It is important to stress that only schools with observations in both periods were used.

Before presenting Models 1, 2 and 3, Table 4.7 shows the results of a regression taking only public schools, before and after decentralization. That estimated (label "Model 0") indicates that test scores in public schools after decentralization are higher than before: the time-dummy coefficient is 0.91 and statistically significant. Clearly, as we discussed in the previous sections, that result not only has the effect of decentralization, but also others effects such as nationwide shocks and other changes beside decentralization that affect public schools. In other words, we cannot take the increment in test scores in public schools as the sole result of decentralization since other factors are embedded in the estimated effect. Precisely, that is the reason of including controls, as Models 1-3 do.

In Model 1 the coefficients for teachers educational level and for the number of teachers in the school are both positive and significant. The coefficient for the ratio of teachers to students is negative and significant (95% level of confidence). One explanation for this negative effect can be that the relationship between test scores and the ratio of teachers to students is not linear. It is possible that in small classes students are losing some of the positive externalities of having other students and in larger sized classrooms the overcrowding effect from greater number of students creates a negative externality. The coefficient for the sex of the individual is positive and significant (females tend to have lower scores after controlling for the other variables). The coefficient for income is positive and significant as expected. The coefficient for the age individual is negative and significant such that younger people tend to perform better in the exam.

The coefficient for the treatment dummy is negative and significant (-12.82, with an standard error of 0.4). That is, on average the public schools have lower test scores. The time dummy is positive but not statistically significant. The coefficient on the difference in difference variable is positive (0.94) and significant at the 95% level of confidence. In other words, after controlling for individual and schools characteristics, there is evidence of a positive impact of decentralization on test scores.

With respect to Model 2 the results are consistent with the results of Model 1 with some minor variations. The majority of the coefficients are very similar, not only in terms of the point estimate but also in terms of their significance. The coefficient on the ratio of teachers to students is, however, now positive but not statistically significant. The second difference

in the estimates is the coefficient of the DD variable that changes from 0.94 to 2.38.

This two models yields the same pattern of results: after controlling for individual and school characteristics, in a model with "inputs-constant treatment effects" by department, there is evidence of a positive impact of decentralization on public schools and on schools located on departments with initially lower autonomy. Moreover, the inclusion of covariates reverses the sign on the impact of decentralization relative to the DD estimate without covariates. In other words, covariates matter. The difference in difference estimator without covariates may be collecting some of the intrinsic characteristics of the localities, schools and individuals. Once the estimation includes controls for localities, schools and individuals, the "inputs-constant treatment effect" impact is positive.

The results of Model 3, the difference in difference in difference model, present a clear contrast to the results of Models 1 and 2 in terms of the "input-constant treatment effect" of decentralization. In this case, the coefficient is negative and significant (-5.05). Given that both the public-private effect and the initially low-high decentralized effect are positive, the driving force behind the result is presumably the private schools in highly decentralized areas. The result, in light of the previous ones, is that despite the positive effect of decentralization in terms of public-private and low-high treatment-control groups, a more flexible model that allows for nationwide effects and public schools-wide effects gives the result that decentralization has not incremented the quality of education.

In order to see potential explanations of the results, it is important to analyze the overall impact of decentralization on the quality of education. The impact of decentralization on

the school quality is not only limited to the DD and DDD estimators but also includes the effects of decentralization on the inputs of the treated schools. If, as it is argued in the previous Chapter, all the changes in schools' inputs are causal, then an important part of the effect of decentralization is operating via these effects.[10]

Table 4.8, Table 4.9, Table 4.10 present the overall effect of decentralization for each Model via the two channels, changes in inputs of schools and the DD and DDD estimators. The impact on inputs is the change in the inputs of the treatment schools times the coefficient found in the different models. The total effect of decentralization is positive for the first two models (2.87 and 4.02 points respectively) and negative 3.99 points for Model 3.

A main difference between Table 4.10 and the other two tables (Table 4.8 and Table 4.9) is the impact of decentralization on the changes in inputs, especially in terms of the quality of teachers. The difference across time and across groups (initially low, public schools versus the rest of schools) for teachers' education is negative (-0.13), representing a clear contrast with the same data for models 1 (1.69) and 2 (1.80). In plain words, the gap in terms of the quality of teachers augmented between public schools in initially centralized areas and the other schools. Clearly, if part of the effect of decentralization operates via inputs, the results are not surprising.

