The Impact of Decentralized Decision Making on Student Outcomes and Teacher Quality. Evidence from Colombia

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Abstract

To contribute to the debate about decentralization of education management, in this paper, we take advantage of the arbitrary rule used in Colombia to define the municipalities that can autonomously manage schools, to evaluate through a Regression Discontinuity methodology the effect of municipal's autonomy on student achievement and teacher characteristics, using as a counterfactual schools located in municipalities that just missed the population criteria, schools that are managed by the departments. Our results suggest that schools in municipalities that became autonomous in terms of their public education administration, have on average, a lower proportion of low-performing students, than similar schools in municipalities that do not manage their schools, especially in 9th grade. Moreover, when analyzing the teachers´ characteristics as a channel to explain academic performance, we found that teachers in certified municipalities score on average, 0.5 to 1 standard deviation higher on the mandatory competency test to become a permanent public-school teacher.

Keywords: Education decentralization, Colombia, educational achievement, teacher quality
JEL Classification: I22, I28, H75

Introduction

The transfer of decision-making power and responsibility to the local or school level has become an increasingly important policy discussion guiding school reform in various countries, both in developing and non-developing settings. These reforms have increased autonomy over decisions regarding curricula, and the allocation of financial and human resources (OECD, 2011; Di Gropello, 1999 for LAC countries; Alonso and Sanchez, 2011 for Eastern Europe countries).

Since the 1980s, Colombia has been undergoing a progressive decentralization process. The 2001 reform enforced administrative decentralization, reallocating local authorities' responsibilities towards the delivery of public services. Law 715/2001 changed the allocation of responsibility of the management of public education to either municipalities or departments[1]. Municipalities with one-hundred thousand or more inhabitants in the year 2002 became "certified in education", which granted them management responsibility for public education in their territories. Municipalities with fewer than one-hundred thousand inhabitants were not certified, and their public education was managed by the departments they belonged to. From receiving a narrow share of transfers and being subject to departmental supervision, certified municipalities transitioned to have greater managerial and financial autonomy, while non-certified ones gave up their already limited powers to the respective department (Brutti, 2016).

There is an ongoing discussion on whether decentralization improves equity and efficiency in the provision of public education. On the one hand, fiscal federalism literature, that examines which functions and instruments should be centralized or decentralized, has identified several mechanisms by which decentralization may lead to improved levels of efficiency in the provision of public goods and services (e.g. Oates, 1972; Lockwood,

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[1] A municipality is a territorial entity managed by the mayor, who governs along with a municipal council; both figures are elected by popular vote. Colombia has 1,123 municipalities. Departments are headed by a governor responsible for the autonomous administration of the public resources. They have autonomy in the handling of matters related to their jurisdiction and operate as entities between the national government and the municipalities. They are administered by a governor and an assembly of deputies elected in popular elections. In Colombia there are 32 departmental units.

2005). First, decentralization advocates maintain that subnational governments have better knowledge of their population's preferences and needs than the central government (Oates, 1972, 1999) so that, in the absence of economies of scale and externalities, decentralization can ensure a better match between political decisions and local preferences (preference-matching argument). In the case of education, for example, local governments have more information about teacher shortage in specific fields (e.g. sciences or foreign languages), which schools need better-trained teachers to compensate the disadvantages faced by low-SES students, or how to design better incentives to attract teachers to hard-to-staff schools (Salinas, 2009). For example, Faguet (2004) finds that after the fiscal and political decentralization reform was instituted in Bolivia, investment in education increased in municipalities with higher illiteracy rates. Second, since local governments are closer to the beneficiaries, authorities are held responsible for the quality of local services (accountability argument). The increase in the degree of political accountability of government could serve as an incentive for public officials to act in the best interests of its citizens and to increase the quality of education (Seabright, 1996).

On the other hand, there are potential negative effects of decentralization on education quality and equity. First, local governments may have a higher probability of being captured by local elites and interest groups in order to allocate public resources. However, this result is context-specific, suggesting the need for empirical studies (Bardhan and Mookherjee, 2005, 2006). Some studies of decentralization reforms reveal the existence of favoritism and corruption in the teacher hiring process at the local level (Khanal, 2012; De Gauwe et al, 2005). Second, decentralization has the potential of increasing inequity in education outcomes, because there is significant heterogeneity in the management capacity of local governments. This argument has been tested in several papers that show that the positive effects of decentralization are concentrated in local governments with greater management capacity, resources, and development (e.g. Galliani et al., 2008; Brutti, 2016).

Several studies have attempted to evaluate the effect of decentralization on educational outcomes using different methodologies and data. First, there are cross country studies, using results from international assessments, that find a positive impact of decentralization,

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but concentrated in developed and high-performing countries (e.g. Falch and Fischer, 2012; Hanushek, Link and Woessmann, 2013). Second, there are studies within educational systems, using difference in difference and panel data techniques and decentralization reforms as an identification strategy, which, in general, find positive effects of decentralization on academic results (e.g. Barankay and Lockwood, 2007; Galiani et al, 2008). Finally, there are a few recent studies that take advantage of arbitrary rules defining different levels of autonomy of local governments or schools to evaluate the impact of educational autonomy in a quasi-experimental setting. For example, Clark (2009) studies a 1988 reform in the United Kingdom that gave public secondary schools the option to opt out of local school district control and become autonomous schools funded directly by the central government. Schools seeking autonomy had to propose to participate in the program and win a majority of votes among parents. Almost one in three high schools voted to become autonomous between 1988 and 1997, and using a version of the regression discontinuity design, the author finds large achievement gains at schools in which the vote barely won compared to schools in which it barely lost. Brutti (2016), exploiting the arbitrary rule of 100,000 inhabitants to be autonomous from the 2001 reform in Colombia, estimate the impact that autonomy has had on student test scores across municipalities, using a regression discontinuity design and fixed-effects regression. She finds a growing test score gap between autonomous municipalities in the top quartile and those in the bottom quartile. From analysis of detailed municipal balance sheet data, she also shows that more advantaged autonomous municipalities invest more in education than the ad hoc transfers they receive, supplementing these with local financial resources[2].

In this paper, we study the effect of the decentralization reform in Colombia introduced in 2001 on student achievement and teacher quality. Colombia is an interesting and unique case because, after the reform, autonomy in the decision making became a function of an arbitrary population threshold, which allows us to estimate the effect of the treatment in a quasi-experimental setting and because the reform mainly affected the management of public education but did not substantially alter the composition of education expenditure

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[2] Cortés (2010) used the same arbitrary rule to study the impact of increased autonomy on total enrollment. Results suggest that more decentralized municipalities subsidize more students in private schools to increase enrollment.

(financial decentralization) or the political structure of the government. Unlike previous papers, we also explore the effect of municipal educational autonomy on the characteristics of the teaching staff to test whether differences in teacher quality is one of the factors that explains potential differences in student performance. As we will see in the following section, the potential differences in the quality of teachers between certified and non-certified municipalities could be explained by differences in the autonomy to influence the results of the hiring process and by differences in the preferences of teachers when applying to the available vacancies in the teaching contest.

Our results show that municipalities that became autonomous in terms of public education administration, have on average, schools with a lower proportion of low-performing students, than similar municipalities that do not manage their schools. Moreover, when analyzing teacher characteristics as a channel to explain academic performance, we found that teachers in certified municipalities score one average, 0.5 to 1 standard deviation higher on the mandatory competency test to become a public-school teacher.

The remainder of this paper is organized as follows. The first section will describe educational decentralization in Colombia. Section II will describe the data and the empirical methods used in the analysis. Section III presents the results and the final section concludes.

I. Decentralization in Colombia

Pre-reform scenario

In the mid-eighties, Colombia started a process of gradual decentralization of government. First, in 1986, citizens began to elect mayors of municipalities who previously were appointed by the president. In 1991, they also started to elect governors of departments (Cortés, 2011). Regarding the administration of public schools, prior to the 2001 reform, both municipalities and departments had responsibilities in the hiring of personnel and in investments in infrastructure and equipment for public schools. Prior to the enactment of the school decentralization law, there was not a clear definition of responsibilities in the legislation. For example, Law 29, enacted in 1989, favored the municipalization of public

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education, but the 1991 Constitution emphasized the role of departments. Then, Law 60 enacted in 1993, which regulated the transfers from the central government to departments and municipalities, strengthened the role of municipalities. In contrast, Law 115 of 1994, the General Education Law, responded to pressure from the teachers' union and assigned a greater role to the departments (Borjas and Acosta, 2000).

