

# Explaining the Rural-Urban Student Performance Gap for Different Distribution Quantiles in Colombia

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## Abstract

This paper studies the determinants of student performance in the PISA 2018 tests in Colombia focusing on the rural-urban gap. Using quantile regression, a student-level education production function at different points along the achievement distribution is estimated. Applying the Oaxaca–Blinder decomposition, estimates of how much of the achievement differential between urban–rural students can be explained by different aspects including individual characteristics, family characteristics, and school characteristics are reported. Results indicate that mean differences in performance between students in rural and urban Colombian schools are significant. Observable factors, especially school characteristics, are the main drivers of the performance gap. Substantial differences are observed when different test percentiles of the performance distribution are considered. Our results suggest that one way in which education can reduce student performance gaps is by investing in improving school quality in rural areas in Colombia.

**Keywords:** Rural-urban education gap; PISA 2018; Oaxaca-Blinder decomposition; Quantile regression; Education policy; Developing countries.

**JEL codes:** I21, I25, R58.

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## 1. Introduction

The Program for International Student Assessment (PISA) tests have become an important frame of reference for the academic level of students in a country and are very useful for identifying the aspects of educational policy that should be reconsidered, reinforced, or implemented for achieving better educational outcomes. In fact, in the past two decades, international large-scale assessments have been on the rise, with the PISA seen by many as having strategic prominence in international education policy debates. The PISA tests were launched by the Organization for Economic Co-operation and Development (OECD) with the main idea of measuring teenagers' level of preparedness for adult life. Analyzing these results, teachers, researchers, and policy makers can contrast various factors that explain the gap in the country's results with respect to others, or the gaps that exist within the students' educational performance in each country.

In contrast to previous large-scale exams, PISA tests are not curriculum-based but literacy-based, allowing for the comparison of results across countries. Specifically, they measure students' knowledge and skills in three main domains, namely reading, scientific, and mathematical literacy. PISA results have strong impact on many educational systems across the participating economies. In fact, evidence suggests that high-income countries have responded to PISA results by seeking to learn from the best experiences of other countries (Dixon et al., 2013; Heyneman and Lee, 2014). Less evidence is available for low- and middle-income countries that participate in PISA and more research is needed for concluding whether results have offered insights for education policy and practice in these countries, and if such insights have affected education policy. In fact, while there are more than 114 published articles evaluating the PISA results for the United States (and at least 72 for Australia, 69 for Germany, 52 for the United Kingdom, and 31 for Ireland), the studies on less developed economies are relatively scarce (Hopfenbecket al., 2018).

Paradoxically, while middle-income countries, and especially Latin American countries, have received less attention, according to the World Bank "The results from PISA 2018 highlight the learning crisis in Latin America and suggest that promoting better and more equitable learning continues to be the most important challenges to be tackled by the

education systems in the region.”<sup>4</sup> More research is required for these countries in which gender and rural-urban gaps are substantial. The few existing studies for Latin America have covered different issues relating PISA results. However, most of them (e.g., Alvarado et al., 2018; De Jorge-Moreno et al., 2018; Kruger and Formichella, 2019; Pinto et al., 2019; Rivero, 2019) study results of PISA 2012 or PISA 2015 focusing on the mean, ignoring the differences that can emerge along the sample’s distribution (see Lounkaew, 2013). This issue is especially relevant for countries in which test results are highly heterogenous among school characteristics (urban vs. rural, public vs. private, etc.). Explanatory variables that have been identified as important determinants of academic achievement may have distinct effects for different percentiles of the scores’ distribution. Therefore, designing effective policies for reducing educational gaps and for improving education outcomes requires a better understanding of the determinants of test performance along different distribution quantiles. Additionally, while the rural-urban gap remains the single most well-documented development and welfare disparity in the economies of the region, existing studies on PISA results in Latin American countries have not focused on the rural-urban performance gap.

We study the determinants of student performance in the PISA 2018 tests, using individual Colombian test-takers data. Colombia is the most recent OECD member. While the country exhibited a high economic growth rate between 2000 and 2015 and attained important development achievements, the country remains as one of the most unequal ones. While poverty in the country has declined, gaps between rural and urban areas, however, remain substantial. In 2017, the share of rural Colombians living in multidimensional poverty was still more than twice as high as for urban dwellers. This development gap reflects also in rural-urban educational gaps. We contribute to the literature, hence, focusing on this gap. To our knowledge, there are only two previous papers for Colombia with this emphasis (Ramos Lobo et al., 2012 and 2016), and neither uses data from the latest PISA test results nor differentiates results for distinct performance distribution quantiles.

