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1 Introduction

Empirical study of the relationship between decentralization and quality of services provided by public institutions is a fundamental one. An efficiency gain in the allocation of resources and improved income distribution are, in general, the main objectives of a decentralization process. At the crux of the arguments of introducing decentralization processes in several countries around the world has been improved quality of services such as education and health.

Several theoretical papers produced during the last three decades argue strongly in favor of decentralized system (for a review of the more recent literature, see IDB [3] and Ter-Minassian [13]). Following the theoretical trend, several countries moved from a very centralize system towards a decentralize organization in political and economic terms. For example, some Latin American countries undertook several structural reforms during the 80’s and 90’s, and one of them was a very ambitious decentralization process. Despite the increasing number of recent “natural experiments,” the empirical impact of the decentralization on the quality of services is, to say the least, unclear. From this perspective, the importance of processes like those promoted in Latin America is that they provide a quasi experiment to measure the actual impact of decentralization.

The decentralization process is a change in the political and administrative order within a country in which the economic (and political) power is transfer from a central government to a lower level like a state or even a county. In economic terms, “power” refers to the power to execute expenditures in programs that are initiatives of the local government and the power to collect revenue within the jurisdiction of the local government.
Behind the idea that decentralization induces a more efficient allocation of resources is the idea of F.A.Hayek [9] that a decentralized system will provided a better allocation of resources than a centralized system because the agents at the micro level have more and better information than the central power. Therefore the individual agents will take better decision for themselves than the ones that the central power may take in their behalf.

More recent literature\(^1\) emphasizes the idea that a decentralize system is going to provided better public services (specially education and health) for several reasons. The first one is that the basic units that provided the services have more and better information than the central government to take decisions. For example, in terms of educational services, the authorities that manage a school will know better which class of investment is needed whereas the central government’s funds with specific investment requirements may not fullfill the needs of a particular location.

The second reason is that, a well design decentralization process can give a better system of incentives for the units that provided the service. For example, the people who run a school can give incentives directly to professors (e.g. bonus) who perform better than others.

The third one is that the process of check and balance can be implemented in a better way in a decentralized system than a centralized one. The reason for this is that, since the provider of the services has the control over the resources and programs to be implement, they also have all the responsibility in the results.

Finally, under the decentralized system the interrelationship between the unit that is providing the service and the community that is receiving the services is direct, and therefore, the supplier of the services can accommodate better to the specific demands of the local community.

Those ideas tend to support the hypothesis that the decentralization process will induce a more efficient outcome than the centralized system, not only in terms of quantity but more important in terms of quality. All of the theoretical aspects mentioned above precisely point out that the decentralization process may induce improvements in the quality of the supply of services. However, the decentralization process is not unique in the sense that there are several policies involved in the process and different countries may take different action to decentralized. On one hand, it delagates the capacity to create and execute programs to the local government. On the other, it

\(^1\)Tiebout [7], Oates [12] and the general overview in IDB [3]
transfers revenue collection to the local authorities. Some countries implemented reforms that gave a strong autonomy to the local level in terms of creating and implementing programs but little taxation power. Others gave an increasing amount of resources to the local level, resources that came from local taxes and general pools of taxes, but with specific destination.

This branch of the literature, however, centers its analysis on the supply side of the problem and neglects the demand side in one critical aspect. Quality of education in this context depends on the interaction between the supply of education, which in turn depends on the characteristics of schools, and the demand for education, which is a function of the characteristics of the individuals. The first part of this paper develops a theoretical model of thee impacts of decentralization on the quality of education. The main conclusion is that despite the improved supply side efficiency from decentralization, the overall impact on quality of education will depend on the income distribution of the individuals in the economy. Intuitively some people with low ability levels will demand no (quality of) education. If the median voter is one of them, the demand for quality of education in these areas will be low and therefore it is possible that the overall result may be a lower quality than in a centralized system.

As the theoretical model will show, the effect of a decentralization process on quality may be positive or negative and therefore empirical methods are needed to determine the impact. The second part of the paper presents an empirical strategy to find out the effects of a decentralization process on quality. The question under investigation is, Does a process of decentralization deliver any change in the quality of education? The treatment, in this concrete case, is the decentralization. The treated are the people who are in schools to which the decentralization process applies, namely the public ones. In the control group are schools to which the decentralization does not apply. The natural option for the control group is private schools. The recent changes in some countries from a very centralized political and economical system to a more decentralized one provide a quasi-experiment for the evaluation of the effect of decentralization on quality of education. The institutional change from a central system to a decentralized one provides the randomization device that separates schools to the treatment group and the control group. The change in the institutional framework provides the randomization since public school cannot decide to be manage in a centralize way and therefore there is no self-selection among public schools into different types of management. The second novelty of this paper is a presentation
of a new way to estimate the effect of decentralization on quality. A final section uses data from Colombia in a quasi-experimental setting and presents the empirical results.

2 A theoretical model of quality of education and decentralization

One of the principal objectives of a decentralization process is to gain efficiency in the provision of services such as education. Despite a foreseeable increase in efficiency, the impact of the institutional change in the quality of education is unclear. Quality in this context depends on the interaction between the demand for education, which is a function of the specific underlying characteristics of individuals, and the supply, which depends on the characteristics of the school.

Some models in the literature have quality directly in the utility function of individuals. It is not clear, however, why this is the case. One way to get around this ad-hoc assumption and incorporate quality into a theoretical model of education is through the income equation of individuals. An important branch of labor economics estimates the relationship between income and education, but as some authors stress, probably it is not the amount of education but the quality adjusted amount of education that is important\(^2\). In this way the income of individuals is endogenous to the amount and quality of education.

Ideally a model will shed some light on the following questions:

- What are the main variables that determine quality of education?

- How is the interaction between demand and supply for quality of education?

- Finally, under which system, centralized or decentralized, the average quality of the service is higher?