The lack of a clear definition of the responsibilities of each level of government generated an overlapping of functions which blurred the lines of accountability. For example, prior to the 2001 reform, there were teachers funded by the central government, departments, and municipalities. Also, in many cases, entities in charge of certain educational functions did not have enough resources and authority to fulfill their responsibilities. For example, municipalities had a central role in the management of public schools, but they had very limited authority to manage staff (Borjas and Acosta, 2000). In practice, until 2001, departments retained the most significant role, because they received the highest percentage of the transfers from the central government. The payrolls of departments included 85-90% of all public-school teachers, and they allocated teachers across municipalities. Municipalities then allocated teachers across schools within their territory and hired the remaining 10-15% that were not on the departmental payrolls. Departments also had the final word on the education proposals of municipalities (Brutti, 2016). Thus, one of the main goals of the 2001 reform was to reduce the responsibility overlap. Further goals were to improve efficiency and reduce waste in the use of public resources, eliminating the fluctuations in financial transfers, and updating some obsolete distribution criteria (Brutti, 2016).

Education decentralization reform in 2001
Law 715 enacted in 2001 redefined the governance of the Colombian education system and introduced a change in the allocation rules of the transfers from the central government. First, regarding the governance of the system, education began to be managed by Certified Territorial Entities (*Entidades Territoriales Certificadas* or ETCs) that can either be Departments (Sub-national level) or Municipalities (local level). The education in non-certified municipalities is managed by the Departments of their jurisdiction. Before 2004,

certification was assigned exclusively to those municipalities exceeding 100 thousand inhabitants (Brutti, 2016). Since 2004, municipalities with less than 100 thousand inhabitants can apply to be certified, after an evaluation of the technical, administrative and financial capacity to manage the school system[3] (Ministerio de Educación Nacional, 2005). Of the 63 municipalities currently certified, 17 have obtained certification through this process. Law 715 differentiated the functions of both levels of government. Table 1 shows the difference between certified and non-certified municipalities (Brutti, 2016).

Table 1. Division of responsibilities and transfers by level of government pre and post 2001

Central Government			
Set minimum learning standards -Set teacher wages-Set general guidelines-Financial transfers to local authorities			
Local authorities			
Up to 2002 (Law 60/1993)		**From 2002 onwards (Law 715/2001)**	
		Certified municipalities	
Transfers:	84% to department 16% to municipalities	Transfers:	100% to municipalities
Teacher hiring, training and placement School infrastructure and materials School transportation and any extra educational programs	Departments and municipalities, under departments' supervision	Teacher hiring, training and placement School infrastructure and materials School transportation and any extra educational programs	Municipality only

[3] Specifically, municipalities with less than 100,000 inhabitants can also be certified fulfilling the following requirements: i) The Development Plan of the municipality regarding education must be aligned with national policies; ii) Schools must be organized into institutions (schools offering all grades) and educational centers; iii) Education staff must be defined in accordance with the national parameters of the student-teacher ratio, and subject to the administrative career path; and iv) Institutional capacity to assume the processes and information required of the education sector. Compliance with these requirements is determined by the Department.

	Non-Certified Municipalities
Transfers:	97% to department 3% to municipality
Teacher hiring, training and placement School infrastructure and materials School transportation and any extra educational programs	Department only (maintenance duties for municipality)

Source: Brutti (2016)

Regarding teacher hiring, training and placement, according to Law 715 of 2001, although the legal authority to hire principals and teachers is the ETC, the Ministry of Education imposes restrictions concerning the number of teachers that can be hired. These limits were implemented to control the number of teachers hired in response to a disproportionate increase in teacher hiring in the 1990s (Congreso de Colombia, 2000). The rise in hiring occurred because municipalities had no restriction in the number of teachers they could hire, and some argue that teacher contracts were used as a political tool by the sub-national levels (Duarte, 2001). This was a problem for the central government's financial sustainability, because when the municipality could not pay salaries, the debt was assumed by the central government. Moreover, as teachers were hired with the municipality's own resources, the inequities with respect to student-teacher ratios between rich and poor municipalities became more pronounced (Congreso de Colombia, 2000).

Since 2002, teachers and principals have been assigned through a contest (*concurso*) designed and implemented at the central level, which reduce the autonomy of ETCs and schools. In the contest, candidates can apply to only one ETC for a specific vacancy (e.g. secondary math teacher). At this point in the process, the candidate only knows the number of vacancies by type of position in each ETC, but not the specific schools that will open vacancies. Later, teachers are ranked based on their level of education (university, graduate degrees, etc.), teaching experience, and the score they obtain on a national teacher assessment, which is administered and graded centrally by governmental agencies. Eligible candidates choose among the available vacancies. The ETCs use an algorithm to place

applicants into vacancies based on their ranking. Although teachers have complete autonomy to choose a school within the ETC, they have a probationary period of four months, after which the school principal must determine whether the teacher is granted tenure. This is the only part of the process where principals participate in the hiring of new teachers. After the hiring process, the secretary of education of each ETC has the legal authority to reallocate teachers within the ETC. The fact that the hiring process is decentralized at the ETC level, implies that, in the case of departments with multiple non-certified municipalities, teachers will be allocated according to his or her ranking and preference in any of these territories.[4] Since more advantaged and high performing schools are often chosen first by the highest scoring teachers, low-performing teachers are often allocated to underachieving, isolated, and disadvantaged schools. Fundación Compartir (2014) and Bertoni et al (2018) show this positive correlation between teacher characteristics and school SES in Colombia. Additionally, a teacher who applies to the vacancies of a departmental ETC has more uncertainty about where she will end up working, especially those who passed the contest assessments but who are not top performers, because remaining vacancies may only be available in remote municipalities or because there is a risk of being moved in a few years to a school with inferior working conditions or located in an isolated area within the same department. These factors likely reduce the incentive to apply to a department over a certified municipality.

The ETC pays teacher salaries, but these resources only come from central government transfers. The budget allocated to pay the teacher payroll cannot be spent on anything else until all the salaries are paid. Neither the ETC nor the school can pay teachers with their own resources. The teacher pay scale is determined by the Ministry of Education (MEN), as well as the annual salary increase agreed with the national teachers' union (FECODE). Accordingly, teachers have different wages depending on their ranking in the salary scale (*escalafón docente)*, which is a function of teacher education and results on competency assessments. The only explicit criteria regarding school needs is a wage supplement for teachers and directors who work in difficult to access areas (15% of the basic monthly

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[4] For example, the department of Cundimarca oversees the implementation of the teacher contest for 113 non-certified municipalities.

salary). In this case, each ETC is responsible for defining which areas are difficult to access.[5]

Regarding teacher contracts, approximately 72% of public-school teachers have a permanent contract and 28% a temporary one. Despite being paid with central government resources, temporary teachers are not mandated to participate in the official contest. This allows the ETCs to hire temporary teachers where they deem necessary, but never surpassing the payroll authorized by the Ministry of Education. Skeptics have argued that the autonomy to hire temporary teachers is often used as a political tool to distribute resources. For example, Ayala and Sanchez (2016) found that when the governor or mayor of an ETC has political affinity with the senator who obtained the highest number of votes in that ETC, the percentage of temporary teachers is higher, compared with the case where the governor is not from the same political party as the senator.

For the rest of the spending categories, other than staff, there are no restrictions on the sources of funding and how resources are distributed. ETCs can use their own resources and transfers coming from the central government. Additionally, non-certified municipalities can add their own resources[6]. The only restriction is that resources must be used for educational purposes: (i) furniture, texts, libraries, didactic and audiovisual materials; (ii) strategies to improve school management; (iii) construction, maintenance and adaptation of infrastructure; (iv) public services and operation; v) improvement of working conditions of teachers; and vi) non-teaching staff. ETCs can attract teachers to schools in their jurisdiction by improving working conditions and dedicating resources to

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[5] To be a difficult to access area, a school must meet at least one of the following criteria: i) two or more means of transportation is necessary to get to the urban perimeter; ii) there are no roads that allow motorized traffic for most of the school year; or iii) public transportation service by land, river or sea, is only available for one daily round trip.