Summing up, there is evidence of a positive impact of decentralization on test scores when the treatment and control groups are public versus private schools and initially low versus initially high localities. In the last decade, the public schools observed an increase in

[10]It may be the case that the changes in the inputs are not completely due to decentralization. The results are, in this case, an upper bound of the effect of decentralization.

test scores. Once we control by individual characteristics, school characteristics and "inputs-constant treatment effect" of departments, the difference in difference estimator is positive and significant. On top of this effect, there is evidence that decentralization changed inputs used in schools, which also induced increments in the mean test score for public schools. However, in the most general, flexible model, the results are that decentralization did not induce increments in the quality of education. Potentially this result can be explained by the fact that the inputs of the schools in the treatment group of Model 3 did not change as they did in the other two models. In this model we do not observe increments in the teacher quality in the treatment group.

In order to test the null hypothesis of these estimates equal zero, a general test of the form $R*\gamma = 0$ was run. In this case, $R$ is the vector of estimates of changes in inputs, $\gamma$ is the vector of estimated coefficients. The variance of the estimator is $Var(R\gamma) = R*Var(\gamma)*R'$, and the distribution an $F(j, n-k) = (R\gamma)'Var(R\gamma)^{(-1)} * j(R\gamma)$ where $j$ is the number of restrictions. For each Model, the value of the $F()$ was 36.87, 52.25 and 17.60 respectively, all of them significant at the 99%. Therefore, the null hypothesis is rejected.

In any case, the effect of decentralization, according to the estimates, is small. The mean of test scores for the public schools in 1999 was 242.56, with an standard deviation of 55.5, whereas the same data for schools in initially highly dependant localities in 1999 was 242.76, with and standard deviation of 54.9. Comparing this number with the estimate of the effect of decentralization, yield a very small impact of decentralization.

In comparing this result with similar studies done in other countries, it is very difficult

given the disparity in the scales of test scores, input measures, and other traits. Following Hanushek [32], some ideas on the size of the results can be discussed. First, Hanushek presents evidence that lead to the conclusion that "there appears to be no strong or systematic relationship between school expenditures and students performance". The results of two models (1 and 2) present evidence that actually changes in inputs of schools, presumably induced by decentralization, has had an impact on students' performance. However, Model 3 shows that the impact has not been positive. Second, one simple hypothesis that explains the apparently small impact of decentralization on student performance is that the measure of the performance is quite parsimonious, and therefore, one cannot expect large changes in short periods of time.

### 4.4.3 Efficiency versus equity

As it is described in the first chapter of the dissertation, there is an apparent trade-off between efficiency and equity for different degrees of decentralization. In order to explore this issue, we formulate the following question: Are there differences in the impact of decentralization across income groups?

Following the same methodology as in the previous section, we run Models 1 to 3 but for different household groups, depending on their income. For individuals who go to public schools, we split the sample between households that have less than the average income and those who have more than the average income. Then, we estimate Models 1 to 3 for each group. In this way, we can explore the effects of decentralization on different income groups.

Table 4.11 shows the results for Model 1. The first column presents estimates when the control group consists of the individuals who go to private schools and the treatment group of the individuals who go public schools and belong to household with less than the average income. Column two shows the estimates with the same control group but where the treatment group consists of the individuals who go to public schools and belong to households with more than the average income.

For the most part, the two regressions are very similar. However, there are two clear differences between the results. First, the coefficient on the time dummy for the sample with public school individuals with lower than mean household income is negative, whereas for the other sample it is positive. Second, and more importantly, the "inputs-constant treatment effect" impact is positive for low-income individuals, whereas it is negative for the high-income ones. If the treated are low-income individuals in public schools, and the control are individuals in private schools, the effect of decentralization is positive, and the contrary occurs when the treatment group consists of high-income individuals in public schools.

Table 4.12 presents the same type of analysis but for Model 2. The estimation results for both samples (low- and high-income public school students) are very similar. Moreover, for both treatment groups the "inputs-constant treatment effect" impact is positive and statistically significant. However, the point estimate for the low-income treatment group is lower than for the high-income treatment group implying that decentralization induces higher gains for high-income individuals, at least through the "inputs-constant treatment effect." This result concurs with the theory laid out in Chapter 2.

Finally, Table 4.13 presents the results for Model 3. Recall that this model is a nested model of Models 1 and 2, and therefore, it is a more flexible specification of the estimation. In short, it allows for both nationwide shocks and shocks affecting only public schools. The estimations for low- and high-income subsamples in this model preserve the same characteristics as the previous two in which the estimation is very similar for the two subsamples. In this model, we do not see differential "inputs-constant treatment effect" impacts across low- and high-income samples. For both samples the impact is negative and statistically significant with point estimates that are statistically equal. In other words, the effect of decentralization is not different across income groups.