The purpose of these pages is to analyze the theoretical discussion on the relationship between decentralization and quality of education through a model of education. It develops a dynamic model in which individuals choose

\(^2\)one example is Griliches and Mason [8].
the amount and quality of education within a utility maximizing framework. The education decision is essentially a dynamic one reflecting the tradeoff of forgone income today for higher income tomorrow. A key element of the model is the equation for income, which depends on past investment in education, measured in “quality” adjusted terms, in a random component that is a proxy of ability and in a transfer from parents to the individual that is a proxy of family income. The paper then examines how two institutional regimes, centralized and decentralized, differ in mean quality of education. Finally, the model incorporates the decision of school(s), stressing the differences in the objectives of schools under the two institutional regimes.

2.1 Individual’s decision

In the model individuals make decisions in two periods. In the first period they decide the amount of consumption $c_t$, the level of education $E = 1$ or $E = 0$ and the amount of quality of education $q_t$ if $E = 1$. Then, in the next period $t + 1$, the individual (inelastically) works and decides the optimal amount of consumption, $c_{t+1}$.

Quality of education enters the model through the income equation and the budget constraint. The income of individual $i$ has the following form:

$$y_{t+1}^i = K^i + B^i \times (E^i_t \times q^i_t) + \eta_0^i$$

(1)

The income in period $t + 1$ depends on the investment in education in period $t$. Investment in education is measured as quality effective education, e.g. one unit of education with higher quality will increase income more than one with lower quality.

The term $\eta_0^i$ is a random component draw at $t = 0$ from a distribution with joint pdf $f(\eta^i, \eta^{p,i})$ and support $[\eta_{\text{min}}, \eta_{\text{max}}]$, where $p, i$ refers to the parent of individual $i$. Although the individual knows this component before the maximization process, it is unobservable for the rest of the population.

The return to education, $B^i$, can be model with two different assumptions. The return to education can depend on the ability of individuals, e.g. $B^i = B(\eta^i)$, or it can be constant across individuals, e.g. $B^i = B$.

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3I develop the same model in a three period framework with the idea that in the first period individuals go to primary school, in the second one the individual decides whether or not to go to college and in the third one the individual works. However, the intuition of the model is more clearly captured in a two period framework, without loosing much in generalization.
The other term in the income equation, \( K^i \), depends on two factors, one that is independent of individual \( i \) and one that is a transfer of income from the parents to the individual, e.g. \( K^i = G + y^{pi} \). The transfer of income from the parents to the child depends in the amount and quality of education and the ability of the parents, \( q^{pi} \) and \( \eta^{pi} \). These two are exogenous to the individual \( i \). The term \( y^{pi} \) will play an important role in determining the mean quality of education. First, this term can be seen as a transfer that the family gives to the child or as the child’s portion of the family assets. Second, it reflects the level of income of the family if the transfer increases with wealth. For all practical purposes it can be taken as a proxy for the family income.

For an individual who chooses \( E = 1 \) the two budget constraints are represented by BC(t) and BC(t+1). At period \( t \), the budget constrain is of the following form:

\[
BC(t) = y^{pi} - c^i_t - p_t * E^i_t * q^i_t
\]  

(2)

where \( p_t \) is the relative price of quality of education in terms of the consumption good. That is, the individual receives a transfer from the parents while he studies and pays for her consumption and the education she acquires. At time \( t + 1 \) the budget constraint becomes

\[
BC(t + 1) = K^i + B^i * E^i_t * q^i_t + \eta^i_0 - c^i_{t+1}
\]  

(3)

The individual works and receives an amount of income that depends on the investment in education at \( t \) and her ability; she also pays for the consumption in that period.

The potential way to solve the maximization problem is by backward induction. In any path of education (whether \( E = 1 \) or \( E = 0 \)), individuals choose optimally \( c_t, q_t, c_{t+1} \). Given the optimal decision over these three variables, the optimal \( E \) will be given by the path that will give the highest utility.

The problem for individual \( i \) when \( E = 1 \) is the following:

\[
\max_{c_t, c_{t+1}, q_t} \left[ (u(c^i_t) + \lambda_t * (BC(t))) + \beta(u(c^i_{t+1}) + \lambda_{t+1} * (BC(t + 1))) \right]
\]  

(4)

For positive values of \( c_t, c_{t+1}, q_t \), the solution for this dynamic problem is given by the Euler Equation

\[
u'(c^i_t) * p_t = \beta u'(c^i_{t+1}) * B^i \]

(5)
and the two budget constraints. The Euler Equation shows the tradeoff that the individual faces: the quality of education imposes a marginal cost of $u'(c_i) * p_t$ in the first period but it will report a marginal benefit in $t + 1$ of $\beta u'(c_{t+1}) * B^i$.

In general, the solution of the problem will be given by the following functions:

$$c_i^* = F(\beta, G, p_t, B^i, \eta_0^i, y^{p,i})$$

(6)

$$c_{t+1}^* = C(\beta, G, p_t, B^i, \eta_0^i, y^{p,i})$$

(7)

$$q_t^* = Q(\beta, G, p_t, B^i, \eta_0^i, y^{p,i}) = Q(\theta, X^i)$$

(8)

The last equation gives the essence of the model. The parameters of the model, $\theta = (\beta, G, p_t)$ and the individual characteristics $X = (B^i, \eta_0^i, y^{p,i})$ determined the demand for consumption and quality of education. As the maximization problem shows, $q_t^*$ depends on $\eta_0^i$, implying the typical problem of ability bias in the estimation of a wage equation under OLS.

Using microeconomic theory we can asse the response of the optimal quantities to changes in $\theta$ and $X$. The effect on quality of education from a price change, $\partial q / \partial p$, can be positive or negative since $q^*$ is a Marshallian demand and therefore has both income effects and substitution effects. On one hand, if the relative price of quality of education increases, the substitution effect will lead to an increase in the consumption of $c_i$ and a decrease in the consumption of quality. On the other hand, the income effect of an increase in $p_t$ will lead to a reduction in the consumption of all normal goods. Besides these two typical effects, there is a dynamic income effect. If the price of quality of education increases and the person reduce the amount of quality she consumes, $c_{t+1}$ will decrease since the income in the second period depends on $q_t$. People will incorporate this in their demand, creating an ambiguous effect on demand from an increase in prices. Assuming that quality of education is a normal good, and that the dynamic effect is small, $\partial q / \partial p$ will be negative.