[6] Similar to the pre-reform scenario, departments and municipalities, including non-certified ones, can invest their own resources in education. These revenues come from direct taxes (e.g. alcoholic beverages), indirect taxes and non-tax revenues (e.g. contributions and fines). Municipalities have autonomy to allocate these resources to education, but they cannot be used to fund teacher salaries (Ley 715 de 2001). However, they can fund infrastructure and maintenance, and additional services like transportation, school meals, and extracurricular activities. In 2016, these resources represented 9% of total public spending. However, they are strongly concentrated in some certified territorial entities. For example, Bogotá (43%), Medellín (8.8%) and Barranquilla (4.9%) account for 56.4% of total resources invested at the national level. In some ETCs like Bogotá, Rio Negro, Barrancabermeja and Sabaneta, own resources represent more than 30% of total resources (Technical Note IDB, 2018).

campaigns to attract high performing candidates. The municipalities can also allocate resources for school transportation services to guarantee education access and permanence of low-SES students from geographically isolated areas. If necessary, they can also invest resources to supplement the school meals program (Ministerial Directive No. 13 of 2002).

Second, regarding the allocation rules of the central government transfers, Law 715/2001 introduced the General Participation System (*Sistema General de Participaciones* or SGP) which is a set of transfers from the central government to ETCs, in order to fund education, health, and water and sanitation services. According to current legislation, of the total SGP resources, 96% is distributed among the social sectors (i.e. education, health and water and sanitation). Currently, 58.5% is allocated to education. In 2016, these resources represented two thirds of the funding in the public sector. The SGP for Education is composed of two main transfers. On the one hand, the component provision of the service (90% of SGP Education), is administered by the ETCs and directed mainly to cover personnel costs (teacher and administrative staff). These resources can also be used to contract private schools when there are not enough seats available in public schools. There is also a quality component (7%), which is subdivided into two items: (i) quality enrollment (4% of SGP), managed by the municipalities, certified and non-certified, which finances some expenses related to basic services, cleaning and surveillance, and minor infrastructure and maintenance work; and (ii) quality free (3% of SGP), which are directly transferred to schools and can be used by school principals to finance basic services and to invest in strategies to improve student learning (Technical Note IDB, 2018).

One of the main criticisms of the school financing model prior to 2001 was that the transfer of resources from the central government was determined by costs, mainly teacher salaries, without considering educational outcomes in terms of access and quality. The reform of 2001 intended to reverse this, introducing a formula based on the enrollments of each ETC and a per student or "typology"[7] allocation. One of the fundamental assumptions of the

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[7] According to Law 715, a typology is a set of variables that characterizes the provision of educational services. In practice, the typologies correspond to ETC groups that receive the same allocation per student. Once the assignments per student have been defined, the total transfer results from multiplying the per-student transfer by the total enrollment. The allocation varies according to school zone (rural and urban) and level (pre-primary, primary and secondary).

reform was that the per student formula would encourage the entities to increase total enrollment as a strategy to increase their education budget (Álvarez and Piñeros, 2018).

In the next section, we take advantage of the arbitrary rule used in Colombia to define the municipalities that can autonomously manage their school systems and evaluate the effect of decentralization on student achievement and on the characteristics of teachers, using as a counterfactual schools located in municipalities that just missed the population criteria, where schools are managed by the department of their jurisdiction. We explore the potential differences in the quality of teachers as a mechanism to explain differences in student achievement between certified and non-certified municipalities. As we discussed above, we hypothesize that certified municipalities in Colombia have more autonomy to manage the teacher hiring process (although they do not have influence on the rules to select new teachers or the pay scale) and because applicants may have less uncertainty when they are applying to the available vacancies in those municipalities. On the other hand, from the more general debate on decentralization, certified municipalities might have better information about students' and schools' needs than departments, improving teacher labor force quality by increasing the number of certified teachers with sufficient abilities and motivation, improving their allocation to schools and designing more effective incentives to attract teachers. However, these positive effects could be reversed if the smaller size of the labor market where decentralized governments can hire teachers makes it more difficult to find high performing teachers, or if local governments are more exposed to the risk of being captured by interest groups (Salinas, 2009).

II.   Methods:
II.I A sharp regression Discontinuity Framework:

Starting in 2003, the autonomy over the management of educational services assigned to municipalities was solely based on whether they had exceeded the one-hundred thousand inhabitant threshold (Brutti, 2014). Though far from being a perfect RCT scenario, this exogenous decision of decentralizing municipalities given their population size, allows us

to compare certified (decentralized) and non-certified municipalities with similar population sizes using a sharp regression discontinuity analysis.

More specifically, we will estimate the effect of being a certified or non-certified municipality on student performance measured by the percentage of a school's students that failed to meet the minimum standards on the 3rd, 5th and 9th grade national standardized tests (*Pruebas SABER[8]*). We will also estimate the impact on measures related to teacher retention and contracts (permanent and temporary) as well as teacher performance on the entry exam required to become a public sector permanent teacher. We examine teacher performance on the entrance assessment as a proxy for teacher quality that may influence student achievement. As we describe in section I, certified municipalities implement the teachers' entry contest and oversee the management of the teaching staff, while for non-certified municipalities those functions are managed at the department level.

Given that in 2003, the rule for a municipality to become certified was according to its population size, with no exceptions, we were able to employ a sharp regression discontinuity design. The effect of municipal education decentralization on academic performance and teacher quality can be estimated by:

$$\delta = \lim_{D_{i\uparrow p}} E[Y_{imt} | P_{im} = p] - \lim_{D_{i\downarrow p}} E[Y_{itm} | P_{im} = p]$$

Where the term Y_{itm} represents the dependent variable of interest for school i in the year t of the municipality m, P_{im} represents the population size of the municipality of school i, and p represents 100,000 inhabitants. This identification strategy assumes that the municipalities cannot manipulate their population for 2001, which would be difficult given that population sizes were forecasted with the population census of 1993. Moreover, similar to the RCT framework, there should not be any differences in the observable

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[8] SABER is the name of a set of standardized tests applied in 3rd, 5th, 9th and 11th grades. The assessments evaluate all schools in the system, including public and private both in urban and rural zones. It focuses on the basic competences that students must develop in the areas of Language and Mathematics. The Colombian Institute for the Evaluation of Education *Instituto Colombiano para la Evaluación de la Educación* (ICFES) is the institution in charge of the organization and implementation of the tests. More information is available at http://www2.icfes.gov.co/instituciones-educativas-y-secretarias/acerca-de-las-evaluaciones/informacion-general

characteristics of the municipalities that were certified and those that were not, around the population threshold. We present an assessment of our assumptions in section IV.

The model, given our assumptions, for the estimation of the treatment effect would be:

$$Y_{imt} = f(population_{mi}) + \delta Cutoff_{mi} + e_i$$

In this equation, "population" equals the distance between the population size of the municipality m of school i and the cutoff to be a certified municipality (100,000 inhabitants). Eligibility is given by the dummy variable $Cutoff_{im}$, which takes the value of one if the municipality m of school i has more than 100,000 inhabitants in 2002. The regression discontinuity literature uses two types of estimators to estimate δ: the local polynomial and the flexible parametric model. In what follows we use a flexible polynomial. Also, we employ a quadratic polynomial for the population size of the municipality and interact it with the cutoff term. We also include different model specifications with higher polynomials in the Annex, though following Gelman & Imbens (2014) we chose a quadratic term. Thus, the estimation equation becomes the following:

$$Y_{imt} = \beta_0 + \vartheta Year_t + \sum_{j=1}^{2} \pi_j population_{mi}^j + \sum_{j=1}^{2} \rho_j population_{mi}^j Cutoff_{im}$$
$$+ \delta Cutoff_{im} + \epsilon_i$$

Where $\sum_{j=1}^{3} \pi_j population_{mi}^j$ represents the municipal population quadratic polynomial and $\vartheta Year_t$ represents year fixed effect to account for events that affect all schools in a particular year (e.g., national policy changes, national economic shocks, etc.). The effect of decentralization on the dependent variables is measured by δ. In all the estimations presented in the next section, standard errors are corrected by cluster at the municipality level.

