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Quality, Equality and Equity in Colombian Education

(Analysis of the SABER 2009 Test)

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March 2012

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Summary

This Technical Note describes the learning inequalities faced by Colombian students and analyzes the equity in the allocation of resources among schools and their relation to learning. Using the SABER 2009 database, the analysis demonstrates that there are high inequalities in students' academic results associated with their families' socioeconomic status, the type of school management, and the school's geographic zone. This relation is more important between schools than within a school, denoting a high degree of segregation of Colombian schools according to students' socioeconomic status. In terms of key school resources, there is a high inequity in their distribution with a clear disadvantage against schools with mostly poor students, as well as rural and public urban schools. This inequitable allocation of resources is associated with a greater risk of students achieving unsatisfactory SABER test results. The results of the multilevel model estimations, where the interaction between school factors and test results are jointly analyzed, indicate that better physical conditions, adequate connection to public services, a complete school day, the presence of rules in the classroom, minimal violence in schools, and greater teacher satisfaction are significantly related with higher probabilities of students achieving adequate test results. Improving these school factors, mainly among schools with poor students, has a great potential for increasing quality and equity of learning in Colombia.

JEL Codes: I24

Key words: Education, inequality, learning, students, inequity, academic results, socioeconomic status, quality, equity, equality, Colombia, SABER.

Introduction

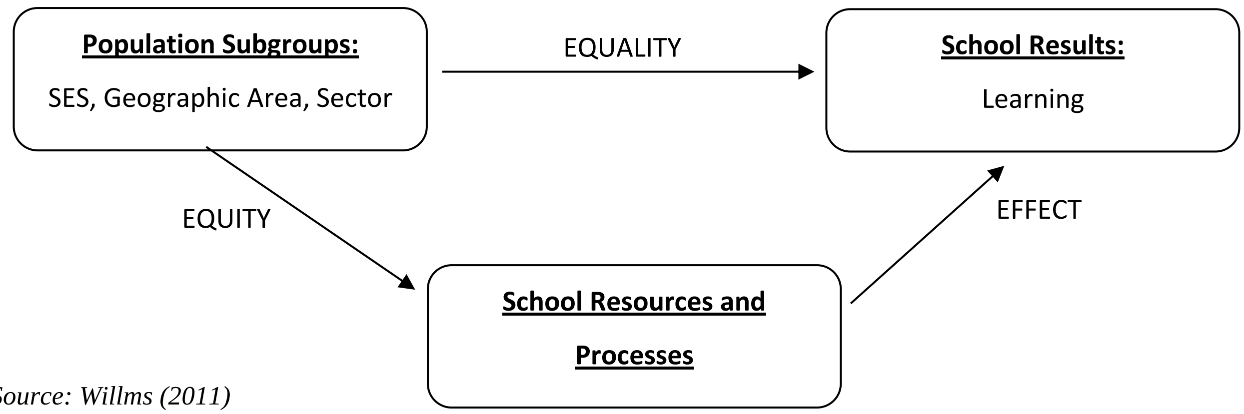
Basic education in Colombia has made important achievements in recent years, both in terms of educational coverage and quality of education. Coverage has increased in all school levels. 80.5% of children ages 4 and 5 attend preschool education. Coverage during the first six years of elementary school is close to universal (96.7%), while middle and secondary school attendance is 81% (own analysis using ECH 2008). At the same time, teaching quality, measured by the results of international learning tests, has undergone significant improvements. A comparison of the country's PISA test results from 2006 and 2009 shows that the percentage of 15 year olds that achieve level 2 or higher in this test (considered as the level of basic proficiency in the evaluated concepts) increased from 44.3% to 52.8% in language, with similar changes in other evaluated areas (OECD 2007, 2010a).

Despite these achievements, the country faces the challenge of uneven development in education, both in terms of coverage and quality of the learning process, affecting socio-economically disadvantaged sectors, rural areas, certain geographical regions, and ethnic minority communities. In terms of coverage, there are great inequalities according to the socio-economic status of children and the area where they live, particularly in the first and last years of schooling. While 71% of children from the poorest quintile attend preschool, 88% of children from the richest quintile do. In secondary school, 77% of students ages 13 to 17 from the poorest quintile attend school, while 92% of young people from the richest quintile do. Similar inequities occur among children and adolescents living in urban and rural areas (own analysis according to ECH 2008). While inequalities in coverage have been studied more extensively (PND 2010-2014, Sarmiento Gómez 2010), inequalities in the quality of the learning process have been explored to a lesser extent, due in large part to the difficulties of information.

The main objective of the study is to describe the inequalities in the learning outcomes of Colombian students and to analyze the equity in the distribution of resources and processes that occur among schools and their relationship to learning. Using the SABER 2009 database, we identify school factors with potential to guide educational policies to improve the academic performance of students through equity. In this study, 'equality' is understood as the distribution of learning outcomes among certain subgroups of the population according to students' socio-economic status (SES), geographical area, and sector in which the school functions (public or private). 'Equity' is understood as the distribution of learning between certain subgroups of the population, taking into account the distribution of resources and processes in schools attended by students of these population subgroups. Quality of education is represented by students' learning, measured through the SABER 2009 tests. To analyze equality, this analysis uses survey data that includes the socio-economic variables of students as well as data on the geographic location and school sector (SABER Sample). To analyze equity, a subsample that also contains information on the resources and processes of schools was used (SABER Related Factors).

The conceptual model used in this study is similar to that of Willms (2011) and is synthesized in Figure 1. Equality (or inequality) of students' academic outcomes (learning) is analyzed by disaggregating them into population subgroups (students' socioeconomic status –SES–, gender, geographical area, etc.). At the same time, academic performance of each subgroup (effect) is mediated by the way various resources and processes are distributed in schools that serve these sub-populations (equity). Both types of analyses are important: the first one because it describes the differences in the academic achievement of students who belong to different population subgroups, and the second one because it provides information to help identify school factors that can simultaneously improve the quality and equity of educational systems.

Figure 1: Conceptual Model of Analysis



Source: Willms (2011)

The study is organized in two parts. The first part describes the equality of the SABER 2009 results according to students' socio-economic status, geographical area, and the sector (public or private) of the school they attend. For this analysis we use different measures of equality: the gradient of the relationship between SES and learning outcomes, the decomposition of the variances between and within schools, and double and triple jeopardy of the compositional effects of schools. The second part of the study examines equity in the results of the tests, according to the distribution of resources and processes among schools serving students from different population subgroups. To analyze equity, we use the concepts of relative risk and population attributable risk, as well as measures of access to resources and processes for students of different population groups. We then use multilevel models to estimate the relationships between school resources and processes and academic performance. The study concludes with recommendations to design interventions that aim to resolve the problematic situations encountered.

Literature Review

Students' learning is influenced by a variety of factors, including their family context, school resources and processes (which include the teacher and school climate), classrooms and the teaching process, and the institutional framework and educational policy. A wide collection of studies confirms that a positive and significant correlation exists between students' socio-economic status and their learning outcomes (Hanushek and Woessman, 2006). Using data from the SERCE tests, administered in 16 countries of Latin America, Duarte, Bos and Moreno (2010a) show that this relation is different when studying the variance between schools and within them. About half of the variance in the scores between schools is associated with the mean socio-economic status of students, while the variance in scores within schools that can be explained by students' socio-economic status is minimal. The high degree of correlation between socio-economic status and observed SERCE test scores, and the differing strength of the relationship between schools and within them, are consistent with the results of other studies that use international tests such as PERCE and PISA (Willms and Somers, 2001; OECD, 2001, 2007 and 2010b; OREALC/UNESCO and LLECE 2010).

The literature also confirms the key role that institutional and pedagogical models of schooling play in the quality of education. Beginning with the study of Rutter, Maughan, Mortimore and Ouston (1979) during the 1970's and continuing through the Effective Schools Movement (Murillo Torrecilla, 2005), school characteristics have been emphasized as one of the key elements in educational policies. Levin and Lockheed (1993) and Dalin (1994) are examples of prominent studies that highlight the importance of the characteristics of educational institutions in students' academic achievement. Further examples include the subsequent study of Rutter and Maughan (2002), which summarizes the works carried out since the publication of their original study to reaffirm their initial findings on the role of schools in determining learning outcomes. Recently, subsequent PISA analyses also have shown that the school plays a key role in the success of learning, explaining about 40% of the variance in test scores (OECD 2010b).

Various studies have sought to determine which school characteristics are associated with better learning. PISA 2009 analyses show that there is a specific group of factors that is repeatedly associated with better learning even after accounting for the effect of the students' socio-economic status. This group of factors includes greater school autonomy for budget decision making, curriculum, and evaluation; the way in which students are grouped according to their abilities when they enter school and between classrooms (negative effect); and the way in which schools invest their resources, particularly if they prioritize better wages for teachers (OECD 2010c). In Latin America, a similar analysis that uses data from the SERCE study finds that while there are large differences between countries, making it difficult to generalize for the entire region, there is a group of factors that consistently predict academic performance, including school climate, principals management, teachers´ performance and satisfaction, and material resources that support the learning process (computers available, basic infrastructure, and services) (OREALC/UNESCO and LLECE 2010).

Nevertheless, the evidence on the relationship between any of these school factors and learning is not definite. Literature on grouping students according to their skills shows mixed results (Betts 2006), as does the literature on awarding greater autonomy to schools (Figlio and Loeb 2006). Hanushek and Woessman (2006) and Behrman (2010) present several studies with different methodologies that confirm the relationship between the different resources and schools' institutional arrangements and students' learning. One of the most discussed and studied school factors is the role of teachers in the learning process and the features of teachers that matter most. In general, all studies confirm the general intuition that teachers are very important in the success of their students (Hanushek, Rivkin and Kain 2001, Sanders and Rivers 1996, Rockoff 2004, Wright, Horn and Sanders 1997, among others), although there is no consensus on a single set of characteristics that is unquestionably associated with better learning in students[1]. This is due, in part, to the fact that many of the features that make a teacher successful are not observable and are difficult to measure, and in part to differences in methodologies used in these studies.

[1] See also Glewwe 2002, Hanushek 1986, Hanushek 1995, Rockoff 2004, Rice 2003, Velez, Schiefelbein & Valenzuela 1993, Greenwald et al., 1996, Hedges & Greenwald 1996, Gustafsson 2003.

In the case of Colombia, several analyses have been conducted on the role of families and the socio-economic status of students in the learning process, as well as on the relationship of certain school factors with learning outcomes. All of the studies confirm the positive and significant relationship between students' socioeconomic status and their academic performance (The Social Mission of the National Planning Department of Colombia DNP, 1997, Sarmiento and Becerra 2000, OECD/GIP 2010, World Bank 2010, Woessman and Fuchs 2005, Piñeros 2011). Several studies analyze the relationship between certain school factors and learning. Using data from PISA 2006, the OECD/GIP report shows that the level of curricular coverage and access to school resources are the school factors that have the greatest association with better learning outcomes. With data from the TIMMS study, the World Bank (2010) confirms the role played by personal and family factors in students' learning process and finds that teachers' expectations of students and the perception of security in the school are among the school factors associated with better learning outcomes. With data from SABER 2009, Piñeros (2011) shows that the factors associated with better learning included an Institutional Educational Project and an Institutional Improvement Plan for the school, a good school climate, and the use of school texts that support the learning process. The present study seeks to go beyond the analysis of school factors associated with learning and place an emphasis on examining how the distribution of these resources and school processes is associated with students' learning outcomes as they belong to different population groups.

Part I: Equality: Learning Outcomes according to Students' Socio-Economic Status, Geographical Area and School Sector

This first part describes the degree of equality in the distribution of the SABER 2009 test results according to students' socio-economic status, geographical area, and the sector (public or private) of the school they attend. For this purpose we use the data from SABER 2009, an exam administered to students in the 5th and 9th grades, which provides information on their language, mathematics, and science capacities, students' housing conditions, and their parents' levels of education[2]. This data is used to estimate the differences in the results of the tests according to the families' socio-economic status (SES), and a combination of geographical area and schools' management sector: urban public, rural public and private sector. In addition, the results are estimated for the seven major cities in the country. In the discussion of the results presented here, it is important to note that this analysis does not seek to establish a causal relationship between the variables analyzed. Rather, it simply tries to document the relationship between academic results and the socioeconomic variables of the students and schools.

The SABER sample covers approximately 102,000 5th grade students in 1,439 schools and approximately 87,000 9th grade students in 1,216 schools. The sampling design allows representative results of the reference population, of the two academic grades, as well as of some subgroups, for example geographical areas (urban and rural), educational sector (public and private), gender, and socio-economic status (ICFES 2010).

[2] It should be noted that this is a sub-sample obtained from the SABER test that covered more than 1 million students and 17 thousand schools.

I.1. Estimation of Socio-Economic Status

To estimate students' socio-economic status an index was built using information collected in the socio-demographic questionnaire of the SABER Sample. To build this index, a model based on the *Item Response Theory* was used, and a *Graded Response Model (GRM)* was applied. There were different estimates of the model with different specifications of items to identify those with a greater degree of difficulty and greater discriminatory capacity. The final version of the SES index used for this report contains information on parents' education, the materials of the floors, access to restrooms at home, and the level of overcrowding at home. Annex A provides the details of the estimates.

Figure 1: Index of Socio-Economic Status (SES) of Students According to SABER Sample 2009

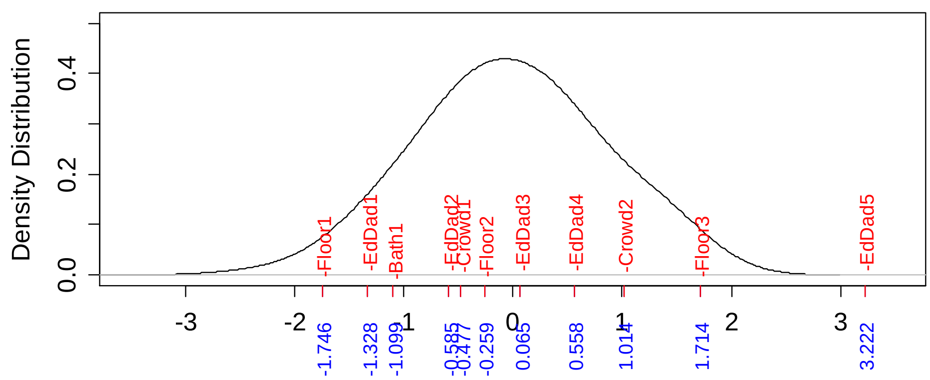


Figure 1 shows the distribution of the SES index. Along the horizontal axis, students are located on a scale that approximates the socio-economic level of their families; the vertical axis measures the proportion of students associated to each SES index value. On the horizontal axis, the figure indicates the household characteristics associated with each socioeconomic status. For example, those families who show a lower SES index value tend to respond with greater frequency that their houses have dirt or gravel floors (floor 1) and that parents have little or no education (education 1); families with near average SES tend to have houses with cement, floorboards, plank, or rough wood floors (floor 2), up to two people living in each room (crowd 1), and parents are likely to have at least completed their secondary education (education 3). Families located in the positive end of the SES index tend to have homes with tile, board, brick or vinyl floors (floor 3), and parents are likely to have completed their higher education (education 4), or in the case of those with higher SES, even postgraduate education or doctorate programs.

I.2. SABER results according to the socio-economic status of students

The general results of the SABER 2009 test reveal several important findings about the quality of the Colombian education system. Only a small percentage of Colombian students achieve a satisfactory or higher level on the tests (Table 1). The deficiencies are notable in the three evaluated areas in both grades. However, it is noteworthy that in the 5th grade only one third of students (and in 9th grade, only 2 out of 5 students) has reached a satisfactory or advanced level of language. This indicates that the majority of students have insufficient foundations in an area that constitutes the base for consolidating learning in other key areas of the curriculum during all of the school cycle.

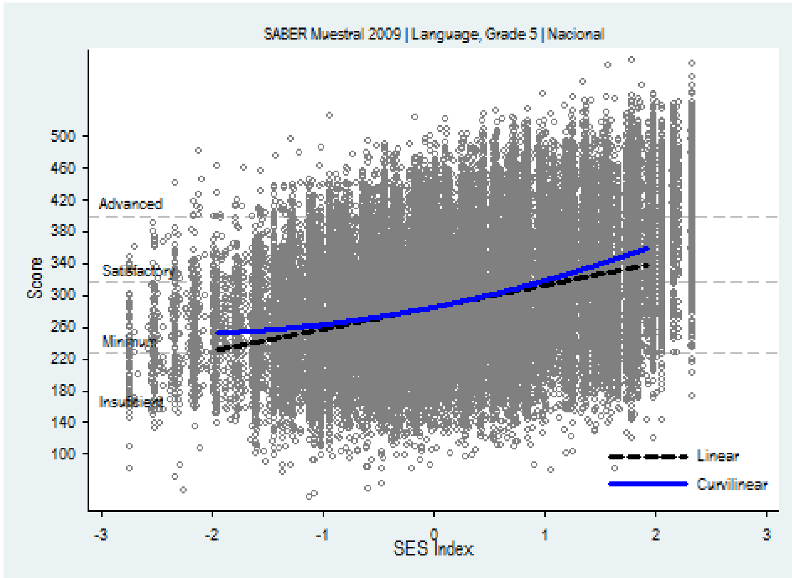
Table 1: Distribution of Students per Performance per Level and per Test (%)

	5th Grade			9th Grade		
	Reading	Mathematics	Science	Reading	Mathematics	Science
Advanced	8,2	6,9	5,9	2,8	3,0	4,8
Satisfactory	26,5	17,5	19,3	36,3	18,2	23,8
Minimum	45,3	31,4	53,8	44,1	53,4	55,7
Insufficient	20,1	44,1	21,0	16,8	25,4	15,7
	100,0	100,0	100,0	100,0	100,0	100,0

To quantify the association between students' scores and SES, geographic area and educational sector, we implement a bivariate linear regression model, using the ordinary least squares method (OLS), standardizing the SES so that it has a mean of zero and a standard deviation of one. The SES with a value of zero represents a student from a home of an average SES. The value related with the SES coefficient is interpreted as the change in a student's score when the SES is increased by one standard deviation above or below the average of each analyzed sample (country or subgroup).

Figure 2 shows the relationship between SES and students' tests scores for the entire country. Each dot on the figure represents a student. The vertical axis indicates each student's score (with a national average of approximately 300 points and a standard deviation of 80 points). The horizontal axis indicates the SES Index and its scale indicates the number of standard deviations above and below the average SES of the country. Dotted horizontal lines show the cut-off scores for the four levels of performance on the language section of the test.

Figure 2: Relationship between SES and Language Test Results in the 5th Grade



Note: Each dot represents a student. Standardized SES Index with mean 0 and standard deviation 1. Lines plotted range from 3 to 97% of the SES Index distribution.

Figure 2 indicates that the relationship between the socio-economic status of students and the score on the language test in the 5th grade is positive and statistically significant (the data behind this Figure is found in Annex A, under Linear Regression). Students belonging to families with better socio-economic situations tend to get higher scores, and vice versa. Each standard deviation of SES is associated with a change of 28 points (equivalent to 0.35 standard deviations) on the test. The socio-economic gradient is present in two ways: first, as a linear relationship (dashed black line), indicating that the magnitude of the increase in test scores associated with an increase in SES is the same at all levels of SES; and second as a curvilinear relationship (continuous blue line), in which the curvilinearity rate is positive (5.7 units) and significant at 1%. The curvilinear representation implies that the relationship between SES and academic performance is more pronounced at higher levels of SES. The R-squared value obtained in the regression indicates that the SES index can explain approximately 16% of the variation in the scores observed on the test. Just as it has been established in other analyses of international tests, the relationship between students' scores and SES is not deterministic: the large number of points above and below the gradient indicates that for students of a particular SES there is a considerable range of performance on the test[3]. In other words, there are students who, despite their low socioeconomic status, have high scores, and vice versa.

The estimates for mathematics and science in 5th grade and for language, mathematics, and science in 9th grade show similar trends. In 5th grade, a change is SES of one standard unit is associated with a change of 28 points in mathematics and 25 points in science. The R-squared values for each test indicate an explained variance for math and science similar to that of language. In 9th grade, the variations range from 30 and 31.5 points per unit of standard deviation of SES in the different areas tested, with explained variances that range between 15%

[3] See the results of PISA 2006 and 2009 (OCDE 2007, 2010) and SERCE (OREAL-UNESCO 2008). See also Duarte, Bos and Moreno (2010a and 2010b) for the case of SERCE in Latin America.

and 18%. In all cases, explained variances are significant at 1%. (Annex B includes details of the estimates; Annex C includes graphics for each grade and subpopulation).

Since trends are similar for both grades and for the different sections of the test, the analyses in this document will focus exclusively on the language test for 5th grade, but the annexes will show the results of the analyses of other areas and grades.

I.3. Results According to Students' SES Within and Between Schools

This section first examines the decomposition of the variation in the SABER test results at the student and school level and how much of that variation in results is associated with socio-economic variables. In educational systems, students are not isolated but grouped into schools and classrooms. Part of the differences in tests results may be exclusively related to the characteristics of students, while another part may be attributed to the characteristics of the schools and classrooms where they study[4]. In other words, students' individual SES or school averages each explain part of the variation in the results.

The analysis of the variation in test results relies on the use of multi-level hierarchical modeling (Raudenbush and Bryk, 2002). This form of analysis offers two advantages. First, it enables us to distinguish between the variance in performance attributable to students' characteristics from the variance attributable to characteristics of the classroom or school (the units of greater hierarchy). Second, it allows us to break down how much of the variance in students' academic performance is attributable to each level of analysis, i.e. to the differences between students within the same school (*within-school*) or differences between schools (*between-schools*)[5] . In the last few years, this approach has become the standard for studies of this type; it is the method used in the OECD's study of PISA results as well as by SERCE in Latin America, among other international studies on the subject.

Table 2: Socio-Economic Status of Students and Schools and Results of the SABER Tests (Language, 5th Grade)

	Test Score	SES Index	Variance Decomposition		Multilevel Regression			
Sample	Average	Average	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	SES Effect within School	Percentage of the variance explained within school	SES Effect between Schools	Percentage of the variance explained between schools
National	290,8	0,0	37,5	47,9	8,021***	0,4	33,307***	38,4
Urban Public	287,5	0,1	21,6	79,9	8,766***	1,1	48,151***	39,4
Rural Public	263,7	-0,7	29,3	79,0	4,535**	0,1	11,029***	3,7

[4] In such cases, students from similar survey strata are not independent, and it is likely that their performance and characteristics are correlated. Since the units of observations are not independent, OLS regression results and estimations are likely biased. In particular, standard errors tend to be underestimated, increasing the possibility of accepting a hypothesis as valid when it should have been rejected.

[5] See PISA 2000 and 2006 (OCDE, 2001 and 2007) and SERCE (OREALC/UNESCO, 2008). In Willms (1986) there is a thorough discussion of the methodology and its advantages.

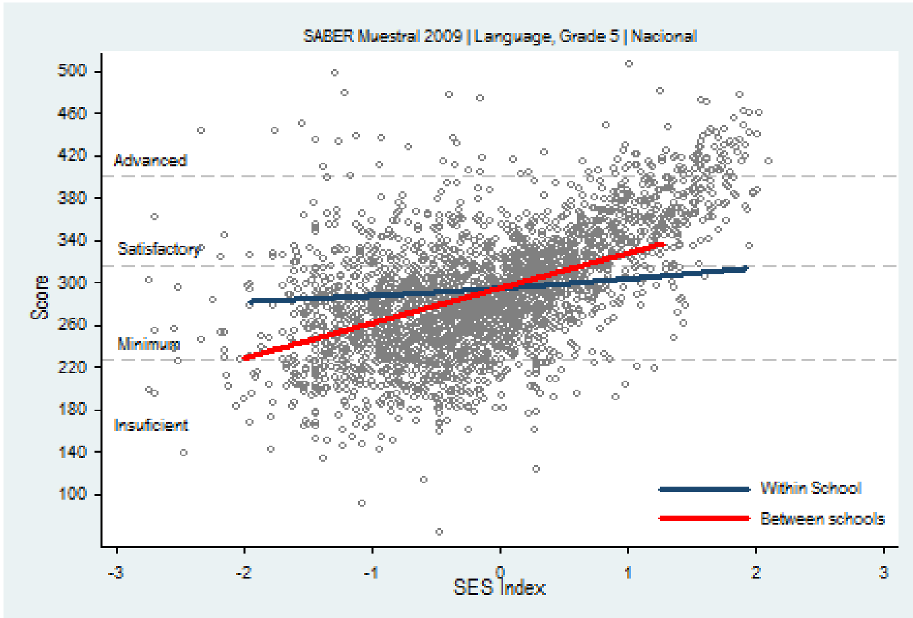
Private	345,1	0,8	38,4	57,3	10,241***	1,1	58,068***	54,1
Medellin	300,1	0,2	27,7	62,6	8,110***	0,7	56,035***	67,5
Bogota	334,3	0,5	28,7	60,4	11,335***	0,9	59,705***	70,6
Pasto	306,7	0,3	33,1	47,6	7,940***	1,0	47,155***	76,0
Bucaramanga	336,8	0,5	30,5	51,2	9,741***	1,0	53,622***	72,1
Cali	298,5	0,5	34,3	63,2	8,387***	0,5	57,611***	56,7

Note: Levels of significance, + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

The results of the analysis indicate that in the case of the SABER test, an important part of the variance in students' performance is attributable to the characteristics of their schools. At a national level, 37.5% of the variance in the results of the SABER test is attributable to the characteristics of students' schools; the remaining 62.5% is attributable to the characteristics of the students themselves (Table 2). For the urban public sector, the variance attributable to schools is 21%; for the rural public sector it is 29%; for the private sector it is 38%; and for selected cities, these percentages vary between 27.7% and 34.3%. These results are in line with numerous studies that demonstrate the important role of educational institutions in students' learning.