The effect of an increase in the “exogenous” income of the individuals on the demand for quality of education, $\partial q / \partial y^{p,i}$, will be positive since it is a pure income effect. Any increase in the transfer that the parents give to the child will lead to an increase in the consumption of all normal goods. Remember that $y^{p,i}$ depends on the education of parents and their ability. Presumably, $y^{p,i}$ depends positively on education of the parents but the effect of ability is unclear: a higher ability of the parent will lead to a high income but it
may induce a reduction in the education of parents since ability represents an opportunity cost.

The changes in the demand for quality of education with respect to the unobservable characteristic of individuals, $\frac{\partial q}{\partial \eta}$ may be negative or positive. On one hand, when the return to education depends positively on the unobservable characteristic of the individuals, $B^i = B(\eta^i)$, $B^i > 0$, the partial derivative may be positive or negative, depending on the margins faced by the individual. If the marginal benefit is greater (smaller) than the marginal cost, $\frac{\partial q}{\partial \eta}$ will be positive (negative). On the other hand, when $B^i = B$, e.g. the returns to education are constant across the population, the only relevant margin is the opportunity cost faced by the individual and therefore, $\frac{\partial q}{\partial \eta}$ will be negative since “ability” enters only as an opportunity cost.

Assuming that the utility function has the form $u(c) = \log c$, the solution for the optimal $q^*_i$ is the following:

$$q^*_i = \frac{\beta B^i y^{p,i} - (y^{p,i} + G + \eta^i)p_t}{(1 + \beta)p_t B^i}$$  \hspace{1cm} (9)

Observe that under this particular demand, the theoretical results hold; $\frac{\partial q}{\partial p} < 0$, $\frac{\partial q}{\partial y^{p,i}} > 0$ and $\frac{\partial q}{\partial \eta} < > 0$, the last result depending on the actual form of $B^i$. For some people the marginal benefit is greater than the cost, and therefore the partial derivative is positive. In the extreme case, in which $B^i = B$, the derivative is negative.

However, this is not an equilibrium since the decision $E = 0$, and therefore $q = 0$, is a possibility. When $E = 0$, the problem of the individual is the following:

$$\max_{c_t, c_{t+1}} [(u(c^i_t) + \lambda_t(BC(t)) + \beta(u(c^i_{t+1}) + \lambda_{t+1}(BC(t + 1)))]$$ \hspace{1cm} (10)

In this case, $BC(t) = K^i + \eta^i_0 - c^i_t$ and $BC(t + 1) = K^i + \eta^i_0 - c^i_{t+1}$.

The importance of this problem is to see under which conditions $E = 1$ is optimal. In other words, there is a participation constraint to be met. $E = 1$ is optimal when

$$\sum_{j=t}^{t+1} u(c^{*}_{j})|_{E=1} \geq \sum_{j=t}^{t+1} u(c^{*}_{j})|_{E=0}$$  \hspace{1cm} (11)

The participation constrain is critical for the model, and it depends on the assumptions about the return to education. Let start with the case in which $B^i = B$. In this case, the participation constraint will not be met
for individuals with high ability in the population (e.g. high $\eta^*_i$) since a high ability person will have a high marginal opportunity cost of studying and not working. Assume that the threshold for the person with the highest ability for which $E = 1$ is $\eta_1$, which is lower than $\eta_{\text{max}}$. (See Figure 1 (A)).

When returns to education depend on ability, some people at the bottom of the distribution will have a higher marginal cost of education than the marginal benefit, if the function of returns to education is increasing on ability and steeper than the cost. The threshold, which is now in the lower part, will depend on how steep the return function of education is with respect to ability. The people who will go to study is the one with ability higher than the threshold $\eta_2$, which is higher than $\eta_{\text{min}}$. (See Figure 1 (B)).

2.2 Two polar cases: a perfectly decentralized economy and a completely centralized one

In the perfectly decentralized case there is a perfect sorting of people, each one expending whatever they want in terms of quality of education, $q$, and therefore there are as many schools as individuals demanding education.

In this institutional arrangement, the mean demand for quality is going to depend on the assumption on the return to education. Let’s start with the simplest case, $B^i = B$. In this framework, the mean quality of education will be given by the integral of quality of education over individuals (and their parents) with ability between $\eta_{\text{min}}$ and $\eta_1$:

$$
\bar{q} = \int_{\eta_{\text{min}}}^{\eta_1} \int_{\eta_{\text{min}}}^{\eta_1} q^* f(\eta_i, \eta_{p,i}) d\eta_i d\eta_{p,i}
$$

(12)

In the specific case at hand, Equation (9) is linear in both $y$ and $\eta$ and therefore yields

$$
\bar{q} = Q(y^m, \bar{\eta}, \theta)
$$

(13)

In other words, quality will depend on the mean income of parents (e.g. the mean income of the family), the mean ability of individuals and the structural parameters of the economy. Two important facts from this equation can be drawn. First, since in this case the benefit of education is constant across the whole population, people with high ability will chose $E = 0$ and therefore the quality of education is truncated at the upper end of the distribution. This leads to a lower demand for quality than in the case where
the whole population chooses $E = 1$. Second, it has the same characteristics as the individual demand: $\partial \varphi / \partial p > 0$, $\partial \varphi / \partial y^{p_i} > 0$ and $\partial \varphi / \partial \eta < 0$.

Explicitly, in the case of the log utility function, Equation (13) becomes

$$\bar{\varphi} = \frac{\beta B y^{p_i} - (y^{p_i} + G + \eta) p_i}{(1 + \beta) p_i B} \quad (14)$$

However, in general the mean quality of education may not depend on the mean income or mean $\eta$, but on the whole distribution of these two variables.