It is important to highlight the methodological improvements implemented herein compared to Brutti (2016). First, as described above, the polynomial used in the estimation

equation is a second order polynomial to avoid misleading results (Gelman & Imbens, 2014). Moreover, our unit of observation are the schools rather than the municipalities, though the treatment is at municipal rather than the school level. This helps to amplify the robustness of the results as the number of observations increases substantially. Dell (2010) implemented a similar model to examine the long-run impacts of the *mita*, an extensive forced mining labor system in effect in Peru and Bolivia between 1573 and 1812, using a household level dependent variable, while the explanatory variable was at the district level.

III.   Data:

To assess the impact of education decentralization on math and language proficiency and the quality of teachers in the municipality, we merged different databases containing municipal information and education-related outcomes.

First, we used a municipal panel database that contains information from the 1990s to 2016. This panel database, constructed by the Center of Economic Studies of Los Andes University, with data from different public sources, contains diverse geographic, demographic and socio-economic characteristics of the 1,121 Colombian municipalities. Some of the municipal variables contained in the database are used herein to assess how different the certified and non-certified municipalities were before the decentralization policy was enacted. In other words, these characteristics allow us to check for balance between the treatment and the control group (Table 3).

Additionally, we used the 1993 Colombian Census containing the total municipal population of 1993 and the projected population from 1994 to 2005. With the 1993 census, specifically the forecasted population of 2001, we were able to determine which municipalities became certified in 2002[9].

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[9] We verified this information with data from the Colombian National Planning Department, where we could verify which municipalities started receiving resources for their decentralized public education administration.

We used three different administrative databases for our dependent variables: student performance and teacher quality. To assess the effect of decentralization on student achievement, we used Spanish and math standardized test scores for 3rd, 5th and 9th grade for the years 2009, 2012-2017, that are publicly available at the Colombian Institute for the Evaluation of Education (ICFES) at the school level. These databases contain the school´s average tests scores for each grade as well as four variables that indicate the number of children within each school that scored within 4 different categories: insufficient, below average, satisfactory, exemplary. We used the percentage of 3rd, 5th and 9th grade students with insufficient performance in the math and Spanish tests for each school from 2012 to 2017.

We used two different databases provided by the Ministry of Education for our teacher quality measures. The first contains information on all the teachers hired by the education system. This database contains different school staff characteristics such as average years of experience, average credentials, type of contract[10], among others. The teacher data set has information from 2008 to 2016. Moreover, we used a database that contains teacher scores on the mandatory exam to become an official teacher and civil servant with a permanent contract. These tests asses the candidate's competencies in areas such as verbal, numeric, and specific subject knowledge based on a teacher's field (Math, physics, history, primary school, etc.). Teachers can take the test multiple times until they pass. We used the maximum score obtained by the teacher on the verbal and numeric tests. This data was then linked to the ministry's database containing all teachers in the official education system to determine the teacher's place of employment. After we merged both databases with the teacher ID number, we averaged the teacher test scores at each school as a proxy for teacher quality.

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[10] Temporary teachers in Colombia are recognized as public servants but are only hired temporarily and are not subject to the benefits that permanent teachers have. They are usually hired because of a lack of permanent teaching staff and do not have to take an entry exam that permanent teachers are required to take and pass. Because of the lack of credentials and filters to be hired, research shows that they are often less effective than permanent teachers (Ayala and Sanchez, 2017).

The databases at the school level were then linked with the municipal database to determine whether the school was located in a certified or non-certified municipality and the municipalities' population size in 2002.

III.I Some Considerations:

Although the sharp regression discontinuity to assess the impact of decentralization is defined by an exogenous decision, there are still a few limitations. First, only 46 municipalities out of the 1,122 became decentralized because they met the population threshold. This would not be a problem if these municipalities were all concentrated near the 100,000-inhabitant threshold. However, the population range of the certified municipalities goes from 105,080 to 6,713,437. This obstacle is clearly displayed in Figure 1. Thus, it is a challenge to establish an optimal bandwidth to estimate the sharp regression discontinuity. Hence, we decided that the most transparent way to display our results was to present the findings for different bandwidth sizes.

Figure 1. Municipal population size for 2002
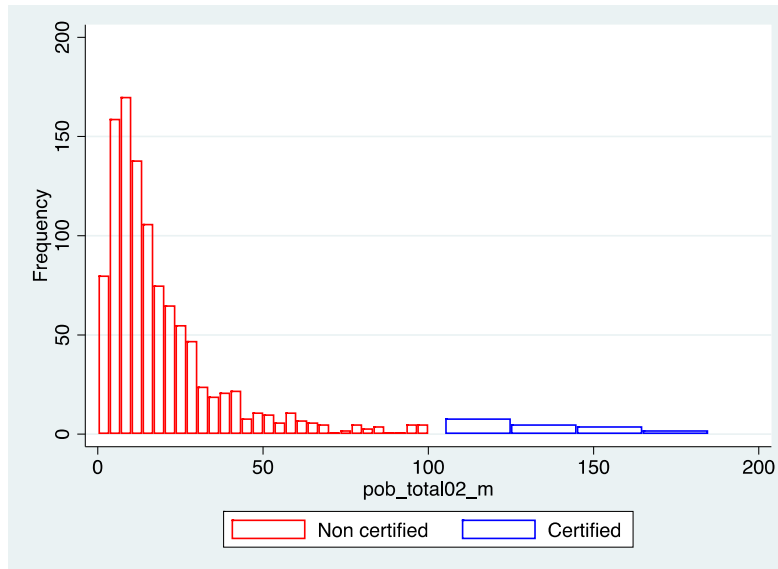
The population size is exposed in thousands and for visualization reasons, the graph only shows municipalities with up to 200 thousand inhabitants.

Moreover, an additional challenge is that since the 2001 reform, the rules to become a certified municipality changed slightly. Though no additional municipalities have been granted administrative autonomy since 2002 based solely on their population size, some municipalities that met other criteria in terms of technical, administrative and financial capacity to administer the education service required to apply to become a certified municipality[11]. Since 2003, 17 municipalities were formally certified using these other criteria (Table 2).

Table 2. Year of certification

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[11] See footnote 3 for details about requirements to be certified in the case of municipalities with less than one hundred thousand inhabitants. There is no precise information on the specific criteria used to give the certification and the thresholds, so it is not possible to implement an RD with multiple running variables (Wong, Steiner and Cook, 2013).

Year	Number of certified municipalities
2003	46
2008	2
2009	4
2010	10
2015	1
Total 2018	63

Though this affects our identification strategy, as some municipalities will be treated as non-certified when they were decentralized, we decided to keep these municipalities in the estimation, treating them as non-certified, because not considering them would significantly restrict the number of schools around the population threshold, which would reduce the precision of the estimates. Given the above, our estimation of the effect of belonging to a certified municipality can be considered a lower bound estimator, because municipalities that became certified after 2003 were granted autonomy based precisely on their educational administrative capacity. Thus, treating them as non-certified will likely under-estimate any possible effect of decentralization on our outcome variables[12]. We also excluded these municipalities, in order to keep only those observations for which the certification is assigned based exclusively on the 2002 population criterion[13].