Having considered the decomposition of the test results according to differences in students and schools, we analyze how much of such variation at each level is associated with socio-economic variables. On average within each school, a change of one standard deviation in a 5th grade student's SES is associated with a change of 8 points in the language score (within-school effect). In addition, students' SES explains only 0.4% of the total variance in scores within schools. These results suggest that the variance in the scores within schools is associated with different factors from the SES of students. On the other hand, we observe that for an increase of a standard deviation of the average SES of the school, the average score in the school increases by 33.3 points (between-schools effect), and the average SES of the school explains 38.4% of the total variance among schools. These results suggest that the variance of the scores between the schools is largely associated with the SES of students (Table 3). These results are consistent with the results of other studies that include data from Colombia, such as PEIC or PISA (Willms and Somers, 2001 and OECD, 2007 and 2010), and also with studies including data from the country itself, as mentioned in the literature review section of this document.

Figure 3: Decomposition (Within and Between Schools) of the Relationship between SES and Test Scores



Note: Each dot represents a school. The vertical axis represents the score observed in the test and the horizontal axis the SES Index standardized with a mean of 0 and a standard deviation of 1. The within school plotted line covers between 3 and 97% of the range of the SES Index at student level. The between school plotted line covers between 3 and 97% of the range of the SES Index aggregated at school level.

Figure 3 shows recently described results. Each dot on the Figure represents a school, and two gradients are shown: one representing the relationship within the school between the test results and the students' SES (within-school effect), corresponding to the continuous blue line; and another representing the relationship between the test results and the average SES of the school (between-schools effect), corresponding to the continuous line red. The vertical axis indicates the average score of each school on the language section administered in 5th grade. The horizontal axis is the average SES of the school (calculated as the average SES of the students from the school).

Figure 3 shows the sharp slope of the gradient representing the relationship between scores and SES between schools, confirming that the average score for schools is highly related to variance in the average level of the SES (red line). The line representing the within-school effect (blue line), on the other hand, is flatter, indicating that variation in scores among students within the same school is less related to the variance in their SES. The ratio of the between-school slope to the within-school slope for 5th grade language is 4.1, confirming the great impact that the differences in the schools' average SES have on the variance of the average scores of schools[6].

The results of the estimations indicate that the relationship between SES and test scores is substantially stronger between schools than within them. This would indicate that the high degree of socioeconomic segregation among schools is related to differences in the quality of learning between schools. This is verified with the estimates of the interclass correlation coefficient (ICC)

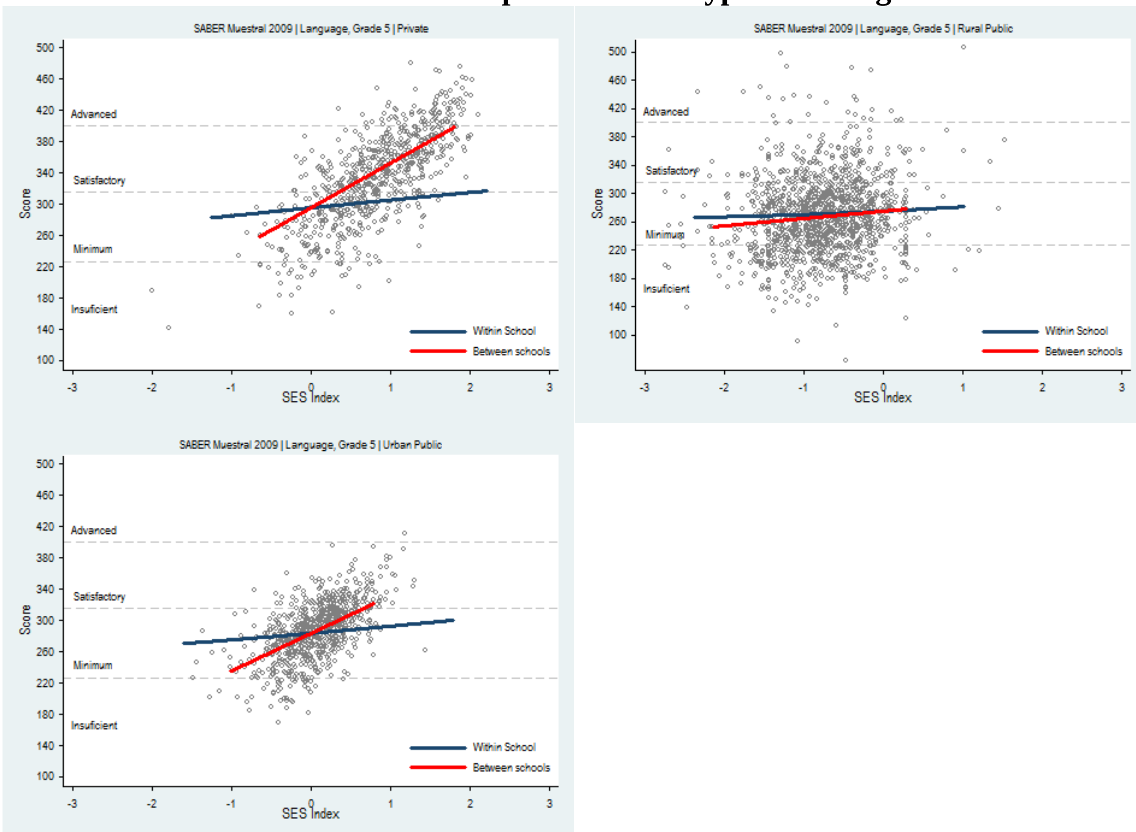
[6] The effects within and between schools are similar in other examined areas for 5th grade. In 9th grade, the slope between schools tends to be even greater than in 5th grade: around 48 points (0.61 standard deviations). See the Figures on the effects within and between schools for each grade and subpopulation in Annex D.

of the SES for the disaggregation of the national data and data from the cities (Table 2). The ICC indicates the probability of students from the same school to have a similar SES. An ICC close to 100 implies high homogeneity in students' SES, while a low ICC indicates heterogeneity of SES among students from the same school. Urban public and rural public schools have an ICC close to 80, showing that there is a high homogeneity of SES within these schools and a very low probability that students with different SES attend the same educational institution. As a reference, for the PISA 2009 tests, the ICC of the OECD countries was 25.2, which indicates, contrary to the Colombian case, high heterogeneity in schools by students' SES[7].

When data is disaggregated by geographical area and type of management (urban public, rural public, and private), and by large cities, the same tendency is observed as in the country data as a whole: the relationship between SES and scores is substantially higher between schools than within them. However, there are important differences between the various groups of schools (Table 2 and Figure 4). The relationship between SES and scores between urban private schools are more marked than in the urban public schools (58.1 points for each standard deviation of SES, compared to 48.2 points). Urban public schools show less dispersion in both scores (vertical) and the average SES of schools (horizontal). In contrast, urban private schools show a greater range of scores among students, especially in satisfactory and advanced levels, and greater segregation by SES (the cloud of dots for schools is more dispersed vertically and biased towards higher SES). In rural areas, there is a large fragmentation both horizontally (although biased toward negative levels of SES) and vertically (although biased toward low tests scores). The between-schools slope is much less marked (although statistically significant at 1%) than in the cases of urban schools: 11 points for each standard deviation of SES. In all cases, the variances explained by SES between-schools are high, while they are higher for private schools than for the rest (Table 2). Finally, the correlation between SES and test scores within-schools is low and similar to the national average, indicating the variance of scores within schools is associated with factors other than the SES of students. The exception occurs in the case of rural public schools, where SES explains more of the variance of scores within schools.

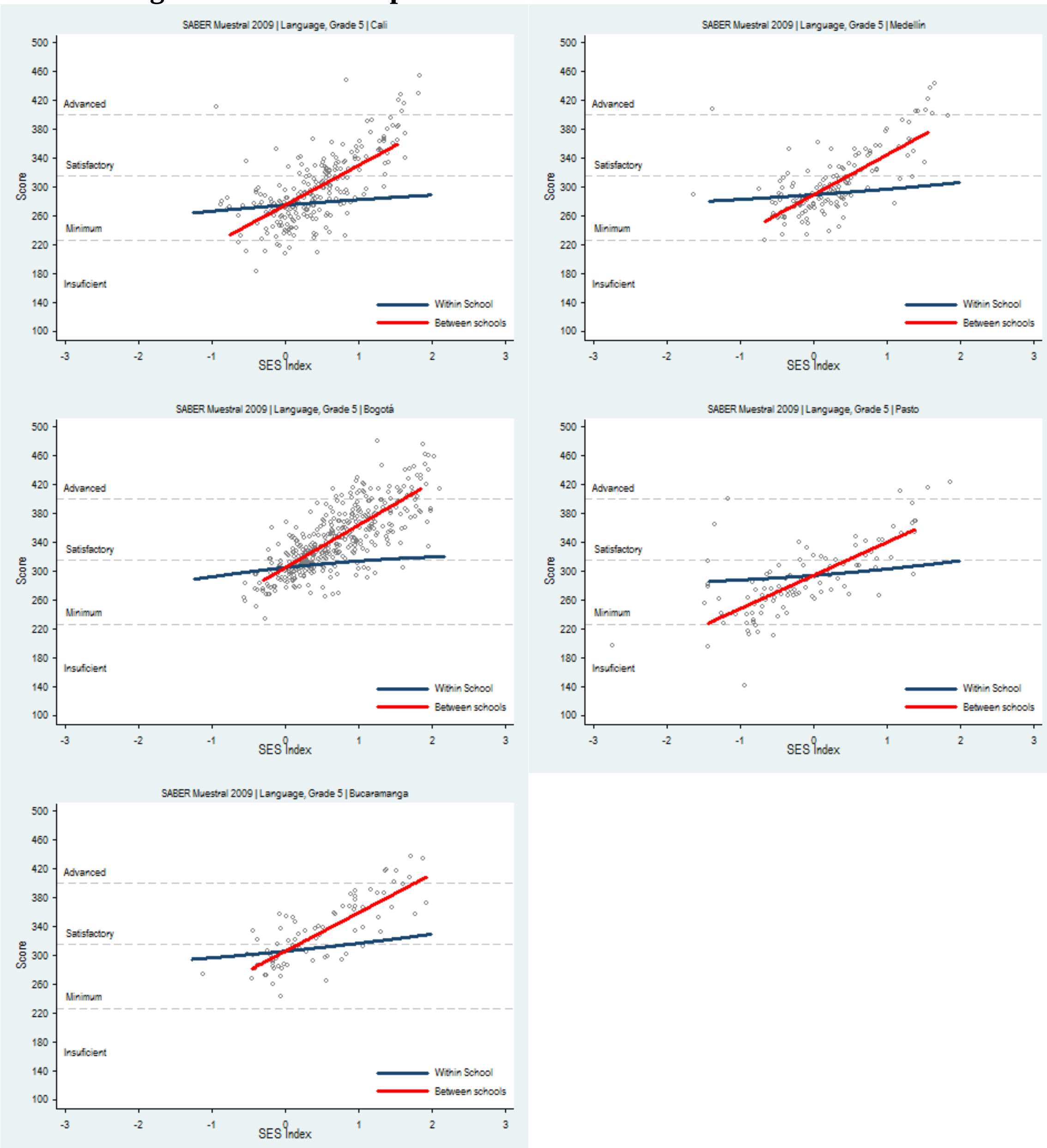
[7] For the results of the PISA 2009 test, the rate of social inclusion, which is the opposite of the ICC is reported as: (100%- ICC) (OCDE, 2010b).

Figure 4: Decomposition (Within and Between Schools) of the Relationship between SES and Test Scores per Area andType of Management



In the data from Medellin, Bogota, Pasto, Bucaramanga, and Cali, the slopes between-schools are quite marked, which implies that these five cities show something similar to what we described in the case of urban schools (public and private): high segregation by students' SES, which in turn is highly related to the differences in test scores between schools (Figure 5). This suggests that in these cities the educational institutions attended a student may be decisive in his or her performance on the standardized tests.

Figure 5: Relationships between SES and Test Scores for Selected Cities



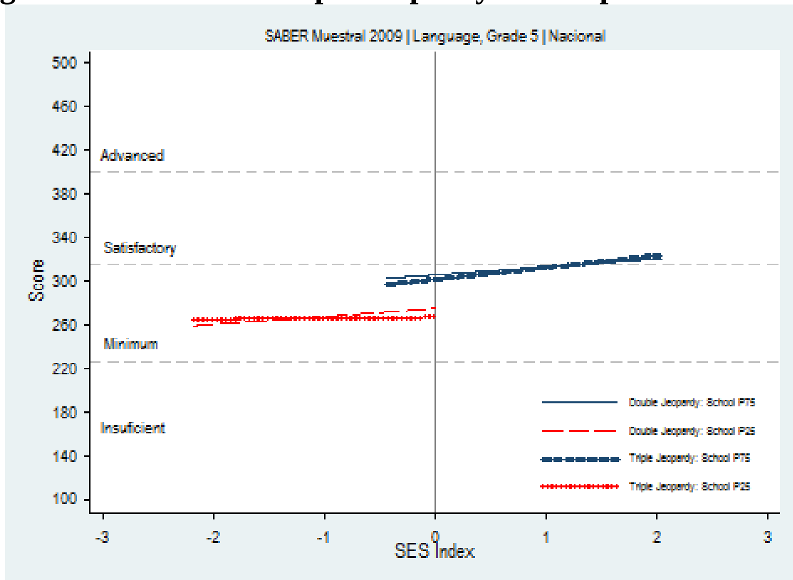
The highlighted findings presented here indicate that there is a high level of segregation among schools in Colombia according to SES, and that students' test results are highly associated with such segregation. This would indicate that the school students attend plays a very important role in their academic performance, more so than their individual SES. Likewise, we find that within schools, there is a positive and statistically significant relationship between students' SES and their test scores, although much smaller than the effect between schools.

I.4. Double and Triple Jeopardy of Compositional Effects

This section analyzes the "compositional effect" of schools in the SES and test scores (Willms, 2006 and 2003), distinguishing on one hand the compositional effect that results from the aggregation of student characteristics (for example, their demographic or socio-economic characteristics), and on the other hand, the contextual effects produced by the characteristics of classrooms, schools, and those relating to the learning and teaching environment[8]. The compositional effect of schools is also known as *double and triple jeopardy*. Double jeopardy is the change (prize or punishment) in the score that a student with an average SES would have if he or she moves to a richer or poorer school (as measured by the average socio-economic level of students attending that school). Triple jeopardy captures the crossover interaction between the socio-economic level of the student's family and the average socio-economic composition of the school. That is to say, in our case, it considers the variations in test scores associated with a simultaneous change of the student's SES and the SES of the school.

[8] Following Willms (2006), contextual effects have to do with the environment in which teaching processes take place: school infrastructure and resources, school culture, educational materials, teaching resources and libraries, interaction between students, student-teacher relationships, and school discipline, among others. Models that include contextual effects attempt to estimate the impact of macro-processes on variables at an individual level beyond the effects of any other single working variable (Blalock, 1984). In educational research, such effects are expressed as the magnitude in which the collective properties of students have an effect on performance, beyond their individual characteristics (Hutchison, 2007). The usual way of including contextual effects involves using variables that represent a macro or collective property without a counterpart at an individual level, as well as the use of aggregate variables based on a subset of individuals, usually a group. The analysis of contextual effects on individual behavior includes both the study of the exogenous characteristics of the group and the behavior of the group to which the individual belongs (endogenous). The latter is often the main objective when studying peer-effects (Boozer and Cacciola, 2001). This part of the study only looks at the impact of compositional effects of average SES of schools. Part II of the study analyzes issues related to the contextual effects of schools (school resources and processes).

Figure 6: Double and Triple Jeopardy of Compositional Effects



Notes: Estimations based on multilevel regressions with random intercepts and random coefficients. Plotted lines cover between 5 to 95% of the range of the SES Index of the students who attend each type of school.

We note that in Colombia, a student whose socio-economic status is similar to the national average (SES equals zero), and who attends a "poor" school, that is, one with an average SES at or below the 25th percentile (red line), would have a lower performance by 30.5 points than a student with the same socio-economic status who attends a "rich" school (average SES in at or above 75th percentile, blue line). This is what we refer to as double jeopardy. Next, if the SES of the student changes simultaneously with that of the school, the difference in scores would be 46.6 points, i.e. 16 points more than if that same student only transfers to a school with different SES. This is what we refer to as triple jeopardy. Although significant, the triple jeopardy of the compositional effect, approximated through the slope of dotted lines, shows a more differentiated impact for students attending "richer" schools, while the impact is smaller for those who attend "the poorest" schools. The figure shows, however, that the triple jeopardy effect in the Colombian case is more theoretical than real because the probability of finding students from very different levels of SES in the same school is low (there is almost no overlap within the red and blue lines).

Table 3: Double and Triple Compositional Jeopardy in SABER tests of 5th Grade, Language

	Double Jeopardy			Triple Jeopardy			
Sample	Intercept	Change per unit in school SES	Change per unit student SES	Intercept	Change per unit in school SES	Change per unit student SES	School SES interaction and student SES
National	294,674***	26,682***	7,459***	289,629***	30,530***	7,486***	8,601***
Urban Public	283,523***	39,004***	8,603***	282,897***	40,248***	8,386***	4,344***
Rural Public	275,263***	6,909*	4,106***	276,317***	10,152**	6,079**	3,337
Private	294,358***	47,173***	10,464***	294,580***	43,862***	6,710***	5,403***
Medellin	289,436***	43,269***	8,679***	286,682***	41,081***	6,280***	10,882***
Bogota	304,537***	49,288***	10,282***	304,547***	49,056***	10,119***	0,342
Pasto	294,398***	36,495***	8,649***	291,284***	38,814***	6,960***	5,883*
Bucaramanga	306,385***	40,777***	10,784***	304,971***	37,002***	7,418**	7,818*
Cali	273,800***	46,949***	8,165***	272,451***	44,402***	4,456**	8,842***

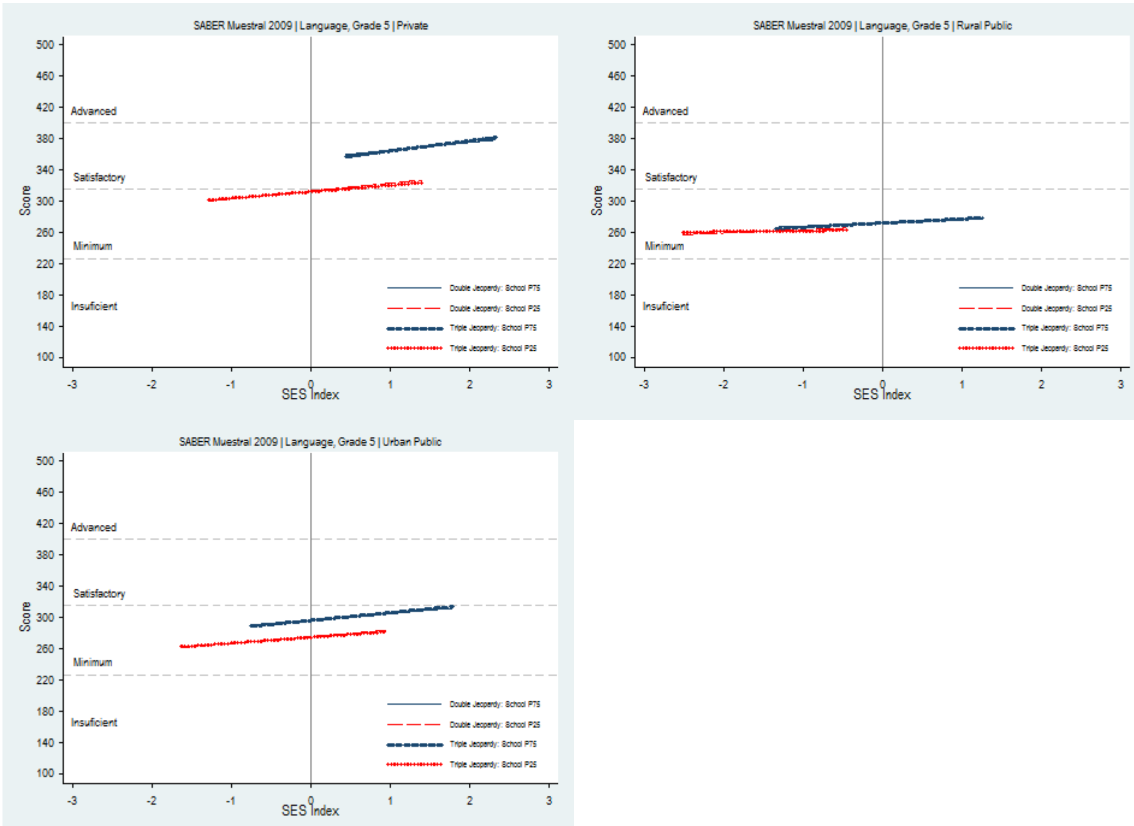
Notes: Significance levels, + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

The disaggregation of estimations of double and triple jeopardy for students from different types of schools shows important differences with regards to the national average. The cases of Bogotá, Cali, and the private sector are those that show greater double jeopardy, i.e. greater punishment for attending poor schools (or reward for attending "rich" schools). In the case of the rural public sector, attending one school or another would imply changes in the scores, although much less than in the rest of the cases, and as in the case of Bogotá, crossover SES interactions of students and schools are not statistically significant. (Annex E includes the Figures of double and triple jeopardy for different degrees and subpopulations).

The analysis of the compositional effects of the SES of schools indicates that in Colombia students are not only subject to unequal learning related to their own socio-economic conditions, but also these inequalities are further accentuated by attending schools with a low socio-economic status, which affecting the poorest segments of students to a greater degree[9].

[9] This same situation occurs in the vast majority of Latin American countries. See Duarte, Bos, Moreno (2010a and 2010b).

Figure 7: Double and Triple Jeopardy of Compositional Effects for the Public (Urban and Rural) and Private Sectors



I.5. Conclusions from Part I

In Colombia, there is a high relationship between the SABER test results and students' socio-economic status. This relationship is important and statistically significant. On average, a change in the SES index of one standard deviation is associated with a change in the test score of 28 points (0.35 standard deviations), while students' SES explains 15% of the variance in their test results.

The relationship between socioeconomic variables and test scores varies in significance between schools and within schools. Average socio-economic status of students has a more marked relationship with scores between schools (33.3 points or almost half a standard deviation), and it explains a greater proportion of the variance in the scores (38.4%). In contrast, within schools, students' socio-economic status has a weaker relationship with individual scores (difference of 8 points on the test), and it explains a very small proportion of the total variance (0.4%). These data indicate the existence of high segregation by SES among schools, associated with high degree of inequality in students' academic outcomes.

High socioeconomic segregation of schools contributes to the relationship between students' socio-economic variables and the results obtained on the tests due to the compositional effects of schools. The poorest students tend to be negatively affected, first by their socio-economic status and then because they study in schools that are mostly attended by poor families. The richest students, in contrast, tend to be positively affected since attending a school of advantaged students increases the likelihood of obtaining better results (double and triple jeopardy of the compositional effect). The educational system in Colombia is experiencing a situation in which students have unequal learning opportunities, originating in the socio-economic conditions that they bring with them to the school system. These conditions are compounded by the high socioeconomic segregation of schools and because schools themselves tend to work against students with lower socioeconomic status. These results suggest that policy interventions to reduce the high inequality in students' academic performance should be centered on schools, giving a higher priority to those that serve students with lower SES.

Part II: Equity of Learning by Distribution of Resources and School Processes

This second part of the study examines equity in the results of the tests, according to the distribution of resources and processes in schools attended by students from different population subgroups. We try to determine whether there is an equitable distribution of resources and school processes and if such distribution is related to the SABER test results, in order to identify school factors that can simultaneously affect the quality and equity of the Colombian educational system. First, we begin with a description of the variables that measure the resources and processes in schools and the indexes created to facilitate the estimates. To analyze equity, we use the concepts of relative risk and population attributable risk, as well as the equitable access to resources and processes for students of different population groups. Finally, we present estimates using multilevel models of the relationships between indicators of school resources and processes and academic performance. For this equity analysis we use the SABER Associated Factors database (SABER-FA). The survey was given to a representative subsample of educational institutions at the national level in the 5th and 9th grade that were part of the operational SABER Sample. The survey collected additional information on students, comments about the classrooms and schools where they were studying, and questionnaires to teachers and principals of educational institutions.[10]

As mentioned in the previous section, when discussing the results of the models presented on equity, it is necessary to warn that in no moment does this analysis seek to establish causal relationships between the analyzed factors and learning. However, the themes focused on here allow the exploration, measurement, and documentation of statistical relationships between academic performance and school or student factors. Understanding these relationships can be useful when designing policy interventions in education.