In the more general case where the returns to education are indexed by individuals, $B_i = B(\eta^i)$, the mean quality of education will depend on the demand of the people who have ability between $\eta_2$ and $\eta_{max}$ such that they will choose $E = 1$. Here the mean quality of education is truncated at the lower end of the ability distribution:

$$\bar{\varphi} = \int_{\eta_2}^{\eta_{max}} \int_{\eta_2}^{\eta_{max}} q^{*,i} f(\eta_i, \eta_p) d\eta_i d\eta_p \quad (15)$$

Clearly, in this case the individual demand for quality depends now in a non-linear way on $\eta$ and it is not possible to find a closed form like Equation 13 without imposing further restrictions on the functional forms of $B^i$.

The centralized case is characterized by one school that provides one unique quality of education. The government will collect a tax over all population and will devote the revenues to the provision of education. For simplicity, it is assumed that the government levies the tax on the transfer that parents give to children and it is collected once the individual is working. The budget constraint for the provision of quality of education is

$$q * p = (1 - \tau) * \int y^{p,i} f(\eta) d\eta \quad (16)$$

The maximization problem now becomes

$$max_{c_t, c_{t+1}, \tau}[(u(c_t^i) + \lambda_t(BC(t))) + \beta(u(c_{t+1}^i) + \lambda_{t+1}(BC(t + 1)))] \quad (17)$$

subject to $q = (1 - \tau) * \bar{y}^{p,i} / p$ and the budget constraints

$$BC(t) = y^{p,i} - c_t^i - p_t * E_t^i * q_t^i \quad (18)$$

$$BC(t + 1) = (1 - \tau) y^{p,i} + G + B^i * E_t^i * q_t^i + \eta_0 - c_{t+1}^i \quad (19)$$
Observe that now the individual is maximizing utility by choosing consumption and taxes.

The solution is characterized by the following Euler equation

\[ u'(c^*_t)\bar{y} = \beta u'(c^*_{t+1})(B^i\bar{y}^i/p - y^i) \]  

(20)

in which, for a positive \( \tau \), \( B^i\bar{y}^i/p - y^i > 0 \). This is the typical restriction in median voter models. The economic implication is that the only case in which the median voter will choose a positive \( \tau \) is when the average benefit from education is higher than her individual cost. For an economy in which the previous inequality do not hold, \( \tau = 0 \), e.g., the median voter will prefer not to have education. The interior solutions for this problem will give the following general equations:

\[ c^*_t = F(\beta, G, B^i, p_t, \eta^i_0, y^p, \bar{y}^i) \]  

(21)

\[ c^*_{t+1} = C(\beta, G, B^i, p_t, \eta^i_0, y^p, \bar{y}^i) \]  

(22)

\[ \tau^*_t = Q(\beta, G, B^i, p_t, \eta^i_0, y^p, \bar{y}^i) \]  

(23)

and, using the budget constrain in the provision of quality,

\[ q^*_t = Q(\beta, G, B^i, p_t, \eta^i_0, y^p, \bar{y}^i) \]  

(24)

When the median voter picks a positive \( \tau \), the government will provide a unique quality of education, equal to one the preferred by the median voter. In other words, if the median voter is represented by \( \tilde{B}, \tilde{\eta} \) and \( y^p \), then the quality of education that the government will provide is

\[ \tilde{q} = Q(\beta, G, p_t, \tilde{B}, \tilde{\eta}, y^p, \bar{y}^i) \]  

(25)

This demand for education will be negatively related to the price when quality is a normal good and there is only an small dynamic income effect; it may be negatively or positively related with respect to the income of the median voter; it will be positive related with respect to the mean income of the parents (which is a proxy for the mean family income); and it may be positively or negatively related with respect to \( \tilde{\eta} \).

In the case of the log utility function, the quality of education of the economy can be written as

\[ \tilde{q} = \frac{(\beta \tilde{y}(\bar{B}\tilde{y} - p\tilde{y}) - (\tilde{y} + G + \tilde{\eta})p}{(1 + \beta)p(\bar{B}\tilde{y} - p\tilde{y})} \]  

(26)
It is not easy to compare the equation of the mean quality of education in the perfect decentralized economy (Equation 13) with the quality of education in the centralized economy (Equation 25), not even in the simple, and quite restricted case, of a log utility function (Equation 14 and Equation 26). In other words, it is not “evident” that a decentralized system will increase the quality of education.

However, three conjectures can be derived from the model.

**Conjecture 1** *Comparing two economies that work in a centralized way with two different levels of income and that change to a decentralized system, the one with the low income will deliver a higher level of demand for quality of education.*

**Conjecture 2** *In an economy with a median voter with family income higher than the mean, the effect of decentralization is positive on the demand for quality of education.*

**Conjecture 3** *Following the above Conjecture, the further to the left the median income is with respect to the mean, the greater the demand for quality of education from a decentralized system.*

**Conjecture 4** *Suppose that under the centralized system the price of education is higher than in the decentralized one. Under general conditions, a movement from the first system to the second will deliver a higher demand for quality of education.*

### 2.3 The problem of schools

In general, schools take as given the “input” of the students, which is the demand for quality and the individual characteristics. In a central system, the unique school will solve the following problem:

\[
\min \sum_{j=1}^{k-1} z_j \cdot w_j \quad \text{s.t.} \quad \hat{q} = q(Z; \bar{X}, \theta) \quad \text{and} \quad z_j = \tilde{z}_j \quad \text{for} \quad j = k \text{ to } J
\]

The inputs that the school uses are the elements of the vector $Z$, from 1 to $J$, with prices $w_j$. The school will take two elements as given; the characteristics of the median voter and a certain level of inputs determined by the central government (which are the ones from $k$ to $J$). For example, the government
will give the school a certain amount of money for teachers and another amount for general inputs such as chairs, blackboards, etc. The school will take the amount for teachers as given but it will try to use the rest of the money for the other inputs in the most efficient way. The solution to the problem is an optimal set of inputs $z_j^j$, $j$ from 1 to $k - 1$ that will yield the following quality of education:

$$q^* = q(Z^*, \tilde{Z}, \bar{X}, \theta)$$  \hspace{1cm} (28)