The contributions of this study are three-fold. First, we estimate a student-level education production function at different points along the achievement distribution. This contribution is especially relevant for a country in which educational inequality is particularly

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<sup>4</sup> Di Gropello et al. (2019).

pronounced, such as Colombia. Second, using the Oaxaca–Blinder decomposition, we estimate how much of the achievement differential between urban–rural students can be explained by different aspects including individual characteristics, family characteristics, and school characteristics. Finally, with the introduction of factors such as bullying, teacher support, positive feelings, and resilience in the PISA 2018 student data, we are among the first studies in estimating, using the Oaxaca–Blinder decomposition, how much of the achievement differential is explained by these factors.

Results from the Oaxaca-Blinder decomposition indicate that mean differences in performance between students in rural and urban Colombian schools are significant. These results hold for mathematics, reading, and science. Observable factors are the main drivers of the observed performance gap. School characteristics explain more than 40% of differences in students' performance. Family characteristics are also important, explaining over 20% of the gap in mathematics and science, and 32% in reading. Individual characteristics explain close to 10% of the gap but are statistically significant only in mathematics and science. Importantly, the unexplained component does not contribute to explaining differences in performance between rural and urban students. Thus, bullying, teacher support, and other subjective factors are not among the most relevant determinants of the gap. Results from estimations by gender indicate that the effects of family and school characteristics are higher for girls than for boys, while individual factors are more important for boys than for girls.

Results from quantile regressions indicate that important differences are observed when distinct test percentiles are considered. Mean estimation results show that all individual characteristics (except gender in the case of results on reading) and almost all family characteristics are relevant in explaining differences in scores both for rural and urban students. Parents educational level and family property, however, are not important drivers in observed differences in results. Interestingly, while Oaxaca-Blinder decomposition results indicate that school characteristics are the most relevant in explaining score gaps, OLS results show that the only school characteristic that matters is whether the school is public or privately own. As in most studies for developing countries, students from private schools outperform their peers in public schools.

Regression results show that the effect of individual, family, and school covariates on student performance vary depending on the quantile of the distribution that is considered. For instance, repeating a year and house characteristics, which are relevant determinants of performance in the mean, lose significance at the two tails of the distribution.

Empirical results of this study have relevant implications for the implementation of educational policy in Colombia and other similar developing economies. Section 2 describes the data. The third section is methodological. The fourth section shows the main results of the Oaxaca-Blinder decomposition and of quantile regressions, and finally the last section concludes.

## **2. Data**

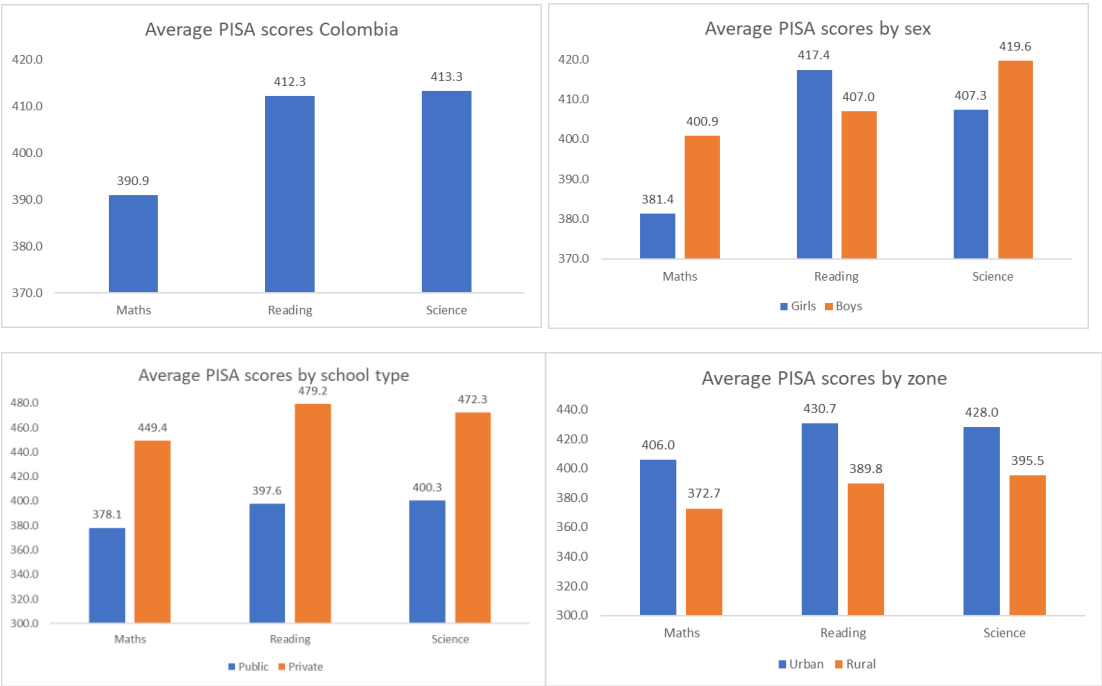
We collect data from the Program for International Student Assessment (PISA) 2018 test, administered to 15-year-old students for measuring their literacy in mathematics, reading, and science. The test, applied for first time in 2000, is conducted every three years. In its latest version students from 79 countries took the test.