II.2. Methodological Approach

The methodological approach for analyzing issues of equity in the SABER-FA survey is based on a proposal from Nonoyama and Willms (2010), in which they introduce two concepts adapted from epidemiological research to the analysis of education issues: "Relative Risk" and

[10] The SABER-FA database was conducted by the Colombian Institute for Educational Evaluation (*Instituto Colombiano para la Evaluación de la Educación*, ICFES). It was given to 4,598 5th grade students in 255 schools and with 4,187 9th grade students in 115 schools. After performing several refinement processes, we succeed in creating a database that contained the cases that were completely observed at both levels; which leaves us with a sample of 240 institutions and 4,145 5th grade students. The final sample does not show significant variations with respect to the initial sample. In the case of the 9th grade, the final sample consisted of 2,759 students and 88 schools. Here, however, we observed a significant change in the characteristics of students as they tend to have slightly higher scores and come from homes with a higher SES, though the average school SES tends to be quite similar to that of the initial sample (details on the values for selected variables can be found in Annex F). Due to problems in collecting the codes to link student with their corresponding classrooms and teachers, the analysis only includes two levels: institutions and students.

"Population Attributable Risk". Relative Risk (R.R.) is a measure of the relative relationship between two values (a ratio) that shows the increased risk of vulnerability associated with exposure to a certain factor, compared to the risk associated with not being exposed to such factor. In the context of educational equality, relative risk may be used to compare the relative risk of failing an exam if a student belongs to a certain subpopulation, compared to the rest of the population's risk of failing. In this case, a R.R. greater than one indicates that students of the subpopulation have a higher risk of failure than the rest of the study body, will a R.R. less than one would indicate the opposite. Population Attributable Risk (P.A.R.) captures the proportion of the total occurrence of a phenomenon that can be attributed to a specific factor, taking into account the prevalence of that factor in a given population. P.A.R. allows the estimation of the proportion in which the risk observed would decrease if that factor fails to act. To continue with the previous example, the P.A.R. would illustrate the decrease in the rate of failure among the entire population, if the rate of failure of a subpopulation were reduced to the rate of the failure rest of the rest of the population. The P.A.R. increases with the size of the subpopulation and the magnitude of the difference between the two vulnerability rates and is a useful tool for determining policy relevance. In our example, if policy makers seek to eliminate the incidence of students failing the standardized exams, the P.A.R. illustrates the decrease in the failure rate that could be achieved by successfully reducing the vulnerability of a particular subpopulation to that of the rest of the population.

In our analysis, a student is in *educational vulnerability* when he does not reach at least the satisfactory level in the SABER tests. We seek to analyze the differences in vulnerability (not achieving satisfactory levels on the SABER tests) between sub-groups of the student population, specifically, between students of different SES, attending schools in different geographical areas with different management. At the same time, we will analyze the vulnerability risk of students that can be attributed to their access to appropriate levels of resources and school processes.

II.3. Estimation of Schools Indexes on Resources and Processes

The different theories on the relationship between schools characteristics and student learning give great importance to factors such as the type of teachers, teaching methods used in the classroom, teaching support materials, the different profiles of principals and school management, the physical infrastructure of schools, and school climate, pointing out not only the relationship between students and professors (and between each of these segments) but also the environment of coexistence in the school, among others. From these aspects, and keeping in mind the data limitations of the SABER 2009 database (large quantity of missing data, minimal variability in the responses, and low or null contribution to the indexes that it tried to construct), this study centers on the student in the familiar context of students and a combination of school resources and processes. Table 4 describes the variables of resources and processes chosen for our analysis.

The authors recognize that the factors that lied outside of the analysis represent an important part of the factors associated with learning, and their exclusion from the analyzed results makes it a partial analysis of the relationship between these and the learning outcomes of students. Despite these restrictions, we manage to obtain robust indicators for a group of students factors that likely affect the differences in school learning and that offer clear suggestions about the type of interventions to improve the quality and equity of education in the country.

Table 4: Indexes and Items of School Resources and Processes

Resources	
State of classrooms	State of floors, roofs, toiletries, desks, windows and walls
Access to utilities	Water, sewerage, electricity, Internet, telephone; status of restrooms
Teachers´ profile	Teachers with complete higher education
School has library	Does the school have a library at the building?
Processes	
Classroom rules	Perception of the student on: There are clear behavior rules; the teacher puts them into practice; students know them and know the consequences of not following them
Proactive teachers	Students' perception on: Does the teacher treat students alike? Does the teacher provide equal attention to the questions of all students? Is the teacher a person that students can trust to get help? Does the teacher have available time to talk with students who need it? Does the teacher do what it takes to help the students who need it?
Students Satisfaction with School Faculty	Perception of students on the relationships between students and school teachers regarding: teacher's interest on students well-being; teacher's interest in listening to students; extra support from teachers to students who need it; and fair treatment by teachers of students
Teachers' Satisfaction	Teachers' perception on: work environment, relationships with colleagues within the school, job stability, materials available to develop their teaching, support received from parents, and recognition of their effort from the school´s principal
School Violence	Students' perception on: Theft at school, threats to teachers coming from students, violence or aggression between students, carrying of weapons in school, the existence of gangs, and use of alcohol or drugs among students of the school.
Full-Day Schedule	Does the school operate full time?

The groups of variables presented in Table 4 are introduced in the analysis as indexes. For the creation of the indexes, we apply a graded response model (GRM), an extension of the IRT model for polytomous data types, similar to that used to come up with the index of SES presented in Part I. Following the suggestions from Nonoyama and Willms (2010), indexes are then dichotomized according to the empirical distribution of difficulty coefficients and considering points that were relevant to policy-makers. When the score of a school (or student) in each index is above the established cut-off point, the school (or student) is considered to show an *adequate* level of the resource or process. If the value is below the cut-off point, then the level of the index is regarded as *inadequate*.

Figure 8: State of Classrooms Index

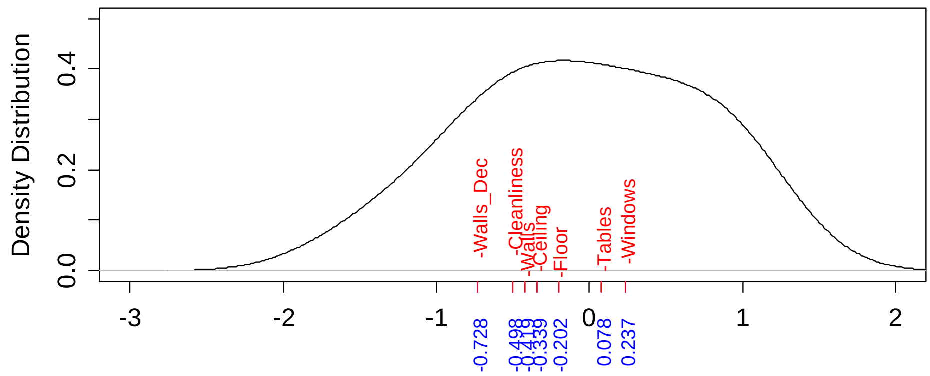
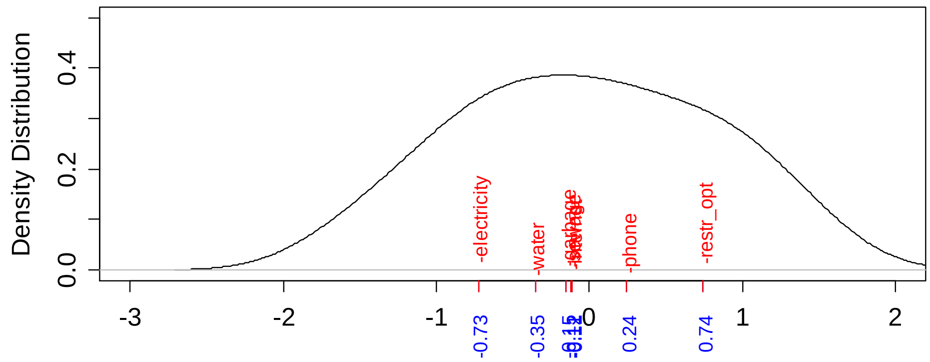


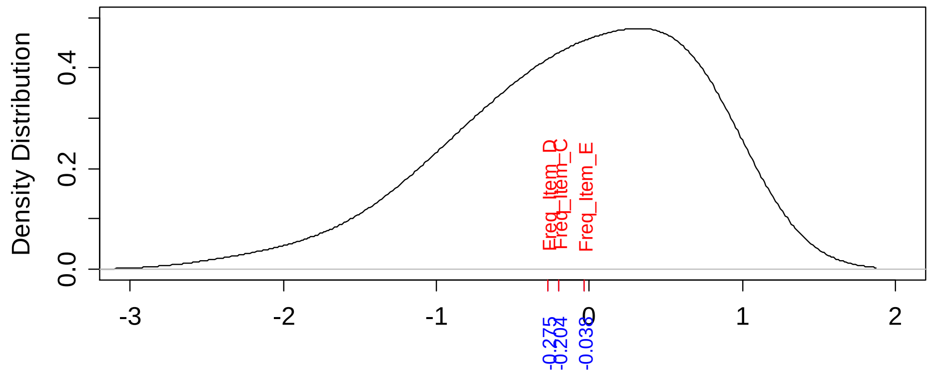
Figure 8 shows the distribution of the *State of the Classrooms* index over the different degrees of difficulty. Each item that composes the index is inserted in the figure and the submitted value is its degree of difficulty, i.e. it indicates how difficult it is to have an adequate level of such item (positive values indicate that it is much more difficult for a school to have the item). Index information shows that it is easier or more frequent to find clean classrooms with decorated walls including educational messages, but it is more difficult or rare to find classrooms with tables and windows in adequate state. The specific deficiencies illustrated by this index may be a useful guide for school administrators on how to improve the situation of classrooms in the Colombian educational system. For this index, a value of 0.27 standard deviations (SD), which is equivalent to the value assigned to schools with windows in adequate state, was chosen as the cut-off point above which we believe that the state of classrooms is in appropriate condition.

Figure 9: Schools' Access to Utilities Index



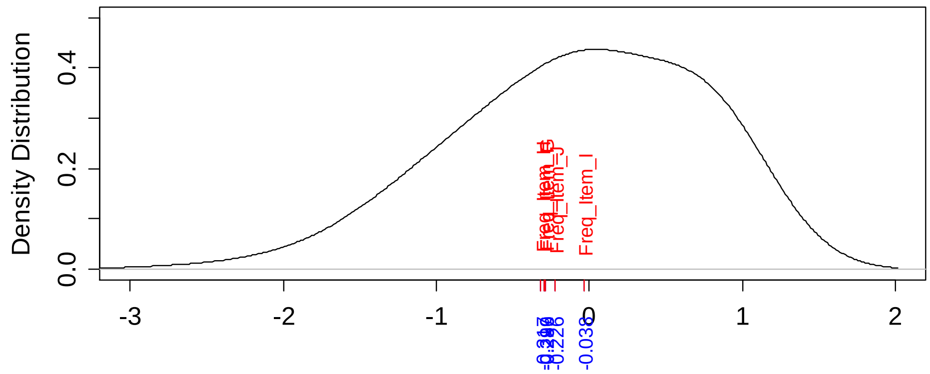
All of the items in the *Access to Utilities* index were dichotomized according to whether the school has access to the service or not. In the case of the state of restrooms, an indicator was built that combines whether or not there is a proper ratio of children per units (20 children per unit), and whether they are in working condition. Figure 9 shows the distribution of this index and the degree of difficulty of each of its items. We see that it is more frequent for schools to have electricity (86% of schools). In contrast, it is a rare occurrence to have proper restrooms and in the appropriate amounts (only 15% of schools have adequate conditions). In addition, we know that 67% of schools have drinking water; 55% are connected to the sewerage system; 56% have garbage collection service; and 36% have a telephone. The cut-off point of the index is 0.74 standard deviations, and it helps to distinguish the schools that we believe have suitable access to public services.

Figure 10: Classroom Rules Index



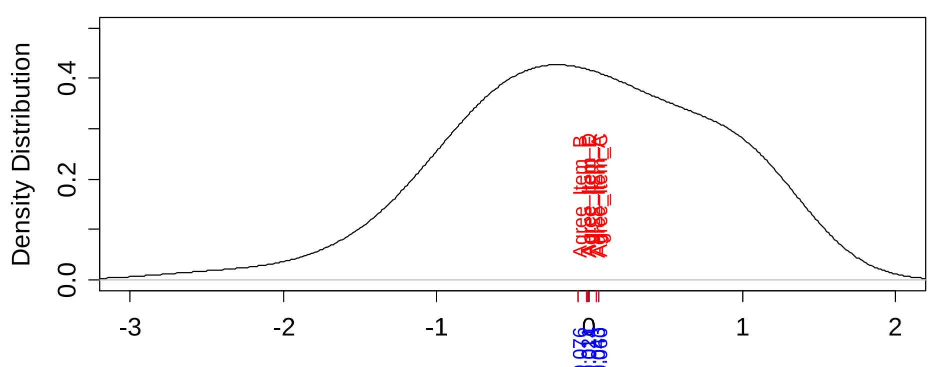
The *Classroom Rules* index is built with variables from the questionnaire given to students, and it reflects the opinion of students with respect to explicit behavior agreements among students and teachers that permit the class to function without disruptions. Out of all available items in the questionnaire, the only ones to discriminate and have different levels of difficulty were: the existence of behavioral rules in the classroom (item C); whether teachers enforced them (item D); and whether students are aware of the consequences of not complying with the rules (item E). Figure 10 shows us the distribution of the index in schools and the cut-off points for each item. It indicates that, while in a greater number of cases, teachers comply with the rules, in fewer cases, students have full knowledge about their existence, and to an even lesser extent about the consequences of not complying with them. This suggests significant weaknesses in communication between teachers and students in a key area such as behavioral rules in the classroom. For our analysis, a school with appropriate classroom rules is one in which the situations described in the three items of the index are simultaneously present in an appropriate manner.

Figure 11: Proactive Teachers in the Subject of the Test Index



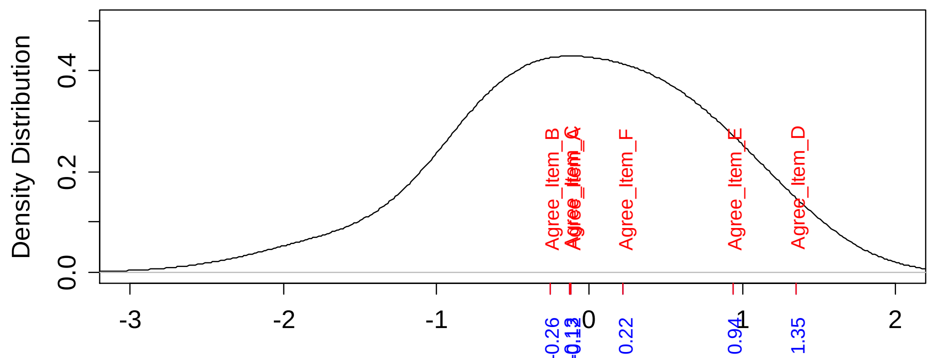
To capture the presence of a proactive, positive and collaborative attitude from teachers to students of a specific subject of the test, the index "Proactive Teachers" was built using students' responses to selected questions. As with other indexes, the IRT analysis ruled out some of the survey questions, and in the end the following items remained about the perception of students: Does the teacher treat students alike? (Item F); Does the teacher provide equal attention to the questions of all students? (Item G); Is the teacher a person that students can trust to get help? (Item H); Does the teacher have available time to talk with the students who need it? (Item I); Does the teacher do what it takes to help the students who need it? (Item J). All indexes are dichotomous and their cut-off line was determined in the category named "frequently". Figure 11 shows that, although a significant proportion of schools evidence problems in student-teacher relationships, it is often the case that there is a perception of confidence in teachers and of non-discriminatory treatment to their students (items F, G, H), but teachers would seem to have little time to help those who need it the most and to respond appropriately to the questions from their students. In our analysis, a school with the adequate level of proactive teachers is one where students answered that the situations described by the five items of the index were frequent in their schools.

Figure 12: Student's Satisfaction with School Faculty Index



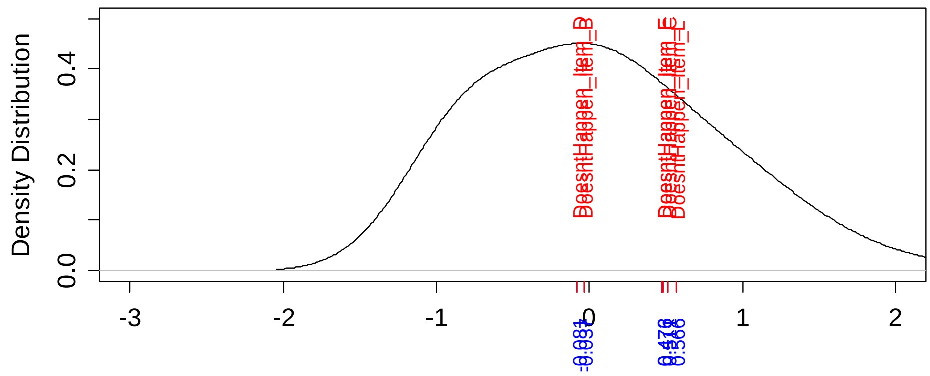
The *Student's Satisfaction with the Faculty* index was built using students' responses about the following aspects: good relationships between students and teachers (item A); teachers' interest in the well-being of students (item B); teachers' interest in listening to students (item C); extra support from teachers to students that require it (item D); and fair treatment by teachers of students (item E). While some items are similar to the index of proactive teachers from the area of the test, the idea here was to capture if students are generally satisfied with the faculty of the school they attend. Items were dichotomized according to whether students responded they agreed with the question regarding the relationship with teachers. The cut-off line of the index was defined at the point at which students responded they agreed (or strongly agreed) with all the items of the index. Figure 12 shows that at about half of the schools surveyed, students have a positive perception of teachers.

Figure 13: Teacher's Satisfaction Index



The *Teacher's Satisfaction* index was built with the responses from the teachers' form. After eliminating some of the questions with the IRT analysis due to their low variability or to differences in their levels of difficulty, six items that capture the satisfaction of teachers were kept: work environment (item A); relationships with colleagues within the school (item B); job stability (item C); materials available to develop their teaching (item D); support received from parents (item E); and recognition of their effort from the school´s principal (item F). Items were dichotomized taking into account if teachers agreed with each topic of the corresponding item. In our analysis, in this area, schools are considered adequate when their items were answered in a positive way (agree or strongly agree). Figure 13 shows that at around half of the schools, teachers have a positive perception of their relationships with other colleagues, their principal, and their work environment, but a smaller proportion feel supported by parents, and a much lower one considers that the school provides them with the necessary materials to carry out their educational work.

Figure 14: Student's Perception on Violence at School Index



The *School Violence* index was built using students' reported perceptions about the following topics: theft at school (item B), threats to teachers coming from students (item C), violence or aggression between students (item D), presence of weapons in school (item E), the existence of gangs (item F), and use of alcohol or drugs among students of the school (item L). Items were dichotomized according to the presence or absence of these situations at school. According to the analysis shown in Figure 14, the most frequent problems in schools at the 5th grade are theft and violence among students, which were reported in almost half of the schools. Less frequent, but still worrisome, are the problems of gangs, weapons within the school, or threats to teachers. The presence of alcohol or drug abuse is even less frequent, but still worrisome, given that it relates to 5th grade students, indicating that it is not an unknown problem within this young group of the population. A school categorized as inadequate according to this index if any of the situations described above are present.

The rest of the school factors used in this analysis did not require the construction of indexes, and they were dichotomized as follows:

- Educational profile of teachers: the appropriate level was defined as a school where at least 50% of its teachers have completed their higher education.
- Library at the school: the appropriate level is when there is a library at the school building.
- Full-time schedule: the appropriate level is that a school that reports full-time coverage.

In addition to the above mentioned indicators, other measures that would approximate those aspects identified as critical by the different theories of school effectiveness were established. However, they were not considered for subsequent analysis of the study because they did not show any relationship with the academic performance of students in the context of this study[11]. In other cases, summary indexes were attempted, but were ruled out due to limitations in the quality of the collected data.

[11] The list of measures included characteristics of teachers, such as age, type of contract, gender, other jobs as teachers or outside of the educational arena, or time they dedicated to teaching; indexes of teachers' processes or approaches to teaching (instruction time in the evaluated subject matter, assigning tasks to students, reviewing homework and delivering feedback to students, classroom environment); and finally measures on the perception of principals about school management aspects, school environment and resources used to support teaching.

II.4. Estimates for Relative Risk and Population Attributable Risk

To measure equity, we use the concepts of relative risk (RR) and the population attributable risk (PAR). The RR allows one to describe the risk of educational vulnerability (obtaining inadequate scores on the tests) for students who belong to a particular segment of the population or are exposed to a particular school factor, relative to those who are not. The PAR estimates the reduction in the vulnerability of the entire population if the affected population would transform positively, meaning if the risk factor were eliminated and the subpopulation's rate of vulnerability were reduced to that of the rest of the population. These relationships are understood as bivariate associations that do not control for the effect of other variables on the equality of learning outcomes. Table 5 shows the results of the estimates of relative risk and population attributable risk in the language section for 5th grade for each of the sub-populations (according to SES quintiles and urban/public, private and rural/public schools) and each of the different factors of school resources and processes. Given the inability to separate the simultaneous impact of other characteristics, the submitted relationships should be interpreted as correlations without proof of causality[12].

[12] See Annex G with the estimates of the RR and PAR for the other subjects assessed in the 5th and 9th grades.

Table 5: RR and PAR for the Language Test in 5th Grade

Risk Associated with Inadequate Scores in Language

			Equality		Resources				Processes					
% of the population: 65.56 (1.01)	**Size of the sub-population**	**Percentage of the sub-population with inadequate score**	**Relative Risk [RR]**	**Population Attributable Risk [PAR]**	**State of the classrooms**	**Access to services**	**Teacher Profile**	**On-Site Library**	**Classroom Rules**	**Proactive Teachers**	**Student's satisfaction with the teacher**	**Teacher's Satisfaction**	**School Violence**	**Full Schedule**
Percentage in inadequate condition					61,7	49,8	16,4	49,5	53,3	52,6	56,7	70,3	44,7	86,9
					0,7	0,8	0,6	0,8	0,7	0,7	0,7	0,8	0,7	0,5
Effect														
Relative Risk [RR]					1,28	1,44	1,02	1,18	1,10	1,09	1,13	1,00	0,89	1,23
					0,03	0,04	0,04	0,03	0,04	0,04	0,03	0,03	0,03	0,05
Population Attributable Risk [PAR]					14,71	17,87	0,38	8,24	4,93	4,47	6,80	0,07	-5,21	16,45
					1,67	1,38	37,70	1,77	3,90	4,36	2,78	44,69	3,81	2,77
Sub-population														
Quintile 1	21,8	78,8	1,28	3,90	0,76	0,46	0,94	0,70	1,03	1,06	1,02	1,43	0,92	0,93
	0,6	1,7	0,04	0,70										
Quintile 2	19,6	75,7	1,20	3,85	0,89	0,66	0,98	0,88	0,93	0,99	0,96	1,08	1,02	0,72
	0,6	1,1	0,03	1,25										
Quintile 3	21,0	66,2	1,02	0,35	1,04	1,07	1,04	1,07	1,11	1,03	0,93	0,89	0,95	0,71
	0,6	1,7	0,04	14,28										
Quintile 4	18,9	57,4	0,85	-2,84	0,86	1,40	1,00	1,13	1,05	0,98	1,02	0,89	1,09	1,12
	0,6	1,1	0,03	2,92										
Quintile 5	18,8	46,1	0,66	-6,83	1,53	1,69	1,04	1,30	0,87	0,93	1,08	0,78	1,04	1,67
	0,6	1,3	0,04	1,59										
Urban Public	52,0	68,9	1,11	5,53	0,31	1,31	1,13	1,15	0,89	0,90	0,93	0,46	1,24	0,40
	0,7	0,8	0,03	3,08										
Private	18,7	39,7	0,55	-9,06	2,10	2,38	0,92	1,71	1,17	0,98	1,04	1,58	0,85	3,12
	0,6	2,3	0,05	1,49										
Rural Public	29,3	76,1	1,24	6,67	1,67	0,15	0,92	0,47	1,03	1,15	1,07	1,50	0,87	0,89
	0,7	1,5	0,04	1,34										

Note: figures below each estimate represent the standard errors.