The problem for the decentralized system is different. Each school, in each district, will solve the following problem:

$$\min \sum_{j=1}^{J} z_j \cdot w_j \text{ s.t. } q = q(Z; X^i, \theta)$$  \hspace{1cm} (29)

The school will take as given the specific demand for education, which depends on the characteristics of each individual in each district. It will minimize the cost of using all inputs $Z = (z_1, ..., z_J)$ at prices $w_1, ..., w_J$. The solution is an optimal use of inputs $Z^*$ with a final supply of quality

$$q^{*,i} = q(Z^*; X^i, \theta)$$  \hspace{1cm} (30)

Equation 28 and Equation 30 go to the heart of the problem. On one hand, it is true that in the decentralized problem the schools will provide the optimal use of resources $Z^*$, which may differ from the provision of the inputs that the central government gave the school ($\tilde{Z}$) and therefore, there is foreseeably an increase in the efficiency of school input use. On the other hand, quality of education also depends on $X^i$ and $\bar{X}$. The interaction between these two inputs, $Z$ and $X$, will determine the mean quality of education in the centralized and decentralized cases.

### 3 The empirical problem

In general terms, the empirical problem of estimating the relationship between decentralization and quality of education can be divide into three parts:

- Having a quasi-experiment in which a country actually change the institutional order towards a decentralized structure in the economic organization.
• Devising a measure of quality of education.

• Determining the factors that affect the quality of education and among them the decentralization process.

This section is divided into two parts. First, it presents a brief overview of the quality of education literature. Second, it builds an empirical strategy to isolate the effects of decentralization on quality. The novelty of the approach is not only the framework it provides for examining the effects of decentralization but also the ability of the methodology to distinguish between direct and indirect effects.

3.1 Quality in education

The theoretical and empirical literature on the quality of education can be divided into two categories. The first one investigates the determinants of the quality of education (Heynaman and Loxley [10] and Lee and Barro [11]) whereas the second one links quality of education to labor income (Behrman and Birdsall [4], Card and Krueger [7] and Card and Krueger [6]).

In order to get a measure of education’s quality, the general approach of the empirical literature is to take a standardize test, usually in the areas of mathematics, sciences and language. In theory these types of exams are designed to measure the capacity of reasoning and the ability to solve problems that are not mechanical; therefore, they provide information on the quality of education that individuals have. However, in the production of education, the inputs of the school are not the only ones affecting the quality of education. The individual’s characteristics are important in the outcome since family background, genetic code, etc play an important part in the acquisition of education and in the ability to perform in these kinds of exams.

From the point of view of the school, the characteristics of the individuals (age, sex, education of parents and socioeconomic level of household) are given. Presumably, the decentralization will affect observable 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.

One paradoxical result of the first studies on the quality of education in the United States (Coleman et. al. [?]) was that the characteristics of the
school seem to play a very small role in the quality of education, whereas the characteristic of the individuals play a decisive one.

A study by Heynaman and Loxley [10] divides poor countries from rich ones, and finds that for high income countries the individual input is more important than the school input and that the contrary is true for low income countries. There is no satisfactory economic explanation for this result, making the study of decentralization even more important. The intuition in this framework is the same: the decentralization will provide more and a better allocation of resources, with a greater impact in low-income areas. Therefore, another source of variation that it is interesting to explore is the one across deparments. Are poor regions getting more benefits from decentralization than the rich ones? If so, what is the explanation for this?

3.2 Quasi-experiments

The common model in the literature is one in which an outcome \( Q \) (usually wages or income, and in the concrete case at hand, quality of education) is a function of individual observable characteristics \( X \) and an unobservable component \( U \). Assuming a linear relationship,

\[
Q = \beta * X + U
\]  

(31)

Letting \( Pu \) denote the individual that actually receives the treatment and \( Pr \) the one that does not, and \( t = 0 \) the period before the treatment and \( t = 1 \) period after the treatment, the effect of the treatment on the treated can be found using the following equations.

\[
\begin{align*}
Q_0^{Pu} &= \beta * X_0^{Pu} + U_0^{Pu} \\
Q_1^{Pu} &= \alpha + \beta * X_1^{Pu} + U_1^{Pu} \\
Q_0^{Pr} &= \beta * X_0^{Pr} + U_0^{Pr} \\
Q_1^{Pr} &= \beta * X_1^{Pr} + U_1^{Pr}
\end{align*}
\]

The first two equations are the ex-ante and ex-post outcome for the treated person. The effect of the treatment is captured in \( \alpha \). \( D \) is the decision to participate in the program. The last two equations are the analogous ones for the control group.

Notice that \( \alpha \) is a fixed, constant gain from the program. That is, the program affects equally all the people that participated in it. Presumably,
$E[U/D] \neq 0$, e.g. the unobservable characteristics of the individuals are correlated with the decision of been part of the program.

The most commonly proposed estimator is the differences-in-difference ($DD$) estimator:

$$DD = (Q_{1}^{Pu} - Q_{0}^{Pu}) - (Q_{1}^{Pr} - Q_{0}^{Pr})$$  \hspace{1cm} (32)

$$DD = \alpha + \beta[(X_{1}^{Pu} - X_{0}^{Pu}) - (X_{1}^{Pr} - X_{0}^{Pr})]$$
$$+ [(U_{1}^{Pu} - U_{0}^{Pu}) - (U_{1}^{Pr} - U_{0}^{Pr})]$$ \hspace{1cm} (33)

Taking expectations over the last equation, conditional on $X$ and $D$, yields the expression that synthesizes the heart of the problem:

$$E[DD/X^{Pu}, X^{Pr}, D] = \alpha +$$
$$E[\beta[(X_{1}^{Pu} - X_{0}^{Pu}) - (X_{1}^{Pr} - X_{0}^{Pr})]/X, D] +$$
$$E[((U_{1}^{Pu} - U_{0}^{Pu}) - (U_{1}^{Pr} - U_{0}^{Pr})]/X, D]$$ \hspace{1cm} (34)

where $X = [X^{Pu}, X^{Pr}]$.

