DOCUMENTOS DE TRABAJO

The impact of a school–based management program on students' cognitive achievement: a case study of Redes Amigas in rural Ecuador

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ABSTRACT. Education decentralization plays an important role in Latin America. Most experiences of decentralization, based on transferring school administration to local communities, come from Central America, where the main objective was to improve school enrolment in remote rural areas. These experiences did not incorporate explicit objectives related to the improvement of the learning process. The Ecuadorian experience is novel because it represents a similar decentralization strategy but the main objective is to improve students' cognitive achievements. This chapter evaluates the impact of decentralization of rural schools in Ecuador on students' cognitive achievements. By using propensity score matching on a restricted sample of program applicants, the study finds evidence of significant and positive effect of *Redes Amigas* on students' test scores. The impact can be attributed to both the improvement of school inputs and changes in the school management structure. However, significant and negative impact on bilingual (Spanish and Quichua) schools is found, potentially, reflecting a problem of culturally inadequate curricula. Because of data limitations results are inconclusive and tentative.

3.1 Introduction

This chapter evaluates the impact of decentralization of education on students' cognitive achievement in rural Ecuador. Decentralization plays an important role in education policy in Latin America. Broadly, two types of decentralization strategies have been applied across the region. First, Mexico and some South American countries implemented a transfer of some administrative functions from the central government to local governments. Second, some Central America countries implemented a transfer of administrative and pedagogical issues from the central government to schools. The Ecuadorian experience corresponds to the latter. Despite the importance of such decentralization processes, empirical evidence that evaluates the impact of decentralization on students' cognitive achievements is scarce. This chapter reviews the literature on this topic and evaluates the impact of a school-based management experience on test scores in rural Ecuador. The novelty of the Ecuadorian experience is that it represents the first example where improving students' learning is stated as an explicit objective. In contrast, most of the school-based strategies from Central America focused on improving school enrolment in remote rural areas. In methodological terms the chapter combines a pipeline design with propensity score matching. Program implementation in certain schools was delayed due to administrative issues, and this provides the possibility of constructing an adequate control group using those schools that had decided to participate but were unable to do so due to these administrative reasons (additional details are provided in the succeeding sections).

The chapter is organized as follows. The following part discusses the experiences of decentralization of education in Latin America. The third part presents the Ecuadorian experience. The fourth part introduces the methodological approach used. The following part gives some descriptive statistics and introduces the data used. The sixth part presents the main results, and the last part concludes.

3.2 Experiences of decentralization of education in Latin America

3.2.1 The debate over decentralization

Most Latin America countries started to decentralize their education systems during the 1990s. From a theoretical point of view, there are several arguments that may be advanced in favor of and against decentralization of education.

The main benefits of decentralization are related to the fact that people at the local level, or those who are closer to the classroom (teachers, parents and students in the case of education), have better information than the civil servants of the central government, and thus are better able to make decisions to improve schools (King and Özler, 2000). In this regard, it is assumed that decisions made by those who are closer to the school are better and more efficient[1] than decisions made by authorities from the central government, because the former can make use of information about local preferences (Di Gropello, 2006). Furthermore, decentralization, when it was thought to transfer schools to private and municipal sectors, was assumed to encourage local competition. In this case it is understood that local competition can improve school efficiency. In addition, decentralization is expected to provide local consumers with greater voice and increase accountability because local people can better control their schools (Winkler and Gershberg, 2000). This reform presumes a well-functioning democracy whereby all the externalities of education are tended to locally.

Among the proponents of decentralization in education, it is argued that the reform will have a direct impact on improving schools, local participation, as well as local competition and technical efficiency (first round effects). As a result of these first round effects, decentralization will have an indirect impact on the learning process leading to better cognitive achievements of students (second round effects). Despite these arguments, empirical evidence on the effects of decentralization is scarce.

Amongst the cons of decentralization, it is argued that if there are local elites that gain control over local decision-making, then the process can lead to the existence of non-democratic structures in the decision-making process, and social welfare may not improve (Winkler and Gershberg, 2000). In political terms, this could lead to a consolidation of local *caudillismos*. Furthermore, if externalities associated with education

are distributed beyond the confines of the locality, there is a strong argument for a high participation of central government in financing local education. Additionally, the different degree of technical development at the local level can influence the results of decentralization. In this regard, decentralization may worsen the provision of public goods if local governments lack administrative capacity (Galiani and Schargrodsky, 2001). It is assumed that local governments with greater administrative capacity can lead to better decentralization experiences than governments that lack technical capabilities. Finally, another argument against decentralization is that the agent[2] (schools), once given decision-making autonomy could use it opportunistically, putting its own interest before the national interest, thereby taking advantage of the fact that the principal (the Ministry of Education) will not observe the true effort of the agent. However, this *moral hazard* issue can be offset by the existence of a second principal through community participation (Di Gropello, 2006)

In any case, as can be observed, most of the theoretical debate is based on assumptions that should be empirically examined. One of the main problems in the debate on decentralization is the scarcity of empirical studies aimed at evaluating these assumptions, or in other words, the empirical analysis of the effects of decentralization.

3.2.2 Experiences with decentralization

As previously stated, in practical terms, there are two kinds of decentralization strategies in the region. First, a strategy based on transferring key administrative school decisions from the central government to local governments (municipal decentralization). Second, a strategy based on giving local communities the decision-making power on key aspects of the education process (school-based management strategy SBM).[3] Despite the focus on educational decentralization in Latin America, empirical evidence on its impacts on students' achievements is scarce. In this section a summary of the main experiences of decentralization in the region is presented. The summary focuses on impact evaluation studies.

Regarding decentralization experiences in Latin America, Chile's reform is the most representative case of municipal decentralization or privatization. Chile started its decentralization in the early 1980s by transferring schools from the central government to municipalities or private agents (privatization). In addition, the amount of resources granted to schools, by the central government, was proportional to the

number of students attending each school (Espínola, 1997). The central government kept the role of financing education, as well as determining the curriculum. On the other hand, municipal governments and private agents were in charge of contracting teachers, administering schools, training teachers and maintaining and constructing school buildings (Espínola, 1997). From the beginning, the process did not incorporate an impact evaluation strategy. As a result, there are no experimental studies of the impact of decentralization on education outcomes. However, a simple comparison of student achievement scores throughout the 1980s shows a decline in learning. In addition, the real per-student education spending also declined in the same period (Winkler and Gershberg, 2000). More recently, a study conducted by Hsieh and Urquiola (2003) found no significant effects of decentralization on school outcomes at the aggregate (municipal) level. Based on panel data from about 150 municipalities, the paper explored the effect of the reform on test scores, repetition rates, and years of schooling. In this case, the study exploits the fact that the privatization of schools would have a greater impact in communities with larger markets (where the demand for private schooling would be greater), and little impact in communities with reduced markets. As long as the differential impact is driven by community characteristics that are fixed over time, the impact of the program is measured by comparing the change in educational outcomes in urban and wealthier communities, to that in communities where private schooling increased to a lesser degree. As mentioned above, the paper finds no significant effects at the municipal level, although it finds a significant increase in the enrolment of better students in private schools. In fact, private schools attracted students from families with higher levels of income and schooling, leading to a fall in student-outcomes of public schools because the better students of public schools migrate to private schools.

During the 1990s, the Chilean government took additional steps toward school decentralization. Improving school inputs, promoting pedagogical innovations, and specific interventions aimed at the most disadvantaged schools were the central components of this phase of the decentralization. This process, again, did not incorporate an impact evaluation design, and, consequently no experimental evaluation studies are found.

On a descriptive level, during the 1990s, the real per capita education expenditures, including teachers' salaries increased. In addition, more stable labor conditions for teachers were guaranteed. Finally, the evolution of test scores indicates a significant improvement during the period.

One specific intervention directed toward improving the quality of the most disadvantaged schools was the program called P-900. The program started in 1990 and was targeted at schools ranking below the regional average test score (for fourth grade in math and language). The intervention included four components: school infrastructure, instructional materials (special textbooks), teacher-training, and tutorial workshops for children with low performance. An impact evaluation study by Chay, McEwan and Urquiola (2005) finds a significant effect of the program on fourth grade test scores in math and language of around two points between 1988 and 1992. The study used a regression discontinuity design and exploited the fact that schools scoring below the average regional test score received the program, while schools scoring above did not. By comparing schools just below the average regional test score with those scoring just above, the study finds unbiased estimates of program impact.

Argentina is another example of municipal decentralization. The country decentralized the administration of the primary system during the 1960s and 1970s. As a consequence, school-administration was transferred to provincial governments. The administration of secondary schools was transferred between 1992 and 1994. The following actions were transferred to the provinces at the secondary school level; the administration of subsidies and the regulation of private schools, the determination of expenditures, the allocation of personnel and non-personnel budget, the appointment and dismissal of directors, teachers and staff, the salary decisions, the definition of the calendar year, and the opening or closure of schools. Schools can choose textbooks, teaching and evaluation methods, and to some degree the content, but in consultation with the provincial authority (Galiani and Schargrodsky, 2001). An impact evaluation of the decentralization of secondary schools, conducted by Galiani and Schargrodsky (2001), finds a positive and significant effect on public school students' test scores in both language and mathematics. The study considers, as a source of exogenous variation, the fact that the transfer of secondary schools to provincial governments was made between 1992 and 1994. School transfers were scheduled

through the signature of bilateral agreements between the federal government and each province, and took place between February 1992 and January 1994. This political experiment generates an exogenous variation in the jurisdiction of administration of secondary schools across time and space, and is used as an instrument to identify the causal effect of decentralization on students' cognitive achievements. On average, between 1994 and 1998, test outcomes of public schools improved 1.2 standard deviations from its distribution as a result of the decentralization process (Galiani and Schargrodsky, 2001). Another important conclusion of this study is that the impact of the program depends on province characteristics. The study finds that the impact was positive when schools were transferred to fiscally ordered provinces, but negative when provinces run significant fiscal deficits (Galiani and Schargrodsky, 2001). In this regard, the study concludes that the efficiency of the decentralization process depends on the level of technical development of the local governments.

Additional examples of decentralization based on transferring administrative issues to municipalities are found in Brazil, Mexico, Bolivia and Colombia.[4] Unfortunately, there are no impact evaluation studies of these decentralization experiences.

Regarding the second type of decentralization (SBM), some interesting experiences can be found especially in Central America. The first experience with a SBM program is EDUCO (*Educación con participación de la comunidad*) from El Salvador. The program started in 1991 and transferred school administration to community education associations (*Asociaciones comunales para la educación, ACEs*). ACEs are in charge of administering and managing schools, selecting, hiring and monitoring teachers, building and maintaining schools, while the Ministry of Education contracts them to deliver a given curriculum to a certain number of students. EDUCO schools can be established in rural areas and provide preschool and basic education (grades 1-9). In addition, there must be at least 28 students per grade in the community and no other education services. The main objective of the program was to expand educational access for children from remote rural areas. No specific objectives regarding students' cognitive achievements were established. However, an impact evaluation conducted by Jimenez and Sawada (1999) found significant and positive impacts of the program on language test scores[5] and on student attendance. The study used an education production function

approach to evaluate the impact of EDUCO, where the outcome variables (test scores or days attended) were regressed on student, school and community characteristics. To deal with the problem of endogeneity due to program selection, the study used instruments such as the proportion of EDUCO schools, and traditional schools at the municipal level. It is assumed that these percentages affect the likelihood that a student will attend an EDUCO school without directly affecting the education production function at the student level.

In 1993, the Nicaraguan government established, as a pilot project, management boards (*Consejos directivos*) in 24 secondary public schools[6] to ensure the participation of school-teachers, parents and students in making school decisions. Initially, the program was directed toward secondary schools, and transferred key management tasks from central authorities to the directive councils. The school councils were in charge of hiring and firing teachers and administrative staff, maintaining the school building, making and overseeing budget allocations, generating additional financial resources (students fees), overseeing teacher performance and making pedagogical choices (Di Gropello, 2006).

Unlike in El Salvador,[7] the goals of Nicaraguan reform were to increase the efficiency and effectiveness of education services (students' attendance, and students' test scores) (Di Gropello, 2006). By the end of 1995, the program covered around 100 secondary schools, and was extended to primary schools. At the primary school level the program took on two forms. One was for urban schools, which is similar to the secondary school model and another for rural schools (*Núcleos Educativos Rurales Autónomos* (NER)). The latter is a group of schools formed around a central school, which functions as a single school network. A central council administrates the NER. Its directive council is based in the central school, which is usually the largest in the group and the only school that has a director. At the end of 2005, there were over 200 single autonomous primary schools and 42 NERs consisting of two to four schools each (King and Özler, 2000). An impact evaluation conducted by King and Özler (2000) found a significant and positive impact of *de facto*[8] decentralization on students' test scores at the primary level both in mathematics and language. The study used a propensity score matching method, as well as an instrumental variable approach to evaluate the effect of both *de jure* and *de facto* decentralization on school outcomes. The instruments used were schools characteristics (enrolment and director's

characteristics), and municipal level variables (mean levels of education and infrastructure and its variances). A potential problem of the study is that the instruments used may not be particularly credible. It is hard to imagine that characteristics of the school and director are not related to student performance. Finally, the paper finds no significant effect of the program at the secondary school level (King and Özler, 2000).

Additional examples of school-based management experiences are found in Guatemala (PRONADE) and Honduras (PROHECO). In such cases the main objective, such as in El Salvador, is to expand school enrolment in isolated rural areas affected by conflict, poverty and natural disasters.[9] However, no impact evaluation studies of those experiences are available. In South America, one can also find some examples of school-based management experiences such as the case of Minas Gerais in Brazil.[10]

As the summary above suggests, the existing empirical studies display different levels of analytical rigor. While there are no experimental studies to evaluate the impact of decentralization, the few quasi-experimental studies that do exist suggest that the results of the effects of decentralization on school outcomes are context and country specific. Regarding decentralization based on the transfer of administrative issues from the central to the local governments, there is some evidence showing that the impact depends on the political, administrative and financial capacity of local governments. The decentralization process can be successful in those local governments with high levels of development, while it can be a disaster in those local governments with low levels.

In the case of privatization, no significant effects at the municipal level are found in the Chilean experience. Nevertheless, deterioration in the performance of public schools because of the migration of better students from public to private schools is found.