In conclusion, the evidence on the impact of decentralization across income groups is mixed. On one hand, against a priori beliefs, decentralization affects positively low-income public students in Model 1. On the other, Models 2 and 3 do not give differences in the impact across individuals. In Model 2, the impact is positive, although of slightly different magnitude, for both income groups; in Model 3, the impact is negative for both income groups.

Table 4.1: Models used in the Estimation

| | | |
|---|---|---|
| **Model 1** | Treatment: | Public Schools |
| | Control: | Private Schools |
| **Model 2** | Treatment: | Public schools in initially less autonomous departments |
| | Control: | Public schools in initially more autonomous departments |
| **Model 3** | | Difference in difference in difference, Models 1 and 2 |

Table 4.2: Model 1

| | Before | After | Diff. |
|---|---|---|---|
| **Private** | $\beta_0$ | $\beta_0 + \alpha_0$ | $\alpha_0$ |
| **Public** | $\beta_0 + \alpha_1$ | $\beta_0 + \alpha_0 + \alpha_1 + \alpha_2$ | $\alpha_0 + \alpha_2$ |
| **Diff.** | $\alpha_1$ | $\alpha_1 + \alpha_2$ | $\alpha_2$ |

Table 4.3: Model 2

| | Before | After | Diff. |
|---|---|---|---|
| **H.Indepen.** | $\beta_0$ | $\beta_0 + \alpha_0$ | $\alpha_0$ |
| **H.Depend.** | $\beta_0 + \alpha_3$ | $\beta_0 + \alpha_0 + \alpha_3 + \alpha_4$ | $\alpha_0 + \alpha_4$ |
| **Diff.** | $\alpha_3$ | $\alpha_3 + \alpha_4$ | $\alpha_4$ |

Table 4.4: Model 3

| | Before | After | Diff. |
|---|---|---|---|
| **H.Indepen.** | | | |
| **Private** | $\beta_0$ | $\beta_0 + \alpha_0$ | $\alpha_0$ |
| **Public** | $\beta_0 + \alpha_1$ | $\beta_0 + \alpha_0 + \alpha_1 + \alpha_2$ | $\alpha_0 + \alpha_2$ |
| **Diff.** | $\alpha_1$ | $\alpha_1 + \alpha_2$ | $\alpha_2$ |
| **H.Depend.** | | | |
| **Private** | $\beta_0 + \alpha_3$ | $\beta_0 + \alpha_0 + \alpha_3 + \alpha_4$ | $\alpha_0 + \alpha_4$ |
| **Public** | $\beta_0 + \alpha_1 + \alpha_3 + \alpha_5$ | $(\beta_0 + \alpha_0 + \alpha_1 + \alpha_2 +$ $\alpha_3 + \alpha_4 + \alpha_5 + \alpha_6)$ | $\alpha_0 + \alpha_2 + \alpha_4 + \alpha_6$ |
| **Diff.** | $\alpha_1 + \alpha_5$ | $\alpha_1 + \alpha_2 + \alpha_5 + \alpha_6$ | |
| **Diff. in Diff.** | | | $\alpha_2 + \alpha_6$ |
| **Third Diff.** | | | $\alpha_6$ |

Table 4.5: Summary statistics Model 1

| | Pre-decent. | | Post-decent. | | DD |
|---|---|---|---|---|---|
| **Model 1** | **Public schools** | **Private schools** | **Public schools** | **Private schools** | |
| **A. Schools character.** | | | | | |
| **Teachers education** | 15.07 | 15.28 | 16.41 | 15.73 | 0.89 |
| (Standard error) | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| **No. of teachers** | 30.87 | 23.91 | 32.96 | 24.86 | 1.14 |
| (Standard error) | 0.07 | 0.07 | 0.05 | 0.06 | 0.14 |
| **Teacher/students** | 0.06 | 0.06 | 0.05 | 0.06 | -0.00 |
| (Standard error) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **B. Individ. character.** | | | | | |
| **Sex (% males)** | 0.45 | 0.44 | 0.45 | 0.44 | -0.003 |
| (Standard error) | 0.002 | 0.003 | 0.001 | 0.002 | 0.004 |
| **Age** | 18.57 | 17.90 | 18.31 | 17.66 | -0.03 |
| (Standard error) | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 |
| **Income** | 1.80 | 2.03 | 1.46 | 2.63 | -0.94 |
| (Standard error) | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| **Mean scores** | 238.31 | 250.95 | 242.56 | 259.92 | -4.72 |
| (Standard error) | 0.18 | 0.27 | 0.15 | 0.26 | 0.45 |
| **Sample size** | 74138 | 39331 | 136870 | 59019 | |