Under what general conditions $E[DD/X^{Pu}, X^{Pr}, D] = \alpha$? First,

$$E[\beta[(X_{1}^{Pu} - X_{0}^{Pu}) - (X_{1}^{Pr} - X_{0}^{Pr})]/X, D] = 0$$ \hspace{1cm} (35)

This condition implies that the characteristics of the control group evolve on average in the same way as the characteristics of the treatment group. Second,

$$E[((U_{1}^{Pu} - U_{0}^{Pu}) - (U_{1}^{Pr} - U_{0}^{Pr})]/X, D] = 0$$ \hspace{1cm} (36)

This condition states that the control group’s unobservable characteristics evolve on average in the same way as the ones in the treatment group.

By comparing the first and second moments of both populations, condition one can be tested in principle. Ideally, both control and treatment group are as close as possible in the observable characteristics.

The randomization will ensure that condition two hold. Since the control group is picked randomly, presumably the unobservable characteristics of this group will evolve similarly to the unobservable characteristics of the treatment group.
3.2.1 A problem with two agents

In the previous section, the relevant relationship is between an outcome \( Q \) and personal characteristics. This relationship can be derived from an economic model of personal utility maximization. In this section the fundamental relationship is a different one since it is the production of an output in which two agents interact.

In formal terms, the production of quality \((Q)\) is a function of two inputs, individual characteristics \((X)\) and school characteristics \((Z)\):

\[
Q = f(X, Z) \tag{37}
\]

Assuming a linear relationship, the analogue to equation 1\(^4\) is:

\[
Q = \beta \ast X + \gamma \ast Z + U \tag{38}
\]

Using the same procedure implemented in the previous section to find the difference in difference estimator, the estimator under the two agents is the following.

\[
DD = (Q_{1u}^P - Q_{0u}^P) - (Q_{1r}^P - Q_{0r}^P) \\
= \alpha + \beta[(X_{1u}^P - X_{0u}^P) - (X_{1r}^P - X_{0r}^P)] \\
+ \gamma[Z_{1u}^P - Z_{0u}^P] - (Z_{1r}^P - Z_{0r}^P)] \\
+ [(U_{1u}^P - U_{0u}^P) - (U_{1r}^P - U_{0r}^P)] \tag{39}
\]

Notice that the treatment group is the public schools \((Pu)\), whereas the control group is the set of schools to which the treatment does not apply. The natural choice for the control group is private schools \((Pr)\).

Taking expectations over \(DD\), conditional on \(X\) and \(D\),

\[
E[DD/X^Pu, X^{Pr}, Z^Pu, Z^{Pr}, D] = \alpha + \\
E[\beta((X_{1u}^P - X_{0u}^P) - (X_{1r}^P - X_{0r}^P))]/X, Z, D] + \\
E[\gamma(Z_{1u}^P - Z_{0u}^P) - (Z_{1r}^P - Z_{0r}^P)]/X, Z, D] + \\
E[(U_{1u}^P - U_{0u}^P) - (U_{1r}^P - U_{0r}^P)]/X, Z, D] \tag{41}
\]

where \(Z = [Z^Pu, Z^{Pr}]\).

\(^4\)The relationship can be of the form \(expQ = k \ast X^\beta \ast Z^\gamma\)
The conditions that ensure $E[DD/X^{Pu}, X^{Pr}, Z^{Pu}, Z^{Pr}, D] = \alpha$ are the following:

First,

$$E[\beta((X^{Pu}_1 - X^{Pu}_0) - (X^{Pr}_1 - X^{Pr}_0))/X, Z, D] = 0$$

(42)

Second,

$$E[\gamma((Z^{Pu}_1 - Z^{Pu}_0) - (Z^{Pr}_1 - Z^{Pr}_0))/X, Z, D] = 0$$

(43)

Third,

$$E[(U^{Pu}_1 - U^{Pu}_0) - (U^{Pr}_1 - U^{Pr}_0)]/X, Z, D] = 0$$

(44)

The first condition implies that on average, conditional on $D$, the observable characteristics of individuals in the treatment group, that is to say the public school, have to evolve in the same way as the ones in the control group. The second condition is analogous to the previous one but for the characteristics of the schools. Finally, the unobservable characteristics for both groups have to evolve in the same way. Several potential problems may deter the actual realization of these conditions. They are discussed in the last section.

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 professors. In this sense, $U$ can be decompose in two terms, one reflecting the individual part and the other the school part: $U = V^{Se} + N^{In}$.

### 3.2.2 Changes in the characteristics of the school as result of the program

The previous section does not take into account that part of the important effects of decentralization presumably will affect the characteristics of the school. In other words, the previous section assumes a fixed, constant linear effect of decentralization. However, decentralization may have an effect on the characteristics of the school such as student/professor ratio, wages of professor, etc. That is to say, it may change the slope of the characteristics of the public schools.

Assume that the initial level of school characteristics is $Z^{Pu}_0$ and the ex-post level is $Z^{Pu}_1(1 + d)$ in which $Z^{Pu}_1 - Z^{Pu}_0$ reflects the exogenous change on observable characteristics due other factors besides the decentralization and
\[ d \ast Z_{1}^{P_u} \] is the direct effect of decentralization. In this case the DD estimator will be

\[
DD = (Q_{1}^{P_u} - Q_{0}^{P_u}) - (Q_{1}^{P_r} - Q_{0}^{P_r}) = \alpha + \beta \ast d \ast Z_{1}^{P_u} + \\
+ \beta[(X_{1}^{P_u} - X_{0}^{P_u}) - (X_{1}^{P_r} - X_{0}^{P_r})] \\
+ \gamma[Z_{1}^{P_u} - Z_{0}^{P_u}) - (Z_{1}^{P_r} - Z_{0}^{P_r})] \\
+ [(U_{1}^{P_u} - U_{0}^{P_u}) - (U_{1}^{P_r} - U_{0}^{P_r})]
\]