In the case of targeted interventions directed to improve the quality of schools with low academic performance, a significant and positive impact is found.

Finally, in the case of SBM programs, empirical evidence on its impact on students' cognitive achievement is not absolute. It should be emphasized that most of these programs, especially in Central America, were established to increase school enrolment in remote rural areas and do not have explicit learning objectives. Therefore, it should not be surprising to find no significant effects on test scores.

The importance of the decentralization of rural areas in Ecuador through *Redes Amigas* is that the program belongs to the second type of decentralization reform in Latin America (SBM), but includes explicit learning objectives. In fact, unlike the Central America experiences of SBM, where the main objective was to improve school enrolment in remote rural areas, the main objective of *Redes Amigas* was to improve students' cognitive achievements.

3.3 Decentralization of education in Ecuador

PROMECEB-REDES AMIGAS started to operate in 1990. The program had two phases: from 1990 to 1999 (PROMECEB) and from 1999 to 2005 (REDES AMIGAS).The main objective of the program was to improve students' cognitive achievements in the rural areas of Ecuador through the decentralization of school management and community participation. To this end, schools were assigned to medium-size administrative units called *Centros Escolares Matrices (CEMs)*. Each center supervised between 15 and 30 schools, compared to the previous institutional framework, where one administrative unit (*Dirección provincial*) supervised up to 3000 schools. In the second phase of this program, starting in 1999, schools in the same CEM were encouraged to organize themselves into autonomous school networks (*Redes Amigas*). These networks have received additional resources coming from the program to define their own teacher-training strategy, and budget for infrastructure and teaching materials.

To support the school network program, participating community boards received a substantial amount of training and advisory services from the central administration. The total budget of the program in its second phase was $50 million, of which $45 million came from the Inter American Development Bank, and $5 million from the Ecuadorian government. The program was supposed to end in 2002, but an extension was approved and the program finished at the end of 2004. From 2005 onwards, the program becomes a permanent activity of the Ministry of Education. In fact, an administration unit in charge of coordinating school networks (*Redes Amigas*) was created in the Ministry of Education.

Every network had, on average, 12 schools, 750 pupils, and 31 teachers. A directive council, made up of 4 teachers, 3 members from the parents' committee, and 1 person from the community was put in charge of decisions related to administrative and pedagogical issues. In the peda-

gogical realm, the directive council was advised by the pedagogical committee, which consisted of the deputy director of the network and the corresponding director of each school. Each network had its own budget and therefore the capacity to hire teachers. In contrast to other schools in Ecuador, where the budget is administered and owned by the provincial directorate for education (*"Dirección Provincial de Educación"*), under *Redes Amigas* resources were transferred and administered by the network.

To participate in the program, schools have to meet the following requirements: a) be located in rural areas, b) be registered at the Ministry of Education (MOE), and c) apply to the program and sign an agreement with the MOE. Before signing the agreement with the MOE, it is compulsory to integrate the directive council as well as the pedagogical committee. In addition, the parents' committee and teachers must fill out a form to join the network.

Every network had two components in its budget: the budget that comes from the program that is distributed according to Table 3.1, and the budget from the government that is used to pay teachers' salaries and to purchase goods and services.

Table 3.1
Budget distribution of Redes Amigas

Activity	Percentage of the budget
Teachers training	15%
Teaching material	25%
Infrastructure	36%
Equipment	14%
Community participation	6%
Audit and consulting services	4%

Source: Redes Amigas

The central unit in charge of administrating the program offered assistance to school networks for five basic purposes: a) teacher-training, b) teaching materials, c) infrastructure, d) equipment, and e) community participation. At the end of the program it covered around 140,000 pupils, 2,200 schools, and 6,000 teachers, with a total of 187 networks. Of this total, 30% were Indigenous networks. The total coverage of the

program represents 58% of all public school students in rural areas, with 40% of those students living in the poorest regions of Ecuador. The program achieved universal coverage among the indigenous schools from the Costa and Amazonía.[11]

By comparing the number of pupils that attended the program and the program's annual budget (US$ 10 million), one can conclude that the per capita program spending was US$ 70 per year.

Finally, it is important to mention that the program had a strong opposition from the teachers' union of Ecuador (*Unión Nacional de Educadores*), especially because of budget transfer from the *Direcciones Provinciales* to the networks. They were against the decentralization strategy because under the *Redes Amigas* structure salaries as well as work conditions for teachers are negotiated at each school level instead of with the Ministry of Education at national level. Teachers' union felt this mechanism as affecting their negotiation power. On the other hand, parents as well as teachers and school directors (not pertaining to the teachers' union) were very enthusiastic about participating in the program. Teachers and school directors saw the program as an opportunity to improve school conditions, to obtain additional resources for school infrastructure and teaching materials, and to improve teachers' conditions, especially in terms of training. Communities saw the program as a way of participating in and monitoring the education process.[12]

3.4 Empirical specification

As mentioned in the introduction, the main idea of an impact evaluation study is to isolate the effect of the intervention. The application of experimental studies requires the design of a baseline and follow-up survey to be applied to randomly assigned groups to treatment and control. *Redes Amigas* did not incorporate any impact evaluation design during its implementation. In this regard it was not possible to have an experimental design. In addition, the program did not have any baseline survey. Within this data constrain, this chapter evaluates the impact of the program by combining two quasi-experimental approaches. The main idea of the methodological strategy is to correct for un-observables by using a pipeline comparison design, and to correct observables by using a propensity score matching. In what follows we develop the identification strategy in more depth.

Following the extensive literature on educational production functions,[13] where the outcome variable is regressed on various input variables intervening in the education process, one can start with the following model for the *i*-th student in the *n*-th school and in the *m*-th community:

$$Y_{inm} = f(X_{inm}, C_{nm}, T_{inm}) \quad (1)$$

Where Y is the outcome variable, X is a vector of student and household characteristics, C is a vector of community and school level variables prior to the program intervention that can influence program participation. T is an indicator variable which takes the value of 1 if a school belongs to a school network and zero if a school belongs to a quasi-network[14]. The main determinants of program participation, in our particular case, are school and community variables. As mentioned, schools that decided to participate in the program had to organize themselves and conform to the directive council (with the participation of community members). It is possible that communities with better organization and participation, as well as schools with more motivated principals, teachers and parents have a higher probability of participating in the program. In this regard, the level of community organization and some specific school characteristics seem important to understand program participation. Unfortunately, information at the school and community level prior to the program intervention is not abundant. In order to gather information on community and school level variables before the execution of the program, this research uses data from the 1990 population census, and from the Ministry of Education.[15] Variables at the parochial level were constructed using data from the 1990 population census. In this case the following variables were matched with our data; poverty incidence, the average years of schooling for those over 24 years of age, and the percentage of illiteracy among those over 14 years of age. In addition, prior to the second phase of the program, some variables from the Ministry of Education (1994) were computed both at the parochial and school level. At the parochial level, the average ratio of students per teacher, the average ratio of students per classroom, and the average ratio of students per school-building were calculated, while at the school level the repetition rate and the students per teacher ratio were used. These variables can have an impact on the outcome variables, as well as on program participation and are included as vector C in equation (1).[16]

Furthermore, program intervention can have an impact on school outcomes through the improvement of school and teacher characteristics, as well as changes in the management structure. One way of isolating the effect of changes in the institutional set up of a school is by including in equation (1) a vector of school and teacher characteristics that are influenced by program intervention. In this case, the model is:

$$Y_{inm} = f(X_{inm}, C_{nm}, S_n, T_{inm}) \tag{2}$$

Where *X*, *C* and *T* are the same as in equation (1), and *S* is a vector of school and teacher characteristics that are influenced by program execution, the difference between results for equation (2) and equation (1) is the effect of changes in the management structure.

Equation 1 can be specified empirically by using a linear model as follows:

$$Y_{inm} = \alpha_0 + X_{inm}\alpha_1 + \alpha_2 T_{inm} + \alpha_3 C_{nm} + \varepsilon_i \tag{3}$$

Where the alphas are the parameters to be estimated, and the key parameter of interest is α_2, ε is an error term normally distributed with zero mean and constant variance. To simplify the notation, error terms associated with the school and community level variables are omitted. The same can be extended to equation (2).

$$Y_{inm} = \beta_0 + X_{inm}\beta_1 + S_n\beta_2 + \beta_3 T_{inm} + \beta_4 C_{nm} + \mu_i \tag{4}$$

In this case the parameter of interest is β_3. Equations (3) and (4) will be estimated using OLS.

There are two limitations of estimates using equations 3 and 4. First, there may be unobserved variables that simultaneously influence program participation and test scores, and have not been accounted for in the model. In this regard, the treatment variable may be correlated to the error term leading to biased and inefficient estimates. To tackle this source of bias the paper relies on a pipeline comparison design.[17] This approach relies on using schools that have successfully applied for the program, but have not yet received it, as a comparison group. These applicants have already indicated a preference toward participation in the program (Angrist, 1998). Therefore, the comparison group is composed of schools that decided to organize themselves as networks, have integrated both the directive council, and the pedagogical committee, and

have subscribed to the agreement with the Ministry of Education of Ecuador to participate in the program. However, the program, mainly because of time and budget constraints and some administrative issues, has not yet been executed. These networks are referred to as quasi-networks.[18]

Second, the analysis is not restricted to the region of "common support"[19] and, in addition, uses a particular specification of the function (linear). One alternative to estimate program impact that allows one to correct both limitations is propensity score matching (PSM). This also allows one to correct for the existence of non-linearities. As already indicated, this paper restricts the PSM to the sample of applicants. The main idea is that by using the pipeline strategy one corrects for un-observables in the selection process, while by using a PSM one corrects for observables.[20] One strong assumption when performing a PSM is the un-confoundedness assumption. This means that program participation is exogenous or un-confounded with potential outcomes conditional on a sufficiently rich set of covariates or pretreatment variables. This can be expressed formally as follows:

$$Y_i(0), Y_i(1) \perp T_i \mid X_i$$

Where *Yi(0)* is the potential outcome for controls, and *Yi(1)* is the potential outcome for treatment. *T* and *X* were already defined and refers to the treatment and control variables respectively.

Under the un-confoundedness assumption the average treatment effect of the program for the treated can be estimated by comparing the outcomes for those in the treatment with those in the control group as follows:

$$ATT(x) \equiv E[Y(1) - Y(0) \mid X = x, T = 1]$$

If there are many covariates, it is recommended to use the propensity score (which is the conditional probability of receiving treatment given covariates). Rosenbaum and Rubin (1983, 1985) have shown that, under the assumption of un-confoundedness, adjusting solely for differences in the propensity score between treated and controls units removes all biases. The propensity score being:

$$p(x) \equiv \Pr(T = 1 \mid X = x) = E[T \mid X = x]$$

Which is assumed to be bounded away from zero and one:

$$0 < p(x) < 1$$

The probability of participating in the program can be computed by using an econometric model where the dependent variable is a dichotomous variable that takes the value of 1 for program participants and zero otherwise. One option is to use a probit model, where the program participation variable is regressed against community and school characteristics previous to program implementation (vector *C*). As already mentioned, community and school variables previous to program intervention are considered the main determinants of program participation. Moreover, the selection equation will control for some household variables.

Formally, let Y_i^k be the outcome variable for individual i in state k. There are two possible states for the outcome; k=1 in the presence of the program, and k=0 in its absence. The average treatment effect on the treated (ATT) when N participants in the program are matched to the nearest non-participant neighbor can be defined as follows:

$$ATT = (1/N)\sum_{i=1}^{N}(Y_i^1 - Y_i^0) \quad (5)$$

Where each participant (Y_i^1) is matched with the nearest non-participant (Y_i^0) based on the propensity score. It is important to note that a major source of bias while working with non-experimental studies is the failure to satisfy the common support condition (Heckman et al. 1998). Imposing common support means that inferences on the impact of the program can be confined to "comparable people" in terms of their propensity scores. Formally, the previous means that:

$$Supp(X \mid P = 1) = Supp(X \mid P = 0)$$

This condition is imposed in our PSM estimation.

Besides one-to-one matching, others types of matching are found in the literature (Ravallion, 2005). The five nearest neighbors and a Kernel matching will be used. In this case, in general terms, the estimator for the average treatment effect on the treated (ATT) can be defined by:

$$ATT = 1/N\sum_{i=1}^{N}(Y_i^1 - \sum_{j=1}^{C}W_{ij}Y_j^0) \quad (6)$$

Where W is the weight used in calculating the counterfactual for each participant, and C in the number of cases used to construct the counterfactual for each participant. Kernel estimates are computed using the Epanechnikov Kernel because it presents the highest asymptotic efficiency among the alternative Kernel distributions (Mittelhammer et al., 2000).

Recent developments in the matching literature show potential efficiency problems of PSM estimates when using bootstrap to compute standard errors. (Imbens, 2004; Hirano, Imbens and Ridder, 2003). Hirano, Imbens and Ridder (2003) propose another way of matching to obtain fully efficient estimates. According to them, one can use weighted OLS in the following equation:

$$Y_i = \gamma_0 + \gamma_1 T_i + X_i \gamma_2 + \varepsilon_i \tag{7}$$

Where Y, T and X are already defined, and the weights used are defined as 1 for the treated units, and $\hat{P}(X)/(1-\hat{P}(X))$ for controls.[21] In this case $\hat{P}$ is the estimated propensity score from the selection equation. Under this approach one can also estimate equation (7) incorporating school and teacher variables (S_i) affected by program intervention in order to isolate the effect of the program because of changes on school management.

As indicated above, PSM estimates will be biased if there are unobserved variables that jointly influence program participation and test scores. This research tries to control for un-observables by using a pipeline design. However, it is still possible that some un-observables influence the timing of program participation. As an example, more enthusiastic and organized communities and teachers can apply to participate in the program earlier than less organized and less enthusiastic communities. In this regard, quasi-networks could pertain to less enthusiastic and less organized communities and teachers and, for this reason, obtain lower scores. In this case, estimates from the pipeline design combined with the PSM will be biased upwards. One can test for un-observables by using a similar logic as the one used to estimate models with sample selection bias.[22] Consequently, one way of testing for un-observables is by analyzing the partial correlation between the outcome variable of the principal equation and the residuals from the selection equation. To do the previous, one can run the following model.

$$Y_i = \delta_0 + \delta_1 T_i + X_i \delta_2 + \delta_3 R_i + \upsilon_i \quad (8)$$

Where Y_i is the outcome variable, T_i is a dummy for program participation, X_i is a vector of control variables, and R_i are the generalized residuals from the probit model used to compute the propensity score in the PSM.[23] Selection bias is determined if δ_3 is different from zero.[24] A key issue in this test is the identification strategy used to estimate the model. Although differences in the functional form of the two equations (non-linear in the selection equation, and linear in the outcome equation) aids identification, it is a weak basis for identifying the model. As already mentioned, we did not find strong instruments in the data that could be used in this test. As a reference, we included pre-intervention variables in the selection equation, and excluded those from equation (8). In any case results of the test have to be taken carefully.