An initial analysis focuses on calculating the RR and PAR, for all students, disaggregated by population subgroups (light blue area of Table 5). The cell "% in the population" shows us the total percentage of the population of students with inadequate scores (vulnerable population), i.e., those who did not achieve at least a satisfactory score on the tests. For 5th grade students, the vulnerability amounts to 65.6%, i.e. two of every three students are not learning the knowledge and skills they should in that grade, showing a systemic problem of quality in Colombia's elementary education[13]. This same vulnerability is analyzed for sub-populations and the results are presented in the column named ¨Percentage of population with inadequate scores¨. Vulnerability for these subgroups evidences important variations that decrease as the SES of students gets higher. 78.8% of students in the poorest quintile (quintile 1) received an insufficient score, indicating that 4 out of 5 students in this quintile do not show satisfactory language capabilities. There are significant differences in language capacities, however, according to socio-economic status. In the middle quintile (quintile 3), 66.2% or approximately 2 out of every 3 students do not receive a sufficient score, while in the richest quintile (quintile 5), this figure drops to 46%. The incidence of vulnerability also varies according to the type of school: the most vulnerable are the students in the rural areas where 76.1% have inadequate scores; for urban public schools the figure is 69%, while for urban private it is much smaller, 39.7%.

The Relative Risk (RR) column shows the results for each population sub-group. The RR of the poorest quintile of SES is the highest, 1.28, indicating that 5th grade students from the poorest quintile are 28% more likely than the rest of the population to lack sufficient knowledge and skills in language. In contrast, students from families within the wealthiest quintile (quintile 5) have a 34% lower risk (1-0.66 multiplied by 100) than the rest of the students of having inadequate results. By sub-sector, students from rural schools have 24% higher risk of educational vulnerability in relation to those from urban schools. The vulnerability of students from urban public schools is 11% higher than of the rest of the student population in 5th grade, while students from the private sector have a 45% lower risk of performing at an insufficient level on the language section than the rest of the student population. While there are students with low scores in all sub-populations, those with the highest levels of vulnerability are clearly the first two quintiles and students from rural areas.

The magnitude of the Population Attributable Risk (PAR) indicates the potential benefit of focusing policy efforts on any particular subgroup: a larger (positive) PAR indicates a larger reduction in overall vulnerability that could be achieved by eliminating the differences in educational outcomes that affect that group. Estimates of the PAR for population subgroups also decrease as the SES increases and vary for schools from different geographical areas and type of management. For quintile 1, PAR tells us that if all children from quintile 1, the poorest one, had scores that were similar on average to those of the rest of the population, the incidence of students with low scores would be reduced by 3.9 percentage points, i.e. from 65.6% to 61.7%. If students from rural schools reduced the incidence of academic vulnerability to that of non-rural schools, the vulnerable population would be reduced by 6.7 percentage points. The same is true for urban public schools, with a reduction of 5.5 percentage points. Negative figures for quintiles 4 and 5 and for urban private schools indicate that if students of these sub-groups performed at

[13] Inadequate scores mean a satisfactory or advanced level was not reached on the language section of the SABER tests, 2009.

the same level as their counterparts, the incidence of vulnerability in the student population would increase.

A second analysis focuses on calculating the RR and PAR for the different indexes of school resources and processes (pink area on Table 5). The first row gives us information about the percentage of schools or students who are affected by each risk factor (inadequate conditions of the indexes of resources and processes), while the second and third rows give us the RR and PAR associated with each factor. A third analysis calculates the access that each sub-population has to each factor compared to the access of the rest of the population (yellow area on Table 5). Crossings between sub-population rows and the columns of school resources and processes provide information on the access that each sub-population has to each factor compared to the access of the rest of the population. A value less than one indicates inadequate access to this factor. The greater the difference below one, the more severe is the disadvantage. Values greater than one indicate adequate access.

The results of these second and third analyses show us that the *state of classrooms* is inadequate in 61.7% of the schools in the sample. The RR for this factor (1.28) indicates that studying in inadequate classrooms (according to the index built for the analysis) is associated with a 28% higher risk for children to receive inadequate scores in the language test of the 5th grade, compared to those students who attend schools with adequate classrooms. The PAR of such factor indicates that eliminating the deficiencies in classrooms (i.e., ensuring all students had adequate classrooms) would reduce the vulnerable student population by 14.7 percentage points. The high level of PAR suggests a high prevalence of this risk factor (inappropriate classrooms) within the school system. The ratio of access to adequate classrooms (yellow area) for the poorest quintile (compared with the rest of the population) is 0.76, meaning that students in the poorest quintiles are 25% less likely to study in adequate classrooms than the rest of the student population. For quintile 2, the ratio of access is 0.89, while for the richest quintile it is 1.53, indicating that these students are 50% more likely to study in adequate classrooms. The differences in access to adequate classrooms is more pronounced by sector and area, as the ratio of access is 0.31 for public schools, meaning students in public schools are 70% less likely to have adequate classrooms than those of private schools, while the ratio of access for students of rural areas is 1.67 and 2.1 for private urban ones. This shows us an unequitable distribution of classrooms in good condition that affects the poorest sub-populations (those with lower SES) and the urban public schools of the country, which in turn have a higher educational vulnerability.

Almost half (49.8%) of the schools of the 5th grade sample have inadequate *access to utilities* (electricity, water, garbage collection, telephone or restrooms). Children who attend schools in these conditions have a 44% higher risk of getting inadequate results on the SABER test than those who attend schools with proper access to utilities (RR of 1.44). If all schools had adequate access to these services, the educationally vulnerable population (i.e., the percentage of students with inadequate scores) would be reduced by 17.9 percentage points. The ratios for access to utilities by subgroups, according to their SES, indicate high inequities affecting, again, the poorest and the rural areas. The ratios for quintiles 1 and 2 (the poorest ones) are 0.46 and 0.66 respectively, while for the wealthiest quintile it is 1.69; there are wide differences between urban public (1.31) and private schools (2.38), on the one hand, and rural schools (0.15) on the other, with rural schools being 85% less likely to have access to utilities than non-rural schools.

The indicator for *teachers´ academic profile* tells us that in 18.4% of the schools, teachers have a low academic profile, i.e., less than half of those teachers have completed their post-secondary studies. The RR is 1.16, indicating that students whose teachers have a poor level of vocational training have a 16% higher vulnerability risk than those in schools where more than 50% have completed a postsecondary degree. The PAR for this indicator; however, is low (2.94) and with a high standard error (1.76), suggesting that it is not statistically different from zero. This likely reflects the low prevalence of inadequate teacher profiles, and thus should not be interpreted to mean that teachers' academic profiles are not an important determinant of learning outcomes. The distribution of teachers with inadequate training profile by sub-populations particularly affects the first socioeconomic quintile and students of rural schools. Urban public schools are 11% more likely to have teachers with a stronger professional profile, as defined by the indicator used here.

In 48.5% of schools from the 5th grade sample, there is no *school library*. The RR associated with factor is 1.18; indicating that children attending schools without libraries have an 18% higher risk of showing inadequate language capabilities on SABER than the rest of students in this grade. The PAR shows that resolving this deficiency would be related to a decrease of 8.24 percentage points in the vulnerable population. The ratios of access to school libraries show an unequitable distribution that negatively affects quintile 1 (0.70), quintile 2 (0.88), and especially rural schools (0.47).

The *Classroom rules* index shows that there are major problems in 53.3% of schools in defining and enforcing behavioral rules. The RR of 1.10 indicates that students in schools with poorly defined and enforced classroom rules have a 10% higher risk of educational vulnerability than the group of students studying in classrooms with functioning rules. The PAR is 4.9 percentage points, but the standard error is high, indicating that improving this index would not be associated with significant changes in the vulnerable population. The distribution of the index by sub-population particularly affects socioeconomic quintiles 2 and 5 as well as students from urban public schools.

The rate of *proactive teachers* (in this case, for language, 5th grade) shows that 52.6% of students evidence deficiencies in the attitude of their teachers. The RR of the factor is 1.09, indicating a 9% higher risk of educational vulnerability for students who report that their teachers are not proactive, but the level of PAR and the standard error indicate that changes in this index would not significantly affect the level of the existing educational vulnerability. On the other hand, an unequitable distribution of this factor is evident when it is disaggregated by SES quintiles, with differences among types of school, and the greatest deficiencies in proactive teachers at urban public schools. It is interesting to note that students' perceptions of this factor are quite positive at rural public schools.

Students´ satisfaction with faculty index shows that more than half of the students (56.7%) qualify the relationship with their teachers as deficient. The RR of this factor is 1.13, which indicates an increased risk (13%) for those students with negative evaluations of their teachers' interests in the students. The PAR would indicate a reduction of the population vulnerable of 6.8 percentage points in the absence of this risk factor, i.e. if all students were satisfied with their teachers. While both RR and PAR evidence a relationship with vulnerability, the distribution of access to an adequate level of this factor among sub-populations does not indicate great inequalities according to SES.

The *Violence index* shows that 44.7% of 5th grade students sampled attend schools with high levels of aggression. The RR of the index is 0.89, indicating that students in those schools with better coexistence are 11% less likely to receive inadequate scores, compared to those that have high rates of violence. The PAR suggests that mitigating incidents of school violence would contribute to a reduction of 5.2 percentage points in the vulnerable student population. (The negative sign of PAR indicates the incidence of vulnerable population would increase if all students were in schools with a high rate of violence). Ratios of sub-populations indicate differences in the levels of violence in schools for students from different income quintiles, but not very extensive, except in the case of quintile 4, where there is a 9% higher probability (compared to the rest of the population) that students are in schools with a high prevalence of violence. Access ratios also indicate that students of urban public schools are exposed to worse security situations and less coexistence compared to students of rural or private schools (1.24 compared to 0.85 and 0.7 of those who attend private or rural public schools, respectively), suggesting the need for specific measures to mitigate the problem in that sub-group of the school system.

The variable *school schedule* informs us that only 13.1% of students attend schools with a full-time schedule. The RR associated with less than full-time schedule is 1.23, suggesting that the risk of obtaining unsatisfactory results on the language section of the exam is 23% higher for those 5th grade students attending schools with incomplete schedules compared to those attending schools with a full-time schedule. The PAR is high, 16.5 percentage points, which indicates that the elimination of this risk factor (i.e., if the entire student population attended educational centers with full time schedules) would be associated with a lower incidence of educational vulnerability. The presence of full-time schedule schools by sub-populations is highly inequitable: the ratio of the first three quintiles is 0.93, 0.72 and 0.71 in ascending order; in urban public schools the ratio is 0.40 and in rural public schools it is 0.89. Private schools, in contrast, are more than three times as likely to have a full-time schedule as public schools, with an access ratio of 3.12. This indicates little presence of a full-time schedule in urban public schools, while there is a high concentration in private schools.

In conclusion, the results describe a highly inequitable distribution of a number of school factors and processes that have a potentially high association with the quality of education. The inequitable distribution adversely affects the poorest quintiles, rural and urban public schools, especially in terms of: state of the classrooms, access to utilities (electricity, water, sewerage, telephone and Internet), libraries, and full-time schedules. Correcting the inequities in the distribution of these aspects could significantly reduce the incidence of educational vulnerability and inequalities in academic performance according to SES. Other factors, such as the presence of proactive teachers in the classrooms, the relationships between students and teachers in schools, or the high rates of violence, do not evidence large variations by quintiles of SES. Nevertheless, it is clear that they negatively affect the group of students who attend urban public schools to a greater extent, and policies aimed at transforming such a situation have a high potential to improve the quality of learning (in particular, the decrease of violence in urban public schools). Similarly, the index that estimates teachers' satisfaction with their jobs presents little variation by quintiles of SES but large differences between public and private schools, although it does not appear to have a predictable impact on students' educational vulnerability.

Finally, the variables that attempted to capture the academic profile of teachers do not show large variations among subpopulations, nor a clear or meaningful connection with student learning. This suggests that in order to capture these relationships, the questions that attempt to measure the quality of teaching should be changed, perhaps by including additional questions about the institutions where they studied, the levels of certification of their academic qualifications, or by using instruments that are different from the traditional ones used in this type of tests.

II.5. Analysis of the Indexes of Resources and Processes in a Multilevel Model

The analysis in the previous section explores the relationships between each of the different factors of school resources and processes (and their disaggregation by sub-populations) in a bivariate manner, with the students' performance on the SABER tests. In this section, we analyze the interactions between school factors and the results from the tests together by taking into account students' socio-economic status.

To describe the relationship and the significance of each observed factor at the level of student learning, we estimate a multilevel regression model[14]. The model includes the indexes of the school resources and processes described in the previous section as predictive variables, dichotomized with values of zero or one (one denoting that the indicator has a proper condition in the school, zero when such a condition is not met). The dependent variable of analysis is the student's test result, a dichotomous variable that indicates whether the student performed above (1) or below (0) the satisfactory level in language. Because of the dichotomous nature of the dependent variable, a multilevel logistic model is estimated with Bernoulli distribution. The estimates also include the student's socioeconomic status.

Some of the indexes used in the previous section (Part II) were excluded from the multilevel regression analysis. Information for the teacher profile and teacher satisfaction indexes was missing for an important part of the sample, and so their inclusion would have reduced the analytical sample significantly (from 240 schools to 190; and from 4,145 students to 3,245)[15]. Furthermore, the proactive teacher index was excluded because it did not show a statistically significant relationship with students' test results on estimates of multilevel bivariate regressions.

The results of the estimates for the *multilevel logistic regression models* are shown in Table 6. The values reported are expressed in logit units or *log odds units*[16]. The first model we estimated

[14] Because of the dichotomous nature of the dependent variable, a multilevel logistic model is estimated with binomial distribution. For further details the reader can refer to Annex H.
[15] The relation of these two indexes with test scores was not significant in the bivariate estimates either.
[16] *Log odds* is the natural logarithm of the ratio between students' probability to perform at an appropriate level in the test over their probability to perform at an inadequate level. The coefficient indicates the amount of change that would be expected in the *log odds* when there is a change from 0 to 1 in the predictive variable in the model, while maintaining the rest of controls constant.

is a null model that allows estimating the value of the intercept without major controls (column A). The second model considers the relationship of each index, controlling for the other indexes (column B). The third model adds the socio-economic status of the student (column C) as a control, and the fourth model captures the impact of the interaction of each index with the SES of the student (column D).

In the model without controls for students' SES, coefficients show the expected association: improving the conditions measured in the indexes from inadequate to adequate increases a student's probability of performing at a satisfactory level on the SABER language exam. All coefficients show a significant and positive association between school factors and learning outcomes, with the exception of the presence of libraries in schools. The perception of violence index shows a negative coefficient, consistent with the way in which it was defined: a higher value implies a reduction in the perception of violence at school. By introducing a control for student's socio-economic status into the model, previously observed associations are maintained in terms of both scale and significance[17]. Based on the magnitude of the *logit* coefficients, we note that the indexes with stronger relation with students' performance are infrastructure (state of the classrooms and access to utilities) and full-time schedules.

Table 6: Results of Multilevel Models for Language, 5th Grade

	Logit Coefficients			Probabilities		
	Null Model	Combined Model without Student SES	Combined Model with SES Focused on the Minimum Value of Each School	Empirical Unconditional Probability	Probability conditioned to an improvement in the associated index (without control by student SES)	Probability conditioned to an improvement in the associated index (includes control by student SES focused on the minimum value of the school)
	A	B	C	D	E	F
	b/se	b/se	b/se			
Intercept	**-0,936*** (0,10)	**-1,837*** (0,16)	**-2,060*** (0,17)	0,28	0,11	0,09
Student SES focused on the minimum score for the school			**0,185*** (0,04)			0,11
State of classrooms		**0,674*** (0,18)	**0,693*** (0,19)		0,20	0,17
Access to utilities		**0,920*** (0,18)	**0,801*** (0,18)		0,24	0,19
School Library		0,284 (0,18)	0,289 (0,18)		0,15	0,12

[17] In statistical terms, an important problem to be solved is the possible multicollinearity between the predictive variables of the model, i.e., that there is a linear relationship between predictors, which can have an impact on the estimated parameters and on standard errors, causing the model to be unstable (Shieh and Fouladi, 2003). To establish the magnitude of multicollinearity we estimated a matrix of polychoric correlations between school resources and processes indexes, as well as for the SES of students. As it is usual in the context of multilevel models, the index of student SES was focused at a group level by using the minimum value observed in each school (the minimum value was used in order to facilitate the interpretation of results). The correlations matrix is reported in Annex J. The observed correlation between the SES index and the index of access to utilities is relatively low (0.14) and significant. The rest of the indexes at school level show correlations even lower (less than 0.1). Nevertheless, we must note the correlation that appears between libraries and full-time schedules and the access to utilities. This suggests that schools with inadequate access to utilities tend to also lack libraries and only on rare occasions (or never) include full-time schedules (and vice versa).

Classroom rules		**0,139+**	**0,143+**		0,13	0,11
		(0,08)	(0,08)			
Student's satisfaction with the teacher		**0,202***	**0,194***		0,14	0,11
		(0,08)	(0,08)			
Perception of violence at school		**-0,215****	**-0,223****		0,14	0,11
		(0,08)	(0,08)			
Full-time schedule school		**0,551****	**0,629****		0,18	0,16
		(0,20)	(0,21)			
Students	4145	4145	4145			
Schools	240	240	240			
Level 2 Variance	1,316	0,847	0,913			
Intraclass Correlation	0,345	0,179	0,202			

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001

The interpretation of coefficients expressed in *logit* units is not always direct, as in the case of the coefficients of linear models. For this reason, we report in Table 6 the probabilities associated with changes in the variables of interest in columns D, E and F[18]. Column D indicates the average likelihood for students of an average school to achieve an adequate level of performance based on the results of the null model (column A). In column E, we present the probability associated with an improvement in each of the indexes included in the model while the rest of the indexes are held constant and without controlling for students' SES. Column F repeats the previous exercise but adding students' SES.

An advantage in the way of specifying these models is that, given that the indexes and controls are dichotomous variables, the interpretation of changes in one of the indexes is done when the rest of indexes are evaluated at zero, i.e., when they are in an inadequate position. Without controlling for any characteristics of the student or school, the likelihood of a 5th grade student to achieve an appropriate level in their language test is 28%. By introducing controls for the resources and processes of the school and assuming that all indexes are in inadequate condition, the probability of achieving an adequate score in language is only 11%. From this baseline, the introduction of selective changes in the indexes is associated with increases in the likelihood that students reach adequate levels in the test. Thus, for example, improvements in the conditions of the classrooms, by bringing them to appropriate levels, is associated with an increase in the probability from 11% to 20%. If we repeat the same exercise for the access to utilities index, such probability would increase to from 11% to 25%; or from 11% to 18% if the school operated under a full-time schedule. For the rest of indexes, changes in the probabilities are somewhat more modest (approximately 2%) but equally significant (except the variable for libraries, as already indicated). Similar increases are also found in the model that controls for students' SES (column F).

A model that analyzes cross-interaction between tests results and students' SES was also considered. This model estimates if the changes in the indexes measuring school resources and processes benefit students in a different manner according to their socio-economic status. Terms associated with the interactions were significant at 10% for the state of classrooms index and the perception of violence and at 5% for the access to utilities index[19]. The rest of the interactions did not evidence significant coefficients. The absence of significant results in the cross-

[18] The probability associated with each index is calculated as 1/ (1+exp (-b)), where b represents the value of the coefficient.

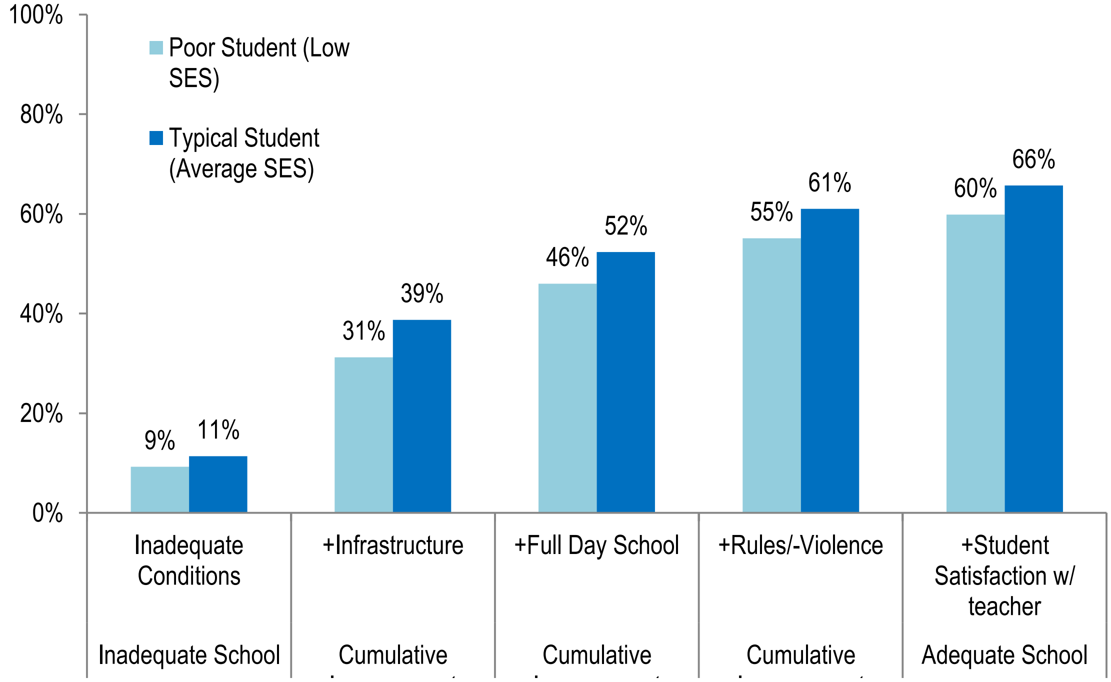
[19] Positive and significant interactions indicate that, while beneficial to all students, widespread improvements in the indexes would give more advantages to those with the highest SES (in relative terms).

interaction between quality and equity in the great majority of indexes suggests that if we are looking to improve equity, universal policies would not be sufficient (for the factors the study analyzes), but targeted actions are required to improve the state of the factors of the model in the schools that serve the poorest groups of the population.

In order to illustrate the potential benefits for students' learning if improvements in the resources and classroom processes presented in the model were introduced, we estimate the change in the probability of students of attaining an adequate level on the tests associated with progressive and cumulative improvements in school resources and processes. The results of this exercise are presented in Figure 15. Given that the estimate of some scenarios might not be feasible (for example, rich students attending schools with deficiencies in all indexes), we compare the changes in the probabilities, taking the group of poor students as a reference compared with the students of average socio-economic status.

As seen previously, students attending schools that show inadequate conditions in all indexes of school resources and processes have a probability of 11% of achieving an adequate level in the language test. If there are improvements in the quality of infrastructure, i.e., schools reach a proper condition in the state of their classrooms and their access to utilities, the probability for students would increase to 39%. If these improvements add full-time schedules, the likelihood of obtaining an adequate score on the test increases to 52%. In turn, if improvements in school processes are added, such as improvements in classroom rules and a decrease in school violence, the probability increases to 61%. Finally, if to all the above we add an improvement in student satisfaction with faculty, the probability of performing at a satisfactory level increases to 66%. These results confirm that moving from a negative school factor to an appropriate one is associated with significant improvements in the likelihood of students to obtain better quality education. Even more, the improvement in the probabilities when introducing changes in the allocation of resources and processes of the school, suggests some potential interventions that could improve the quality and equity of learning in schools.

Figure 15: Students Likelihood to Achieve an Appropriate Level in the Language Test in 5th Grade According to Groups of Factors by School Type



II.5. Conclusions from Part II

The results of the analysis of RR and PAR show that in schools serving 5th graders in Colombia, the poorest students and those attending rural and urban public schools are at an increased risk of vulnerability, i.e., a greater the risk of having insufficient language capabilities, as measured by the SABER standardized exam. We observe that if pupils in these poorest subgroups manage to increase their academic performance to the level of the rest of the student population, the educational vulnerability of the total population decreases. On the other hand, we analyze the risk of educational vulnerability for those students who have inadequate educational resources and processes, and we found that the shortcomings in school infrastructure (state of classrooms and access to utilities), as well as the absence of full-time schedules present the highest vulnerability risk. Improving such variables may have a significant impact in reducing educational vulnerability. The analysis of access to resources and processes for the various groups of the population presents a highly inequitable distribution which adversely affects the poorest students (socioeconomic quintiles 1 and 2) and students from rural public and urban public schools. Deficits are serious, especially in terms of the state of classrooms, access to utilities (electricity, water, sewerage, telephone and Internet), libraries, and full-time schedules. Closing the gaps in the distribution of these factors among subpopulations and types of schools could have a high impact on the decline in educational vulnerability. Other factors that are related to school processes, such as the presence of proactive teachers in the classroom, the relationships between students and teachers, or high rates of violence do not vary much per quintile of SES, but instead they are unevenly distributed by school types, negatively affecting students from urban public schools to a greater extent. Finally, the variable that attempts to capture the academic profile of teachers does not show large variations across subpopulations, nor any significant relationship to the learning of the students, within the framework of this study, which suggests that other type of variables and/or other methodologies should be explored to capture such a relation.