The PISA samples students with a two-stage procedure. First, schools are sampled and then students within selected schools are sampled. This sampling technique increases the standard errors within a population. In practice, this means that the estimation of a population parameter requires to use weights associated with the sampling and to compute the uncertainty due to the sampling. Hence, student performance must be estimated using ten plausible values for each student and results must be aggregate. Data is weighted to account for three facts. First, students do not have the same probability of being selected. Second, differential participation rates require nonresponse adjustments. And third, some explicit strata are over-sampled for national reporting purposes.

Data for Colombia consists of 7522 observations for students in 247 participating schools. Figure 1 presents some descriptive statistics. Panel (a) shows average scores for Colombia in mathematics, reading and science. These results are far below average test scores for the 79 participating countries, especially in mathematics (391 in Colombia vs. a test average of 489).

Panel (b) shows average performance by gender. Boys outperform girls both in mathematics and science, while girls do better in reading. However, most notable gaps are observed when scores are stratified by school type. Private schools widely outperform public schools in the three areas. Notably, scores for private Colombian schools are close to the world (79 countries) averages. Importantly, as panel (d) shows, large gaps are observed between students in rural and urban areas. As in other developing countries, students in rural areas in Colombia have less school choice than their urban peers and most go to public schools, as shown by Echazarra and Radinger (2019). In 2017, only 4.2% of rural students attended an independent private school compared with 23.4% of urban students (Sanchez, 2018).

**Figure 1. Summary Statistics for Colombian Student Performance**



### 3. Methodology

The literature has shown that student performance is mostly explained by three basic components, namely individual characteristics, family characteristics, and school

characteristics (see, for instance Hanushek, 1997; Sherman et al., 2008; Woessmann, 2016) We include, additionally, a fourth component related with other subjective factors with the potential to affect student performance, like bullying, teacher support, positive feelings, and resilience. These factors, which have shown to be important determinants of scholar performance (Dietrich and Cohen, 2019) were included in the PISA 2018 student survey allowing their inclusion in PISA evaluation studies.

The following equation is the starting point of our empirical model:

$$P_i = \alpha + \beta' I_i + \gamma' H_i + \delta' S_i + \varepsilon_i \quad (1)$$

where  $P_i$  stands for student  $i$ 's average score of the ten plausible values for each subject area.  $I_i$ ,  $H_i$ ,  $S_i$  are vectors of individual characteristics, family characteristics, and school characteristics, respectively. Finally,  $\alpha$  is the intercept and  $\varepsilon_i$  represent an independently and identically distributed zero-mean error term.

Our emphasis is on the rural-urban gap. Thus, students are grouped according to their school location, i.e., whether it is in a rural or an urban Colombian area. Rural school are in small towns or villages with a population of less than 15,000 people. Urban school are the complement set. Furthermore, in some specifications we stratify also by gender.

### **3.1 Oaxaca-Blinder Decomposition**

We first use the traditional Oaxaca-Blinder decomposition (Blinder 1973; Oaxaca 1973), frequently implemented in studies identifying some sort of labor market discrimination (by race, gender, etc.). This decomposition is a statistical method that explains the difference in means of a dependent variable between two strata into a part that responds to observed differences in the mean values of the model's covariates within the groups and group differences in the effects of the covariates. Emphasis is usually exerted on the second part of the decomposition, namely the unexplained differential in the dependent variable.

In this study, the Oaxaca-Blinder decomposition estimates the difference in student performance by urban and rural groups and explains how much is due to observable factors and how much is due to unobservable or residual aspects.