In methodological terms, one strong limitation of this study is the existence of only one survey. As mentioned, the evaluation study was conducted at the end of the program and no baseline survey was available. It would have been useful to have at least two surveys to construct panel data. If un-observables remain unchanged between the baseline and the follow-up survey, one can control for un-observables by using a difference-in-difference approach. In addition, because learning is a cumulative process, it would have been better to analyze the change in test scores (value added approach) as an outcome variable instead of only one point in time. This would be possible with panel data. However, as mentioned, the program did not have a baseline and it was only possible to incorporate information prior to the program, from the 1990 population census, and from administrative data from the Ministry of Education.

3.5 Data and descriptive statistics

Data were collected by the Latin America Faculty of Social Sciences (*Facultad Latinoamericana de Ciencias Sociales (FLACSO-Ecuador)*), and refer to the rural area of Ecuador.[25] Students from second and fourth grade in primary schools were interviewed. The survey was carried out from November 2004 through February of 2005, and used three different instruments: school, teacher, and household questionnaires. In addition, students from second and fourth grades were evaluated using standardized tests in both mathematics and language. Those tests were designed by a

pedagogical team and evaluated the level of basic skills achieved by children in both language and mathematics. The skills evaluated were the same as those used by the Ecuadorian System of Educational Achievements Measurement ("*Sistema Nacional de Medición de Logros Académicos SNMLA"*). Tests were different for the Hispanic and the bilingual schools.[26] For every child the research team gathered information on their test scores (in both math and language), characteristics of schools and teachers, and household variables. The test scores, as well as school and teacher questionnaires, were completed in the school, while the household questionnaire was filled out at the child's home. The research used a multi-stage cluster random sampling design, where, in the first stage, networks (and quasi-networks) were randomly selected. In the second stage, all the schools pertaining to the selected network were interviewed, and, finally, in the third stage, all the students from second and fourth grade were interviewed and took the tests. The sample was designed to have statistical representation for Hispanic and Indigenous networks as well. For this purpose, Indigenous networks were oversampled. Bilingual schools from the coast, as well as schools from the *Amazonia* (jungle) could not be included in the sample because the program achieved universal coverage and no controls were available. For this reason, the sample is representative in the Hispanic system for the Sierra and Costa regions, while in the bilingual system just for the Sierra.

Table 3.2
Sample size and distribution

	Second grade	Fourth grade
Hispanic		
Treatment	491	422
Control	435	448
Bilingual		
Treatment	206	167
Control	206	181
Total	1338	1218

The comparison group consisted of the total quasi-networks available at the time of the evaluation. The number of students sampled in bilingual and Hispanic schools, for treatment and comparison groups, as well

as for second- and fourth-grade is introduced in Table 3.2. The total sample size is 1,338 children from second-grade, and 1,218 children from fourth grade. In the Hispanic case, for second-grade, there are 491 children in the treatment group, and 435 in the comparison group. In the bilingual case, there are 206 children in the treatment group and 206 in the comparison group. In fourth grade, there are 422 and 448 children in the treatment and control group in the Hispanic case, as well as 167 and 181 in the treatment and comparison group in the bilingual case.

At the school level the sample size is of 147 schools (94 in the Hispanic system and 53 in the bilingual system). To have more comparable results of program impact, the sample design took into account the time of program intervention in order to avoid strong disparities among schools in the Hispanic and the Bilingual system. In this sense, the average number of years of program intervention is 6 for the Hispanic schools and 6 for the bilingual schools. The school questionnaire had information about the director of the school, school infrastructure, the number of teachers and its schooling level and experience, the number of students, the number of classrooms, books, computers, labs and other school inputs, location, and some information about the year of the last improvements (in terms of infrastructure) in the school. The teachers' questionnaire was applied to the person in charge of teaching mathematics and language. In this case the survey obtained information about teacher's schooling, experience, the type of contract (hired by the Ministry of Education or by the school), and the number of training courses attended during the last four years.

The household-questionnaire starts with a register of every household member, their names, sex, age and their relationship to the head of the household. Then, there is a module on household assets and infrastructure. On an individual level, the survey collects information on the schooling level, parents' level of education, marital status, and the language spoken by all household members. In addition, employment status, labor conditions and incomes are noted among persons aged 5 and over. For children between the ages of 5 and 17, information on school enrolment, the type of school attended, education spending, and attendance is available. Finally, the questionnaire has some questions about the time spent by the child in order to record the number of hours he/she works, helps in housework, watches television, and the degree of assistance received to complete homework assignments.

School, teacher, and household variables were matched to child variables. Table 3.3 introduces descriptive statistics for children from treatment and comparison groups of second grade in the Hispanic system. In addition, variables previous to program intervention are also included. Starting with child variables, students from the treatment group have better test scores than students from the comparison group for both math and language. In addition, children from the treatment group dedicate more hours to homework and to study with their parents, and to watch television than children from the comparison group. On the other hand, students from the comparison group work more hours on weekdays than those on the treatment group. Regarding household variables, the score in the Selben index[27] as well as the schooling of the household's head are higher for those in the treatment group. The control group has a higher percentage of households headed by indigenous. In general, the treatment group has better socioeconomic conditions than the control group. No significant differences are found in terms of household composition, except for the number of members from 6 to 17-years old. In this case the control group has more members than the treatment group.

In relation to school variables, as expected, children from the treatment group attend schools with better infrastructure and school inputs than children from the comparison group. The treatment group attends schools with more books, than children from the comparison group. Furthermore, the index of infrastructure[28] (out of five) is higher among children from the treatment group. Additionally, an important difference is that the percentage of children from the control group that attend to multi-grade schools is higher than those in the treatment group.

Regarding teacher characteristics, some significant differences are observed between treatment and comparison groups. Children in the treatment group are taught predominantly for female and younger teachers than those in the comparison group. In addition, the percentage of children attending classes with teachers contracted by the Central Ministry is higher for the comparison group. As previously mentioned, one of the key elements of *Redes Amigas* was that economic resources were transferred to the networks and teachers are hired and fired by the network. No significant differences are found in terms of teacher-training or in teachers' academic level. Finally, all variables previous to intervention show significant differences between the two groups. Control group has

Table 3.3
Descriptive statistics for control and treatment: second grade (Hispanic system)

Variable	Second grade			
	Treatment	Control	Difference	
Child variables				
Math (out of 20)	11.9556	7.4327	4.5229	*
			(0.3042)	
Language (out of 20)	12.8209	9.4747	3.3462	*
			(0.2916)	
Dummy female=1	0.4889	0.4821	0.0068	
			(0.0320)	
Number of hours worked on weekdays	4.9339	6.8940	-1.9601	*
			(0.5316)	
Hours dedicated to homework (daily)	1.6614	1.5062	0.1552	*
			(0.0516)	
Hours that children study with parents (daily)	0.8691	0.4853	0.3838	*
			(0.0476)	
Hours dedicated to watch TV. (daily)	1.5164	0.8530	0.6634	*
			(0.0716)	
Household variables				
Score in Selben index	46.7527	37.5201	9.2326	*
			(0.6801)	
Schooling of the household's head	6.5983	5.5063	1.0920	*
			(0.2225)	
Household's head is indigenous (%)	0.1030	0.3494	-0.2464	*
			(0.0255)	
Household's head is illiterate (%)	0.0991	0.1284	-0.0293	
			(0.0203)	
Household's head is female (%)	0.1474	0.1052	0.0422	**
			(0.0213)	
Number of members younger than 6 in the hh.	0.8591	0.9517	-0.0926	
			(0.0611)	
Number of members from 6 to 17 in the hh.	2.6690	2.9308	-0.2618	**
			(0.0883)	
Number of members from 18 to 44 in the hh.	1.8812	1.9224	-0.0412	
			(0.0588)	
Number of members from 45 to 64 in the hh.	0.3963	0.3731	0.0232	
			(0.0428)	
Number of members older than 64 in the hh.	0.1066	0.1341	-0.0275	
			(0.0260)	

(Continued)

higher levels of poverty incidence, illiteracy rates, and students per teacher at the parochial level.

Table 3.4 shows the same descriptive statistics for fourth grade in the Hispanic system. Results are similar to those found in second grade.

Table 3.3 (*Continuation)*

Variable	Second grade			
	Treatment	Control	Difference	
School variables				
% of children attending multi-grade schools	0.1649	0.2620	-0.0971	*
			(0.0260)	
% of children attending schools with full time director	0.0523	0.0628	-0.0105	
			(0.0149)	
Number of learning guides per child	0.0590	0.1366	-0.0776	*
			(0.0190)	
% of children attending schools with at least one computer	0.7706	0.7316	0.0390	
			(0.0276)	
Number of books per student	3.3459	2.4758	0.8701	**
			(0.3420)	
% of children attending schools with access to internet	0.0000	0.0628	-0.0628	*
			(0.0109)	
Index of school infrastructure (out of five)	4.0523	3.6058	0.4465	*
			(0.0485)	
Teacher variables				
% of children with female teacher	0.8692	0.6142	0.2550	*
			(0.0267)	
Average age of teachers	34.2535	40.9580	-6.7045	*
			(0.5940)	
% of children with teachers with superior academic level	0.7786	0.7987	-0.0201	
			(0.0261)	
% of children with teachers contracted by the Ministry	0.7545	0.9098	-0.1553	*
			(0.0235)	
Average number of training courses received by teachers (last four years)	8.3179	8.7861	-0.4682	
			(0.5279)	
Variables previous to intervention				
Poverty incidence	69.5771	81.0860	-11.5089	*
			(0.9308)	
Ratio student per teacher (parochial level)	12.8306	16.4648	-3.6342	*
			(0.2880)	
Ratio student per classroom (parochial level)	22.1266	21.8079	0.3187	
			(0.2796)	
Ratio student per school building (parochial level)	88.6374	79.0331	9.6043	*
			(2.5925)	
Illiteracy rate (parochial level)	13.8246	18.6785	-4.8539	*
			(0.3855)	
Years of schooling (parochial level)	5.3452	3.9758	1.3694	
			(0.0754)	
Percentage of people with superior education level	0.0752	0.0325	0.0427	*
			(0.0022)	
Repetition rate (school level)	0.0179	0.0256	-0.0077	**
			(0.0022)	
Ratio student per teacher (school level)	29.7346	25.8327	3.9019	*
			(0.6783)	

Note for Tables 3.3-3.6: Standard errors are in parenthesis. *Significant at 1%. ** Significant at 5%. *** Significant at 10%.

Table 3.4
Descriptive statistics for control and treatment: fourth grade (Hispanic system)

Variable	Fourth grade			
	Treatment	Control	Difference	
Child variables				
Math (out of 20)	9.7249	7.2570	2.4679	*
			(0.2620)	
Language (out of 20)	13.7762	11.9739	1.8023	*
			(0.2860)	
Dummy female=1	0.5221	0.4598	0.0623	**
			(0.0328)	
Number of hours worked on weekdays	5.3165	7.0916	-1.7751	*
			(0.4847)	
Hours dedicated to homework (daily)	1.7513	1.5638	0.1875	*
			(0.0556)	
Hours that children study with parents (daily)	0.6567	0.4278	0.2289	*
			(0.0453)	
Hours dedicated to watch TV (daily)	1.5705	0.9379	0.6326	*
			.0765	
Household variables				
Score in Selben index	46.3854	37.9890	8.3964	*
			(0.6942)	
Schooling of the household's head	6.1563	5.4878	0.6685	*
			(0.2339)	
Household's head is indigenous (%)	0.1007	0.3279	-0.2272	*
			(0.0264)	
Household's head is illiterate (%)	0.1384	0.1428	-0.0044	
			(0.0229)	
Household's head is female (%)	0.1662	0.1106	0.0556	**
			(0.0225)	
Number of members younger than 6 in the hh.	0.6736	0.8172	-0.1436	**
			(0.0581)	
Number of members from 6 to 17 in the hh.	2.8158	3.1445	-0.3287	**
			(0.0878)	
Number of members from 18 to 44 in the hh.	1.9090	1.9196	-0.0106	
			(0.0661)	
Number of members from 45 to 64 in the hh.	0.4335	0.5100	-0.0765	
			(0.0482)	
Number of members older than 64 in the hh.	0.0885	0.0963	-0.0078	
			(0.0214)	

(Continued)

Table 3.4 (*Continuation)*

Variable	Fourth grade			
	Treatment	Control	Difference	
School variables				
% of children attending multi-grade schools	0.1561	0.1726	-0.0165	
			(0.0244)	
% of children attending schools with full time director	0.0372	0.0522	-0.0150	
			(0.0137)	
Number of learning guides per child	0.0598	0.1307	-0.0709	*
			(0.0196)	
% of children attending schools with at least one computer	0.7132	0.7891	-0.0759	*
			(0.0282)	
Number of books per student	3.0525	3.1087	-0.0562	
			(0.3012)	
% of children attending schools with internet access	0.0000	0.0522	-0.0522	*
			(0.0107)	
Index of school infrastructure (out of five)	3.9976	3.7040	0.2936	*
			(0.0470)	
Teacher variables				
% of children with female teacher	0.5804	0.6385	-0.0581	***
			(0.0320)	
Average age of teachers	39.5244	40.8895	-1.3651	**
			(0.6155)	
% of children with teachers with superior academic level	0.8275	0.8493	-0.0218	
			(0.0242)	
% of children with teachers contracted by the Ministry	0.8484	0.8995	-0.0511	**
			(0.0216)	
Average number of training courses received by teachers (last four years)	8.6247	7.7991	0.8256	
			(0.3730)	
Variables previous to intervention				
Poverty incidence	69.3247	78.9492	-9.6245	*
			(0.9974)	
Ratio student per teacher (parochial level)	13.0975	16.2871	-3.1896	
			(0.2942)	
Ratio student per classroom (parochial level)	22.3800	22.3388	0.0412	
			(0.2869)	
Ratio student per school building (parochial level)	85.9899	82.2709	3.7190	
			(2.6345)	
Illiteracy rate (parochial level)	13.7579	17.8593	-4.1014	*
			(0.4084)	
Years of schooling (parochial level)	5.3110	4.1316	1.1794	*
			(0.0803)	
Percentage of people with superior education level	0.0740	0.0353	0.0387	
			(0.0022)	
Repetition rate (school level)	0.0199	0.0287	-0.0088	*
			(0.0023)	
Ratio student per teacher (school level)	29.7452	26.3407	3.4045	*
			(0.6465)	