Table 4.6: Summary statistics Model 2

| | Pre-decent. | | Post-decent. | | DD |
|---|---|---|---|---|---|
| **Model 2** | **Highly dependent** | **Less dependent** | **Highly dependent** | **Less dependent** | |
| **A. Schools character.** | | | | | |
| **Teachers education** | 14.90 | 15.34 | 16.39 | 16.45 | 0.38 |
| (Standard error) | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 |
| **No. of teachers** | 29.64 | 32.86 | 33.16 | 32.51 | 3.87 |
| (Standard error) | 0.09 | 0.10 | 0.06 | 0.07 | 0.18 |
| **Teacher/students** | 0.06 | 0.05 | 0.05 | 0.04 | -0.00 |
| (Standard error) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **B. Individ. character.** | | | | | |
| **Sex (% males)** | 0.46 | 0.44 | 0.46 | 0.43 | 0.002 |
| (Standard error) | 0.002 | 0.003 | 0.002 | 0.002 | 0.005 |
| **Age** | 18.65 | 18.46 | 18.34 | 18.23 | -0.072 |
| (Standard error) | 0.02 | 0.01 | 0.01 | 0.02 | 0.04 |
| **Income** | 1.79 | 1.82 | 1.42 | 1.54 | -0.087 |
| (Standard error) | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| **Mean scores** | 237.22 | 240.02 | 242.76 | 242.13 | 3.43 |
| (Standard error) | 0.23 | 0.30 | 0.18 | 0.27 | 0.51 |
| **Sample size** | 45469 | 28669 | 93225 | 43645 | |

Table 4.7: Regression analysis

| **Dependent Var.: Test scores** | **Model 0** | **Model 1** | **Model 2** | **Model 3** |
|---|---|---|---|---|
| **Teachers years of education** | 1.82 | 1.69 | 1.80 | 1.75 |
| | (0.12) | (0.10) | (0.12) | (0.10) |
| **Number of teachers** | 0.25 | 0.37 | 0.25 | 0.36 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| **Ratio teachers / students** | 2.84 | -3.94 | 3.02 | -4.73 |
| | (3.10.) | (2.13) | (3.11) | (2.13) |
| **Age of individuals** | -2.62 | -3.11 | -2.62 | -3.10 |
| | (0.03) | (0.03) | (0.03) | (0.03) |
| **Sex of individual** | 14.03 | 13.76 | 14.03 | 13.77 |
| | (0.24) | (0.20) | (0.24) | (0.20) |
| **Family income** | 4.64 | 6.30 | 4.65 | 6.29 |
| | (0.11) | (0.08) | (0.11) | (0.08) |
| **Time dummy (Dt)** | 0.91 | 0.48 | -0.64 | -2.67 |
| | (0.31) | (0.39) | (0.48) | (0.53) |
| **Treatment dummy (Dg:Pu.=1)** | | -12.82 | | -16.61 |
| | | (0.40) | | (0.58) |
| **Treatment dummy (Dl:HD.=1)** | | | -21.24 | -16.29 |
| | | | (6.63) | (5.28) |
| **Dg*Dl** | | | | 8.20 |
| | | | | (0.79) |
| **DDg: Dg*Dt** | | 0.94 | | 2.88 |
| | | (0.48) | | (0.71) |
| **DDl: Dl*Dt** | | | 2.38 | 6.73 |
| | | | (0.56) | (0.77) |
| **DDD: Dg*Dl*Dt** | | | | -5.05 |
| | | | | (0.96) |
| **Constant** | 230.34 | 251.08 | 231.75 | 254.09 |
| | (1.86) | (1.62) | (1.89) | (1.65) |
| **N** | 190499 | 276460 | 190499 | 276460 |
| **F** | 670 | 1231 | 653 | 1147 |
| **Adj R-sq.** | 0.11 | 0.15 | 0.12 | 0.15 |

(Standard errors in parenthesis)