IV.   RD assumption assessment

The two most important RD assumptions are local continuity on observable covariates and no manipulation at the cutoff point. Local continuity states that at the threshold (100,000 inhabitants), there should be no discontinuity in the relationship between the running variable (population size) and other pre-treatment covariates related to education quality (i.e., variables correlated with Y (outcome variable) different from being a certified municipality). Accordingly, if local continuity holds, we can assume that schools on both

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[12] This could happen through two different pathways. First, the desire to become decentralized would likely intensify a municipality's effort to improve education outcomes signaling their institutional maturity to become a certified municipality. Second, since these municipalities already had better administrative practices than other municipalities, once they became certified, the inflow of direct resources for education would likely improve student performance.
[13] Results are presented in Annex B.

sides of the cutoff point are very similar. Another way to asses if the control and the treatment group are similar in aspects that could affect their educational outcomes is by performing a balance test, similar to those used in RCTs to assess if the randomization was successful. In table 2, it is evident that despite not having many observations near the threshold, on average, municipalities within different bandwidths are not significantly different. The results of this balance test are presented in Table 3 and Figure 2.

Sufficient conditions for the regression discontinuity design to be a good identification strategy also requires continuity expectations of the contrafactual outcomes in the running variable. These continuity assumptions may not be plausible if municipalities are able to manipulate their forecasted population size (McCrary, 2006)[14]. Though this seems improbable given that the values were calculated by the government by projecting the municipalities population size using the 1993 census. Graphs displaying the McCrary test with different specifications are provided below in Figure 3. The graphs illustrate that with 95% of confidence, the population size was not manipulated at the cutoff point.

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[14] The McCrary test is based on an estimator for the discontinuity at the cutoff (100,000 inhabitants) in the density function of the running variable. The test is implemented as a Wald test of the null hypothesis that the discontinuity is zero. The test is implemented using two steps. First, it obtains a finely gridded histogram and second, it smooths the histogram using local linear regression, separately on either side of the cutoff. See McCrary (2004) for further explanation.

Table 3. Balance Test between certified and non-certified municipalities

	60-140 thousand			75-135 thousand			70-130 thousand			75-125 thousand			80-130 thousand		
	Certified (N=13)	Non Certifies (N=46)	Difference	Certified (N=11)	Non Certifies (N=33)	Difference	Certified (N=11)	Non Certifies (N=27)	Difference	Certified (N=8)	Non Certifies (N=25)	Difference	Certified (N=11)	Non Certified (N=19)	Difference
Population 1993 (Thousands)	103.6	65.5	38.104***	102	70.4	31.442***	101.9	72.5	29.388***	101.6	73.6	28.109***	101.9	75.3	26.674***
			(5.039)			(5.678)			(5.989)			(7.114)			(6.797)
Population 2002 (Thousands)	123.8	77.51	46.258***	121.4	83.35	38.007***	121.4	86.85	34.510***	118.6	87.99	30.585***	121.4	91.17	30.189***
			(3.931)			(3.597)			(3.075)			(3.258)			(2.687)
Population 2016 (Thousands)	138	95.8	42.206***	135.	103.7	31.350*	135.02	108778	26240*	140051	111705	28347	135019	120895	14123
			(13.556)			(15.603)			(15.417)			(17.983)			(16.733)
Municipal development Index	46.08	43.20	2.883	45.19	43.45	1.733	45.19	45.99	-0.801	45.77	45.80	-0.032	45.19	45.34	-0.152
			(3.796)			(4.356)			(3.898)			(4.504)			(3.557)
Unsatisfied Basic Needs(UBN) 2001	39.20	43.80	-4.604	41	43.88	-2.884	41	40.25	0.745	38.20	41.12	-2926	41	40.58	0.417
			(6.409)			(7.349)			(6.493)			(7.366)			(7.125)
GINI	0.451	0.432	0.019**	0.450	0.430	0.020*	0.450	0.437	0.014	0.454	0.438	0.016	0.450	0.438	0.012
			(0.009)			(0.011)			(0.011)			(0.013)			(0.013)
SABER 11 Mathh Score	49.07	49.04	0.032	49.07	48.94	0.128	49.07	48.96	0.112	49.16	48.96	0.202	49.07	49.06	0.016
			(0.432)			(0.484)			(0.502)			(0.598)			(0.592)
SABER 11 Total Score	48.27	47.88	0.393	48.33	47.87	0.464	48.33	48.01	0.325	48.49	48.05	0.431	48.33	48.05	0.288
			(0.857)			(0.984)			(1.051)			(1.241)			(1.204)
Public Primary school enrollment rates	0.960	0.990	-0.030	0.944	0.978	-0.034	0.944	0.973	-0.029	0.905	0.981	-0.076	0.944	0.942	0.002
			(0.072)			(0.079)			(0.079)			(0.092)			(0.084)
Public Secondary School Enrollment Rates	0.439	0.413	0.026	0.430	0.418	0.013	-0.003	(0.033)	-0.003	-0.001	(0.040)	-0.001	-0.001	(0.037)	-0.001
			(0.032)			(0.039)			(0.033)			(0.040)			(0.037)
Rural-Urban student Ratio	0.214	0.269	-0.055	0.238	0.260	-0.021	0.238	0.218	0.020	0.241	0.228	0.013	0.238	0.210	0.028
			(0.052)			(0.060)			(0.052)			(0.059)			(0.057)
Student-Teacher Ratio	27.47	25.64	1.830	27.63	25.55	2082	27.63	25.79	1843	27.08	25.95	1131	27.63	25.93	1705
			(1.351)			(1.405)			(1.167)			(1.342)			(1.356)

Figure 2. Local Continuity at the threshold
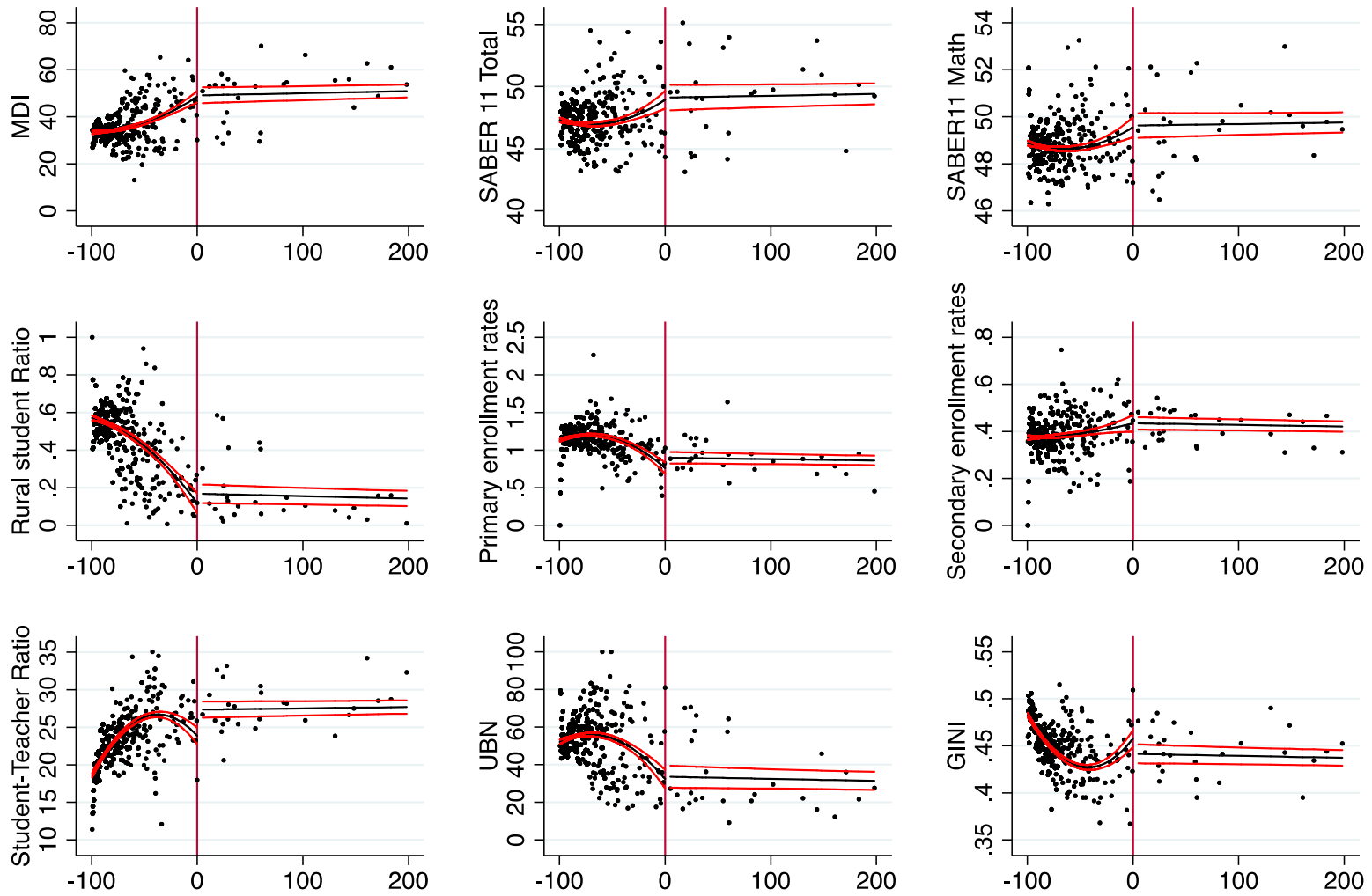
Figure 3. McCrary Test to asses manipulation