Table 3.5
Descriptive statistics for control and treatment: second grade (bilingual system)

Variable	Second grade			
	Treatment	Control	Difference	
Child variables				
Math (out of 20)	5.8309	8.6895	-2.8586	*
			(0.4435)	
Language (out of 20)	7.6291	11.2780	-3.6489	*
			(0.3909)	
Dummy female=1	0.5258	0.4729	0.0529	
			(0.0455)	
Number of hours worked on weekdays	8.8685	27.4440	-18.5755	*
			(1.6589)	
Hours dedicated to homework (daily)	1.4830	1.4034	0.0796	
			(0.0725)	
Hours that children study with parents (daily)	0.3497	0.2768	0.0729	**
			(0.0216)	
Hours dedicated to watch TV. (daily)	0.2417	0.7996	-0.5579	*
			(0.0907)	
Household variables				
Score in Selben index	27.4680	34.3170	-6.8490	*
			(0.9967)	
Schooling of the household's head	2.3238	4.4053	-2.0815	*
			(0.3536)	
Household's head is indigenous (%)	0.9526	0.9407	0.0119	
			(0.0208)	
Household's head is illiterate (%)	0.4312	0.2771	0.1541	*
			(0.0433)	
Household's head is female (%)	0.1327	0.1962	-0.0635	***
			(0.0343)	
Number of members younger than 6 in the hh.	1.1830	0.9134	0.2697	**
			(0.0907)	
Number of members from 6 to 17 in the hh.	3.0751	3.1552	-0.0801	
			(0.1157)	
Number of members from 18 to 44 in the hh.	1.8967	1.6895	0.2072	**
			(0.0982)	
Number of members from 45 to 64 in the hh.	0.5258	0.5054	0.0204	
			(0.0717)	
Number of members older than 64 in the hh.	0.1971	0.1263	0.0708	
			(0.0488)	

(Continued)

Table 3.5 (*Continuation)*

Variable	Second grade			
	Treatment	Control	Difference	
School variables				
% of children attending multi-grade schools	0.2112	0.1588	0.0524	***
			(0.0351)	
% of children attending schools with full-time director	0.0000	0.0252	-0.0252	**
			(0.0107)	
Number of learning guides per child	0.0852	0.0214	0.0638	*
			(0.0154)	
% of children attending schools that have at least one computer	0.2159	0.1335	0.0824	**
			(0.0340)	
Number of books per student	1.5249	1.4303	0.0946	
			(0.3131)	
% of children attending schools that have access to internet	0.0000	0.0000	0.0000	
			0	
Index of school infrastructure (out of five)	3.2582	3.4945	-0.2363	
			(0.0988)	
Teacher variables				
% of children with female teacher	0.4272	0.4332	-0.0060	
			(0.0452)	
Average age of teachers	32.7511	30.8808	1.8703	**
			(0.7063)	
% of children with teachers with superior academic level	0.7464	0.7256	0.0208	
			(0.0403)	
% of children with teachers contracted by the Ministry	0.5023	0.5234	-0.0211	
			(0.0456)	
Average number of training courses received by teachers (last four years)	9.1220	7.7111	1.4109	
			(1.4113)	
Variables previous to intervention				
Poverty incidence	92.3483	90.2179	2.1304	**
			(0.8030)	
Ratio student per teacher (parochial level)	16.8101	20.1332	-3.3231	*
			(0.6149)	
Ratio student per classroom (parochial level)	26.0079	25.0079	0.9999	**
			(0.46079)	
Ratio student per school building (parochial level)	98.3741	81.1411	17.2330	*
			(3.8508)	

(Continued)

***Table 3.5** (Continuation)*

Variable	Second grade			
	Treatment	Control	Difference	
Illiteracy rate (parochial level)	40.4559	41.5311	-1.0752	
			(1.5464)	
Years of schooling (parochial level)	3.4575	2.7664	0.6911	*
			(0.1875)	
Percentage of people with superior education level	0.0739	0.0612	0.0128	*
			(0.0048)	
Repetition rate (school level)	0.0025	0.0007	0.0018	**
			(0.0007)	
Ratio student per teacher (school level)	24.6347	24.6316	0.0031	
			(0.8529)	

Table 3.5 presents descriptive statistics for second grade in the bilingual system. In this case, students from the comparison group have higher test scores than those of the treatment group in both mathematics and language. In addition, children from the comparison group work considerably more hours on weekdays, and dedicate fewer hours to study with parents than those in the treatment group. Regarding household variables, children from the comparison group have better socioeconomic conditions that those from the treatment group. The comparison group has a higher score in the Selben index, and the head of the household has a higher level of education than the treatment group. No significant differences are found in the percentage of households headed by indigenous peoples. One interesting point in the indigenous case is that most of school conditions are not statistically different between comparison and treatment groups. There are no differences in the infrastructure index, the number of books, or access to Internet. However, there are better conditions for the comparison group in terms of multi-grade schools, learning-guides per student, and full time director. No significant differences are found in terms of teacher variables. Finally, the comparison group has a lower poverty incidence, but the treatment group has better schooling levels at the parochial level.

Similar results are observed in fourth-grade. See Table 3.6.

Table 3.6
Descriptive statistics for control and treatment: fourth grade (bilingual system)

Variable	Fourth grade			
	Treatment	Control	Difference	
Child variables				
Math (out of 20)	6.4137	9.2731	-2.8594	*
			(0.3595)	
Language (out of 20)	7.1666	9.8981	-2.7315	*
			(0.3757)	
Dummy female=1	0.5057	0.4444	0.0613	
			(0.0508)	
Number of hours worked on weekdays	9.9684	33.3310	-23.3626	*
			(2.3870)	
Hours dedicated to homework (daily)	1.4425	1.4876	-0.0451	
			(0.0748)	
Hours that children study with parents (daily)	0.3060	0.2530	0.0530	
			(0.0508)	
Hours dedicated to watch TV (daily)	0.2442	0.5787	-0.3345	*
			(0.0854)	
Household variables				
Score in Selben index	28.5939	34.7311	-6.1372	*
			(1.1305)	
Schooling of the household's head	3.2941	4.4272	-1.1331	**
			(0.4582)	
Household's head is indigenous (%)	0.9298	0.9209	0.0089	
			(0.0270)	
Household's head is illiterate (%)	0.3567	0.3411	0.0156	
			(0.0489)	
Household's head is female (%)	0.1111	0.2046	-0.0935	**
			(0.0376)	
Number of members younger than 6 in the hh.	1.0517	0.7870	0.2647	**
			(0.0943)	
Number of members from 6 to 17 in the hh.	3.4425	3.1064	0.3361	**
			(0.1332)	
Number of members from 18 to 44 in the hh.	1.9195	1.8888	0.0307	
			(0.1128)	
Number of members from 45 to 64 in the hh.	0.5747	0.5046	0.0701	
			(0.0788)	
Number of members older than 64 in the hh.	0.1264	0.0879	0.0385	
			(0.0367)	

(Continued)

Table 3.6 (Continuation)

Variable	Fourth grade			
	Treatment	Control	Difference	
School variables				
% of children attending multi-grade schools	0.2241	0.1435	0.0806	**
			(0.0389)	
% of children attending schools with full-time director	0.0000	0.0324	-0.0324	**
			(0.0134)	
Number of learning guides per child	0.0617	0.0244	0.0373	*
			(0.0130)	
% of children attending schools with at least one computer	0.2298	0.1481	0.0817	**
			(0.0394)	
Number of books per student	1.5634	1.5041	0.0593	
			(0.3921)	
% of children attending schools with Internet access	0.0000	0.0000	0.0000	
			0	
Index of school infrastructure (out of five)	3.1954	3.5370	-0.3416	*
			(0.1086)	
Teacher variables				
% of children with female teacher	0.3045	0.2592	0.0453	
			(0.0457)	
Average age of teachers	33.1436	32.4675	0.6761	
			(0.8053)	
% of children with teachers with superior academic level	0.8965	0.7824	0.1141	
			(0.0376)	
% of children with teachers contracted by the Ministry	0.6551	0.6712	-0.0161	
			(0.0482)	
Average number of training courses received by teachers (last four years)	6.4425	6.5972	-0.1547	
			(0.5974)	
Variables previous to intervention				
Poverty incidence	93.0994	90.8220	2.2774	**
			(0.9022)	
Ratio student per teacher (parochial level)	18.2533	20.9606	-2.7073	*
			(0.7116)	
Ratio student per classroom (parochial level)	25.0303	25.1932	-0.1629	
			(0.4567)	
Ratio student per school building (parochial level)	99.4929	75.4402	24.0527	*
			(4.0879)	
Illiteracy rate (parochial level)	43.2205	42.7989	0.4216	
			(1.8088)	
Years of schooling (parochial level)	3.2825	2.5806	0.7019	*
			(0.2069)	
Percentage of people with superior education level	0.0706	0.0572	0.0134	**
			(0.0052)	
Repetition rate (school level)	0.0015	0.0004	0.0011	**
			(0.0006)	
Ratio student per teacher (school level)	26.7809	25.3750	1.4059	
			(1.0821)	

In sum, from this descriptive analysis one can conclude that, in the Hispanic case, schools that finally received program intervention are composed of students with better socioeconomic background than schools that did not receive treatment. In the bilingual case, it is the opposite. Schools that receive the intervention are composed of students with worse socioeconomic conditions than schools that do not receive treatment. If the pipeline design worked appropriately one would not expect such differences. In addition, the large differences in observable characteristics amongst the treatment and control groups raises doubts about the ability of the pipeline comparison design to control for differences in unobservable characteristics. This issue will be evaluated later on in the text.

Finally, in the Hispanic system, treatment schools have better infrastructural and learning conditions that those in the comparison group, while in the bilingual system no significant differences are observed between treatment and comparison schools. This could mean differences in program application between the Hispanic and the bilingual system. In this regard, it seems important to highlight that the application of the program in the bilingual system started at the end of the 1990s. For this reason, the pedagogical materials and school inputs used by the program were the same as those developed under the Hispanic system. Although the first experiences of bilingual schools started in the early 1980s, the pedagogical materials used by the program did not reflect this important experience. Additionally, in the bilingual case the Ministry explicitly promoted the participation in the program of the poorer schools. In the Hispanic case, meanwhile, there was more self-selection, and participation in the program depended more on the community, teachers and parents' willingness.

3.6 Results

3.6.1 OLS estimation

The first step to evaluate the program impact, as indicated in the methodological section, was to run an education production function. In this regard, OLS estimates of equations 3 and 4 are introduced in Tables from 3.7 to 3.10. In those tables the following specifications were used. Specification 1 includes only the treatment variable to see the simple difference in test scores between treatment and comparison groups. Speci-

fication 2 includes, in addition, child[29] and household variables. Observed household and children characteristics reflect parents' ability to provide a supportive environment for their children. At the individual level, some characteristics that seem important are; sex, since parents or teachers may treat boys and girls differently, and age, since older students are more mature and more likely to score higher, and they can also have potential achievement problems. Because of credit market imperfections in the Ecuadorian context, assets variables, expressed through the Selben index, are included to take into account socioeconomic circumstances of the household. In addition, parent's characteristics, which can affect living standards and preferences for children's education, are also included (ethnicity, and illiteracy). Finally, household composition seems important because more children implies less time for parents to dedicate to every child. Specification 3 includes, in addition, community and school level characteristics previous to program intervention. As already mentioned, community and school level characteristics were important to determine program participation. Poverty and illiteracy levels give us an idea of the socioeconomic level of the community. In addition, student per teacher, student per school building, and student per classroom, were computed at parochial level and included to proportionate an idea of the schooling context of the community. Finally, some variables at school level are also included, such as the repetition rate and the student per classroom ratio.[30] Specification 4 includes, in addition, some school and teacher characteristics that are influenced by program execution and are expected to affect test scores. The following variables were included in this case; the school infrastructure index, the number of learning-guides per student, the number of textbooks per students, a dummy variable for schools with full-time principal, and the number of training courses received by teachers in the last four years. Those variables try to capture the different components of program execution. As stated above, specification 3 represents the overall effect of the program, while specification 4 estimates the effect of changes in school management after controlling for improvements in school inputs.