(45)

and the equation of the expectation

\[
E[DD/X^{P_u}, X^{P_r}, Z^{P_u}, Z^{P_r}, D] = \alpha + \beta \ast d \ast Z_{1}^{P_u} + \\
E[\beta((X_{1}^{P_u} - X_{0}^{P_u}) - (X_{1}^{P_r} - X_{0}^{P_r})]/X, Z, D] + \\
E[\gamma[Z_{1}^{P_u} - Z_{0}^{P_u}) - (Z_{1}^{P_r} - Z_{0}^{P_r})]/X, Z, D] + \\
E[(U_{1}^{P_u} - U_{0}^{P_u}) - (U_{1}^{P_r} - U_{0}^{P_r})]/X, Z, D]
\]

(47)

Notice that the problem for identification of the effect of decentralization is the same as in the previous section. The difference is that the net effect of the program (the decentralization) on the quality of education has a fixed component as well as a slope component, e.g. \( \alpha + \beta \ast d \ast Z_{1}^{P_u} \).

The economic interpretation of the change in the characteristics of the school (e.g. \( \beta \ast d \ast Z_{1}^{P_u} \)) is an interesting one. Before the decentralization process, schools were constrained by the decision of the central government and thus, potentially the allocation of resources were not optimal. Once the system was decentralized, schools could start changing the internal characteristics since the decentralization provided more autonomy to the public schools. However, it is difficult to foresee in which way the characteristics would change. For instance, one obvious characteristic that may have changed due to decentralization is the student/教授 ratio. With a high probability, this ratio was quite high before the decentralization. Once the school began to have more autonomy in expenditure, it may have increased the number of professor and therefore reduced the ratio. However, this does not rule out the opposite case. Suppose that before decentralization the central government forced all schools to have certain number of teachers. It may be the case of some schools with sub optimal low student/教授 ratio, and in this case, these schools would have increased the ratio after the decentralization.
The economic interpretation of the fixed effect gain from the decentralization on quality of education (e.g. \( \alpha \)) 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 fixed effect will capture these effects.

### 3.2.3 Different control groups

Mainly three factors can contaminate the experiment, all of which may induce a bias in the estimation of the effect of the program. The first one can be described as a problem of general equilibrium effect, the second as a problem with the randomization of individuals and the last as a problem with the randomization of schools.

The last problem (randomization of schools) can be present if some public schools did not decentralizing at all. In this case, these schools will contaminate the experiment since it will be a self-selected group that did not decentralize. Most likely neither equation 13 nor equation 14 will hold. This is not, however, a problem in the case at hand since the institutional change in the country affects all public schools.

Even though the problem of randomization of schools is not present in the particular case at hand, that does not mean that prior to the institutional change there were no differences among the public schools in their degree of decentralization. For instance, schools in big cities and with a large student population may have had more autonomy than smaller schools in the remote areas of the country due to better access to the policy makers. This feature may be a potential asset since it is possible to use the more autonomous public schools as controls. Again, it is important to see empirically if the first and second moments of the two groups are similar.

There is, however, a problem with this control group since other institutional changes that may affect quality of education will be capture as part of the effect of decentralization. For instance, suppose that simultaneously with the decentralization the government implement a massive health program for all kids in the school age. As long as health program improves the quality of life of children, it may induce better educational outcomes. If the control group is a public school that previous to the decentralization was more autonomous, the \( DD \) estimator cannot disentangle the effects of
these two programs since both programs affects simultaneously both types of groups. Now suppose that the control group is the private school. Since the health program affect all schools, and the decentralization only affect the public ones, the DD estimator will effectively separate this health effect from the decentralization effect, assuming that the other conditions holds.

The second problem is more severe in the context of education. Presumably some characteristics of the individual in the public school are quite different from the characteristics of individuals in private schools, for example, income. In the case in which public education is cheaper than private education, different means in income will prevail in both schools. Again, a proper control group is important to avoid potential contamination of the experiment.

One potential solution to this problem may be finding locations in the country where there are only public schools. Presumably, in those areas the characteristics of individuals in public schools will mimic more closely the characteristics of the individuals in private schools. The potential problem is that this involves another decision of individuals, which is location.

The problem of general equilibrium effects can be better described with an example. 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 an important 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 the decentralization itself, but because of a redistribution of skills between the two types of schools. Again, the data are crucial in determining if this contamination is pervasive. For instance, if the enrollment in public and private schools changed dramatically right after the decentralization it is possible that the experiment is contaminated, making it difficult to find the true effect of the program over the outcome.

\(^5\)For instance, if individual’s nutrition is better in private schools than in public ones and better health reflects in better performance in school.
4 Colombia as a quasi-experiment: the decentralization process and the data

4.1 Decentralization in Colombia

Several developing countries around the world undertook decentralization during the 80’s and 90’s. These countries provide quasi-experiments to analyze the potential impact of this reform on several economic and political outcomes. For instance, Ter-Minassian [13] and Bird and Vaillancourt [5] look at several countries, focusing in the potential impact of the decentralization process in fiscal outcomes. However, the impact over quality of services is not mentioned, probably because changes in the quality of services are difficult to measure or because the reforms were relatively recent to have any impact in the short run.

The case of Colombia is very interesting to analyze (for a more detail overview of the Colombian’s case, see Ahmad and Baer [1].) First, the country realized a major decentralization reform in 1991, following an incipient one tried in 1986. The “quasi-reform” of 1986 created some space for the “municipios” to create and promote own programs. However, it did not give the necessary financial resources to implement such programs.

The reform of 1991 gave substantial expenditure responsibilities to municipalities and departments and increased the amount of resources, both from central revenues and from own taxes. However, the general policies are determined by the central government: the majority of the transfers are earmarked, mainly for education and health. In this sense, this decentralization process is similar to the recently implemented reform in welfare in the United States in which the States have more capacity to design and implement programs but with specific designation of certain funds (For instance, see Baicker [2].)