Cubic Polynomial	Quadratic Polynomial
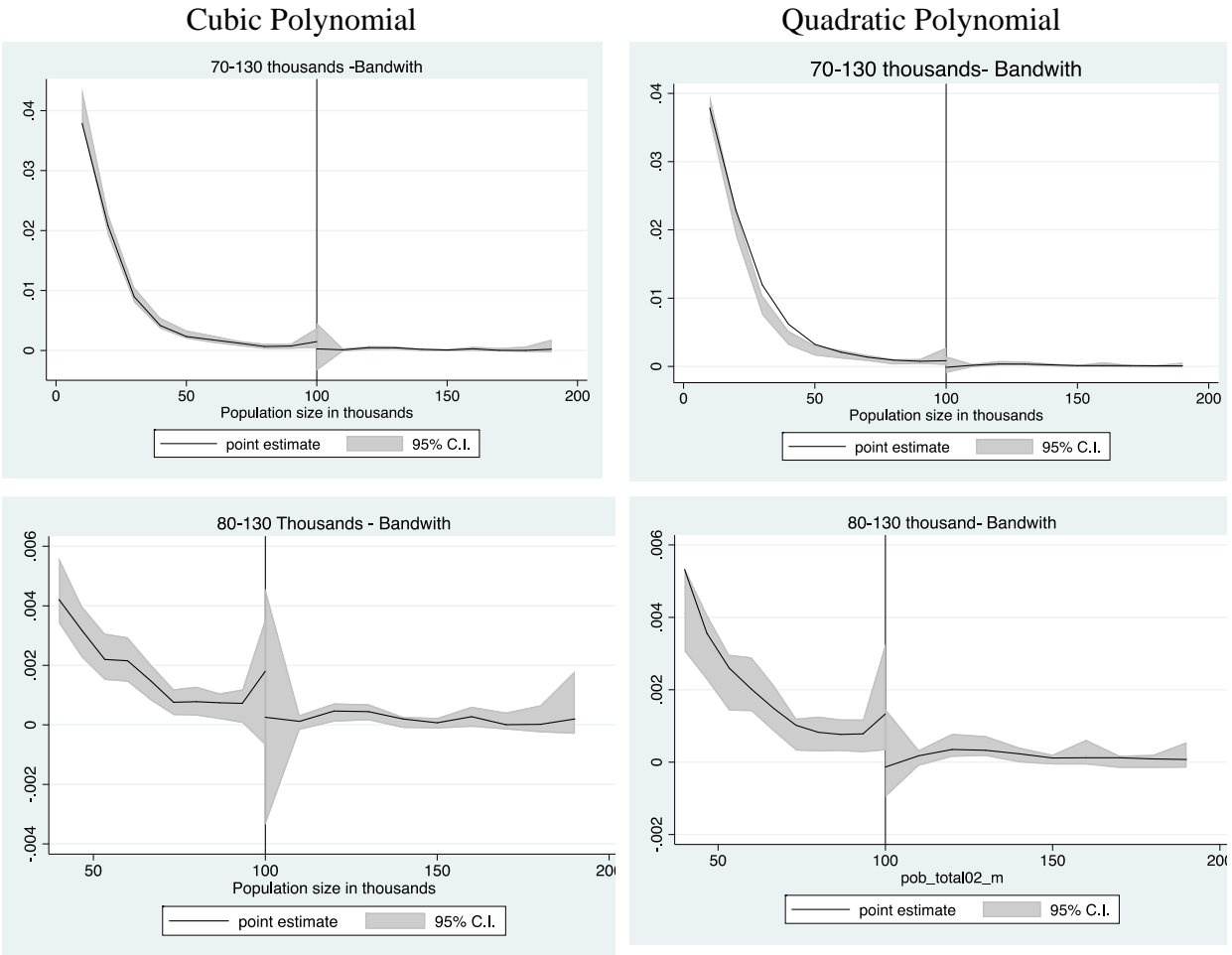
V.   Results:

V. I Academic Performance

To assess the effect of having a more decentralized public education administration on academic performance, we estimated, within different bandwidths, how being a decentralized municipality compared to being dependent on a department's administration, affects the proportion of low-performing students on 3rd, 5th and 9th grade standardized tests. The results are presented in tables 4, 5 and 6. It is important to mention that the identification strategy used in this paper only allows us to calculate local average treatment effects. This means that the estimations presented below might not hold for very big or small municipalities, which can differ significantly from those within the bandwidths used to calculate the RD.

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Regarding the results, though for some bandwidths the effect is not distinguishable from zero, for the majority, the effect is consistently negative. In other words, schools in certified municipalities compared to those in non-certified ones have a lower proportion of low-performing students for all of the tests analyzed, especially for the 5th and 9th grade assessments. The effect appears to strengthen with years, being higher and more significant for 9th grade test scores than for 5th and 3rd grade. Specifically, schools belonging to certified municipalities have a reduction of 10%-15% of the proportion of students scoring insufficient on both Math and Spanish tests in 5th and 9th grade. For third grade there appears to be no significant difference between certified ad non-certified municipalities[15].

It is important to highlight that, as mentioned earlier, some municipalities became certified years later, for reasons related to good practices in their public education administration. These municipalities are treated as non-certified in all of our analyses. Though this problem violates our sharp regression discontinuity design, we strongly believe that this problem puts downward pressure on our results. Even when treating the most outstanding municipalities as non-certified, though they were granted administrative decentralization for their exceptional administrative and institutional performance for some of the years we observe, non-certified municipalities show inferior outcomes on their student's school performance and the average quality of their teaching staff (as presented in the next section). Hence, we argue that the estimates shown above likely underestimate the positive effect of being a decentralized municipality on school performance.

To support our argument regarding the results being underestimated, we present a table in Annex B, where municipalities that were certified by criteria other than population are compered in terms of managerial and financial variables with municipalities that remain uncertified during the period analyzed. The comparison shows that municipalities that were certified after 2003 had in 2002 a superior (i) GDP per capita, (ii) income coming from local tax collection, (iii) government

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[15] Brutti (2016) finds similar results when she estimated the effect of decentralization on the high school exit exam in Colombia. Though, she compares municipalities with similar development indices, and she finds that the municipalities that benefit the most from decentralization are mainly those in the top quartile of the institutional development index. We do not perform the heterogenous analysis implemented by Brutti (2016) as separating the municipalities in different subgroups will affect the sample even more, making the number of municipalities from which we would be making an inference less than 8.

expenditure, (iv) investment in education, (v) performance in education and (vi) municipal development index. Moreover, municipalities certified by criteria other than population also have a smaller proportion of rural students. This is true for all bandwidths, though we only portray bandwidths with 60-140 thousand inhabitants and 80-130 thousand. This supports the idea that including these municipalities as non-certified is likely to underestimate the positive effect of decentralization on reducing students with insufficient academic performance.