Table 3.7
OLS estimates of program impact on test scores: equations 3 and 4 second grade (Hispanic system)

Mathematics, second grade

	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	4.4423*	0.6766	4.1638*	0.7115	3.9356*	0.7712	3.5757*	0.7562
Age			1.0425	1.3001	1.4305	1.3237	1.3588	1.3251
Age squared			-0.0519433	0.0701	-0.0674	0.0714	-0.0670	0.0721
Dummy (1=female)			0.1220	0.3165	0.17450	0.3035	0.1857	0.3050
Selben index			0.0224	0.0238	0.0163	0.0240	0.0310	0.0201
Schooling of the head of hh.			-0.0739	0.0513	-0.0716	0.0475	-0.0796	0.0489
Head of hh indigenous			-1.0153***	0.5618	-1.2779**	0.6017	-1.4140**	0.5740
Head of hh is female			0.2980	0.5773	0.2719	0.5512	0.2798	0.5416
Hh members aged <6			-0.004789	0.1801	-0.0900	0.1758	-0.0371	0.1705
Hh members aged 6–17			-0.1752834	0.1465	-0.1968	0.1381	-0.1644	0.1369
Hh members aged 18–44			0.1823***	0.1864	0.1642	0.1757	0.1019	0.1687
Hh members aged 45–65			-0.4040645	0.2185	-0.3191	0.2060	-0.3315	0.2078
Hh members aged >65			0.1560846	0.3764	-0.0162	0.3781	-0.0058	0.3715
Dummy for region (Cos-ta=1)			-0.0368644	0.7902	-1.4881	0.9248	-1.1934	0.9398
Poverty incidence (parrochial level, 1990)					-0.0656**	0.0292	-0.0630**	0.0269
Illiteracy rate (parrochial level, 1990)					-0.00465	0.0567	0.0049	0.0502
Student per teacher (parrochial level, 1994)					0.00865	0.0753	-0.0353	0.0732
Student per school building (parroch. level)					-0.0351*	0.0125	-0.0340**	0.0113
Student per classroom (parrochial level, 1994)					0.2719**	0.1330	0.2753**	0.1320
Repetition rate (school level, 1994)					-18.074**	8.1353	-18.234**	9.0326
Student per teacher (school level, 1994)					0.0109	0.0313	0.0144	0.0300
School infrastructure index							-0.0106	0.3658
Number of learnig guides per student							1.5003	1.0537
Number of textbooks per student							0.03941	0.0373
Dummy (full time principal = 1)							0.0610	2.2251
Number of training courses for teachers							-0.0614**	0.0244
Constant	7.4965*	0.4532	2.5207	0.687	3.3234	6.8149	3.773575	6.6725
Number of cases	926		926		926		926	
R squared	0.1792		0.1971		0.2385		0.2541	

	Language, second grade							
	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	3.0061*	0.6860	2.1808*	0.6843	2.0289*	0.6526	2.1475*	0.6705
Age			1.2556	0.9534	1.5144***	0.9258	1.776**	0.8722
Age squared			-0.0692	0.0542	-0.0818	0.0524	-0.0962**	0.0489
Dummy (1=female)			-0.0589	0.2997	-0.0711	0.2865	-0.1011	0.2967
Selben index			0.0738*	0.0263	0.0675*	0.0245	0.0577**	0.0236
Schooling of the head of hh.			-0.0099	0.0561	-0.0091	0.0544	-0.00771	0.0548
Head of hh is indigenous			-1.8825*	0.6336	-1.4854**	0.6368	-1.368**	0.6555
Head of hh is female			-0.1506	0.4984	-0.1758	0.4771	-0.2384	0.4823
Hh members aged <6			0.1923	0.1736	0.1100	0.1750	0.1068	0.1778
Hh members aged 6–17			-0.0036	0.1121	-0.0282	0.1163	-0.0397	0.1157
Hh members aged 18–44			-0.0892	0.2036	-0.0786	0.2073	-0.075	0.2066
Hh members aged 45–65			-0.0896	0.2600	-0.0495	0.2588	-0.0363	0.2583
Hh members aged >65			-0.3103	0.4447	-0.2853	0.4201	-0.2720	0.4135
Dummy for region (Costa=1)			-0.3569	0.7044	-1.535***	0.8467	-1.6172**	0.8241
Poverty incidence (parrochial level, 1990)					-0.0147	0.0181	-0.0212	0.0210
Illiteracy rate (parrochial level, 1990)					-0.113**	0.0456	-0.0998**	0.0500
Student per teacher (parrochial level, 1994)					0.0399	0.0871	0.0763	0.1000
Student per school building (parroch. level)					-0.0217**	0.0092	-0.0207**	0.0095
Student per classroom (parrochial level, 1994)					0.1697	0.1183	0.1403	0.1196
Repetition rate (school level, 1994)					-14.786**	6.8832	-16.882**	7.2197
Student per teacher (school level, 1994)					0.020	0.0267	0.0197	0.0254
School infrastructure index							0.2547	0.4704
Number of learnig guides per student							-0.3612	0.5362
Number of textbooks per student							0.0430	0.0343
Dummy (full time principal = 1)							1.2230***	0.7380
Number of training courses for teachers							0.0333	0.0242
Constant	9.8068*	0.4540	2.1964	4.2114	1.9074	4.5973	0.0465	5.0873
Number of cases	926		926		926		926	
R squared	0.1013		0.1638		0.204		0.2133	

Note: *Significant at 1%, ** Significant at 5%, and *** significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations

Table 3.8
OLS estimates of program impact on test scores: equation 3 and 4 fourth-grade (Hispanic system)

Mathematics, fourth grade

	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	2.3588*	0.5487	2.168*	0.5325	2.177*	0.5462	2.201*	0.5023
Age			1.108	1.2863	0.8467	1.2787	0.8994	1.2834
Age squared			-0.0529	0.0567	-0.040	0.0563	-0.0424	0.0570
Dummy (1=female)			0.5360	0.3008	0.584**	0.2977	0.5737**	0.2864
Selben index			-0.0007	0.0241	-0.002	0.0249	0.0032	0.0232
Schooling of the head of hh.			-0.0278	0.0451	-0.041	0.0480	-0.0149	0.0451
Head of hh is indigenous			-1.2218**	0.5861	-1.602*	0.5181	-1.327*	0.5004
Head of hh is female			0.2491	0.4802	0.3050	0.4549	0.4108	0.4645
Hh members aged <6			0.0529	0.1803	0.0168	0.1728	0.0496	0.1634
Hh members aged 6–17			0.0447	0.1405	0.0261	0.1326	0.0273	0.1295
Hh members aged 18–44			0.2106	0.1312	0.211	0.1313	0.1723	0.1348
Hh members aged 45–65			-0.0292	0.2009	-0.0533	0.2082	0.0304	0.2015
Hh members aged >65			0.8115**	0.3566	0.717**	0.3546	0.8129**	0.3406
Dummy for region (Costa=1)			0.1146	0.5849	-0.0741	0.5625	0.0402*	0.5169
Poverty incidence (parrochial level, 1990)					-0.0586	0.0204	-0.0548*	0.0209
Illiteracy rate (parrochial level, 1990)					0.0830	0.0590	0.1022***	0.0632
Student per teacher (parrochial level, 1994)					0.1421	0.0981	0.132***	0.0791
Student per school building (parroch. level)					-0.0024	0.0081	0.0029	0.0074
Student per classroom (parrochial level, 1994)					-0.1127	0.1060	-0.1395	0.0928
Repetition rate (school level, 1994)					-7.986	8.0373	-9.511	7.8926
Student per teacher (school level, 1994)					0.0424	0.0328	0.050	0.0313
School infrastructure index							0.268	0.3850
Number of learnig guides per student							2.815*	0.8247
Number of textbooks per student							0.113*	0.0525
Dummy (full time principal = 1)							1.1559***	0.7021
Number of training courses for teachers							-0.0237	0.0385
Constant	7.401*	0.3419	1.238	7.1008	5.590	6.9270	2.861	6.9043
Number of cases	870		870		870		870	
R squared	0.0809		0.1064		0.1483		0.1959	

	Language, fourth grade							
	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	1.536**	0.7927	0.7602	0.6903	1.1123**	0.5360	1.139**	0.4372
Age			2.287**	1.1401	1.957***	1.0954	1.982**	1.0390
Age squared			-0.0976**	0.0500	-0.084***	0.0482	-0.085***	0.0455
Dummy (1=female)			0.2657	0.2780	0.3252	0.2594	0.3326	0.2512
Selben index			0.1243*	0.0218	0.0851*	0.0186	0.084*	0.0174
Schooling of the head of hh.			0.0385	0.0484	-0.0114	0.0427	0.0084	0.0401
Head of hh is indigenous			-1.502**	0.6218	-0.6617	0.4603	-0.4943	0.4765
Head of hh is female			-0.3459	0.4126	-0.4530	0.4149	-0.4759	0.4238
Hh members aged <6			0.0535	0.2155	-0.1291	0.1759	-0.118	0.1706
Hh members aged 6–17			-0.0058	0.0996	-0.111	0.1089	-0.1526	0.1110
Hh members aged 18–44			0.0619	0.1502	0.104	0.1367	0.0386	0.1380
Hh members aged 45–65			-0.1732	0.2109	-0.121	0.1939	-0.1003	0.2010
Hh members aged >65			0.6202	0.3784	0.4769	0.3776	0.4974	0.3863
Dummy for region (Costa=1)			-1.255***	0.6879	-2.037*	0.6441	-1.996*	0.5498
Poverty incidence (parrochial level, 1990)					-0.058*	0.0236	-0.0578*	0.0199
Illiteracy rate (parrochial level, 1990)					-0.1367*	0.0393	-0.1273*	0.0418
Student per teacher (parrochial level, 1994)					0.233*	0.0467	0.2691*	0.0579
Student per school building (parroch. level)					-0.0044	0.0074	-0.0006	0.0065
Student per classroom (parrochial level, 1994)					-0.0472	0.0985	-0.1076	0.0851
Repetition rate (school level, 1994)					-0.1758	8.0768	-4.4564	7.4929
Student per teacher (school level, 1994)					-0.0204	0.0356	-0.021	0.0313
School infrastructure index							0.1248	0.3313
Number of learnig guides per student							1.147**	0.5417
Number of textbooks per student							0.193**	0.0757
Dummy (full time principal = 1)							0.5116	0.6286
Number of training courses for teachers							-0.051	0.0369
Constant	12.281+	0.4164	-5.361	6.6613	3.9555	6.6544	3.554	6.6805
Number of cases	870		870		870		870	
R squared	0.0312		0.2002		0.2875		0.3272	

Note: *Significant at 1%, ** Significant at 5% *** Significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Table 3.9
OLS estimates of program impact on test scores: equation 3 and 4 second grade (bilingual system)

Mathematics, second grade

	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-2.5388**	1.190	-1.7109	1.2581	-3.2841*	1.2009	-3.444*	1.2703
Age			1.3418	0.8363	0.6592	0.7046	0.6339	0.7317
Age squared			-0.0496	0.0391	-0.0201	0.0345	-0.0152	0.0361
Dummy (1=female)			-0.5408	0.4585	-0.8814**	0.4314	-0.7419	0.4049
Selben index			0.1179*	0.0384	0.0252	0.0344	0.0204	0.0315
Schooling of the head of hh.			-0.0361	0.0595	0.0133	0.0611	0.0335	0.0555
Head of hh is indigenous			-1.8241**	0.9230	-1.8436**	0.7558	-1.7161**	0.8329
Head of hh is female			-0.9111	0.7032	-0.6577	0.5423	-0.3815	0.5445
Hh members aged <6			0.3485	0.2814	-0.0035	0.2420	0.0844	0.2212
Hh members aged 6–17			0.0007	0.1674	0.0217	0.1761	-0.0644	0.1715
Hh members aged 18–44			-0.2177	0.2565	-0.1842	0.2312	-0.2529	0.2197
Hh members aged 45–65			0.3179	0.2973	0.2138	0.3018	0.2595	0.3163
Hh members aged >65			-0.5930**	0.3015	-0.4133	0.3210	-0.3722	0.3524
Poverty incidence (parrochial level, 1990)					0.0231	0.1182	0.0952	0.1225
Illiteracy rate (parrochial level, 1990)					-0.0514	0.0956	-0.1366	0.0912
Student per teacher (parrochial level, 1994)					-0.2155	0.1950	-0.1305	0.1592
Student per school building (parrochial level)					-0.0134	0.0189	-0.0159	0.0203
Student per classroom (parrochial level, 1994)					0.2187**	0.0955	0.1044	0.0888
Repetition rate (school level, 1994)					162.261*	35.9733	133.20*	39.0924
Student per teacher (school level, 1994)					-0.0828	0.0727	-0.0151	0.0706
School infrastructure index							-0.3485	0.4342
Number of learnig guides per student							-1.5013	2.0665
Number of textbooks per student							0.0385	0.0693
Dummy (full time principal = 1)							-7.9001*	2.0463
Number of training courses for teachers							0.0820*	0.0199
Constant	8.3446*	0.7113	-1.6533	5.317902	7.4120	8.2398	4.908	7.7323
Number of cases	412		412		412		412	
R squared	0.0677		0.1387		0.3132		0.391	

Language, second grade

	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-3.2912*	1.0544	-2.957**	1.1555	-3.259**	1.3342	-3.838*	1.3734
Age			0.4756	0.6048	0.5037	0.5114	0.5455	0.5169
Age squared			-0.0150	0.0273	-0.0139	0.0243	-0.0158	0.0243
Dummy (1=female)			-0.6372	0.4802	-0.9071**	0.4169	-0.9502**	0.4032
Selben index			0.0586	0.0398	0.0105	0.0366	0.0205	0.0373
Schooling of the head of hh.			-0.0478	0.0563	0.0075	0.0536	-0.0085	0.0540
Head of hh is indigenous			-1.595***	0.9170	-0.2879	0.9863	-0.3796	1.0179
Head of hh is female			0.8544	0.6097	0.5981	0.6341	0.5441	0.6428
Hh members aged <6			0.2790	0.2845	0.1560	0.2068	0.1745	0.2067
Hh members aged 6–17			-0.0755	0.1754	-0.0721	0.1690	-0.0987	0.1704
Hh members aged 18–44			-0.1662	0.2141	-0.1878	0.2123	-0.1695	0.1989
Hh members aged 45–65			0.0249	0.2424	-0.0059	0.2396	0.0291	0.2324
Hh members aged >65			-0.0446	0.2990	-0.0241	0.3416	-0.1982	0.3426
Poverty incidence (parrochial level, 1990)					0.1525	0.1038	0.2074***	0.1080
Illiteracy rate (parrochial level, 1990)					-0.2339*	0.0835	-0.2382**	0.0902
Student per teacher (parrochial level, 1994)					0.1240	0.1721	0.0810	0.1685
Student per school building (parrochial level)					-0.0117	0.0214	-0.0077	0.0210
Student per classroom (parrochial level, 1994)					-0.0422	0.0760	-0.0425	0.1003
Repetition rate (school level, 1994)					62.805**	24.8776	60.60***	34.6953
Student per teacher (school level, 1994)					0.0378	0.0555	0.0632	0.0625
School infrastructure index							0.0460	0.4022
Number of learnig guides per student							3.038***	1.6673
Number of textbooks per student							0.0641	0.0630
Dummy (full time principal = 1)							-3.016***	1.7195
Number of training courses for teachers							-0.0034	0.0177
Constant	10.8009	0.6542	7.8100***	4.6316	2.555	6.9345	-2.813	7.7685
Number of cases	412		412		412		412	
R squared	0.1325		0.1679		0.3293		0.3533	