Equation (1) is estimated separately for students in rural and urban areas. As average values of residuals in these linear regressions are zero, then:

$$\bar{P}_U - \bar{P}_R = [\alpha_U - \alpha_R] + [\beta'_U \bar{I}_U - \beta'_R \bar{I}_R] + [\gamma'_U \bar{H}_U - \gamma'_R \bar{H}_R] + [\delta'_U \bar{S}_U - \delta'_R \bar{S}_R] \quad (2)$$

where the subscript U corresponds to urban students and R corresponds to rural students.

Following Jann (2008), equation (2) can be written in the following way:

$$\begin{aligned} \bar{P}_U - \bar{P}_R = & [\alpha_U - \alpha_R] + \{[\beta'_U(\bar{I}_U - I)] + [\gamma'_U(\bar{H}_U - \bar{H}_R)] + [\delta'_U(\bar{S}_U - \bar{S}_R)]\} + \\ & \{[(\beta'_U - \beta'_R)\bar{I}_R] + [(\gamma'_U - \gamma'_R)\bar{H}_R] + [(\delta'_U - \delta'_R)\bar{S}_R]\} \quad (3) \end{aligned}$$

The component given by  $\{[\beta'_U(\bar{I}_U - \bar{I}_R)] + [\gamma'_U(\bar{H}_U - \bar{H}_R)] + [\delta'_U(\bar{S}_U - \bar{S}_R)]\}$  measures the portion of the difference in student performance that is attributable to group differences in endowments, in other words the explained component. The component given by  $\{[(\beta'_U - \beta'_R)\bar{I}_R] + [(\gamma'_U - \gamma'_R)\bar{H}_R] + [(\delta'_U - \delta'_R)\bar{S}_R]\}$  represents the contribution of differences in the coefficients, more specifically, the unexplained component. Some studies call this component the “discrimination” component. However, the unexplained differential in the dependent variable should not be interpreted as the amount of the difference due only to discrimination, because other covariates not included in the regression, such as unobserved factors, may also account for these differences.

### 3.2 Quantile regression

Under the assumptions of linearity and  $E\{\varepsilon|I, H, S\}$  it is possible to use OLS to estimate the coefficients of Equation (1). However, the literature suggests the presence of potentially relevant nonlinear relationships between the dependent variable and the included independent variables derived, for example, from the presence of heteroskedasticity in the education production function (Sosa Escudero, et al. 2009; Gertel et al. 2012) due to unobservable factors. In this study we therefore perform regressions on the mean, and on the 10th and the 90th percentiles of the sample distribution.

Quantile regressions are useful for evaluating test results considering heterogeneity in the population under analysis and for testing whether the coefficients of the explanatory variables depend on the corresponding quantile. Results from quantile regressions may be very useful

for public policy as they provide the policymaker with important insights on the effect of different covariates on performance for students on the center and the tails of the distribution.

#### **4. Empirical Results**

Oaxaca-Blinder decomposition results are presented in Table 1. Estimation results are consistent in showing that test performance is significantly different for students in rural and urban Colombian areas. On average, students in rural areas obtain a score which is 30.7 points lower in mathematics, 36.9 points lower in reading, and 29.6 points lower in science than their urban school peers. These differences are significant at the 1% significance level. Interestingly, all these differences in test outcomes can be accounted by explained factors, with school and family characteristics being most important.

This result is very relevant as school characteristics, which account for over 40% of the rural-urban gap, can be modified and improved by public policy actions. Rural schools in Colombia have higher student-teacher ratios, poorer physical endowments, and lower teacher quality than schools in urban areas. Educational policy should aim to close student performance gaps by investing in improving school quality in rural areas in Colombia. However, results also indicate that the gap cannot be closed by educational policy alone, as family characteristics explain an important portion of the gap (above 20% in mathematics and science, and 32% in reading). Other social policies must be implemented as well for reducing poverty in rural areas and improving the overall learning environment of school students. Finally, individual characteristics explain near 10% of the gap. Interestingly, bullying, teaching support and other perception variables are insignificant in explaining the gap.