The results of the estimates of the multi-level hierarchical models, which together analyzed the interactions among all school factors and the test results, indicate that all school resources and processes analyzed have a significant relationship with learning, with the exception of the presence of a library in the school. The factors showing the strongest association with test results are infrastructure (state of classrooms and access to utilities) and the full day schedule, followed by the indexes of violence at school and student satisfaction with the faculty, and the index of classroom rules (significant at 10%). The conversion of the coefficients in the multilevel logistic regressions to probabilities allows us to analyze different scenarios where we can see how students' probabilities of reaching a satisfactory level improve when they move from having inadequate schools processes or resources to adequate ones. As this can happen in a similar way in both schools attended by poor students as in those attended by non-poor ones (although from different floors), actions to simultaneously improve the equitable distribution of school factors and educational quality must be carried out in a focused way.

General Conclusions and Policy Recommendations

The results of the analyses presented here confirm that in Colombia there are high inequalities in the students' academic performance according to socio-economic status and the type of management and geographic area of the schools they attend. There is also an inequitable distribution of school resources, with a clear disadvantage for the poorest quintiles of the population and for urban and rural public schools. These inequities are associated with unequal probabilities for students to achieve adequate scores in their tests, indicating significant differences in language capacities as a result of inequitable conditions for learning.

When the relationship between students' socio-economic status is disaggregated according to variations within schools and between schools, significant differences can be observed: the average socio-economic status of students has a more pronounced relationship with the variation of scores between schools (almost a half standard deviation in the scores for each standard deviation of the school SES), and it explains a greater proportion of the variance in the scores (nearly three-fifths of the total variance). In contrast, within schools, the individual socio-economic status of students has a weaker relationship with students' scores (although statistically significant), and it explains a very small proportion of the total variance. This indicates a high degree of segregation between schools, according to the SES of their students, associated with high inequality in academic results.

High socioeconomic segregation of schools further develops the relationship between students' socio-economic status and the results obtained on the tests due to the compositional effects of schools. Students have unequal opportunities for learning that originate in the socio-economic conditions that they carry with them to the school system. These conditions, in turn, are amplified by the high socioeconomic segregation of schools.

The results of the Relative Risk and Population Attributable Risk analysis show that the poorest students, as well as those attending rural and urban public schools, are at an increased risk of educational vulnerability, i.e., a greater the risk of getting unsatisfactory results on the SABER test. If pupils in these poorest subgroups managed to increase their learning outcomes to the level of the rest of the students, the educational vulnerability of the total population would decrease. On the other hand, the analysis shows that the inadequate levels of school infrastructure - state of classrooms and access to utilities - as well as the absence of full-time schedules are the factors that are most associated with educational vulnerability, suggesting that these factors have a high potential to decrease the total incidence of vulnerability. Finally, the analysis of access to school resources and processes for the various groups of the population shows a highly inequitable distribution, which adversely affects the poorest students (SES quintiles 1 and 2) and students from rural public and urban public schools. The deficits are serious, especially in terms of the physical state of classrooms, access to utilities (electricity, water, sewerage, telephone and Internet), libraries, and full-time schedules. The presence of proactive teachers in the classroom, the relationships between students and teachers, or the high rates of violence do not vary much per SES quintile, but they are unevenly distributed by school types, and they negatively affect the group of students from urban public schools to a greater extent. Closing the gaps in access to these resources among subpopulations or types of schools could have a significant impact in reducing educational vulnerability.

The results of the multilevel models, in which we analyze the interactions between school factors and tests results, indicate that the factors that are most highly associated with higher quality of learning for students are better physical conditions of classrooms, proper access to utilities, full-time schedules, classroom rules, lower level of violence in schools, and greater teacher satisfaction.

The strong relationship between the selected indexes of school resources and processes with test results suggests that moving from inadequate school factors to adequate ones is associated with significant increases in children's chances of obtaining better scores in quality testing.

In the case of 5th grade, average SES students attending schools that show inadequate conditions in all indexes of school resources and processes have a probability of only 11% to achieve an adequate level in the language test. For average SES students attending schools with improvements in the quality of infrastructure, i.e., schools reach a proper condition in the state of their classrooms and their access to utilities, their probability for achieving an adequate level in the test would increase to 39%. For average SES students attending schools with good infrastructure and expose to a full time schedule, the likelihood of obtaining appropriate scores on the test would increase to 52%. In turn, if average SES students attend schools with all of the above and improvements are added in certain school processes such as classroom rules and a decrease in school violence, their probability would increase to 61%. Finally, for average SES students attending schools where all the conditions used in our model are good, their probability of getting a satisfactory level in the test would increase to 66%.

Given the nature of the analysis, the results may only be interpreted as associations, rather than effects or causality. Nevertheless, the strong evidence of significant relationships between school characteristics and the test results suggests the following policy guidelines.

First, the high socioeconomic segregation of schools observed suggests that policy interventions to reduce the high inequality in academic performance of students should be centered on schools, giving a higher priority to those that serve students of low SES. On the other hand, the results of the cross-interaction analysis between variables of quality and equity indicate that there are no individual factors affecting both at the same time. This reinforces the conclusion that if one wants to improve equity, there is no other way than to design targeted interventions at schools attended by the students in most need.

Second, the analysis of school factors and their relation to vulnerability indicates that the priority in school infrastructure interventions should be aimed at raising the level of access to public services (electricity, water, sewerage, adequate amount of restrooms, telephone, and Internet) and at the physical improvement of classrooms (floors, roofs, toiletries, desks, windows, and walls), focusing on the neediest schools. School libraries also have potential to improve the academic performance of students. The high correlation between the presence of libraries with connection to services and SES suggests that the lack of libraries especially affects schools attended by students from lower socio-economic status, which in addition indicates their potential to improve equity.

Third, the consistent evidence of the importance of full-time school days throughout this analysis lend support to interventions seeking to implement this change in schools; Of the school factors considered in this analysis, full-day schedules are one of the factors that are more highly associated with the reduction of the risk of educational vulnerability. A full-time school schedule equally impacts poor or non-poor students, but given the shortcomings with which the former arrive at school, it might be an intervention with high impact on equity.

Fourth, the existence of classroom rules, students' knowledge of them, and their unbiased implementation by the teacher has the potential to improve student learning. The analysis of data from the SABER test indicates the need for more training and support to teachers to enable them to improve their work and ensure coexistence in the classroom. Likewise, it confirms what other studies have already found: a friendlier, less violent and less exclusionary school environment is associated with better academic results. Recent efforts in Colombia aimed at improving coexistence at schools, respect for differences, the dissemination of human rights through education, and the implementation of civic skills among students and teachers should be strengthened.

Fifth, it is necessary to rethink how to capture information on what happens inside classrooms and about teaching practices used by teachers. It may be the case that the information collected in the SABER survey is not accurately capturing the school characteristics we seek to observe. Perhaps, surveys of this kind are not the ideal instrument to capture the richness of teaching practices. Elsewhere, countries are using approaches that include recorded lessons or direct observation from peers as part of the teaching assessment as well as information search processes to design interventions for better teaching practices.

Finally, we highlight the value of using concepts such as RR and PAR for the analysis of equity issues in the education sector, as they have a high potential to identify the gaps in educational outcomes between subpopulations, both regarding risk of vulnerability and the distribution of school factors. Furthermore, due to the ease of calculation, the two indicators deliver information that is easy to communicate to policy makers, that can be used to identify potential school factors that improve quality and equity, and as a tool to prioritize and plan the type of interventions required.

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Annex A

Table 1: Socio-Economic Status of Students and Schools and Results of SABER Tests
SABER Sample 2009 | 5th grade, Language

	Test Score	SES Index	Linear Regression			Multilevel Regression				Variance Decomposition		Variance Explained	
Sample	Average	Average	SES Effect	SES Effect ^2	Intercept	SES Effect within School	SES Effect within School ^2	SES Effect between Schools	Intercept	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	Percentage of the variance explained within school	Percentage of the variance explained between schools
National	290,8	0,00	27,627***	5,693***	285,075***	8,021***	0,858***	33,307***	294,564***	37,5	47,9	0,4	38,4
Urban Public	287,5	0,08	18,680***	-0,177	286,143***	8,766***	0,376	48,151***	283,683***	21,6	79,9	1,1	39,4
Rural Public	263,7	-0,67	8,874***	-0,851	270,667***	4,535**	0,194	11,029***	275,303***	29,3	79,0	0,1	3,7
Private	345,1	0,83	33,927***	3,422**	311,407***	10,241***	0,179	58,068***	294,107***	38,4	57,3	1,1	54,1
Medellin	300,1	0,24	22,783***	6,138***	289,485***	8,110***	0,414	56,035***	288,828***	27,7	62,6	0,7	67,5
Bogota	334,3	0,52	25,667***	5,608***	315,205***	11,335***	-1,501**	59,705***	304,646***	28,7	60,4	0,9	70,6
Pasto	306,7	0,28	25,312***	4,592+	295,061***	7,940***	0,845	47,155***	294,867***	33,1	47,6	1,0	76,0
Bucaramanga	336,8	0,49	30,994***	5,234*	315,479***	9,741***	1,453	53,622***	306,174***	30,5	51,2	1,0	72,1
Cali	298,5	0,46	24,163***	6,878***	281,120***	8,387***	-0,531	57,611***	273,092***	34,3	63,2	0,5	56,7

Note: Significance levels, + p<0,1, * p<0,05, ** p<0,01, *** p<0,001

Table 2: Socio-Economic Status of Students and Schools and Results of SABER Tests
SABER Sample 2009 | 5th grade, Math

	Test Score	SES Index	Linear Regression			Multilevel Regression				Variance Decomposition		Variance Explained	
Sample	Average	Average	SES Effect	SES Effect ^2	Intercept	SES Effect within School	SES Effect within School ^2	SES Effect between Schools	Intercept	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	Percentage of the variance explained within school	Percentage of the variance explained between schools
National	282,2	0,00	27,781***	4,065***	278,110***	8,510***	-0,369	32,843***	286,680***	40,3	52,9	0,9	35,1
Urban Public	280,7	0,08	18,426***	-2,319***	280,953***	9,307***	-1,062**	45,020***	276,741***	25,0	19,6	1,5	31,5
Rural Public	253,0	-0,68	8,706***	-2,019***	261,252***	6,196***	-0,607	14,702***	270,961***	36,1	21,2	0,8	3,6
Private	334,4	0,84	33,989***	2,851*	301,382***	7,652***	0,476	60,273***	280,731***	40,3	43,8	0,5	56,5
Medellin	293,5	0,24	22,324***	6,320***	282,614***	9,110***	-0,325	52,408***	282,497***	29,3	40,1	1,2	69,1
Bogota	330,7	0,51	25,012***	5,006***	312,781***	10,965***	-1,763***	55,726***	303,165***	28,6	40,9	1,0	70,6
Pasto	303,6	0,28	20,910***	3,409	294,221***	5,313**	0,718	38,786***	293,990***	35,8	55,5	0,2	56,4
Bucaramanga	336,9	0,49	28,916***	3,065	319,116***	11,207***	-0,174	46,582***	309,724***	24,0	48,3	1,2	72,2
Cali	290,1	0,45	22,619***	5,980**	274,548***	8,808***	-0,429	54,196***	264,311***	34,4	36,0	0,7	49,2

Note: Significance levels, + p<0,1, * p<0,05, ** p<0,01, *** p<0,001

Table 3: Socio-Economic Status of Students and Schools and Results of SABER Tests
SABER Sample 2009 | 5th grade, Natural Science

	Test Score	SES Index	Linear Regression			Multilevel Regression				Variance Decomposition		Variance Explained	
Sample	Average	Average	SES Effect	SES Effect ^2	Intercept	SES Effect within School	SES Effect within School ^2	SES Effect between Schools	Intercept	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	Percentage of the variance explained within school	Percentage of the variance explained between schools
National	289,0	0,00	24,935***	5,262***	283,729***	7,368***	0,653*	28,586***	296,424***	41,6	52,3	0,5	24,9
Urban Public	285,0	0,08	16,221***	-0,190	283,775***	7,879***	0,767+	44,828***	281,609***	21,1	19,8	1,0	32,9
Rural Public	265,5	-0,68	5,337***	-2,342***	271,801***	4,448**	-0,373	10,988***	282,231***	38,2	20,9	0,3	1,4
Private	339,9	0,83	34,927***	1,338	308,709***	8,953***	-0,359	56,140***	291,462***	41,3	43,0	0,8	44,6
Medellin	291,9	0,23	21,707***	6,000***	281,823***	8,407***	-0,454	53,545***	281,141***	28,4	37,5	0,8	68,1
Bogota	329,9	0,51	24,233***	5,438***	311,808***	10,607***	-0,976+	55,182***	302,953***	29,6	40,5	0,8	64,4
Pasto	301,3	0,28	22,032***	5,369*	289,777***	5,851***	1,092	44,593***	290,633***	37,1	52,0	-0,1	68,2
Bucaramanga	334,0	0,50	26,750***	4,389+	315,613***	8,376**	0,806	47,479***	306,033***	25,5	47,3	0,7	64,9
Cali	296,7	0,45	23,267***	5,830***	280,792***	8,342***	-1,410	54,634***	271,794***	36,2	37,7	0,5	48,0

Note: Significance levels, + p<0,1, * p<0,05, ** p<0,01, *** p<0,001

Table 4: Socio-Economic Status of Students and Schools and Results of SABER Tests
SABER Sample 2009 | 9th grade, Language

	Test Score	SES Index	Linear Regression			Multilevel Regression				Variance Decomposition		Variance Explained	
Sample	Average	Average	SES Effect	SES Effect ^2	Intercept	SES Effect within School	SES Effect within School ^2	SES Effect between Schools	Intercept	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	Percentage of the variance explained within school	Percentage of the variance explained between schools
National	293,1	0,00	29,918***	5,236***	287,827***	11,310***	1,479***	47,537***	295,632***	35,9	53,7	1,4	59,8
Urban Public	285,8	-0,05	19,688***	0,129	286,592***	11,881***	1,419**	42,485***	287,742***	20,3	22,1	1,7	29,2
Rural Public	263,6	-0,79	6,918***	-5,459***	276,538***	6,837**	0,164	30,493***	287,335***	22,9	19,1	0,6	17,7
Private	343,9	0,84	37,416***	4,328**	305,905***	12,029***	1,022	65,071***	285,815***	39,1	48,3	1,4	63,1
Medellin	301,3	0,17	29,674***	10,693***	287,777***	10,500***	1,849+	68,253***	288,570***	34,9	45,0	1,2	73,3
Bogota	329,0	0,41	30,402***	6,647***	310,393***	13,877***	-0,973	61,429***	303,088***	30,7	47,4	1,5	77,9
Pasto	311,4	0,28	27,675***	7,387**	296,450***	13,629***	2,639*	41,754***	298,634***	29,7	56,3	3,1	68,8
Bucaramanga	344,9	0,45	33,093***	4,683	325,319***	13,820***	0,494	59,498***	307,695***	35,2	48,3	2,0	67,2
Cali	303,5	0,41	27,065***	10,314***	283,255***	10,133***	2,498*	68,682***	276,754***	35,7	43,2	1,3	74,1

Note: Significance levels, + p<0,1, * p<0,05, ** p<0,01, *** p<0,001

Table 5: Socio-Economic Status of Students and Schools and Results of SABER Tests
SABER Sample 2009 | 9th grade, Math

	Test Score	SES Index	Linear Regression			Multilevel Regression				Variance Decomposition		Variance Explained	
Sample	Average	Average	SES Effect	SES Effect ^2	Intercept	SES Effect within School	SES Effect within School ^2	SES Effect between Schools	Intercept	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	Percentage of the variance explained within school	Percentage of the variance explained between schools
National	288,9	0,00	31,271***	5,824***	283,057***	10,773***	0,365	48,700***	290,334***	41,6	53,3	1,6	54,1
Urban Public	280,9	-0,05	19,982***	-0,612	282,318***	11,291***	0,336	42,713***	282,341***	24,4	22,2	2,0	26,4
Rural Public	257,7	-0,79	11,031***	-2,472***	269,780***	11,058***	1,504	20,667***	272,227***	24,4	16,4	1,2	7,0
Private	343,7	0,84	39,787***	4,726**	303,227***	10,675***	-0,685	72,797***	275,116***	48,1	47,8	0,8	58,9
Medellin	293,9	0,17	31,023***	10,953***	279,827***	10,045***	0,911	70,372***	281,138***	38,7	44,8	1,1	75,5
Bogota	328,8	0,41	29,898***	7,178***	309,843***	12,137***	-1,996***	63,046***	300,272***	36,9	46,5	1,2	64,8
Pasto	305,2	0,25	26,861***	8,643**	289,997***	12,211***	0,808	39,427***	296,414***	35,3	56,1	2,4	58,1
Bucaramanga	342,1	0,44	31,001***	5,806+	322,331***	14,144***	1,081	55,321***	308,872***	33,7	48,5	2,1	57,0
Cali	296,9	0,40	30,825***	9,187***	276,691***	9,339***	-1,293	73,995***	266,009***	44,2	42,3	0,8	66,6

Table 6: Socio-Economic Status of Students and Schools and Results of SABER Tests
SABER Sample 2009 | 9th grade, Natural Sciences

	Test Score	SES Index	Linear Regression			Multilevel Regression				Variance Decomposition		Variance Explained	
Sample	Average	Average	SES Effect	SES Effect ^2	Intercept	SES Effect within School	SES Effect within School ^2	SES Effect between Schools	Intercept	Percentage of the variance associated to school	Intraclass Correlation (ICC) based on SES Index	Percentage of the variance explained within school	Percentage of the variance explained between schools
National	290,2	0,00	30,773***	6,879***	283,287***	12,431***	1,378***	48,001***	293,676***	37,2	52,6	2,0	56,5
Urban Public	281,0	-0,05	20,434***	0,784	281,455***	13,039***	1,465***	39,828***	283,113***	19,7	22,0	2,3	28,6
Rural Public	264,9	-0,76	9,479***	-3,826***	277,099***	9,849***	0,651	21,748***	280,670***	20,3	16,4	1,5	8,1
Private	344,0	0,83	38,553***	6,440***	302,208***	11,414***	1,304+	73,194***	278,767***	44,8	48,0	1,4	66,9
Medellin	297,7	0,18	30,201***	11,083***	283,373***	11,957***	1,032	68,923***	284,777***	35,0	43,4	1,7	73,7
Bogota	326,3	0,41	30,596***	8,538***	305,734***	13,450***	-0,585	64,816***	298,826***	34,3	47,6	1,6	76,3
Pasto	311,1	0,25	26,771***	8,090**	296,453***	12,312***	2,272	44,164***	298,872***	34,0	56,4	2,6	70,7
Bucaramanga	339,0	0,45	34,592***	6,886+	316,302***	15,188***	1,311	62,078***	303,775***	35,1	49,4	2,5	71,1
Cali	298,4	0,41	27,660***	9,570***	278,382***	9,723***	1,703	68,621***	270,814***	38,1	42,5	1,3	69,2

Note: Significance levels, + p<0,1, * p<0,05, ** p<0,01, *** p<0,001

Annex B: Relationship between SES and results per tests and grades

Figure 1: Relationship between SES and results in the Mathematics test for 5th grade (National, per selected territorial entity and Management/Geographical Area)

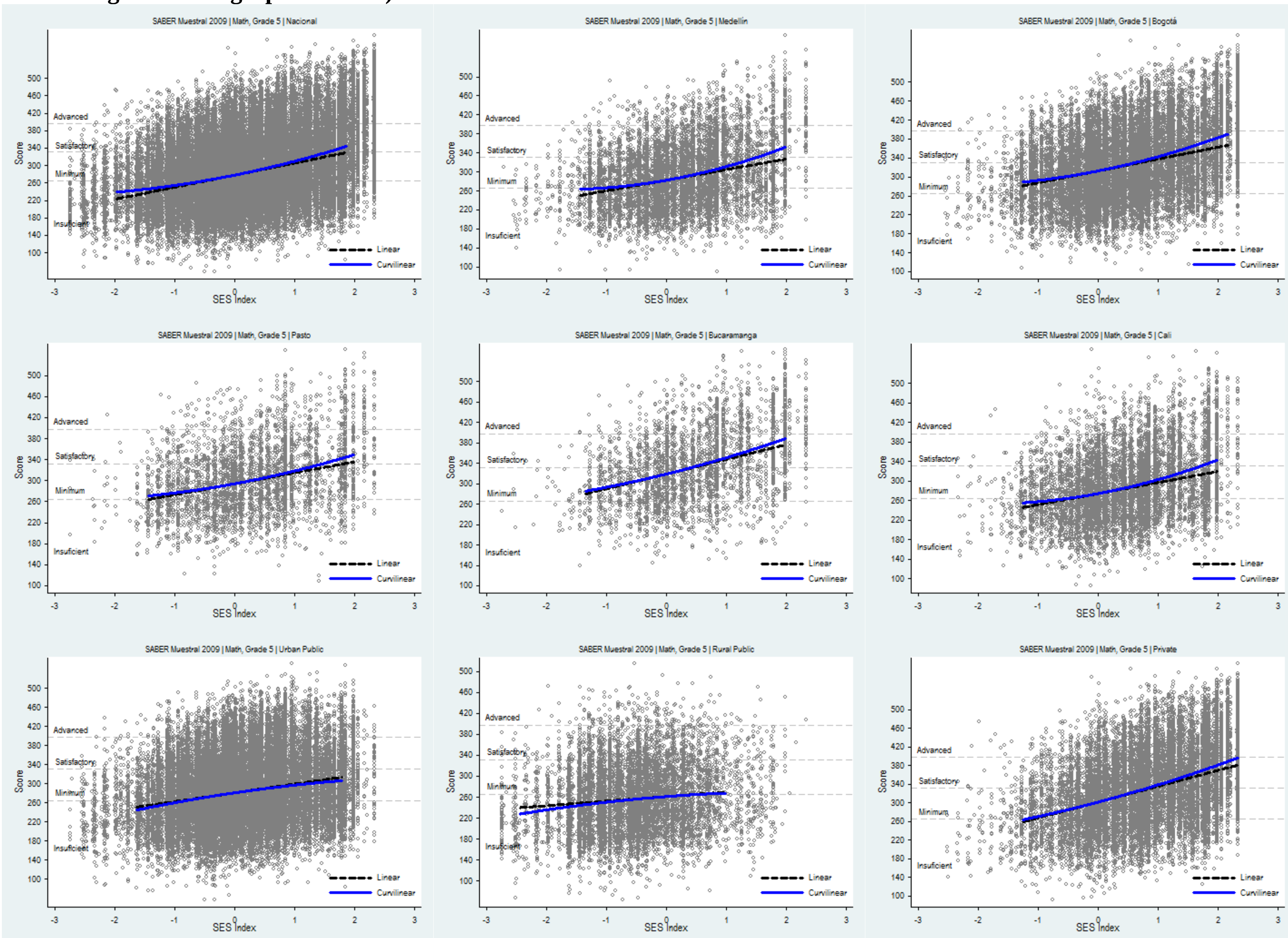


Figure 2: Relationship between SES and results in the Science test for 5th grade (National, per selected territorial entity and Management/Geographical Area)

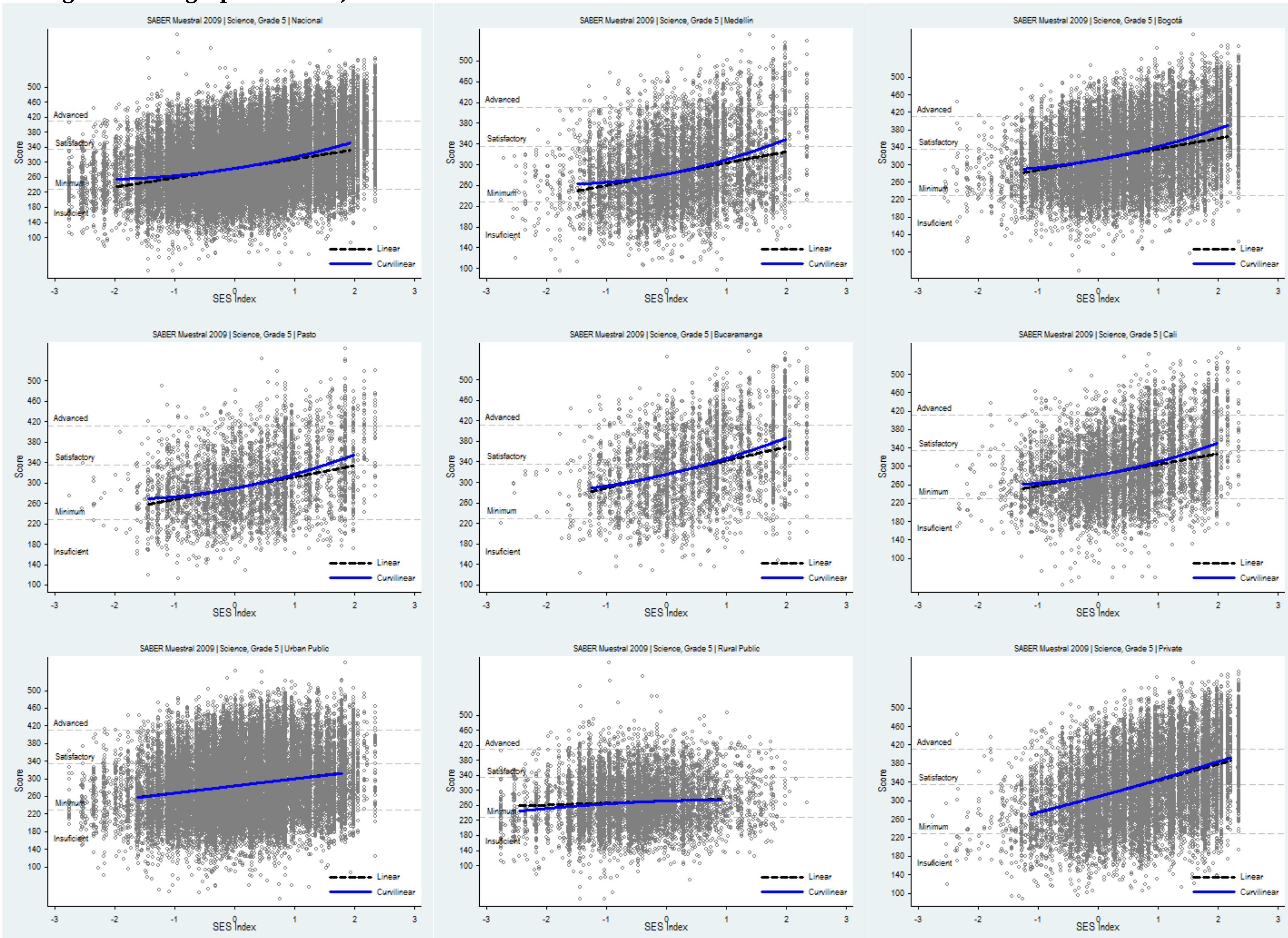


Figure 3: Relationship between SES and results in the Language test for 9th grade (National, per selected territorial entity and Management/Geographical Area)