Note: *Significant at 1%, ** Significant at 5% *** Significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Table 3.10
OLS estimates of program impact on test scores: equation 3 and 4 fourth grade (bilingual system)

Mathematics, fourth grade

	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-3.012*	0.7845755	-3.064*	0.7334	-4.338*	1.2221	-5.385*	1.6532
Age			-0.3729**	0.1979	-0.3296	0.2578	-0.228	0.2833
Age squared			0.0081**	0.0037	0.0066	0.0051	0.0043	0.0055
Dummy (1=female)			-0.3336	0.4253	-0.2809	0.4261	-0.0262	0.4209
Selben index			0.0350	0.0279	0.038	0.0265	0.027	0.0265
Schooling of the head of hh.			-0.065	0.0479	-0.0742	0.0507	-0.0787	0.0504
Head of hh is indigenous			-1.260***	0.7266	-1.004	0.6441	-1.012	0.6418
Head of hh is female			0.684	0.6155	0.6494	0.5897	0.700	0.5868
Hh members aged <6			-0.1253	0.2865	-0.098	0.2950	-0.135	0.2913
Hh members aged 6–17			0.291***	0.1551	0.1819	0.1403	0.184	0.1359
Hh members aged 18–44			0.511**	0.2402	0.4929**	0.2319	0.388***	0.2281
Hh members aged 45–65			0.320	0.2700	0.2690	0.2699	0.071	0.2526
Hh members aged >65			0.1850	0.4871	0.1147	0.4248	-0.0860	0.4488
Poverty incidence (parrochial level, 1990)					0.1297	0.1165	0.207***	0.1225
Illiteracy rate (parrochial level, 1990)					0.055	0.0969	0.053	0.1031
Student per teacher (parrochial level, 1994)					-0.2156	0.1622	-0.2932	0.2006
Student per school building (parrochial level)					0.0077	0.0189	0.0139	0.0216
Student per classroom (parrochial level, 1994)					-0.200**	0.0976	-0.282***	0.1615
Repetition rate (school level, 1994)					-10.898	23.5797	-24.13	35.8086
Student per teacher (school level, 1994)					0.077	0.0598	0.123**	0.0603
School infrastructure index							-0.233	0.4906
Number of learnig guides per student							3.196	2.6006
Number of textbooks per student							0.096	0.0746
Dummy (full time principal = 1)							-5.566**	2.3035
Number of training courses for teachers							0.0083	0.0524
Constant	9.425*	0.5286598	11.056	2.158252	3.7867	8.8415	-0.658	8.1155
Number of cases	348		348		348		348	
R squared	0.1584		0.2059		0.2487		0.3002	

Language, fourth grade

	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-2.68*	0.7699793	-2.222*	0.7727	-2.657	1.6423	-3.023	2.1799
Age			-0.0166	0.2571	0.1301	0.2927	0.084	0.2905
Age squared			0.0038	0.0045	0.0005	0.0053	0.0008	0.0053
Dummy (1=female)			-0.3735	0.4481	-0.4675	0.4588	-0.428	0.4359
Selben index			0.076**	0.0335	0.059***	0.0316	0.0469	0.0302
Schooling of the head of hh.			0.0215	0.0451	0.0321	0.0413	0.022	0.0392
Head of hh is indigenous			0.4207	0.5187	0.4604	0.5754	0.3688	0.5461
Head of hh is female			0.4261	0.4873	0.4842	0.4658	0.4581	0.4383
Hh members aged <6			-0.0836	0.2407	-0.086	0.2250	-0.1463	0.2068
Hh members aged 6–17			0.111	0.1512	-0.0047	0.1247	-0.015	0.1262
Hh members aged 18–44			0.235	0.2233	0.2149	0.2127	0.1638	0.2111
Hh members aged 45–65			0.295	0.2588	0.1958	0.2526	0.0934	0.2523
Hh members aged >65			0.3725	0.5997	0.195	0.6368	0.0524	0.5960
Poverty incidence (parrochial level, 1990)					0.127	0.1151	0.183	0.1299
Illiteracy rate (parrochial level, 1990)					-0.078	0.1175	-0.0998	0.1278
Student per teacher (parrochial level, 1994)					-0.0938	0.1948	-0.116	0.2379
Student per school building (parrochial level)					-0.0062	0.0243	-0.0103	0.0273
Student per classroom (parrochial level, 1994)					0.0636	0.1384	0.097	0.1952
Repetition rate (school level, 1994)					23.08	26.9811	33.41	37.8907
Student per teacher (school level, 1994)					0.061	0.0459	0.091**	0.0416
School infrastructure index							0.1975	0.4238
Number of learnig guides per student							5.442**	2.6102
Number of textbooks per student							0.0465	0.0635
Dummy (full time principal = 1)							-0.5618	1.9792
Number of training courses for teachers							-0.1187**	0.0499
Constant	9.80*	0.4662342	5.569***	3.2487	-3.728	8.3031	-7.485	7.8747
Number of cases	348		348		348		348	
R squared	0.1202		0.1703		0.2133		0.2775	

Note: *Significant at 1%, ** Significant at 5% *** Significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Table 3.11
Probit model to estimate the equation for program participation

Dependent variables: T (1=Redes Amigas)	Hispanic				Indigenous			
	Second grade		Fourth grade		Second grade		Fourth grade	
	Coeficient	*Std. Error*	*Coeficient*	*Std. Error*	*Coeficient*	*Std. Error*	*Coeficient*	*Std. Error*
Age	-0.1956	0.4465	-0.9869***	0.5352	-1.340*	0.4191	-0.0732	0.1422
Age squared	0.020	0.0248	0.0516	0.0244	0.0577*	0.0188	0.0002	0.0026
Dummy (1=female)	0.0502	0.0873	0.226**	0.0890	0.0976	0.1053	0.1127	0.1431
Selben index	0.0680*	0.0103	0.0652*	0.0120	-0.0821*	0.0152	-0.0825*	0.0169
Schooling of the head of hh.	0.0076	0.0227	-0.0232	0.0234	-0.0606**	0.0251	0.0421	0.0359
Head of hh is indigenous	-0.2405	0.2613	-0.4146	0.3619	-0.4621	0.5499	0.6412**	0.3031
Head of hh is female	0.2926**	0.1368	0.21401	0.1811	0.1209	0.2593	-0.527**	0.2803
Hh members aged <6	0.2006*	0.0579	0.0991	0.0694	-0.0755	0.0759	0.0957	0.0856
Hh members aged 6–17	-0.0358	0.0305	0.0030	0.0565	-0.0802	0.0570	-0.0806	0.0549
Hh members aged 18–44	-0.0183	0.0597	0.0054	0.0374	0.0959	0.0881	-0.1219***	0.0739
Hh members aged 45–65	0.1456***	0.0821	-0.0924	0.1012	-0.0851	0.0823	-0.1363	0.1455
Hh members aged >65	0.2065	0.1561	0.1225	0.1721	0.1592	0.1194	0.3167	0.2028
Dummy for region (Costa=1)	1.4335*	0.4768	1.1693**	0.5360				
Poverty incidence (parrochial level, 1990)	-0.0146	0.0188	-0.0023	0.0190	0.076	0.0731	0.0933	0.1202
Illiteracy rate (parrochial level, 1990)	0.0229	0.0327	0.0188	0.0322	0.2448***	0.1489	0.5419*	0.1160
Student per teacher (parrochial level, 1994)	-0.2507*	0.0779	-0.2592*	0.0760	-0.7254***	0.4475	-1.049*	0.3207
Student per school building (parrochial level)	-0.0086	0.0072	-0.0100	0.0071	-0.00007	0.0188	0.035*	0.0103
Student per classroom (parrochial level, 1994)	0.1154	0.0848	0.0918	0.0917	-0.0892	0.1642	-0.8068*	0.2645
Repetition rate (school level, 1994)	0.9100	5.0944	-2.660	5.6295	-12.617	48.5049	-45.390	62.2298
Student per teacher (school level, 1994)	0.0278***	0.0161	0.027***	0.0168	0.0091	0.0219	0.0266	0.0142
Constant	-1.725	2.5100	3.042	3.5565	9.552**	4.2813	8.617***	4.4763
Number of cases	928		870		412		348	
Pseudo R squared	0.4393		0.3871		0.5012		0.7593	

Note: *Significant at 1%, ** Significant at 5% *** Significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

As displayed in Table 3.7, the OLS estimates show a statistically significant impact of the program on second grade mathematics and language for the Hispanic system. The result remains significant through the four different specifications used, showing a positive effect of the intervention through two channels: improving school inputs, and changing the school management structure. However, the effect of school inputs seems weak. In mathematics, none of the school input variables is signif-

icant; suggesting that the overall impact of the program is mainly due to changes in school management. In language, on the other hand, the dummy for full-time principal has a significant and positive association with test scores.

Table 3.8 displays results for the Hispanic system in fourth grade. In this case, again, one finds significant and positive effects of the program on both mathematics and language. In addition, in both cases the number of learning-guides and the number of textbooks per student, as well as the dummy for full-time principal has a significant and positive association with test scores. Conspicuously, in the bilingual case, the effect of program intervention is significant but negative for both mathematics and language in second grade. The result remains through the four specifications used. However, in terms of school inputs, the number of learning-guides per student, and the number of training courses for teachers are positively associated with test scores in language and math respectively suggesting that improving these items could lead to improvements in students' achievements. Contrary to the Hispanic case, under the bilingual system, having a full-time principal is negatively associated with test scores. This is an unexpected result. It is hypothesized that having a full-time principal can improve school management and lead to improvements in the learning process; however, this does not appear to be happening in bilingual schools. It is likely that improving the management structure leads to additional school inputs, especially textbooks. A potential problem is that textbooks and other inputs used by bilingual schools were developed under the Hispanic system and may not be suited to the needs of students in the bilingual system.[31]

Similar results are found for fourth-grade. See Tables 3.9 and 3.10.

3.6.2 PSM estimates

The next part introduces the results of the PSM estimates. As mentioned earlier, estimates under PSM use several types of matching (nearest neighbor, five nearest neighbors and Kernel), and are restricted to the region of common support. To begin, the results of the selection equation are introduced. As already mentioned, the selection equation is a probit model that analyzes the probability of program participation by incorporating variables related to community and school characteristics previous to program intervention, as well as control variables at the household level, plus geographic controls (a dummy variable for region).

Results for the Hispanic as well as the bilingual case are displayed in Table 11. In the Hispanic case there is a significant and positive association between the score in the Selben index and program participation. Higher values in the Selben index (wealthier households) are associated with a higher probability of participating in the program. Schools pertaining to the *Costa* have higher probability of participating in the program than those of the *Sierra*. The student per teacher ratio, which shows the size of the student population as well as the endowment of teachers at parochial level has a significant and negative relation to program participation. This means that communities with higher levels of concentration of schooling age population have lower probability of participating in the program. Finally, the student per teacher ratio at school level, which reflects the congestion of schools, shows a significant and positive relation to program participation. Schools with higher classroom congestion have more probability of participating in the program. Results are similar for fourth and second grade. Regarding the bilingual system, Table 11 shows a negative relation between program participation and the Selben index, as well as with the schooling of the household head. This means that households with a lower socioeconomic status and a lower schooling level of its head have a higher probability of participating in the program. At the parochial level, the illiteracy rate has a positive association with program participation. It also suggests that communities with higher illiteracy rates have a higher probability of participating in the program. The number of students per teacher at parochial level is negatively associated with program participation. Again, this means that communities with higher levels of concentration of schooling age population have lower probability of participating in the program.

Results of PSM estimates are presented separately for second- and fourth-grade in the Hispanic as well as the bilingual system. See Tables 3.12 and 3.13.

Table 3.12
PSM estimates of program impact in second grade.
Several types of matching. Restricted to the region of common support.

Hispanic National	**One to one matching**		**Five nearest neighbors**		**Kernel matching**	
ATT	*Math*	*Language*	*Math*	*Language*	*Math*	*Language*
Treated	11.8308	12.8589	11.8308	12.8589	11.8308	12.8589
Controls	7.6200	9.6804	6.9632	9.7203	6.9633	9.7804
Difference	4.2108*	3.1784*	4.8676*	3.1385*	4.8675*	3.0784*
Standard error	0.5182	0.6443	0.4942	0.5803	0.4674	0.5763
Cases on common support	914	917	914	917	914	917
Bilingual	**One to one matching**		**Five nearest neighbors**		**Kernel matching**	
ATT	*Math*	*Language*	*Math*	*Language*	*Math*	*Language*
Treated	4.6666	7.5097	4.6666	7.5208	4.6660	7.5208
Controls	8.0625	10.9029	7.8541	10.2625	7.9895	10.3461
Difference	-3.3958*	-3.3932*	-3.1875*	-2.7416*	-3.3228*	-2.8252*
Standard error	0.8557	0.8149	0.7185	0.8940	0.9692	0.7266
Cases on common support	302	412	302	412	302	412

Note: *Significant at 1%. ** Significant at 5%. *** Significant at 10%. Standard errors in parenthesis and computed by bootstrapping.

In the Hispanic case, a positive and significant impact of the program is found in both mathematics and language for second and fourth grade. Results are robust through the different types of matching used. The program has an impact of around 5 points, and 3 points (out of 20) in second grade for math and language respectively. In fourth grade the impact is around 2 points for math and 1 point for language. In the bilingual system (of *Sierra*) for second grade, the program has a negative impact on both mathematics and language. The result is robust through the different types of matching. In fourth-grade the effect of the program is also negative for mathematics, and no significant results are found for language. Appendix A introduces the results for the OLS estimates of equation (3) and (4) for the Hispanic and bilingual system respectively, but restricting the sample only to the region of common sup-

port. Results are the same as those found under the OLS estimates for the complete sample.

Table 3.13
PSM estimates of program impact in fourth grade.
Several types of matching. Restricted to the region of common support.