The main characteristics in terms of Taxes of the 1991 decentralization process in Colombia can be synthesized as follows. Major taxes, such as VAT, international trade, personal and corporate income taxes, are assigned to the national government. The departments’ taxes are over alcohol drinks,

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6Colombia is divided politically in mainly three levels: central government, departamentos and municipios. Probably the best reference in terms of EEUU is federal government, states and counties. However, the States has more power, and more independence from the Federal Government, than the departamentos does
cigarettes and motor taxes. The municipalities’ taxes are a property tax, a business tax and a motor tax. An important characteristic of the system in terms of taxation is that there are not sources of own revenues fully under control of municipalities and department.

The technical capacity of department and municipalities in collecting and administrating taxes ranges from very low to quite high, depending on the income of the regions. The major cities have modern systems of collection, tracking and punishment of evasion; whereas, in general, small poor municipalities do not have technical tax capacity.

With respect to Revenue sharing and expenditures, the Constitution of 1991 dictates some rules of revenue sharing, which were implemented in practice since 1993. There are four main systems of revenue sharing: two funds with specific destination, one system of cofinancing funds and a fund of royalties.

The first fund, the situado fiscal, provides transfers to the departments for the specific areas of education and health. 15% of the fund is distributed equally among the departments and the rest according to the population of each department. The law was implemented in 1993 with the imposition of a 22.5% as the minimum share of central government’s total current revenues for the fund, percent that increased to 24.5% by 1996.

The participacion municipal fund is for the municipalities, to be used mainly for the areas of education, health and water. This fund was implemented in 1993 as well, with an increasing participation of the total revenues of the central government of 14% to 21% by 2000. 60% of the resources are to be distributed according to the number of poor people in the municipality and 40% according to the number of population, fiscal and administrative efficiency and progress in reducing poverty in the local region.

The system of cofinancing funds started in the eighties as a way to induced investment in social and infrastructure projects. After the new constitution, there was an explosion in the number of these funds which represent by 1996 almost 40% of the transfers to the municipalities.

Finally, the National Royalties’ fund is formed largely by oil revenues. By 1995 it represented almost the same amount of transfers as the cofinancing funds. The rule of redistribution is on a presumptive equal per capita share.

The interesting point about the case of Colombia is that the “experiment” of changing from a very centralized system toward a more decentralized one has a clear cut-off point in time. Therefore, a key element to identify the effects of the decentralization process over quality is the time dimension.

23
Provided that it is possible to construct a measure of quality in education, it is possible to analyze what happens ex-ante and ex-post reform to public schools. However, in order to have the real impact of decentralization it is necessary to have a control group that isolates the effect of the decentralization from other factors than may affect the quality of education during the period of the analysis. The control group would be private schools, which are not directly influenced by the decentralization process. In order to have a good control group it is necessary that the two groups (the treatment and the control one) are “similar”, a fact that needs to be tested empirically.

The first step in the empirical part is to analyze the time series properties of $SC$ in private versus public schools. Clearly, the decentralization process may have a significant impact in the characteristics of the school, such as decreasing the student/professor ratio, increasing the education of professors, etc.

### 4.2 Data and Estimation

(This section is under work. The results are VERY PRELIMINARY. However, as May 31st, the process of cleaning the data and preliminary estimations are under way...)

The empirical data are composed from two parts. First, one dataset gives information about the schools in Colombia collected via a school survey. On average the number of observations per year is 61,000 schools. Data between 1990 and 1994 gives information about the fixed characteristics such as the location of the school (rural or urban), its municipality and department, the schedule of the school (morning, afternoon, or night) and the level of education that the school provides (kindergarten, primary or secondary). Also, the survey provides information on the number of students, the number of students who need to repeat a year and the number of drop outs. There is additonal detailed information on teachers: number (separated by sex), level of education of the teachers (primary, secondary, college and graduate studies), areas of teaching, etc. Combining the information about students and teachers it is possible to find ratios such as (students/teachers), (students/science teachers), (students/teachers with college education), etc. The data between 1996 and 1999 is richer than the earlier years. Besides all the variables already mentioned, there is information on the infrastructure of the school. For example, if the school has drinkable water, how many seats the school has, etc.
A first step to see the effects of decentralization on quality is to observed the temporal evolution of the characteristics of schools. For instance, if the ratio (student/teacher) pre-decentralization (1990-1992) is higher than in the period post-decentralization (1993 onwards), then there exist a change in one characteristic of the school that may be the effect of decentralization. As the previous section argues, a natural control for other factors influencing the change in characteristic of the school is to take the difference between the change in the characteristic of the school in the control group versus the one of the treatment group (which is a Wald estimator).

Preliminary estimation (using the data that has been cleaned so far, 1990-1994) of 15 key characteristics gives surprising results. Comparing public schools from 1990 to 1994, 12 of the 15 characteristics have the expected sign for a quality improvement. Now, constructing the Wald estimator (controlling by private school) nine characteristics still have the right sign. The characteristics are: the number of drop outs, the number of repeters, the number of places in the school, the demand for places, the enrollment, the number of teachers, the ratio of teachers with primary, secondary, college and graduate studies to total number of teachers, the ratio of teachers with (primary and secondary)/(teachers with college and graduate studies) and the students-teacher ratio.

The second dataset measures the quality of education. Colombia administers a national test (ICFES Test) to all high school graduates. The test is formed of approximately 500 questions in biology, chemistry, history, geography, language and mathematics. Some of these questions have appeared in multiple years in the last decade (1990-1999). For example, one question in mathematics may have appeared in 1990 1991 and 1994 and another in 1991, 1996 and 1998. There is a core of approximated 50 questions in mathematics and language that have appeared more than four times in the past decade. These core questions can be used to form a quality index for the period 1991-1999. The database has general information, like school, sex and age of individuals, for the period 1990-1997 and more detailed information, like education of parents and income, since 1998-1999. Also, since it is possible to know the location of the exam, there exists information on population, income per capita, etc of the locality.

Clearly the final step is to merge the ICFES Test dataset with the school characteristics and carry out the empirical estimation laid out in the previous section.
References