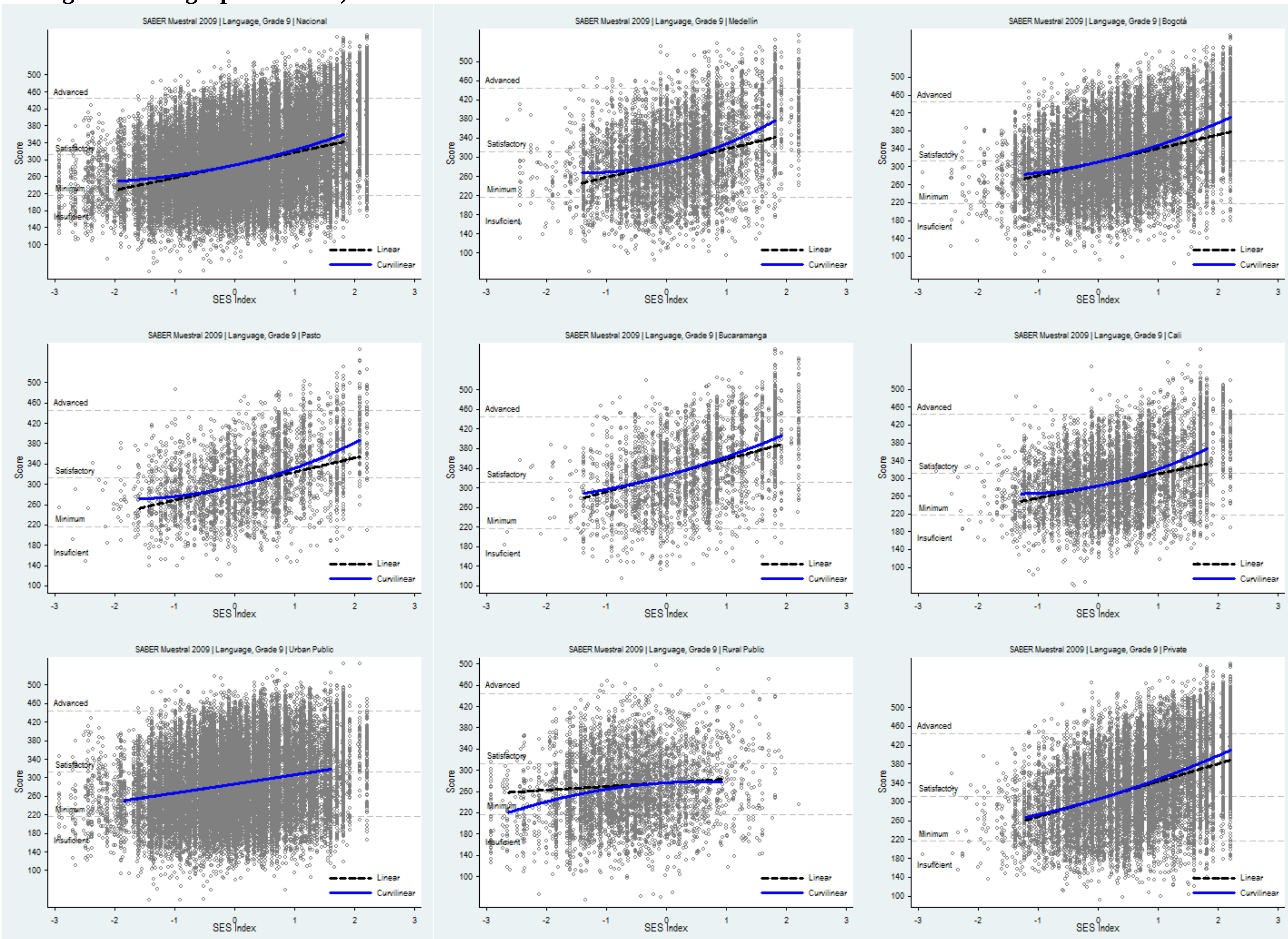


Figure 4: Relationship between SES and results in the Mathematics test for 9th grade (National, per selected territorial entity and Management/Geographical Area)

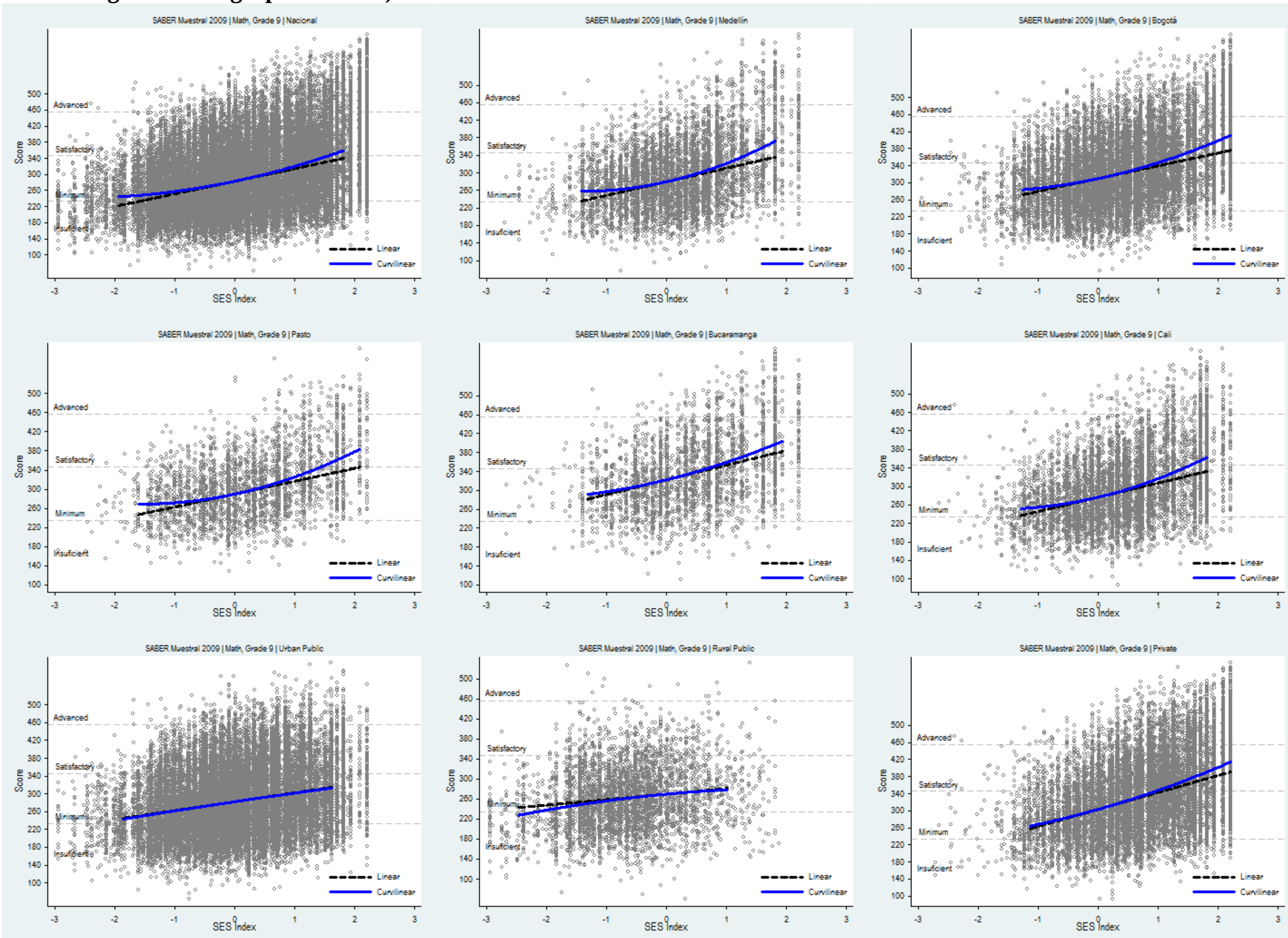
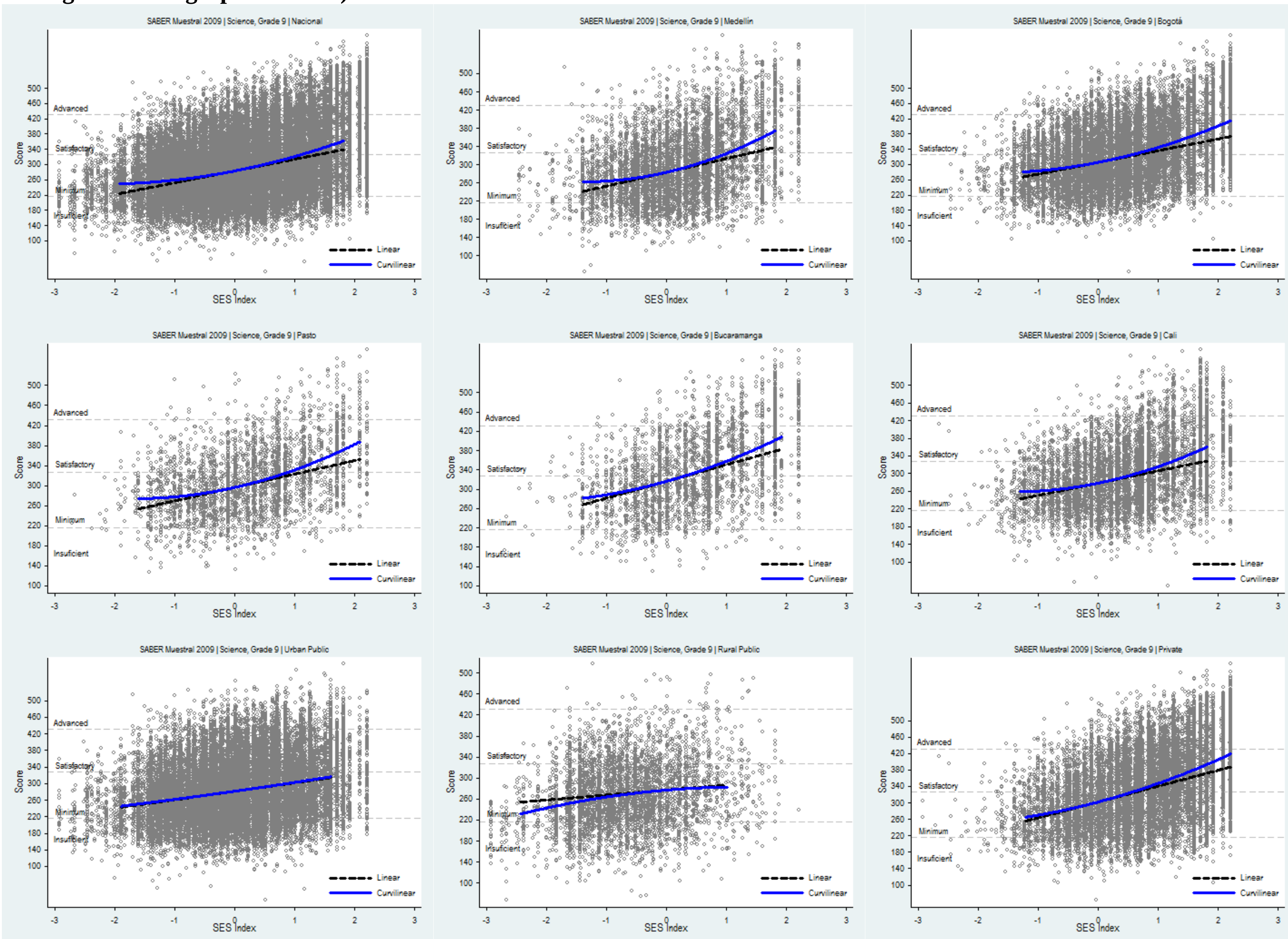


Figure 5: Relationship between SES and results in the Science test for 9th grade (National, per selected territorial entity and Management/Geographical Area)



Annex C: Decomposition (within and between Schools) of the Relationship between Socio-Economic Level and Scores Obtained per Tests and Per Grade

Figure 1: Decomposition (within and between Schools) of the Relationship between Socio-Economic Level and Scores Obtained in Mathematics in 5th Grade (National, per selected territorial entity and Management/Geographical Area)

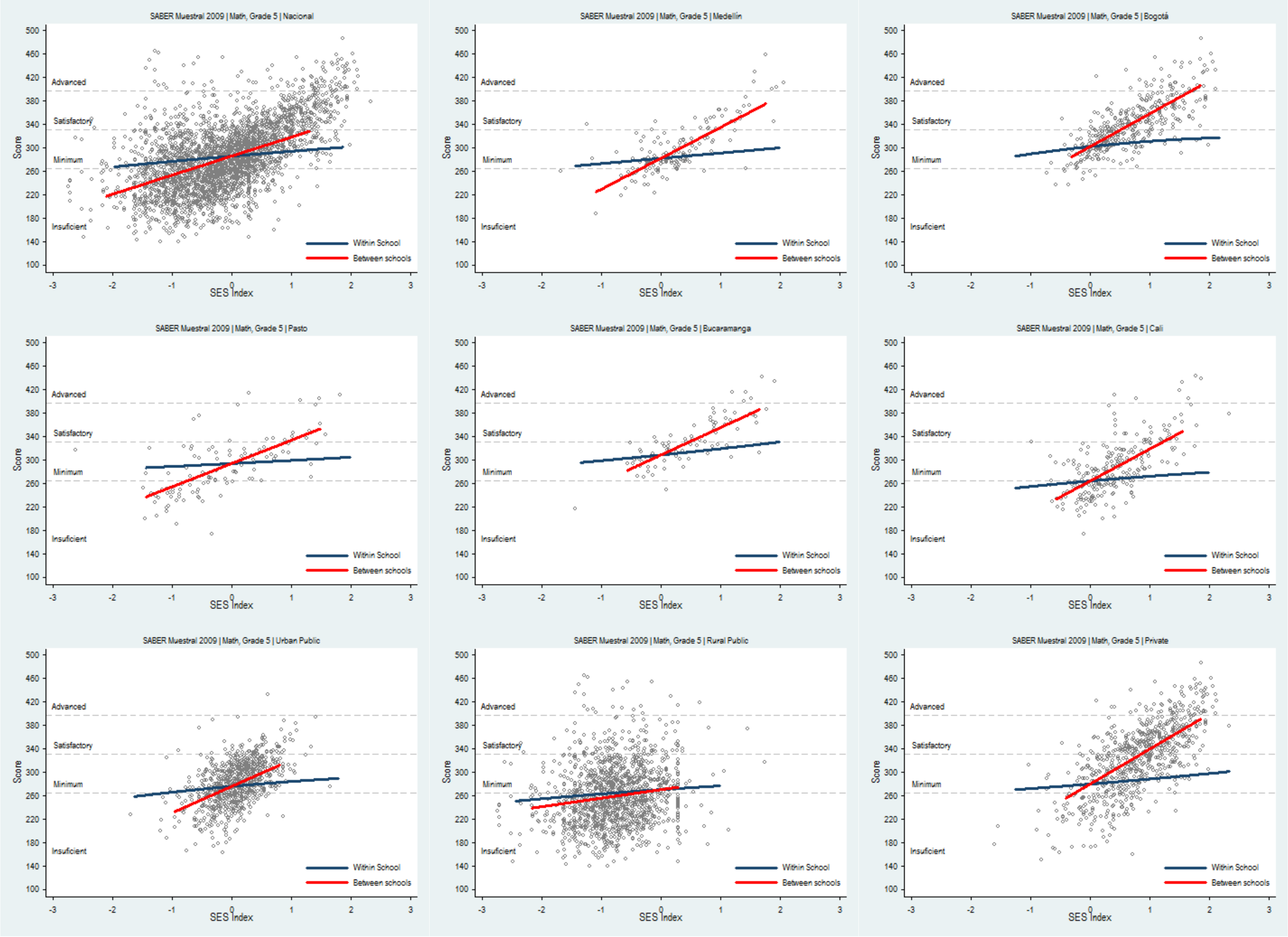


Figure 2: Decomposition (within and between Schools) of the Relationship between Socio-Economic Level and Scores Obtained in Science in 5th Grade (National, per selected territorial entity and Management/Geographical Area)

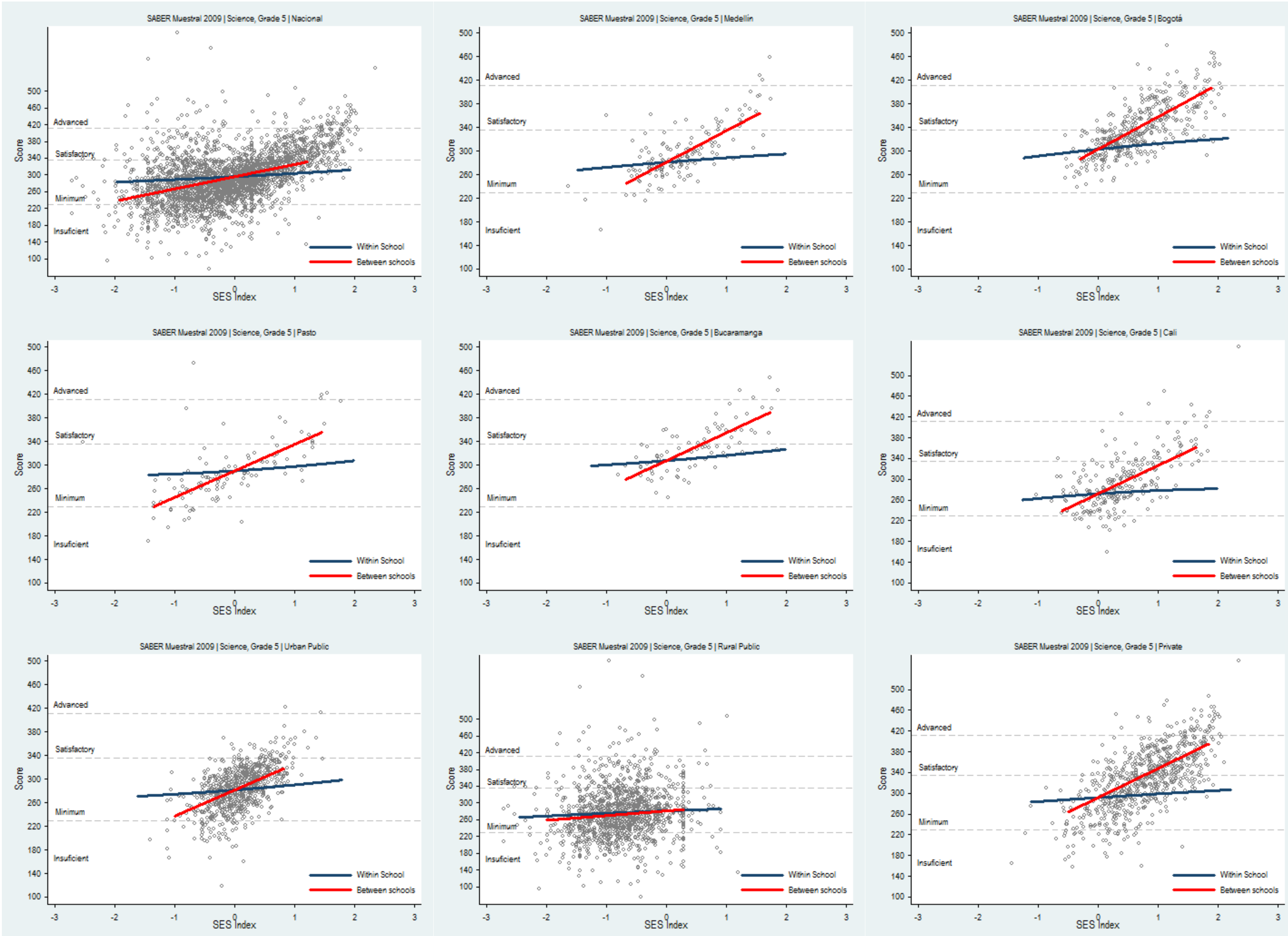


Figure 3: Decomposition (within and between Schools) of the Relationship between Socio-Economic Level and Scores Obtained in Language in 9th Grade (National, per selected territorial entity and Management/Geographical Area)

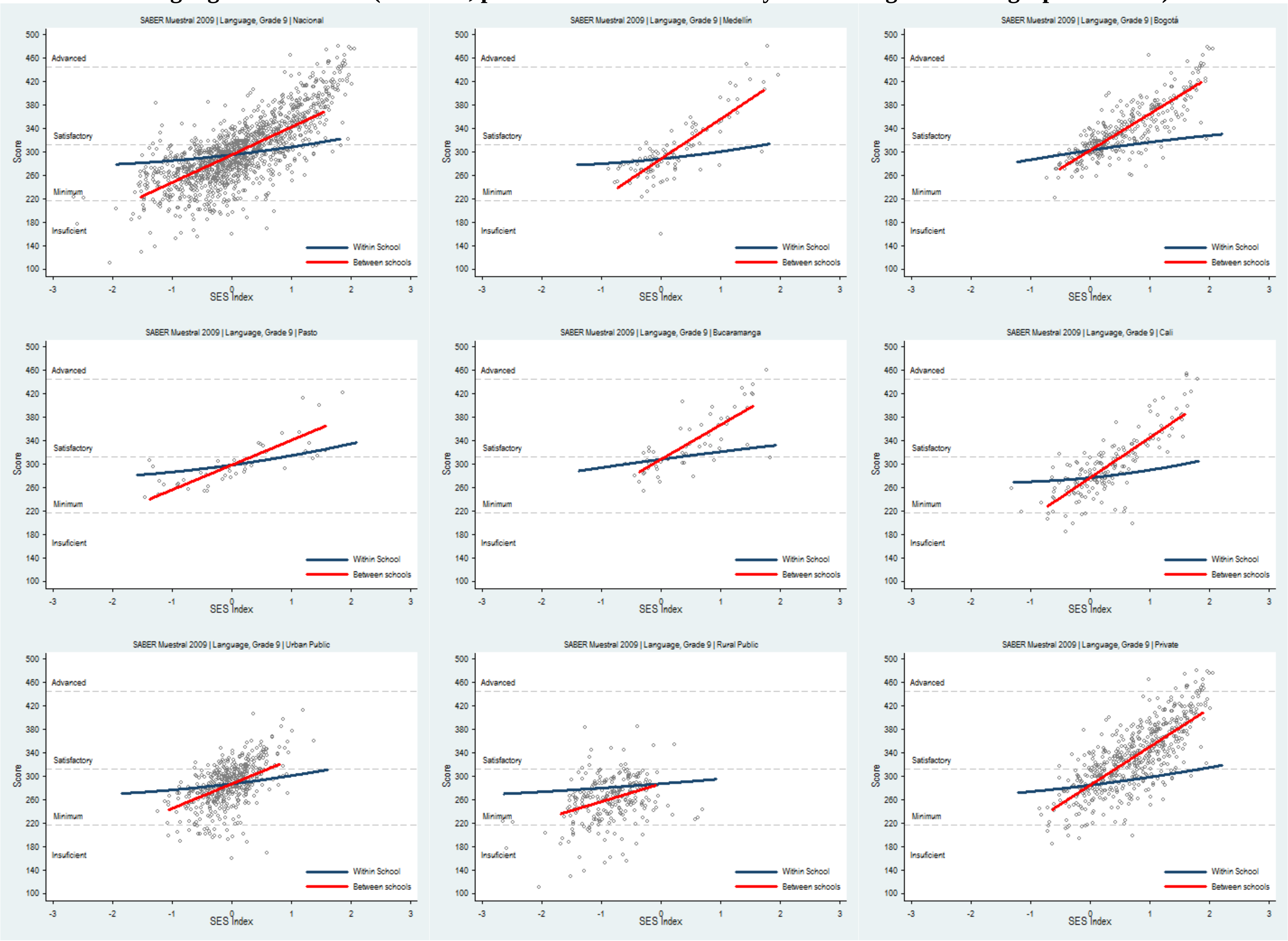


Figure 4: Decomposition (within and between Schools) of the Relationship between Socio-Economic Level and Scores Obtained in Mathematics in 9th Grade (National, per selected territorial entity and Management/Geographical Area)