Table 4.8: Total effect of decentralization: Model 1

| | Change in inputs | Coefficient | Impact (product) |
|---|---|---|---|
| **Teachers years of education** | 0.89 | 1.69 | 1.50 |
| **Number of teachers** | 1.14 | 0.37 | 0.42 |
| **Ratio teachers / students** | -0.002 | -3.94 | 0.01 |
| **Difference in difference** | | 0.94 | 0.94 |
| **Total Effect** | | | 2.87 |

Table 4.9: Total effect of decentralization: Model 2

| | Change in inputs | Coefficient | Impact (product) |
|---|---|---|---|
| **Teachers years of education** | 0.38 | 1.80 | 0.69 |
| **Number of teachers** | 3.87 | 0.25 | 0.97 |
| **Ratio teachers / students** | -0.003 | 3.02 | -0.009 |
| **Difference in difference** | | 2.38 | 2.38 |
| **Total Effect** | | | 4.02 |

Table 4.10: Total effect of decentralization: Model 3

| | Change in inputs | Coefficient | Impact (product) |
|---|---|---|---|
| **Teachers years of education** | -0.13 | 1.75 | -0.23 |
| **Number of teachers** | 3.35 | 0.36 | 1.22 |
| **Ratio teachers / students** | -0.013 | -4.73 | 0.06 |
| **Difference in difference** | | -5.05 | -5.05 |
| **Total Effect** | | | -3.99 |

Table 4.11: Impact differences across income groups: Model 1

| **Dependent Var.: Test scores** | **Below mean income** | **Above mean income** |
|---|---|---|
| **Teachers years of education** | 1.68 | 1.69 |
| | (0.12) | (0.14) |
| **Number of teachers** | 0.39 | 0.50 |
| | (0.01) | (0.01) |
| **Ratio teachers / students** | -6.73 | -4.51 |
| | (2.37) | (2.52) |
| **Age of individuals** | -3.64 | -3.05 |
| | (0.03) | (0.03) |
| **Sex of individual** | 13.99 | 13.07 |
| | (0.23) | (0.28) |
| **Family income** | 7.59 | 6.49 |
| | (0.11) | (0.11) |
| **Time dummy (Dt)** | -0.33 | 0.48 |
| | (0.38) | (0.42) |
| **Treatment dummy (Dg:Pu.=1)** | -13.35 | -11.67 |
| | (0.44) | (0.52) |
| **DDg: Dg*Dt** | 4.62 | -2.69 |
| | (0.54) | (0.62) |
| **Constant** | 258.23 | 248.80 |
| | (1.86) | (2.22) |
| **N** | 199744 | 162677 |
| **F** | 1101 | 685 |
| **Adj R-sq.** | 0.18 | 0.14 |

(Standard errors in parenthesis)

Table 4.12: Impact differences across income groups: Model 2

| **Dependent Var.: Test scores** | **Below mean income** | **Above mean income** |
|---|---|---|
| **Teachers years of education** | 1.74 | 1.90 |
| | (0.14) | (0.21) |
| **Number of teachers** | 0.20 | 0.29 |
| | (0.01) | (0.01) |
| **Ratio teachers / students** | 1.91 | 3.69 |
| | (4.30) | (4.60) |
| **Age of individuals** | -3.10 | -2.25 |
| | (0.04) | (0.04) |
| **Sex of individual** | 14.43 | 13.24 |
| | (0.29) | (0.41) |
| **Family income** | 7.33 | 2.38 |
| | (0.34) | (0.23) |
| **Time dummy (Dt)** | 2.78 | -2.18 |
| | (0.65) | (0.83) |
| **Treatment dummy (Dl:HD.=1)** | 0.87 | 8.28 |
| | (13.57) | (13.98) |
| **DDl: Dl*Dt** | 1.88 | 3.59 |
| | (0.68) | (0.96) |
| **Constant** | 237.14 | 230.71 |
| | (2.34) | (3.29) |
| **N** | 113783 | 76716 |
| **F** | 395 | 205 |
| **Adj R-sq.** | 0.12 | 0.09 |

(Standard errors in parenthesis)