Hispanic National	**One to one matching**		**Five nearest neighbors**		**Kernel matching**	
ATT	*Math*	*Language*	*Math*	*Language*	*Math*	*Language*
Treated	9.6910	13.7513	9.6910	13.7513	9.6910	13.7513
Controls	7.9109	13.1675	7.4209	12.8157	7.3822	12.8959
Difference	1.7801*	0.5837	2.2701*	0.9356***	2.3088*	0.8553**
Standard error	0.4953	0.4856	0.4751	0.4766	0.3655	0.3404
Cases on common support	830	830	830	830	830	830
Bilingual	**One to one matching**		**Five nearest neighbors**		**Kernel matching**	
ATT	*Math*	*Language*	*Math*	*Language*	*Math*	*Language*
Treated	6.0780	7.1257	6.0780	7.0992	6.0158	7.0158
Controls	9.1418	5.0239	8.1546	5.4141	8.8898	5.4573
Difference	-3.0638**	2.1017***	-2.0765***	1.6851	-2.8740**	1.5585
Standard error	1.2961	1.3337	1.1024	1.0660	1.123	1.2456
Cases on common support	322	348	322	348	307	307

Note: *Significant at 1%. ** Significant at 5%. *** Significant at 10%. Standard errors in parenthesis and computed by bootstrapping.

Appendix C introduces the results for the bias corrected matching developed by Abadie and Imbens (2002). The advantage of this technique is that it combines the bias reduction from the matching – produced by comparing units with similar values of the covariates-, with the bias reduction from the regression. In addition, the technique uses matching with replacement, which allows one to improve the quality of matching (Abadie and Imbens, 2002). Results are similar to those of the normal matching showing a positive and significant impact of the program in mathematics and language in the Hispanic system. Results for

the bilingual system become positive or insignificant. Results for the weighting match in the Hispanic and the bilingual case are introduced in Tables 3.14 and 3.15 respectively.

Table 3.14
Weighted OLS estimates of program impact (equations 7 and 7.1)
Hispanic system

	Hispanic							
	Second grade				Fourth grade			
	Specif.1	*Specif.2*	*Specif.3*	*Specif.4*	*Specif.1*	*Specif.2*	*Specif.3*	*Specif.4*
Mathematics								
T	4.8441*	5.2614*	4.7367*	3.7437*	2.1604*	2.3458*	2.3537*	2.2859*
	(0.9463)	(0.9424)	(0.6856)	(0.6917)	(0.5353)	(0.4617)	(0.4593)	(0.4319)
R squared	0.2235	0.2800	0.3647	0.3969	0.0779	0.1380	0.1662	0.2127
Language								
T	3.3962*	3.1687*	2.7314*	2.2281*	0.8637*	0.9014	1.1403**	1.0915*
	(0.8004)	(0.7299)	(0.6960)	(0.8015)	(0.9861)	(0.7592)	(0.4456)	(0.3985)
R squared	0.1350	0.2226	0.2546	0.2904	0.0107	0.1595	0.2798	0.3338
Number of cases	927	927	927	927	870	870	870	870

Note: *Significant at 1%, ** Significant at 5%. *** Significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Table 3.15
Weighted OLS estimates of program impact (equations 7 and 7.1)
Bilingual system

	Bilingual							
	Second grade				Fourth grade			
	Specif.1	*Specif.2*	*Specif.3*	*Specif.4*	*Specif.1*	*Specif.2*	*Specif.3*	*Specif.4*
Mathematics								
T	-2.2885**	-2.0798***	-3.6080*	-3.7292*	-1.1992	-1.3756***	-1.8852**	-2.0751**
	(1.1024)	(1.1987)	(0.9407)	(0.8434)	(0.7470)	(0.7768)	(0.7745)	(0.8884)
R squared	0.0527	0.1160	0.3468	0.4359	0.0508	0.2909	0.4170	0.5017
Language								
T	-3.5314*	-3.3192*	-3.8099*	-4.3181*	2.5177**	1.860***	1.2420	1.1772
	(1.1474)	(1.1426)	(1.1364)	(1.1228)	(0.9220)	(1.0751)	(0.8145)	(0.7725)
R squared	0.1352	0.1609	0.3556	0.4064	0.1177	0.3823	0.5769	0.6498
Number of cases	412	412	412	412	348	348	348	348

Note: *Significant at 1%, ** Significant at 5%. *** Significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Results are similar to those under the simple matching. Under the weighting match, the same four specifications as in the simple OLS are used, and results show a significant and positive impact of the program on test score for both language and mathematics in the Hispanic case. In second grade the effect of the program on mathematics is around 4.7 points under specification (3), while under specification (4) it is only around 3.7 points. In the case of language the effect to the program is around 2.7 points under specification (3) and 2.2 points under specification (4). In fourth grade, the effect of the program on math is around 2.4 points under specification (3) and 2.3 under specification (4); while the effect of the program on language is around 1.1 points under specification (3) and 1 point under specification (4). These results suggest that the effect of the program works through two channels of intervention: improving school infrastructure (around 80% for math in second grade) as well as through changes in school management (around 20% of the effect for math in second grade). In the bilingual case the effect of the program is significant and negative for both mathematics and language in second grade. For fourth grade the program has a negative effect on math, but no significant effect on language.

An explanation for the negative result in the bilingual system could be that, as already mentioned, in the bilingual case, the Ministry of Education explicitly promoted the participation of the poorest schools and despite the use of PSM and restricting comparisons to applicants and participants the evaluation design may not have successfully eliminated preprogram differences between participants and non-participants. One additional explanation, as already mentioned, refers to the hypothesis of culturally inadequate curricula (Glewwe et al. 2007). The program provided Indigenous and Hispanic schools with the same school textbooks and other inputs. The indigenous children have a different worldview and cultural values than the children form the Hispanic system. The mechanical transposition of school materials developed for other cultural context could produce negative effects on the learning process.

Figure 3.1
Distribution of propensity scores for treatment and control groups
Hispanic system

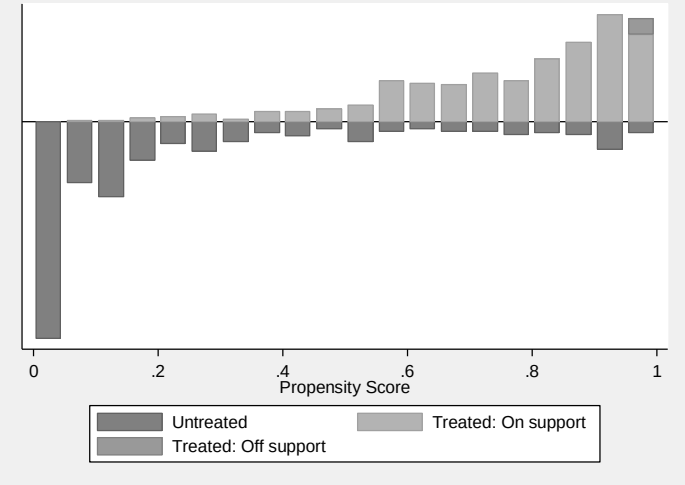
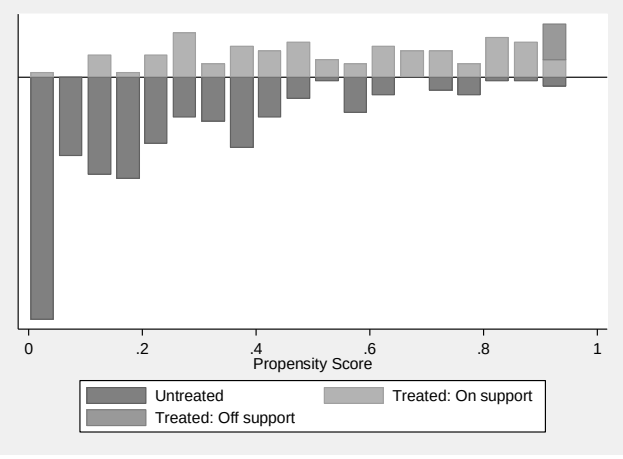


Figure 3.2
Distribution of propensity scores for treatment and control groups
bilingual system



In order to evaluate the quality of the matching, Appendix B introduces the test for balancing variables before and after matching across the treatment and control groups. Results are introduced separately for second grade in the Hispanic and the bilingual system.[32] While post-matching tests support the null hypothesis of equality of means (between treatment and control groups) of most of the variables included in the selection equation, there are some important variables that determine program participation, such as the score in the Selben index, the dummy for region, and the ratio student per classroom that remain significantly different between treatment and control groups. The post-matching differences between the treatment and control groups suggest that given the available data it is difficult to obtain an unbiased estimate of the effect of the decentralization program on test scores. The same conclusion can be obtained when one analyses the regions of common support between treatment and control groups (see Figures 3.1 and 3.2). One interesting point in this part is that according to this evidence the matching for the bilingual case performs better than the matching for the Hispanic schools.

As mentioned in the methodological section, a potential bias of PSM estimates could come from the presence of un-observables in the selection process. Results of estimates of equation (8) to test for un-observables are presented in table 16. As mentioned, the idea of the test is to compute the generalized residuals from the probit model used to estimate program participation, and then incorporate them, as a regressor, in a OLS regression where the dependent variable is the outcome variable of interest (the respective test score). Two specifications were used. Specification 1 includes individual and household characteristics, and specification 2 includes, in addition, school variables that were influenced by the program.[33] In all cases the coefficient of the generalized residuals is statistically insignificant, implying that, possibly, un-observables do not exert an influence on program participation.[34]

Table 3.16
Test for un-observables in the selection process: equation 8

	Second grade				Fourth grade			
	Mathematics		***Language***		***Mathematics***		***Language***	
	Specif.1	*Specif.2*	*Specif.1*	*Specif.2*	*Specif.1*	*Specif.2*	*Specif.1*	*Specif.2*
Hispanic								
Mills ratio	0.0211	-0.3880	0.3344	0.6521	0.3892	0.2755	0.9043	0.8425
	(0.8165)	(0.6828)	(0.7622)	(0.9017)	(0.6603)	(0.6309)	(0.7490)	(0.7223)
T	4.1375*	4.4224*	1.7648	1.3985	1.6744***	1.8377***	-0.3883	-0.3116
	(1.0500)	(0.9411)	(1.2923)	(1.4877)	(0.9898)	(0.9617)	(1.0340)	(1.0516)
R squared	0.1971	0.2169	0.1644	0.1764	0.1073	0.1541	0.2051	0.2517
Number of cases	926	926	927	927	870	870	870	870
Bilingual								
Mills ratio	-2.0465	-1.7047	-0.4850	-1.0037	0.1657	0.1445	1.5901	1.7911
	(1.3707)	(1.3236)	(1.2929)	(1.1940)	(0.9065)	(1.0310)	(1.0430)	(1.1471)
T	0.2004	-0.4048	-2.5044	-1.9021	-3.4828*	-3.6948*	-3.0590*	-3.3154*
	(1.7702)	(1.4765)	(1.5816)	(1.4392)	(0.7848)	(0.7271)	(0.9008)	(0.8206)
R squared	0.1659	0.2537	0.1696	0.2382	0.2269	0.2478	0.194	0.2358
Number of cases	412	412	412	412	326	326	326	326

Note: *Significant at 1%, ** Significant at 5%, and *** significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

3.7 Conclusions

Decentralization of education is an important component of educational policies in Latin America. Most Latin American countries started decentralizing their education systems during the 1990s. Broadly, two types of decentralization reforms are found in the region. First, decentralization based on transferring school administration from the central government to local governments or private associations. Second, decentralization based on transferring school administration to local communities with parents' participation. Despite the importance of decentralization in Latin America, evidence on the impact of these policies on school outcomes is scarce. The existing evidence shows that when decentralization is based on transferring school administration to local governments, its impact on school outcomes depends on the level of development of local

governments. The process appears to be successful when local governments have adequate technical, financial and political capability.

Regarding the second case of decentralization based on transferring school administration to local communities with parents' participation, most of the experiences come from Central America, where the main objective was to improve school enrolment in remote rural areas.

Ecuador, like most Latin America countries, started its decentralization process at the beginning of the 1990s. The model of decentralization applied was based on transferring administrative, budget, and pedagogical responsibilities to schools. One novel point in the Ecuadorian experience of educational decentralization was that the program explicitly intended to improve students' cognitive achievements. The program was expected to improve learning conditions through two channels; by improving school inputs, and by changing the school management structure. In this chapter, an impact evaluation of this program was conducted.

The original design of the program, like most decentralization experiences in Latin America, did not include an impact evaluation design. Consequently, it was not possible to carry out an experimental study, or to have a baseline survey. Administrators of the program decided to evaluate its impacts once it had almost finished. Fortunately, a group of schools that decided to participate in the program, but had not received the treatment was available to create a comparison group. In this regard, by restricting the sample to program applicants (pipeline design) this paper attempted to control for un-observables in the selection process for program participation. In addition, the paper tried to control for observables by using a propensity score matching. Despite methodological efforts to construct an appropriate control group, post-matching statistical tests suggested that the treatment and control group still differ, raising the possibility that the positive effect of decentralization in Hispanic schools and the negative effect in bilingual schools may well be attributed to positive and negative selection, respectively. Overall, given the currently available data it would be premature to draw conclusions about the effect of the decentralization program on test scores. However, decentralization has increased parental and community participation in the educational process. Therefore, decentralization could play an important role in improving school monitoring through parents and the community. A greater parental role may bring parents closer to the educational

process and increase the acceptability and value of educational investments.

Notes

[1] Efficiency can de defined in two different ways; technical as well as social efficiency. Technical efficiency refers to produce a higher output for similar costs or the same output for lower costs. Social efficiency refers to choices that reflect more closely consumers' preferences. (Di Gropello, 2006).

[2] This argument comes from the principal-agent literature. See Di Gropello (2006) for a review.

[3] Di Gropello (2006) finds three decentralization models of education in Latin America: The "Sub-national government model" applied in Argentina, Mexico, Chile and Brazil, where the education service delivery was transferred to the municipal level. The "Sub-national shared responsibility model", applied in Colombia and Bolivia, where the main responsibilities in education were transferred to the departmental and municipal level. Finally, the "School autonomization model", applied in Nicaragua, Honduras, El Salvador, and Guatemala, where school administration was transferred to local communities.

[4] See Espínola V. (1997), Gershberg A. (1999), and Winkler and Gershberg (2000) for a review.

[5] Although the effect of the program is not robust, it is sensitive to the specification of the participation equation. The main conclusion of the paper is that the program has not lessened child learning (Jimenez and Sawada, 1999).

[6] Taken from a total of around 400 public secondary schools.