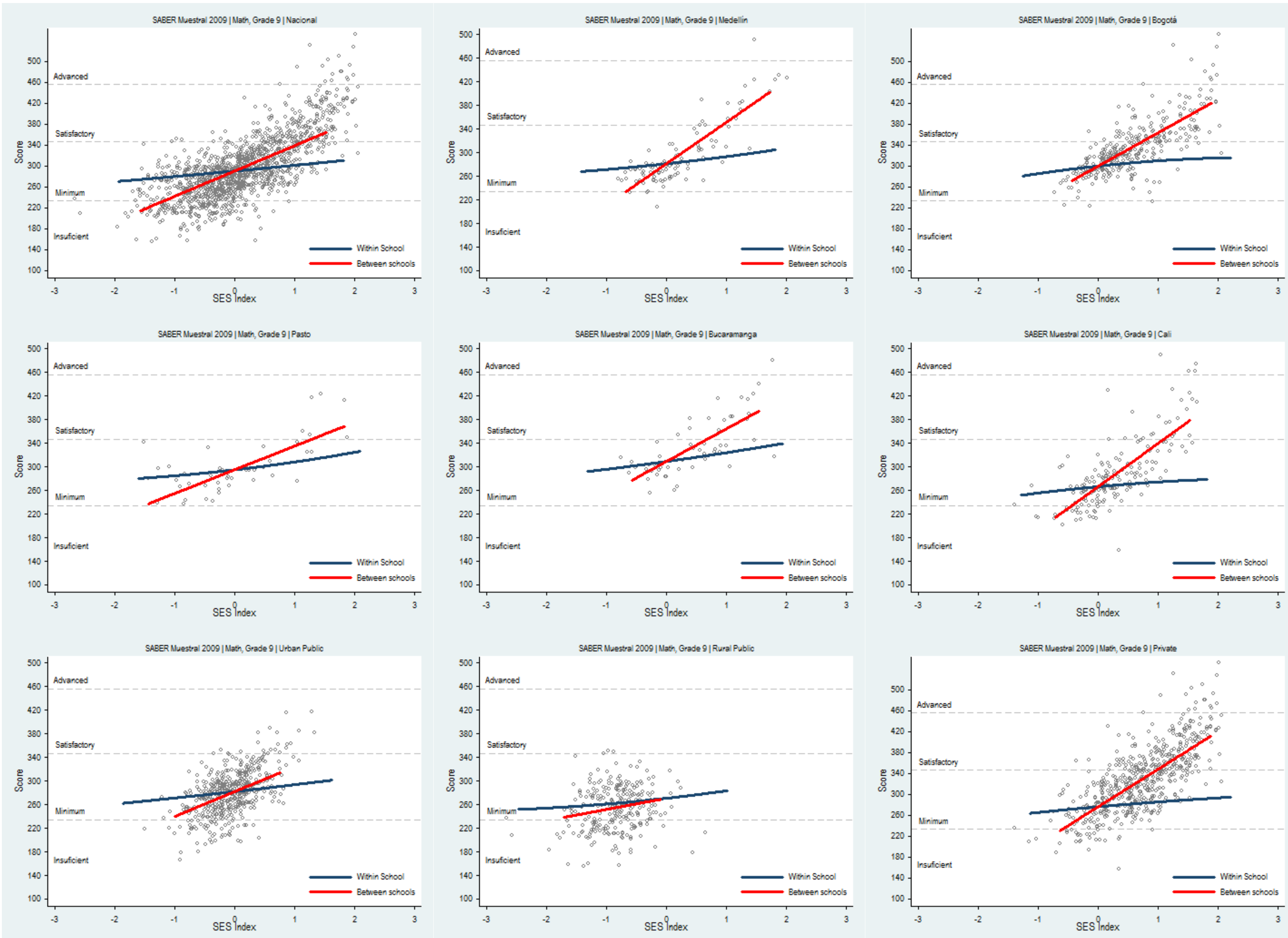
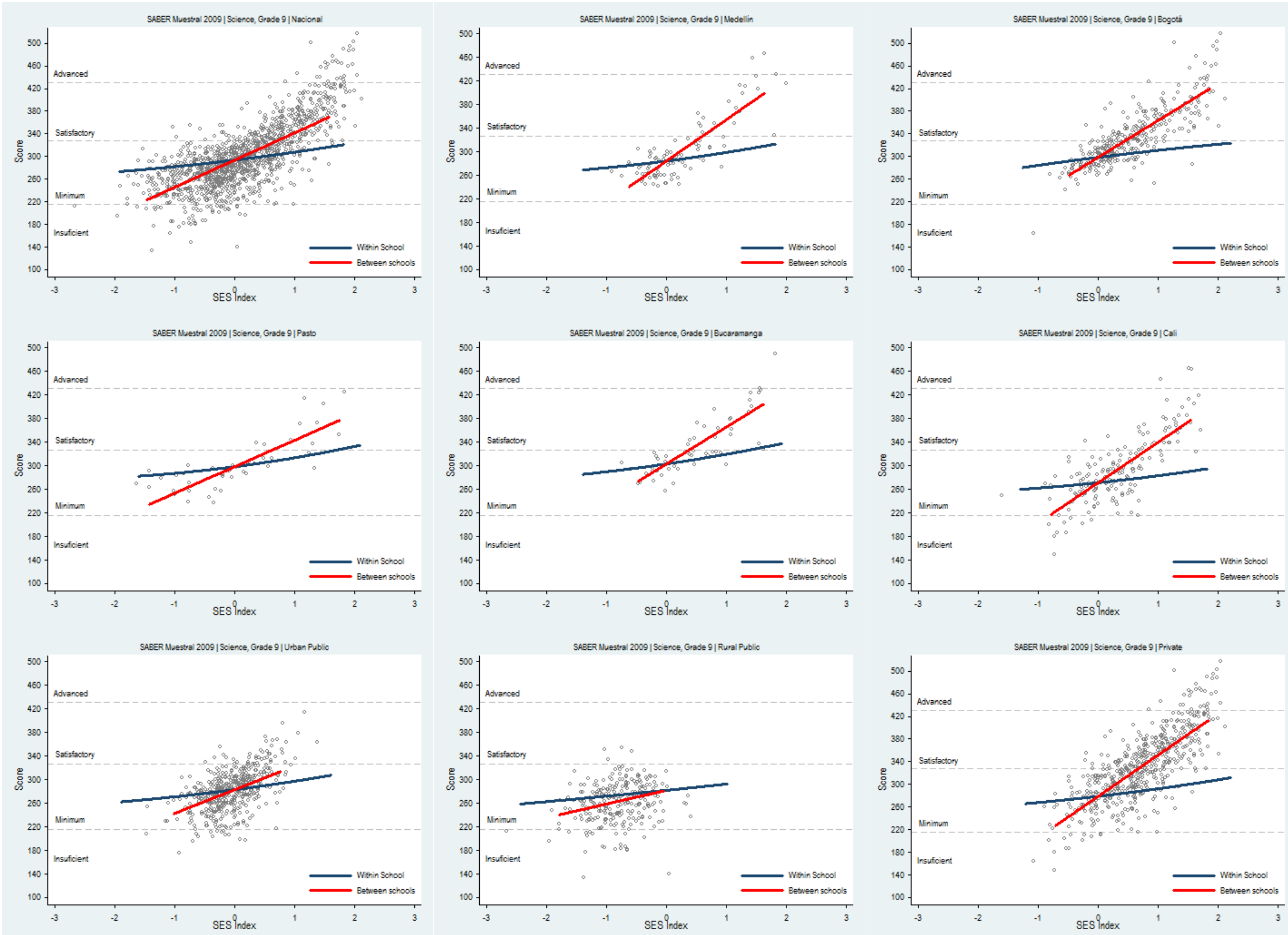


Figure 5: Decomposition (within and between Schools) of the Relationship between Socio-Economic Level and Scores Obtained in Science in 9th Grade (National, per selected territorial entity and Management/Geographical Area)



Annex D: Double and Triple Jeopardy of Compositional Effects per Test and Grade

Figure 1: Double and Triple Jeopardy of Compositional Effects in Mathematics for 5th Grade (National, per selected territorial entity and Management/Geographical Area)

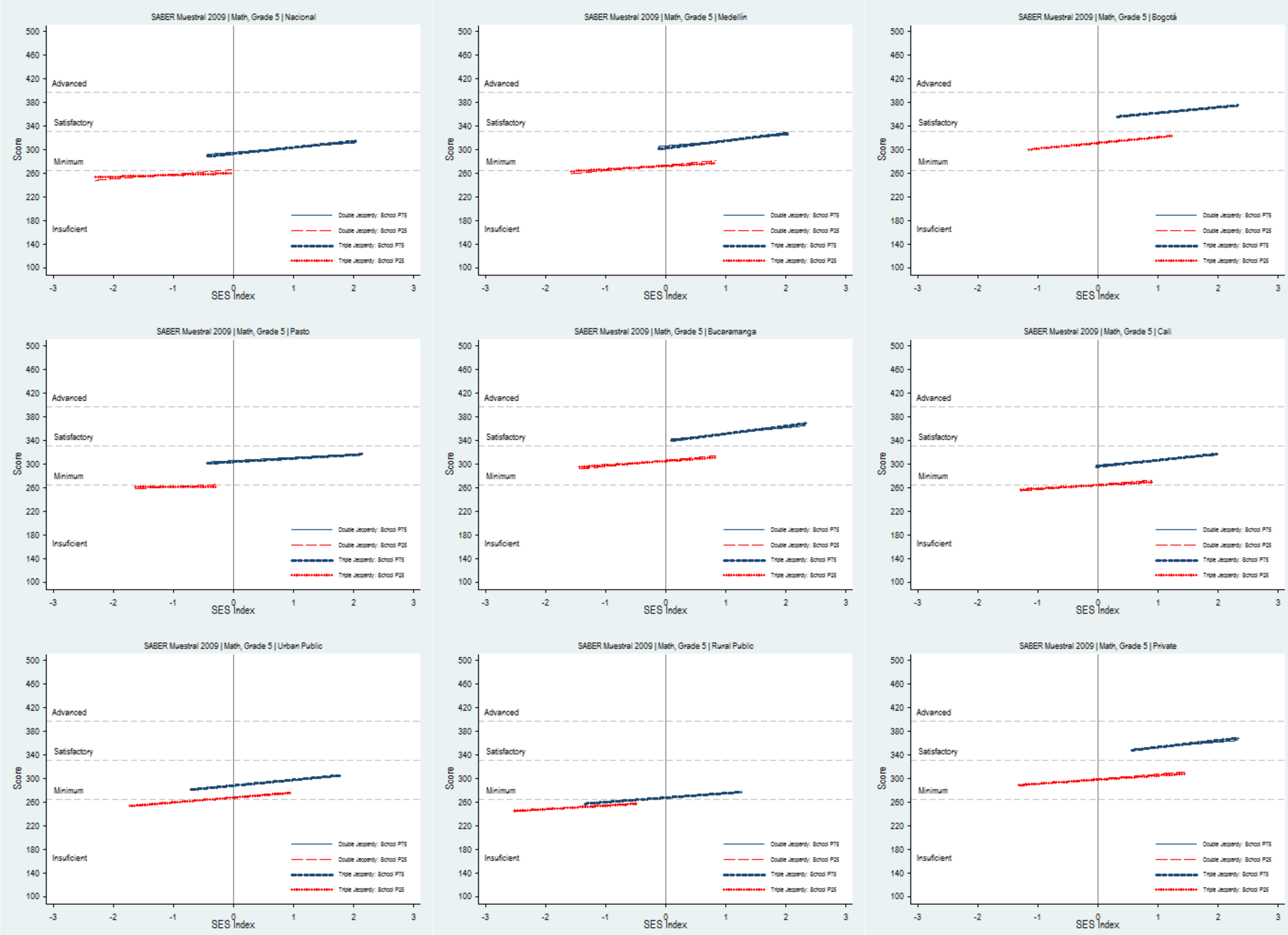


Figure 2: Double and Triple Jeopardy of Compositional Effects in Science for 5th Grade (National, per selected territorial entity and Management/Geographical Area)

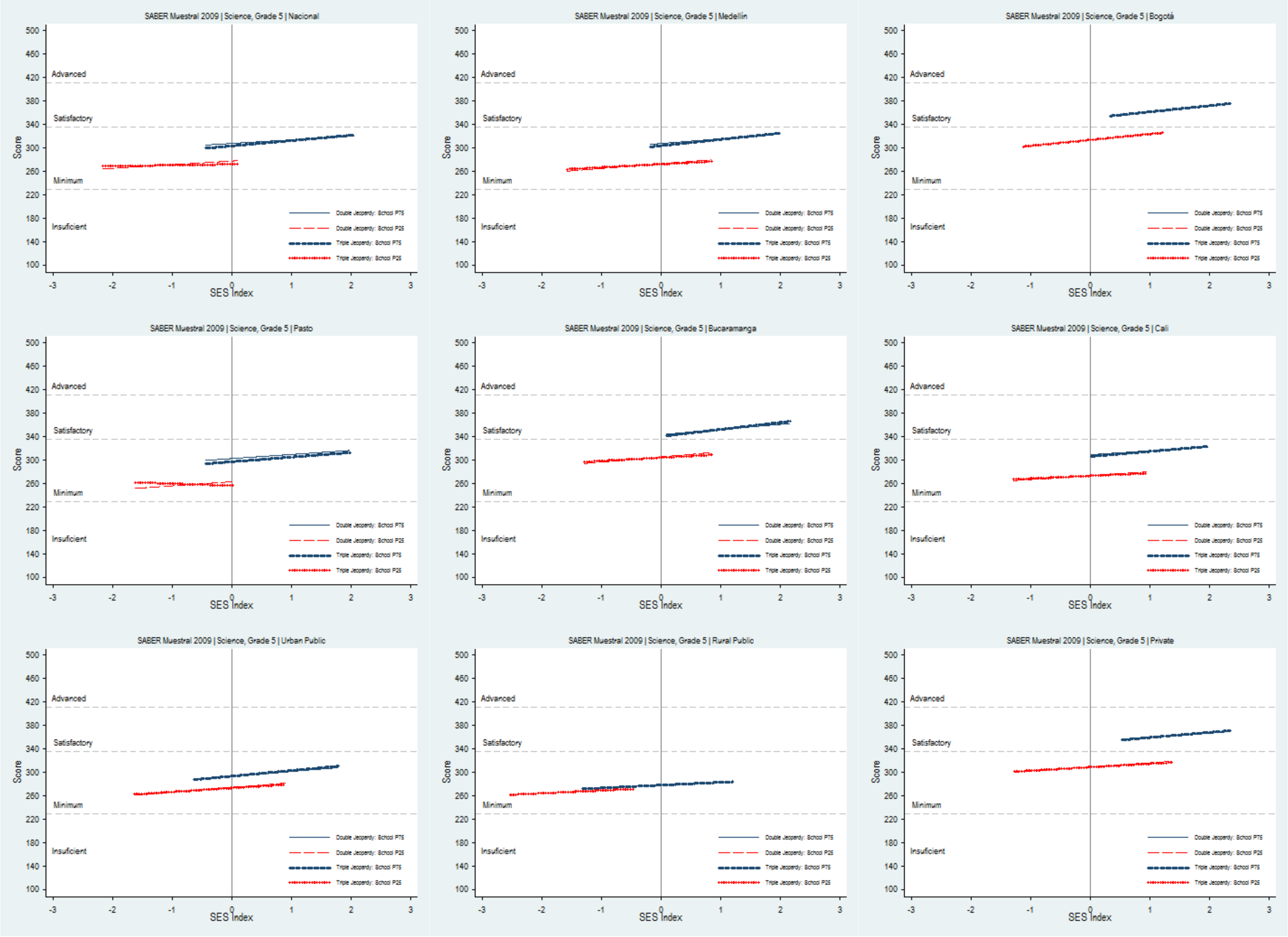


Figure 3: Double and Triple Jeopardy of Compositional Effects in Language for 9th Grade (National, per selected territorial entity and Management/Geographical Area)

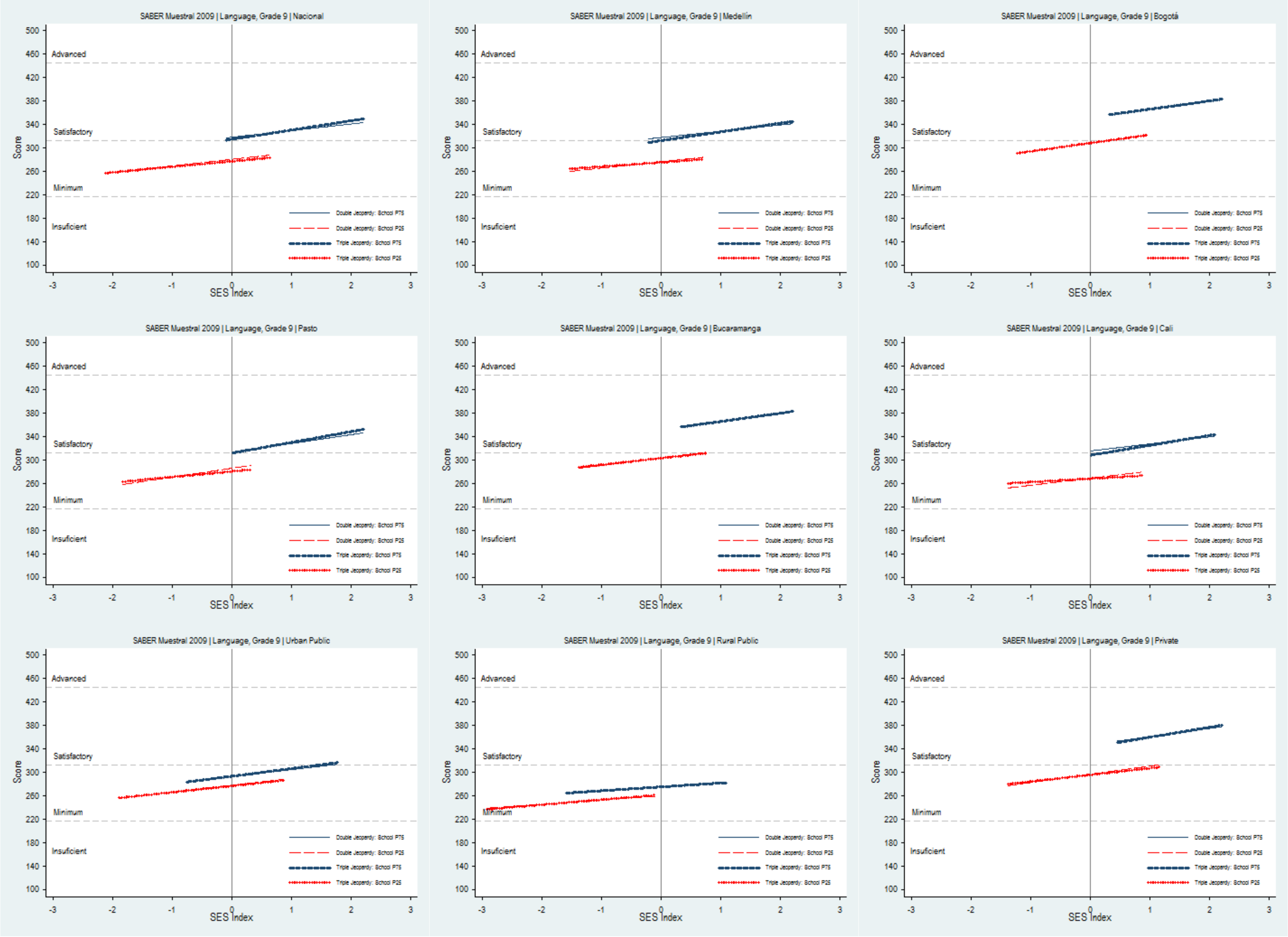


Figure 4: Double and Triple Jeopardy of Compositional Effects in Mathematics for 9th Grade (National, per selected territorial entity and Management/Geographical Area)

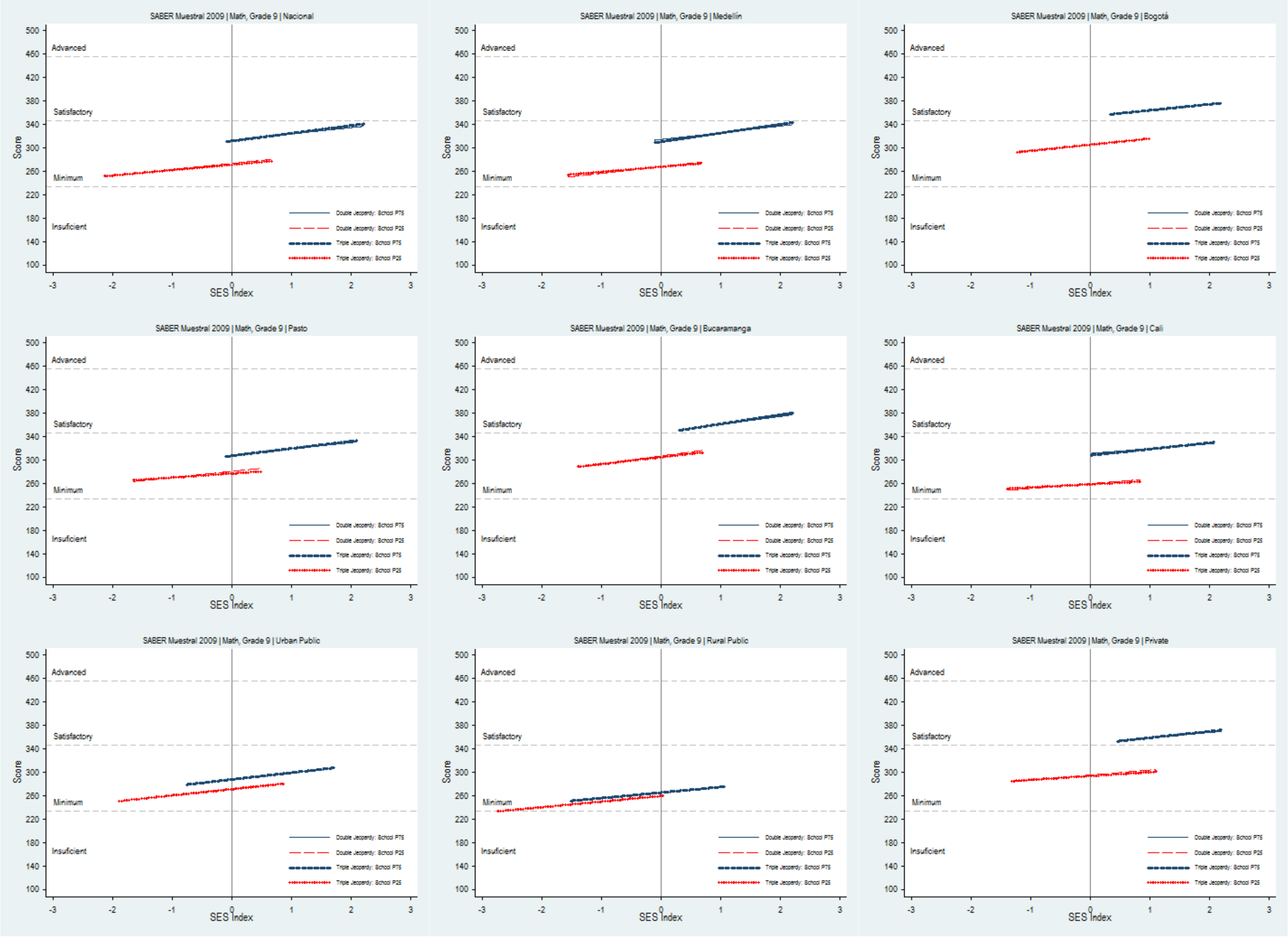
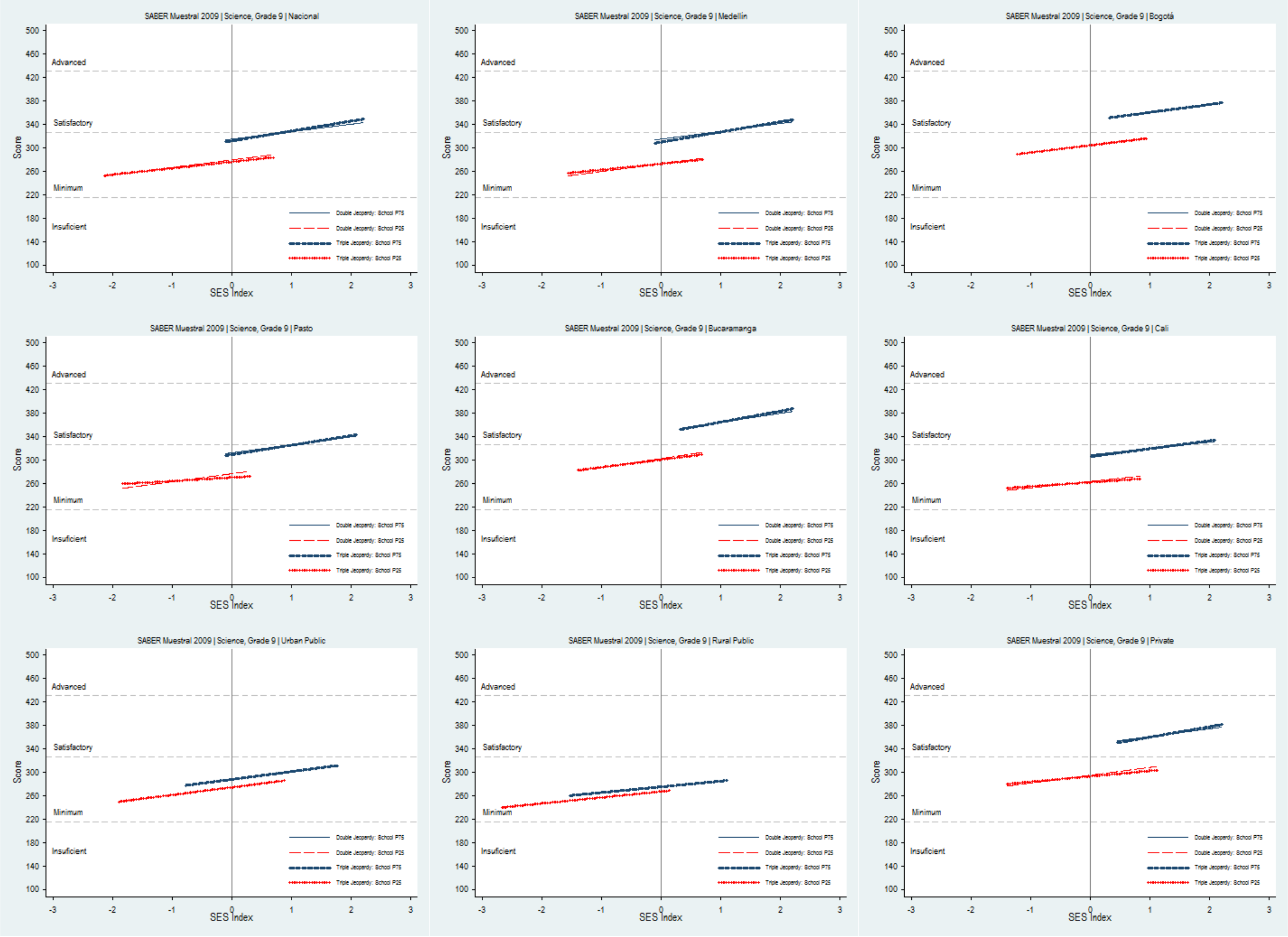