When we re-estimate the results excluding those municipalities certified by criteria other than population, in order to keep only those observations for which the certification is assigned based exclusively on the 2002 population criterion[16], the magnitude of the estimators increases slightly, but the standard errors increased because of the reduction in the number of schools used in the estimation, especially in the smallest bandwidths. In the case of the widest bandwidth, 60 to 140 thousand inhabitants, the effects are positive and statistically significative. Specifically, the estimations show a decrease in the proportion of students scoring insufficient in Spanish by about 16 - 20 percent and in Math by 16-25 percent, in all three grades, with bigger effects for 9th grade. These results represent a decline of approximately 3 percentage points in students scoring insufficient in Spanish and 3-6 pp decrease in Math. The results almost double the main results presented in this section.

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[16] Results are presented in the Annex C.

Table 4. SABER 3: Proportion of low-performing students for different population bandwidths

SABER 3	Spanish					Math				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	60-140	65-135	70-130	75-125	80-130	60-140	65-135	70-130	75-125	80-130
VARIABLES	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand
mun_cert	-0.083**	-0.071	-0.090	-0.126	-0.062	-0.076**	-0.067	-0.087	-0.139	-0.057
	(0.036)	(0.056)	(0.058)	(0.080)	(0.051)	(0.035)	(0.055)	(0.057)	(0.087)	(0.048)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	9092	7150	6662	6027	5810	9142	7182	6695	6045	5838
Clusters	58	43	37	33	30	58	43	37	33	30
Mean	0.183	0.183	0.178	0.172	0.175	0.171	0.172	0.166	0.160	0.162
SD	0.192	0.197	0.191	0.189	0.193	0.183	0.188	0.182	0.180	0.183

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. SABER 5: Proportion of low-performing students for different population bandwidths

SABER 5	Spanish					Math				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	60-140	65-135	70-130	75-125	80-130	60-140	65-135	70-130	75-125	80-130
VARIABLES	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand
mun_cert	-0.097**	-0.097*	-0.123**	-0.149*	-0.099*	-0.144**	-0.126	-0.163	-0.232*	-0.107
	(0.036)	(0.055)	(0.056)	(0.075)	(0.051)	(0.061)	(0.099)	(0.098)	(0.136)	(0.088)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	10542	8212	7621	6859	6633	10529	8206	7615	6858	6630
Clusters	58	43	37	33	30	58	43	37	33	30
Mean	0.174	0.177	0.172	0.168	0.169	0.361	0.362	0.355	0.347	0.347
SD	0.171	0.176	0.170	0.169	0.173	0.257	0.263	0.259	0.258	0.262

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note- All estimations include: 2001 municipal development index

Table 6. SABER 9: Proportion of low-performing students for different population bandwidths

SABER 9	Spanish					Math				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	60-140	65-135	70-130	75-125	80-130	60-140	65-135	70-130	75-125	80-130
VARIABLES	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand	thousand
mun_cert	-0.153***	-0.140**	-0.162***	-0.105	-0.109**	-0.181***	-0.168**	-0.188**	-0.128	-0.122*
	(0.042)	(0.056)	(0.057)	(0.063)	(0.053)	(0.051)	(0.073)	(0.073)	(0.091)	(0.063)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	7634	5877	5541	4984	4735	7559	5822	5485	4929	4684
Clusters	58	43	37	33	30	58	43	37	33	30
Mean	0.180	0.188	0.184	0.181	0.181	0.240	0.250	0.246	0.242	0.242
SD	0.176	0.180	0.178	0.178	0.180	0.203	0.208	0.207	0.207	0.210

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note- All estimations include: 2001 municipal development index

V.II Teacher Quality

There are several possible hypotheses as to why achievement is higher in certified municipalities. For example, Brutti (2016), attempting to explain why certified municipalities have on average, higher performing students, compares the average per-pupil expenditure with local resources by municipalities. The author finds that certified municipalities in the highest development quartile spend almost 21% more than municipalities in the lowest development quartile. Moreover, within education expenditure, the difference on personnel salaries is 12%, 28% for school infrastructure and materials, and as much as 58% higher on other education expenditures and programs.

To examine other sources of variation that can potentially justify the higher schooling performance of students in certified municipalities, as opposed to non-certified ones, we examined the differences in teacher's characteristics as proxies of teacher quality. We explored measures related to teacher retention and type of contracts as well as their performance on the entry exam for becoming a public sector permanent teacher[17]. For the first two measures, though we found a positive relationship between higher retention and teachers with permanent contracts, the effects were not significant for all of the bandwidths. Nonetheless, when we measure the average performance of teachers on the exam, we find that teachers that work in schools located in certified municipalities have higher scores, both on the verbal and mathematics sections of the assessment (Table 7). Both scores were standardized with a mean of zero and a standard deviation equal to one. The results show that teachers in certified municipalities score between one half and one standard deviation higher than teachers in non-certified municipalities.

One possible explanation for this result is related to the variation in the efficiency of the municipalities' hiring process. Thus, the results could be driven by more effective hiring in the certified municipalities, through for example, assertive recruiting. This could be a possibility if municipalities invest time and their own resources on persuading teachers to apply to their

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[17] Ayala and Sanchez (2017) find that an increase of one standard deviation in the proportion of temporary teachers in a secondary school decreases by 0.26 standard deviations the average score in SABER 11th grade test. Regarding the teacher entry exam, Brutti and Sanchez (2017) find that teachers selected with the new regulation (merit-based contest based on an entry exam and with further quality incentives) have a positive impact on student performance. The teacher exam is structured into three modules: i) pedagogical aptitude, ii) subject knowledge, and iii) psychometric values. Candidates must score a minimum of 60/100 points on each of the three modules to qualify to become a permanent teacher.

municipalities. On the other hand, the differences may also be explained by teacher preferences during the hiring process. In Colombia, teachers choose the territorial entity and school they would like to work at. Their entrance exam score and the number of other candidates applying to the same ETC and school, determine whether or not they are granted a position at their preferred choice. Teachers who apply to a certified municipality will be placed in the school they choose within that municipality while teachers who apply to a department can be placed in any of its non-certified municipalities within that department if they do not score high enough to able to choose from the total pool of vacancies. The certainty of where teachers will end up when applying to a certified municipality as opposed to a non-certified one may help to attract more qualified teachers to certified municipalities.

To try to determine if the differences in teacher quality can be attributed to the actions of the certified municipalities during the hiring process or to a self-selection of the best applicants, we compared the scores of the applicants in the 2013 teacher contest between certified municipalities and departments. As we can observe in Table 8, teachers who apply to municipal ETCs have on average, higher scores than teachers who apply to departmental ETCs (non-certified municipalities). This might indicate that a fraction of the teacher quality gap can be explained by differences in the quality of the pool of applicants from which ETCs can select. However, it is possible that certified municipalities do have influence in attracting better applicants through better information about vacancies or non-monetary incentives. Thus, this result likely does not simply reflect preferences of the applicants for municipal ETCs. Nonetheless, the results suggest that there are differences prior to the implementation of the contest by the ETCs.

Table 7. Average standardized score on teacher contest evaluation for different population bandwidths

Teacher Score	Verbal					Numeric				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	60-140 thousand	65-135 thousand	70-130 thousand	75-125 thousand	80-130 thousand	60-140 thousand	65-135 thousand	70-130 thousand	75-125 thousand	80-130 thousand
mun_cert	0.447*	0.763**	0.799**	0.749*	0.860***	0.512**	0.773**	0.847**	0.465*	0.919**
	(0.231)	(0.305)	(0.304)	(0.416)	(0.289)	(0.213)	(0.327)	(0.327)	(0.256)	(0.358)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	6691	5167	4785	4265	4074	6691	5167	4785	4265	4074
Clusters	58	43	37	33	30	58	43	37	33	30
Mean Teacher Score	63.64	63.70	63.65	63.51	63.39	64.37	64.57	64.50	64.38	64.33
SD Teacher score	5.006	4.880	4.840	4.913	4.938	5.571	5.519	5.380	5.449	5.460

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note- All estimations include: 2001 municipal development index

Table 8: 2013 Application tests for municipal and departmental ETC

	Average Numeric Test	SD Numeric Test	Average Verbal Test	SD Verbal Test
Departmental ETC	49.38	15.20	49.87	15.30
Municipal ETC	52.09	16.21	51.48	16.30

VI.   Conclusions:

In this paper, to contribute to the debate about the effect of decentralization of education management on education outcomes, we take advantage of the arbitrary rule used in Colombia to define the municipalities that can autonomously manage schools, to evaluate the effect of autonomy on student achievement and teacher quality, using as a counterfactual schools located in municipalities that just missed the population criteria, which are managed by the departments.