[7] In addition to El Salvador, the cases of Guatemala, and Honduras also defined as the main objective of decentralization to improve school enrollment in remote rural areas.

[8] *De facto* decentralization was computed by using an index that measures the level of participation of parents on key school decisions. It does not refer to program participation, which is named *de jure* decentralization by the authors. See, King and Özler 2000 for more details.

[9] See Emanuela Di Gropello (2006) for a review of those programs.

[10] See Guedes, at, al. (1997) for a review of the experience of Minas Gerais.

[11] Ecuador has three geographic regions (*Costa, Sierra and Amazonía),* and two different education systems, the Hispanic system, where the official language is Spanish and most students are *mestizos*, and the indigenous system where Spanish and Quichua are taught, and most students are indigenous.

[12] An evaluation study of the program, using qualitative data, show that teachers and communities of schools in the program were more enthusiastic and more involved in the education process (Flacso, 2005). I was the head of the team in charge of this study.

[13] For a review of the education production function approach, see Bowles, 1970; Hanushek, 1979; Behrman, 1999; Pritchett and Filmer, 1997; Todd and Wolpin, 2003.

[14] Quasi-networks are composed of schools that have successfully applied for the program, but, because of some administrative issues, have not yet received it.

[15] The Ecuadorian Ministry of Education takes schools and teachers information every year. Data have been available in electronic means since 1994.

[16] Those variables could not be used as instruments under an instrumental variable approach. Although they are highly correlated with program participation, they do not satisfy the "exclusion restriction" because they are also correlated with test scores.

[17] Examples of studies using a pipeline comparison design are: Angrist, 1998; Chase, 2002; and, Galasso and Ravallion, 2004.

[18] Most of the quasi-networks did not receive treatment due to administrative reasons. For example, an incorrectly filled admission form, or the composition of the pedagogical committee was not adequate.

[19] The region of common support refers to individuals with similar characteristics regarding the variables that influence program participation.

[20] Like all experiences of decentralization in Latin America, the initial design of the program did not incorporate an impact evaluation part. In this sense, an experimental design was not possible. The evaluation study only was contracted at the end of the program as a requirement of the IDB. Fortunately, the availability of quasi-networks was an opportunity to use a pipeline comparison design.

[21] Using this weight one obtains the average treatment on the treated. If one wants to get the average treatment effect for the population, the weights are $1/(\hat{P}(X)$ for treated units, and $1/(1-(\hat{P}(X))$ for the controls (See, Hirano, Imbens and Ridder 2003 for details).

[22] For a review of models with sample selection bias see Vella (1998).

[23] This term is the inverse Mills ratio for the entire sample. See Vella (1998) for a review.

[24] Jalan and Ravallion (1999) use this test.

[25] I was the head of the team in charge of designing the survey as well as taking the data.

[26] Tests were different in order to capture cultural differences between children from Hispanic and bilingual schools. Tests were probed and validated with the technical support of the Ministry of Education.

[27] The Selben index is a multivariate index computed using nonlinear principal components, and it is a combination of 20 variables representing basically household assets, and household socio-demographic characteristics. The index is scaled from 0 to 100 and is used to target social programs in Ecuador. Values close to 0 stand for extremely poor, while values close to 100 stand for wealthy.

[28] The school infrastructure index is scaled from 0 to 5, and was computed using indicator variables that take the value of 1 if the characteristic is present. The following characteristics were taken into account: teacher housing, potable water, electricity, bathrooms, and space for children to play.

[29] Some child variables such as time dedicated to work, time watching TV, and whether parents help to children with homework, were not included because of endogeneity concerns. However, results are not different when those variables are included.

[30] It was not possible to incorporate current school and community fixed effects because of the sample design. As mentioned, the sampling unit was the network and inside the network information was taken for all the schools pertaining to the network. Networks superpose to communities, so it is impossible to find in one community schools for treatment and control group. In the same way, it is impossible to find in one school students from treatment and control group.

[31] Glewwe et al. (2007) using an experimental design found no significant effect of a textbooks program in Kenya. One of the reasons for the null impact is that the textbooks were written in English and the poorer students could not use them. According to the authors, this is an example of culturally inadequate curricula.

[32] Results are similar for fourth grade and are available under request.

[33] Individual and household variables, as well as school characteristics are the same introduced under the OLS estimates of equations (3) and (4).

[34] As already mentioned, to facilitate the identification of equation 8, I included community level variables previous to program intervention in the selection equation, and excluded them from the output equation. Although these variables are not good instruments (because they also affect test scores); the fact that those variables are lagged several years can be helpful. In this case the endogeneity affects only the small sample properties of the OLS estimates but not its asymptotic distribution (Verbeek, 2000).

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Appendix A

Results of OLS estimates of equation (3) and (4). Only for the region of common support.

Hispanic system

Second grade	Mathematics, second grade							
	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	4.3343*	0.6710	4.1548*	0.7098	4.0199*	0.7436	3.6543*	0.7276
Number of cases	914		914		914		914	
R squared	0.1728		0.1906		0.2341		0.2483	
	Language, second grade							
	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	3.0287*	0.6847	2.1598*	0.6911	1.9898*	0.6619	2.124*	0.6788
Number of cases	913		913		913		913	
R squared	0.1032		0.1638		0.2015		0.2101	

Fourth grade	Mathematics, fourth grade							
	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	2.2893*	0.5685	2.1570*	0.5351	2.1882*	0.5467	2.2112*	0.5022
Number of cases	830		830		830		830	
R squared	0.0757		0.1036		0.1477		0.1976	
	Language, fourth grade							
	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	1.47***	0.8163	0.7522	0.6891	1.1324**	0.5383	1.1698*	0.4387
Number of cases	830		830		830		830	
R squared	0.0284		0.1906		0.2793		0.3171	

Note: *Significant at 1%, ** Significant at 5%, and *** significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Bilingual system

Second grade	**Mathematics, second grade**							
	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-3.6779**	1.5274	-2.9772*	1.4790	-3.0324**	1.2042	-3.8848**	1.1672
Number of cases	302		302		302		302	
R squared	0.1214		0.2244		0.3741		0.4401	
	Language, second grade							
	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-3.2801*	1.4927	-2.821***	1.5029	-3.0250**	1.3504	-4.3717*	1.2023
Number of cases	302		302		302		302	
R squared	0.1165		0.1738		0.2926		0.3695	

Fourth grade	**Mathematics, fourth grade**							
	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-3.3474*	0.8037	-3.4456*	0.7246	-3.1097*	0.9176	-4.4839*	1.0002
Number of cases	322		322		322		322	
R squared	0.1826		0.2278		0.2794		0.3421	
	Language, fourth grade							
	Specification 1		**Specification 2**		**Specification 3**		**Specification 4**	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
T (1 = Redes Amigas)	-2.7073*	0.8611	-2.2436**	0.8761	-0.8977	1.1322	-1.7069	1.2248
Number of cases	322		322		322		322	
R squared	0.1158		0.1734		0.2667		0.3406	

Note: *Significant at 1%, ** Significant at 5%, and *** significant at 10%. Standard errors are in parenthesis and corrected by heteroskedasticity and within-peer correlations.

Appendix B
Test for balancing variables, before and after matching

Hispanic system

Variable	Sample	Mean		%bias	% redu bias	t	p>t
		Treated	Control				
Score in Selben index	Unmatched	46.842	38.813	77.8	11.8	0	
	Matched	46.511	43.153	32.5	58.2	5.08	0
Schooling of the household's head	Unmatched	6.609	5.4138	34.6	5.22	0	
	Matched	6.5324	5.6159	26.5	23.3	4.1	0
Household's head is indigenous	Unmatched	0.10183	0.31264	-53.8	-8.27	0	
	Matched	0.10438	0.09603	2.1	96	0.43	0.667
Household's head is female	Unmatched	0.14868	0.10345	13.6	2.06	0.039	
	Matched	0.14823	0.15031	-0.6	95.4	-0.09	0.928
Hh members aged <6	Unmatched	0.85743	0.90345	-4.9	-0.74	0.461	
	Matched	0.86013	0.93111	-7.5	-54.3	-1.14	0.254
Hh members aged 6-17	Unmatched	2.6568	2.9126	-18.5	-2.81	0.005	
	Matched	2.6649	3.0063	-24.6	-33.4	-3.89	0
Hh members aged 18-44	Unmatched	1.8859	1.9241	-4.1	-0.62	0.532	
	Matched	1.8873	1.7912	10.3	-151.5	1.66	0.097
Hh members aged 45-64	Unmatched	0.39511	0.38391	1.7	0.25	0.8	
	Matched	0.39875	0.41962	-3.1	-86.3	-0.5	0.616
Hh members aged >64	Unmatched	0.10794	0.13793	-7.3	-1.12	0.263	
	Matched	0.10647	0.08977	4.1	44.3	0.68	0.498
Dummy for region (Costa=1)		0.45621	0.18391	61	9.19	0	
		0.45303	0.56159	-24.3	60.1	-3.38	0.001
Poverty incidence	Unmatched	69.491	80.231	-74.3	-11.13	0	
	Matched	69.897	63.432	44.7	39.8	6.53	0
Illiteracy rate (parochial level)	Unmatched	13.808	18.824	-80.7	-12.45	0	
	Matched	13.893	12.478	22.8	71.8	4.44	0
Ratio student per teacher (paroch. level)	Unmatched	12.835	16.648	-82.5	-12.67	0	
	Matched	12.924	12.823	2.2	97.3	0.45	0.65
Ratio student per school building (parochial level	Unmatched	88.529	83.636	12.4	1.89	0.059	
	Matched	88.308	103.61	-38.7	-212.8	-7.13	0
Ratio student per classroom (paroch. level)	Unmatched	22.135	22.389	-6	-0.92	0.359	
	Matched	22.179	23.438	-29.9	-394.9	-4.5	0
Repetition rate (school level)	Unmatched	0.01816	0.02551	-21.2	-3.19	0.001	
	Matched	0.01801	0.02375	-16.5	21.9	-2.51	0.012
Ratio student per teacher (school level)	Unmatched	29.722	25.826	38.1	5.7	0	
	Matched	29.909	29.216	6.8	82.2	0.96	0.337

Bilingual system

Variable	Sample	Mean		%bias	% redu bias	t	p>t
		Treated	Control				
Score in Selben index	Unmatched	27.531	32.937	-54.5	-5.53	0	
	Matched	28.316	26.703	16.3	70.2	1.18	0.238
Schooling of the household's head	Unmatched	2.3252	4.4029	-53.6	-5.44	0	
	Matched	2.5521	1.9792	14.8	72.4	1.19	0.234
Household's head is indigenous	Unmatched	0.96117	0.96117	0	0	1	
	Matched	0.97917	0.98958	-5.4	.	-0.58	0.563
Household's head is female	Unmatched	0.13592	0.15534	-5.5	-0.56	0.577	
	Matched	0.14583	0.08333	17.7	-221.9	1.36	0.176
Hh members aged <6	Unmatched	1.1893	0.98058	20.9	2.12	0.034	
	Matched	0.96875	0.92708	4.2	80	0.31	0.756
Hh members aged 6-17	Unmatched	3.1019	3.2282	-9.9	-1	0.317	
	Matched	3.1771	3.1563	1.6	83.5	0.11	0.913
Hh members aged 18-44	Unmatched	1.9126	1.733	16.7	1.7	0.09	
	Matched	1.9167	1.8542	5.8	65.2	0.42	0.673
Hh members aged 45-64	Unmatched	0.52427	0.54854	-3	-0.31	0.758	
	Matched	0.55208	0.53125	2.6	14.2	0.18	0.856
Hh members aged >64	Unmatched	0.19417	0.08738	20.4	2.07	0.039	
	Matched	0.125	0.16667	-7.9	61	-0.73	0.467
Poverty incidence		92.494	91.635	9.8	1	0.318	
		93.687	95.15	-16.8	-70.3	-1.89	0.06
Illiteracy rate (parochial level)	Unmatched	40.932	44.402	-20.6	-2.1	0.037	
	Matched	46.574	48.706	-12.7	38.6	-1.09	0.277
Ratio student per teacher (paroch. level)	Unmatched	16.951	21.318	-65.9	-6.69	0	
	Matched	21.281	22.282	-15.1	77.1	-1.18	0.241
Ratio student per school building (parochial level)	Unmatched	97.535	72.542	62.1	6.31	0	
	Matched	77.844	70.14	19.2	69.2	1.6	0.11
Ratio student per classroom (paroch. level)	Unmatched	26.051	25.607	8.5	0.86	0.39	
	Matched	25.887	26.423	-10.3	-21	-1.1	0.271
Repetition rate (school level)	Unmatched	0.00259	0.00078	24.2	2.45	0.015	
	Matched	0.00238	0.00083	20.6	14.6	1.46	0.146

Ratio student per teacher (school level)	Unmatched	24.656	24.384	3.1	0.31	0.754	
	Matched	26.734	25.275	16.6	-435.9	1.06	0.288

Appendix C
Bias adjusted matching

Hispanic

	Second grade			Fourth grade		
	One to one	*Five nearest*	*Ten nearest*	*One to one*	*Five nearest*	*Ten nearest*
Math						
ATT	4.6681*	4.7952*	4.6319*	2.4243*	2.1511*	1.9468*
	(0.4932)	(0.4087)	(0.3884)	(0.5228)	(0.4200)	(0.3784)
Language						
ATT	1.8583*	1.8525*	1.8569*	0.7161	0.7625	1.0059*
	(0.4359)	(0.3535)	(0.3340)	(0.5206)	(0.3638)	(0.3243)
Cases	927	927	927	870	870	870

Indigenous

	Second grade			Fourth grade		
	One to one	*Five nearest*	*Ten nearest*	*One to one*	*Five nearest*	*Ten nearest*
Math						
ATT	7.5548*	3.8543*	3.3708*	-1.0009**	0.2538	-0.2688
	(0.5332)	(0.4505)	(0.4040)	(0.4441)	(0.4136)	(0.4149)
Language						
ATT	-0.2564	-5.4606*	-5.7938*	3.3094*	4.370*	4.1953*
	(0.5179)	(0.4267)	(0.4108)	(0.4501)	(0.4414)	(0.4391)
Cases	412	412	412	348	348	348

Note: *Significant at 1%, ** Significant at 5%, and *** significant at 10%. Standard errors are in parenthesis.