Table 4.13: Impact differences across income groups: Model 3

| **Dependent Var.: Test scores** | **Below mean income** | **Above mean income** |
|---|---|---|
| **Teachers years of education** | 1.69 | 1.75 |
| | (0.12) | (0.14) |
| **Number of teachers** | 0.39 | 0.49 |
| | (0.01) | (0.01) |
| **Ratio teachers / students** | -7.65 | -5.39 |
| | (2.37) | (2.52) |
| **Age of individuals** | -3.64 | -3.05 |
| | (0.03) | (0.03) |
| **Sex of individual** | 14.00 | 13.07 |
| | (0.23) | (0.28) |
| **Family income** | 7.58 | 6.44 |
| | (0.11) | (0.11) |
| **Time dummy (Dt)** | -3.43 | -2.52 |
| | (0.52) | (0.56) |
| **Treatment dummy (Dg:Pu.=1)** | -16.57 | -16.35 |
| | (0.65) | (0.81) |
| **Treatment dummy (Dl:HD.=1)** | -12.83 | -33.89 |
| | (8.43) | (16.09) |
| **Dg*Dl** | 6.92 | 9.27 |
| | (0.87) | (1.05) |
| **DDg: Dg*Dt** | 6.66 | -0.30 |
| | (0.80) | (0.96) |
| **DDl: Dl*Dt** | 6.64 | 6.38 |
| | (0.75) | (0.82) |
| **DDD: Dg*Dl*Dt** | -5.18 | -5.43 |
| | (1.03) | (1.25) |
| **Constant** | 261.28 | 251.29 |
| | (1.87) | (2.26) |
| **N** | 199744 | 162677 |
| **F** | 1026 | 640 |
| **Adj R-sq.** | 0.18 | 0.14 |

(Standard errors in parenthesis)

# Chapter 5

# Conclusions

The main contribution of this thesis is the empirical effort to test a critical question in economics: Does decentralization provides better quality of education? This question has both theoretical and practical implication. On one hand, there is an important strand of theoretical literature exploring the issue from several points of view. On the other, numerous countries started to implement decentralization during eighties and nineties.

The second chapter of the dissertation explores the issue from a theoretical point of view. The leading argument of the discussion is the apparent trade-off between efficiency and equity of centralized and decentralized systems. There are theoretical reasons for decentralization increasing efficiency. Centralized systems, however, may induce a more homogenous expenditure of resources across localities, inducing more equity into the system.

Based on theory, decentralized schools might perform better than centralized ones. First, decentralized schools have better information in terms of the preferences of the individuals

in the community and on the idiosyncratic problems that the school faces. Second, local control might increase community involvement and this can lead to better process of checks and balances on the local provider of the service. Despite this, there are some reasons to think that decentralization might imply efficiency losses, based on general equilibrium models. These models yield results in which decentralization might segregate localities and, in presence of local externalities that implies losses in efficiency. Also, there may be economies of scale in the provision of certain services and the size of the government.

The results from the empirical studies, based on court ordered equalizations across communities presented in USA, are mixed at best. Some of them find that court orders actually induce equalization of expenditures and that poor localities increases expenditure. Other studies find that equalization occurs towards the districts with lowest expenditure, that rich districts are induced to spend less, and that several localities receive educational services that do not match their preferred consumption bundles of the community.

As a conclusion, the second chapter underlines the importance of empirical tests. Chapters 3 and 4 of the dissertation examine the impact of the Colombia decentralization on the quality of education.

Chapter 3 describes the main aspects of decentralization in Colombia. In short, Colombia experienced a partial decentralization in which important resources were transferred from the central power to the local governments, but with significant limitations on the expenditure of the resources. The chapter presents as well the data used in the estimation. It argues that an important channel for the impact of decentralization on education is via changes in the inputs

of schools. The chapter presents a strong case for a positive impact of decentralization on the quality of teachers: all the statistics indicate that the relative teacher quality improved in public schools after decentralization. This conclusion, however, is sensitive to the comparison groups. As the last chapter shows, decentralization does not imply an increase in a critical input of the schools in the most flexible model tested.

The last chapter presents result of the impact of decentralization on student test scores using a quasi-experimental methodology. In terms of comparing public versus private schools, and public schools in initially highly dependant localities versus public ones in initially highly independent localities, the results are clear: there is evidence of a positive impact of decentralization on the schools that we expect to benefit from decentralization. However, the impact is negative when a more flexible model is used. This last model allows for nationwide shocks (like recessions) and other changes across public schools (like changes in curriculums), making possible the estimation with a more complete description of potential events that have affected the education system. A possible explanation of the results is that the quality of teachers, measured as their level of education, has not increased for public schools in the initially highly dependent departments.

The dissertation concludes with an empirical approximation to the question of the trade-off between equity and efficiency of decentralization. The results are mixed as well. In two of the estimated models, decentralization is income-neutral (same directional effect across different incomes). However, a surprising result emerges from Model 1: decentralization has a positive impact for low-income individuals and not on high-income students.

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