Figure 5: Double and Triple Jeopardy of Compositional Effects in Science for 9th Grade (National, per selected territorial entity and Management/Geographical Area)



Annex E: Characteristics of the Initial and Final Sample of the Language Tests in 5th and 9th Grade

Panel A

Language test sample in 5th grade

	Initial Sample	Final Sample
Characteristics of the student		
Comments	4,598	4,145
Test Score	28919	28909
SES Index	009	009
Attended pre-school	083	083
Works	036	037
Has repeated a grade	031	030
Characteristics of building		
Comments	255	240
Average Test Score	27832	27887
Average SES Index	-056	-057
Urban	036	035
Public management	090	089
Full enrollment at building	24586	24055
Number of Schools	608	603

Panel B

Language test sample in 9th grade

	Initial Sample	Final Sample
Characteristics of the student		
Comments	4,187	2,759
Test Score	29527	30247
SES Index	002	012
Attended pre-school	088	088
Works	032	031
Has repeated a grade	029	029
Characteristics of building		
Comments	115	88
Average Test Score	28702	28976
Average SES Index	-023	-020
Urban	065	060
Public management	076	069
Full enrollment at building	58990	57918
Number of Schools	384	382

Annex F: Relative Risks [RR] and proportion of Population Attributable Risk (PAR) per Tests per Grades

Table 1: RR and PAR for the Language Test in 5th Grade

			Equality		Resources				Processes					
% of the population: 65,56 (1,01)	**Size of the sub-population**	**Percentage of the sub-population with inadequate score**	**Relative Risk [RR]**	**Population Attributable Risk [PAR]**	**State of the classrooms**	**Access to services**	**Teacher Profile**	**On-Site Library**	**Classroom Rules**	**Proactive Teacher**	**Student's satisfaction with the teacher**	**Teacher's Satisfaction**	**School Violence**	**Full Schedule**
Percentage in inadequate condition					61,7	49,8	16,4	49,5	53,3	52,6	56,7	70,3	44,7	86,9
					0,7	0,8	0,6	0,8	0,7	0,7	0,7	0,8	0,7	0,5
Effect														
Relative Risk [RR]					1,28	1,44	1,02	1,18	1,10	1,09	1,13	1,00	0,89	1,23
					0,03	0,04	0,04	0,03	0,04	0,04	0,03	0,03	0,03	0,05
Population Attributable Risk [PAR]					14,71	17,87	0,38	8,24	4,93	4,47	6,80	0,07	-5,21	16,45
					1,67	1,38	37,70	1,77	3,90	4,36	2,78	44,69	3,81	2,77
Sub-population														
Quintile 1	21,8	78,8	1,28	3,90	0,76	0,46	0,94	0,70	1,03	1,06	1,02	1,43	0,92	0,93
	0,6	1,7	0,04	0,70										
Quintile 2	19,6	75,7	1,20	3,85	0,89	0,66	0,98	0,88	0,93	0,99	0,96	1,08	1,02	0,72
	0,6	1,1	0,03	1,25										
Quintile 3	21,0	66,2	1,02	0,35	1,04	1,07	1,04	1,07	1,11	1,03	0,93	0,89	0,95	0,71
	0,6	1,7	0,04	14,28										
Quintile 4	18,9	57,4	0,85	-2,84	0,86	1,40	1,00	1,13	1,05	0,98	1,02	0,89	1,09	1,12
	0,6	1,1	0,03	2,92										
Quintile 5	18,8	46,1	0,66	-6,83	1,53	1,69	1,04	1,30	0,87	0,93	1,08	0,78	1,04	1,67
	0,6	1,3	0,04	1,59										
Urban Public	52,0	68,9	1,11	5,53	0,31	1,31	1,13	1,15	0,89	0,90	0,93	0,46	1,24	0,40
	0,7	0,8	0,03	3,08										
Private	18,7	39,7	0,55	-9,06	2,10	2,38	0,92	1,71	1,17	0,98	1,04	1,58	0,85	3,12
	0,6	2,3	0,05	1,49										
Rural Public	29,3	76,1	1,24	6,67	1,67	0,15	0,92	0,47	1,03	1,15	1,07	1,50	0,87	0,89
	0,7	1,5	0,04	1,34										

Table 2: RR and PAR for the Mathematics Test in 5th Grade

% of the population: 74,97 (1,12)	Size of the sub-population	Percentage of the sub-population with inadequate score	Equality Relative Risk [RR]	Population Attributable Risk [PAR]	Resources State of the classrooms	Access to services	Teacher Profile	On-Site Library	Processes Classroom Rules	Proactive Teachers	Student's satisfaction with the teacher	Teacher's Satisfaction	School Violence	Full Schedule
Percentage in inadequate condition					61,5	49,6	16,4	49,5	52,6	52,4	55,7	70,9	46,1	86,8
					0,7	0,8	0,6	0,8	0,7	0,7	0,7	0,8	0,7	0,5
Effect														
Relative Risk [RR]					1,27	1,33	1,02	1,16	1,03	1,00	1,03	1,05	0,94	1,22
					0,03	0,03	0,03	0,02	0,02	0,02	0,02	0,03	0,02	0,03
Population Attributable Risk [PAR]					14,00	13,97	0,35	7,26	1,73	0,12	1,81	3,38	-2,84	15,82
					1,67	0,86	76,52	1,46	10,25	110,00	7,69	6,27	4,55	1,33
Sub-population														
Quintile 1	19,8	86,6	1,21	3,90	0,88	0,46	0,93	0,70	1,03	1,07	1,04	1,14	0,84	1,01
	0,6	0,6	0,02	0,70										
Quintile 2	21,3	86,5	1,21	4,23	0,92	0,66	0,98	0,94	0,95	1,01	0,96	1,26	1,00	0,60
	0,6	0,9	0,02	0,75										
Quintile 3	20,1	77,0	1,04	0,72	0,87	1,01	1,04	0,99	1,06	1,07	0,99	0,93	0,97	0,82
	0,6	1,1	0,02	7,66										
Quintile 4	19,3	68,6	0,90	-2,00	0,88	1,36	1,02	1,10	1,04	0,96	1,06	0,95	1,09	1,04
	0,6	1,2	0,03	3,15										
Quintile 5	19,5	54,1	0,68	-6,74	1,50	1,76	1,03	1,32	0,93	0,90	0,95	0,77	1,11	1,68
	0,6	1,2	0,03	1,40										
Urban Public	52,1	79,4	1,13	6,48	0,32	1,30	1,13	1,13	0,84	0,82	0,84	0,45	1,35	0,40
	0,7	0,7	0,02	1,69										
Private	18,7	51,1	0,64	-7,32	2,08	2,37	0,92	1,72	1,26	1,04	1,11	1,63	0,85	3,08
	0,6	2,0	0,04	1,40										
Rural Public	29,2	82,3	1,14	4,03	1,66	0,16	0,92	0,48	1,03	1,22	1,13	1,49	0,77	0,91
	0,7	0,6	0,02	1,31										

Table 3: RR and PAR for the Science Test in 5th Grade

			Equality		Resources					Processes				
% of the population: 70,82 (1,22)	**Size of the sub-population**	**Percentage of the sub-population with inadequate score**	**Relative Risk [RR]**	**Population Attributable Risk [PAR]**	**State of the classrooms**	**Access to services**	**Teacher Profile**	**On-Site Library**	**Classroom Rules**	**Proactive Teachers**	**Student's satisfaction with the teacher**	**Teacher's Satisfaction**	**School Violence**	**Full Schedule**
Percentage in inadequate condition					61,4	49,8	16,6	49,6	52,8	52,6	56,2	70,7	45,9	86,7
					0,7	0,8	0,6	0,8	0,7	0,7	0,7	0,8	0,7	0,5
Effect														
Relative Risk [RR]					1,37	1,30	0,94	1,21	1,04	1,04	1,04	1,11	0,92	1,24
					0,04	0,04	0,05	0,03	0,03	0,02	0,03	0,05	0,03	0,06
Population Attributable Risk [PAR]					18,61	12,94	-0,95	9,30	2,12	1,88	1,99	7,30	-3,90	17,01
					1,67	1,34	24,06	1,44	8,81	9,45	2,900,00	4,00	4,28	2,79
Sub-population														
Quintile 1	20,5	82,5	1,22	3,90	0,90	0,43	0,95	0,66	0,97	1,04	1,03	1,37	0,88	0,82
	0,6	1,4	0,04	0,70										
Quintile 2	19,9	82,4	1,22	4,13	0,73	0,70	0,99	0,94	1,01	1,09	0,92	1,02	1,07	0,76
	0,6	2,7	0,05	1,20										
Quintile 3	20,6	71,8	1,02	0,41	0,92	1,06	1,06	1,02	1,04	0,98	1,00	0,91	0,92	0,80
	0,6	1,5	0,03	24,98										
Quintile 4	19,7	63,6	0,88	-2,46	1,01	1,37	0,97	1,16	1,10	1,04	1,16	1,04	1,00	0,97
	0,6	1,4	0,04	3,18										
Quintile 5	19,4	52,1	0,69	-6,33	1,50	1,66	1,03	1,27	0,88	0,85	0,90	0,74	1,15	1,81
	0,6	2,2	0,04	1,63										
Urban Public	52,3	78,1	1,24	11,21	0,31	1,30	1,14	1,14	0,84	0,88	0,86	0,46	1,29	0,39
	0,7	0,7	0,04	1,66										
Private	18,7	44,2	0,57	-8,64	2,07	2,38	0,93	1,72	1,27	1,00	1,09	1,60	0,86	3,05
	0,6	2,3	0,05	1,42										
Rural Public	29,0	74,9	1,08	2,36	1,68	0,16	0,91	0,47	1,02	1,16	1,12	1,48	0,81	0,94
	0,7	2,3	0,04	4,39										

Table 4: RR and PAR for the Language Test in 9th Grade

% of the population: 60,02 (1,01)	Size of the sub-population	Percentage of the sub-population with inadequate score	Equality		Resources				Processes					
			Relative Risk [RR]	Population Attributable Risk [PAR]	State of the classrooms	Access to services	Teacher Profile	On-Site Library	Classroom Rules	Proactive Teachers	Student's satisfaction with the teacher	Teacher's Satisfaction	School Violence	Full Schedule
Percentage in inadequate condition					60,0	70,4	2,1	39,1	54,4	51,3	60,1	76,9	46,4	83,5
					0,9	0,9	0,3	0,9	0,8	0,8	0,8	0,8	0,8	0,6
Effect														
Relative Risk [RR]					1,34	1,22	1,01	1,24	0,95	0,96	0,86	1,12	1,04	1,54
					0,05	0,04	0,13	0,04	0,03	0,03	0,03	0,05	0,03	0,06
Population Attributable Risk [PAR]					16,94	13,60	0,03	8,68	-2,67	-2,10	-9,11	8,52	1,88	31,20
					1,30	2,20	48,03	1,79	8,77	12,31	3,36	4,05	10,58	1,40
Sub-population														
Quintile 1	20,4	78,1	1,41	4,12	0,54	0,46	1,01	0,71	1,07	1,02	1,21	0,85	0,92	0,83
	0,6	1,0	0,03	0,56										
Quintile 2	20,3	69,3	1,21	3,99	0,75	0,98	1,00	0,76	1,01	1,04	1,12	1,11	1,06	0,68
	0,6	1,6	0,03	1,61										
Quintile 3	19,8	59,3	0,99	-0,24	0,91	1,46	1,00	0,90	0,98	1,01	1,03	0,95	1,09	0,90
	0,6	1,6	0,04	24,52										
Quintile 4	19,2	52,6	0,85	-2,89	1,00	1,35	0,98	1,11	1,01	1,03	0,85	0,80	1,06	0,90
	0,6	1,3	0,04	3,30										
Quintile 5	20,3	39,6	0,61	-8,61	1,85	0,87	1,01	1,50	0,93	0,90	0,81	1,28	0,89	1,85
	0,6	0,8	0,05	1,50										
Urban Public	70,9	62,5	1,16	10,20	0,63	3,31	1,06	0,83	0,83	1,00	0,93	0,54	1,25	0,30
	0,7	0,9	0,04	2,75										
Private	14,3	40,0	0,63	-5,58	2,29	0,76	0,92	1,80	1,25	1,09	0,97	2,12	0,71	2,58
	0,5	1,3	0,05	1,60										
Rural Public	14,8	67,4	1,15	2,13	0,68	0,00	1,00	0,60	1,07	0,92	1,15	1,05	0,94	2,19
	0,5	1,0	0,03	2,28										

Table 5: RR and PAR for the Mathematics Test in 9th Grade

			Equality		Resources					Processes				
% of the population: 77,11 (1,29)	**Size of the sub-population**	**Percentage of the sub-population with inadequate score**	**Relative Risk [RR]**	**Population Attributable Risk [PAR]**	**State of the classrooms**	**Access to services**	**Teacher Profile**	**On-Site Library**	**Classroom Rules**	**Proactive Teachers**	**Student's satisfaction with the teacher**	**Teacher's Satisfaction**	**School Violence**	**Full Schedule**
Percentage in inadequate condition					60,0	70,4	2,1	39,1	54,5	52,1	59,7	76,9	47,6	83,5
					0,9	0,9	0,3	0,9	0,8	0,8	0,8	0,8	0,8	0,6
Effect														
Relative Risk [RR]					1,29	1,15	1,11	1,27	0,97	0,94	0,90	1,05	1,02	1,46
					0,03	0,04	0,08	0,02	0,02	0,02	0,02	0,03	0,02	0,05
Population Attributable Risk [PAR]					14,83	9,25	0,23	9,70	-1,72	-3,09	-6,23	3,88	1,13	27,53
					1,30	2,38	3,51	0,67	11,70	4,51	2,66	5,95	11,40	1,55
Sub-population														
Quintile 1	20,0	89,5	1,21	4,12	0,57	0,60	1,01	0,76	1,10	1,03	1,21	0,89	0,90	0,89
	0,6	1,0	0,02	0,56										
Quintile 2	21,7	85,7	1,15	3,19	0,70	0,89	1,01	0,74	1,01	1,09	1,11	1,08	1,03	0,64
	0,6	0,7	0,02	0,97										
Quintile 3	19,6	80,2	1,05	1,04	0,87	1,34	1,00	0,89	0,99	1,05	1,08	0,88	1,11	0,73
	0,6	0,9	0,02	3,93										
Quintile 4	19,3	70,7	0,90	-1,94	1,02	1,33	0,98	1,15	0,94	0,94	0,85	0,77	1,05	0,85
	0,6	1,7	0,03	3,01										
Quintile 5	19,3	56,8	0,69	-6,27	1,94	0,90	1,01	1,46	0,96	0,89	0,76	1,38	0,92	2,22
	0,6	1,5	0,04	1,43										
Urban Public	70,9	81,1	1,21	12,74	0,63	3,32	1,06	0,84	0,84	1,00	0,99	0,54	1,24	0,30
	0,7	0,8	0,02	1,14										
Private	14,3	56,5	0,70	-4,46	2,29	0,76	0,92	1,80	1,21	1,04	0,94	2,13	0,74	2,58
	0,5	1,0	0,04	1,43										
Rural Public	14,8	77,7	1,01	0,13	0,68	0,00	1,00	0,60	1,10	0,95	1,07	1,05	0,93	2,18
	0,5	1,1	0,02	120,00										

Table 6: RR and PAR for the Science Test in 9th Grade

% of the population: 70,69 (1,37)	Size of the sub-population	Percentage of the sub-population with inadequate score	Equality		Resources				Processes					
			Relative Risk [RR]	Population Attributable Risk [PAR]	State of the classrooms	Access to services	Teacher Profile	On-Site Library	Classroom Rules	Proactive Teachers	Student's satisfaction with the teacher	Teacher's Satisfaction	School Violence	Full Schedule
Percentage in inadequate condition					60,0	70,4	2,1	39,1	54,8	52,4	60,3	76,9	47,3	83,6
					0,9	0,8	0,3	0,9	0,8	0,8	0,8	0,8	0,8	0,6
Effect														
Relative Risk [RR]					1,29	1,10	1,04	1,26	0,99	0,94	0,87	1,08	1,01	1,50
					0,04	0,04	0,09	0,04	0,02	0,03	0,02	0,04	0,02	0,06
Population Attributable Risk [PAR]					14,84	6,72	0,09	9,37	-0,66	-3,19	-8,46	5,65	0,59	29,37
					1,30	3,43	15,55	1,25	31,40	5,78	2,53	4,44	26,98	1,83
Sub-population														
Quintile 1	20,1	86,5	1,30	4,12	0,55	0,51	1,00	0,78	1,11	1,08	1,25	0,74	0,88	0,93
	0,6	0,9	0,03	0,56										
Quintile 2	21,1	80,3	1,18	3,62	0,74	0,91	1,01	0,75	1,05	1,05	1,06	1,00	1,09	0,64
	0,6	1,6	0,03	1,25										
Quintile 3	19,5	73,4	1,05	0,94	0,93	1,21	1,01	0,91	0,99	0,97	1,04	0,98	1,09	0,81
	0,6	1,1	0,03	5,73										
Quintile 4	19,4	64,2	0,89	-2,23	0,99	1,53	0,98	1,07	0,92	1,01	0,90	0,93	1,04	0,86
	0,6	1,7	0,03	3,21										
Quintile 5	19,9	48,2	0,63	-7,89	1,85	0,93	1,01	1,49	0,93	0,90	0,77	1,32	0,91	1,97
	0,6	2,0	0,04	1,45										
Urban Public	70,9	74,9	1,24	14,61	0,63	3,32	1,06	0,84	0,82	0,98	0,95	0,54	1,23	0,30
	0,7	1,1	0,03	1,37										
Private	14,3	48,7	0,66	-5,20	2,29	0,76	0,92	1,80	1,26	1,12	0,98	2,13	0,73	2,60
	0,5	1,1	0,04	1,46										
Rural Public	14,7	71,7	1,02	0,25	0,68	0,00	1,00	0,60	1,10	0,92	1,10	1,04	0,96	2,15
	0,5	1,9	0,03	17,05										

Annex G: Generalized Multilevel Model for the Analysis of Dichotomous Variables.

In this study, we estimated the relationship between resources and processes observed in schools and the learning of students. The hierarchical structure of data, students within schools, requires multilevel regression methods of analysis[20] to recognize that the variability in the observed results occurs both at the level of students and at the schools they attend. Multilevel models allow the results to be estimated with greater precision (more precise standard errors). In addition, these methods can be used to estimate the magnitude of the association of characteristics that are attributable to schools without the need of collapsing information which usually leads to the loss of precision in the variability.

In the SABER Survey on Associated Factors, each student has information on the score reached each test and on the levels of learning associated with the achieved score. For the purpose of modeling the level of learning achieved by the student, advanced and satisfactory levels were treated as a single category defined as adequate learning, while minimum and inadequate levels were treated as the category of inappropriate learning. The dichotomous nature of this new variable requires the use of a generalization of the multilevel regression model, specifically of a multilevel logistic regression model[21]. Given the non-normality of the dependent variable, it is necessary to use a statistical model that includes data transformation to achieve normality and reduce heteroscedasticity and choose an appropriate distribution of the errors. Generalized linear models can deal with these situations, given the following assumptions:

1 The distribution of probability is binomial (μ) with μ mean.

2 The linear predictor is the multiple regression equation for η,

$$\eta = b_0 + b_1X_1 + b_2X_2,$$

3 The link role is the *logit* function given by $\eta = \text{logit}(\mu)$,

The multilevel extension of this model for the two-level structure that we want to model, is expressed as follows:

Adequate learning situation $_{ij} = \pi_{ij}$; $\pi_{ij} \sim \text{Binomial}(\mu)$

$\pi_{ij} = \text{logistic}(\eta_{ij})$

$\eta_{ij} = y_{00} + y_{10} X_{ij} + y_{01} X_{0j} + u_{0j}$

[20] These models are also known as Hierarchical Linear Models (HLM) or Mixed Models.

[21] For additional details, see Hox (2010) and Hedeker (2008).

In a more concise way:

$$\pi_{ij} = \text{logistic } (y_{00} + y_{10} X_{ij} + y_{01} X_j + u_{0j})$$

Where *i* represents the units of level 1 (observation units) or students while *j* represents the units at level 2, in our case, schools or buildings; X_{ij} represents a vector of student characteristics and X_j represents a vector of school characteristics.

Note that the *logit* function for binomial data can also be expressed as: logit (p_{ij}) = log odds (p_{ij}) = ln (p_{ij} /1- p_{ij})), where p_{ij} represents the probability that a student within a school reaches appropriate learning. The logit function transforms the proportions, with boundaries between 0 and 1 by definition, into logit values on a scale that ranges from -∞ to +∞.

Annex J: Matrix of Polychoric Correlations of each Index with the SES Index the School and between indexes

Shows students and schools in the language test for 5th grade

Correlation with Student SES				State of classrooms	Access to services	School Library	Classroom rules	Student's satisfaction with the teacher	Perception of violence at school	Full-time schedule school
Rho	(SE)	t-test								
-0,020	0,020	-0,992	State of classrooms	1,000						
0,140	0,019	7,216	Access to services	0,340	1,000					
0,052	0,020	2,646	School Library	0,161	0,425	1,000				
-0,090	0,024	-3,782	Teacher´s Satisfaction	0,163	0,020	-0,029				
-0,045	0,019	-2,300	Classroom rules	0,037	-0,051	-0,048	1,000			
0,008	0,020	0,394	Student's satisfaction with the teacher	0,075	0,025	-0,033	0,257	1,000		
0,092	0,019	4,721	Perception of violence at school	-0,060	0,066	0,023	-0,227	-0,256	1,000	
-0,118	0,023	-5,041	Full-time Schedule	0,204	0,359	0,454	-0,011	-0,015	0,051	1,000