Our results suggest that municipalities that became autonomous in terms of public education administration, have on average, schools with a lower proportion of low-performing students, than similar schools in municipalities that do not manage their schools, especially in 9th grade. Moreover, when analyzing the teacher characteristics as a channel to explain academic performance, we found that teachers in certified municipalities score on average, 0.5 to 1 standard deviation higher on the mandatory competency test to become a permanent public-school teacher.

One of the limitations in this paper is that we do not have enough information to understand the mechanisms through which decentralization may affect educational outcomes. As we discussed in the first two sections, the positive effect of more autonomy could be explained, among other reasons, by the greater amount of information that the certified municipalities have about local needs, by their smaller geographic extension, which reduces coordination costs, or by the existence of greater accountability mechanisms in these municipalities. Our preliminary results suggest that one potential mechanism could be higher average teacher quality in certified municipalities, measured as the score on the mandatory application test to become a permanent teacher. We also present suggestive evidence indicating that a fraction of this teacher quality gap may be due to self-selection of better candidates into those municipalities. However, determining which fraction of the effect is attributable to the preferences of the teachers and how much is explained by the actions of the certified entities and what specific policies are implemented by certified municipalities to attract and retain better teachers are topics for future research.

Finally, something that should be considered when interpreting the results of this paper, is that we are analyzing the impact of decentralization within a group of municipalities close to meet the population threshold, but we cannot conclude that these findings can be extended to smaller municipalities which probably have less capacity and resources to manage schools. In such cases, the positive effects of decentralization would be conditional on the implementation of other policies that deliver greater resources to these municipalities.

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Annex A: Certified and non-certified municipalities within the bandwidths for 2002

Municipality	Value
El Cerrito	60021
Aguadas	60338
Pamplona	60395
San José del Guaviare	61046
Florida	61526
Jamundí	62844
Villa del Rosario	63002
Tierralta	63168
Sevilla	63475
Puerto Asís	64365
Chía	64869
Caucasia	64909
Fundación	64987
Samaniego	66290
Uribia	67015
Candelaria	67038
Plato	67412
Pivijay	68685
Caldas	69264
San Andrés	71516
Santa Rosa de Cabal	73837
Santander de Quilichao	75640
Agustín Codazzi	77320
Yumbo	77368
Calarca	78254
Espinal	79117
El Carmen de Bolívar	79665
Yopal	80723
El Banco	81003
Arauca	82258
La Dorada	84816
Pitalito	84939
Chinchiná	85085
Cereté	86060
Aguachica	87188
Rionegro	91501
Ipiales	93610
Sabanalarga	94367
Facatativá	95126
Zipaquirá	95995
Apartadó	96140
Malambo	97154
Piedecuesta	98390
Ocaña	98558
Riohacha	99380
Quibdó	99999
Fusagasugá	105080
Girón	111395
Duitama	116815
Turbo	118849
Tunja	122941
Lorica	124133
Girardot	124405
Ciénaga	124951
Maicao	128079
Guadalajara de Buga	128917
Sahagún	129419
Cartago	135347
Florencia	138714

Annex B.

	60,000-140,000			80,000-130,000		
	Never certified	Certified after 2003	Pval-Diff	Never certified	Certified after 2003	Pval-Diff
ln_GDP pp	15.48	15.69	0.21	15.42	15.72	0.26
ln_tax income	7.62	8.72	0.00	7.70	8.67	0.00
ln_gov_expenditure	9.50	9.96	0.00	9.62	9.92	0.10
ln_education_inv	13.48	13.70	0.54	13.56	13.32	0.63
SABER11_MATH	48.29	48.89	0.27	47.91	48.90	0.31
% rural students	0.29	0.26	0.52	0.22	0.20	0.64
MDI	40.05	47.16	0.05	41.88	46.83	0.18

Note: MDI: Municipal Development Index

Annex C. Estimates without municipalities certified by criteria other than population

SABER3

	(1)	(2)	(3)	(4)	(5)
VARIABLES	60-140 thousand	65-135 thousand	70-130 thousand	75-125 thousand	80-130 thousand
Spanish	-0.158**	-0.116	-0.118	-0.120	-0.143
	(0.075)	(0.120)	(0.121)	(0.166)	(0.129)
Math	-0.149**	-0.113	-0.119	-0.135	-0.142
	(0.070)	(0.116)	(0.118)	(0.167)	(0.125)
Year FE	YES	YES	YES	YES	YES
N (Spanish Test)	6122	4587	4213	3498	3436
N (Math Test)	6132	4597	4221	3493	3450
Clusters	44	31	26	21	19
Mean Spanish	0.183	0.183	0.178	0.172	0.175
Mean Math	0.171	0.172	0.166	0.160	0.162
SD Spanish	0.192	0.197	0.191	0.189	0.193
SD Math	0.183	0.188	0.182	0.180	0.183

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note- All estimations include: 2001 municipal development index

SABER5

VARIABLES	(1) 60-140 thousand	(2) 65-135 thousand	(3) 70-130 thousand	(4) 75-125 thousand	(5) 80-130 thousand
Spanish	-0.163**	-0.135	-0.143	-0.138	-0.164
	(0.070)	(0.114)	(0.116)	(0.161)	(0.124)
Math	-0.239**	-0.180	-0.207	-0.218	-0.200
	(0.104)	(0.180)	(0.187)	(0.263)	(0.188)
Year FE	YES	YES	YES	YES	YES
N Spanish	7103	5293	4831	3974	3938
N Math	7080	5280	4818	3966	3928
Clusters	44	31	26	21	19
Mean Spanish	0.174	0.177	0.172	0.168	0.169
Mean Math	0.361	0.362	0.355	0.347	0.347
SD Spanish	0.171	0.176	0.170	0.169	0.173
SD Math	0.257	0.263	0.259	0.258	0.262

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note- All estimations include: 2001 municipal development index

SABER 9

VARIABLES	(1) 60-140 thousand	(2) 65-135 thousand	(3) 70-130 thousand	(4) 75-125 thousand	(5) 80-130 thousand
mun_cert	-0.213*	-0.195	-0.192	-0.106	-0.176
	(0.110)	(0.144)	(0.147)	(0.177)	(0.146)
	-0.252**	-0.234	-0.225	-0.117	-0.210
	(0.120)	(0.168)	(0.170)	(0.212)	(0.169)
Year FE	YES	YES	YES	YES	YES
N spanish	5109	3817	3536	2888	2797
N Math	5065	3789	3507	2862	2773
Clusters	44	31	26	21	19
Mean Spanish	0.180	0.188	0.184	0.181	0.181
Mean Math	0.240	0.250	0.246	0.242	0.242
SD Spanish	0.176	0.180	0.178	0.178	0.180
SD Math	0.176	0.180	0.178	0.178	0.180

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note- All estimations include: 2001 municipal development index

Teachers Test Scores

VARIABLES	(1) 60-140 thousand	(2) 65-135 thousand	(3) 70-130 thousand	(4) 75-125 thousand	(5) 80-130 thousand
Verbal	0.159	0.403	0.399	0.346	0.595*
	(0.210)	(0.288)	(0.288)	(0.437)	(0.293)
Math	0.434**	0.670*	0.748**	0.334	0.999**
	(0.205)	(0.347)	(0.332)	(0.283)	(0.362)
Year FE	YES	YES	YES	YES	YES
N Verbal	4673	3350	3008	2488	2400
N Math	4673	3350	3008	2488	2400
Clusters	43	30	25	21	19
Mean Verbal	63.64	63.70	63.65	63.51	63.39
Mean Math	64.37	64.57	64.50	64.38	64.33
SD Verbal	5.006	4.880	4.840	4.913	4.938
SD Math	5.006	4.880	4.840	4.913	4.938

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note- All estimations include: 2001 municipal development index