Table 1: Oaxaca-Blinder decomposition results for the rural-urban educational gap in Colombia using PISA 2018 test results (mathematics, reading and science)

	<b>Mathematics</b>	<b>Reading</b>	<b>Sciences</b>
Overall urban	408.4*** (90.88)	432.5*** (84.03)	429.9*** (91.04)
Overall rural	377.6*** (73.42)	395.6*** (74.96)	400.4*** (81.07)
Difference	30.74*** (4.60)	36.92*** (5.11)	29.58*** (4.37)
Explained	25.54*** (5.29)	28.08*** (5.96)	23.97*** (5.54)
Individual	4.024* (2.38)	3.504 (1.87)	3.780* (2.32)
Family	7.761*** (3.92)	9.665*** (5.46)	6.888*** (4.26)
School	13.76*** (3.79)	14.91*** (3.97)	13.30*** (3.53)
Unexplained	5.201 (0.94)	8.839 (1.55)	5.608 (0.94)

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. t statistics in parentheses. In Tables 1 and 2 the variables included in each dimension are: Individual: Grade Repetition, Student Grade, Gender; Family: Highest parental education in years of schooling, Home possessions, Highest parental occupational status, Cultural possessions at home, Home educational resources, Family wealth; School: School Ownership, Student-Teacher ratio, School Size, Number of available computers per student at modal grade, Proportion of available computers that are connected to the Internet, Total number of all teachers at school, Proportion of all teachers fully certified, Class Size.

Source: Authors elaboration based on PISA 2018 microdata.

Similar conclusions are reached when results are stratified by gender (see Table 2). However, the effects of endowments (i.e., the explained part) are larger for girls than for boys. Furthermore, while school and family characteristics are more relevant for girls than for boys,

the opposite is true for individual characteristics. Family characteristics are probably more important for girls than for boys as in Colombia gender discrimination is an issue and many girls must play a discriminatory gender role in their homes. The degree of gender discrimination is highly correlated with family characteristics (Rodriguez-Burbano et al., 2021).

Table 2: Oaxaca-Blinder decomposition results for the rural-urban educational gap in Colombia using PISA 2018 test results and stratified by gender (three areas)

	Mathematics		Reading		Sciences	
	Boys	Girls	Boys	Girls	Boys	Girls
Overall urban	419.3*** (78.34)	397.5*** (82.08)	428.1*** (70.00)	436.8*** (84.01)	437.4*** (75.06)	422.6*** (89.87)
Overall rural	387.0*** (63.49)	369.4*** (70.67)	389.0*** (60.97)	401.3*** (80.53)	406.2*** (66.69)	395.2*** (85.23)
Difference	32.33*** (4.15)	28.16*** (4.05)	39.10*** (4.62)	35.44*** (4.94)	31.21*** (3.85)	27.33*** (4.05)
Explained	23.30*** (4.27)	27.05*** (5.19)	27.05*** (5.01)	30.65*** (5.81)	23.03*** (4.50)	25.09*** (5.29)
Individual	4.482* (2.09)	2.612 (1.51)	5.031* (2.10)	2.765 (1.49)	4.551* (2.15)	2.452 (1.48)
Family	6.513** (3.17)	8.845*** (3.63)	8.077*** (4.51)	10.94*** (4.62)	5.091** (3.06)	8.438*** (4.04)
School	12.31** (2.83)	15.60*** (3.96)	13.94** (3.01)	16.94*** (4.21)	13.39** (2.79)	14.20*** (3.60)
Unexplained	9.023 (1.39)	1.108 (0.18)	12.06 (1.66)	4.795 (0.86)	8.174 (1.08)	2.246 (0.39)

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. t statistics in parentheses

Source: Authors elaboration based on PISA 2018 microdata.

Quantile regression results are shown in Tables 3 (mathematics), 4 (reading), and 5 (science), in the Appendix. Mean estimations indicate that all individual characteristics (except for gender in results for reading) and almost all family characteristics (notable exceptions are parents' educational level and cultural possessions) are relevant in explaining differences in scores both for rural and urban students. Interestingly, while Oaxaca-Blinder decomposition results indicate that school characteristics are the most relevant in explaining score gaps, OLS results show that the only school characteristic that matters is whether the school is public or privately own. As in most studies for developing countries, students from private schools outperform their peers in public schools. This result is particularly relevant in this study, as rural schools are mostly public. Therefore, a combination of policies aimed at improving the quality of public schools and of promoting the development of a stronger private school system in rural areas should be implemented for closing the rural-urban educational gap in the country.

In Mathematics and Science boys outperform girls, and differences are higher for urban schools. In mathematics, boys in urban (rural) schools obtain on average 28.4 (23.4) points more than girls. In science these differences are of 21.5 (16.8) points, respectively. Meanwhile, no significant gender differences in score are observed in reading. Students that have repeated a year have significantly lower results in test score in the three areas.

Regressions for the 10<sup>th</sup> and 90<sup>th</sup> percentile show some relevant differences with respect to mean regressions. For instance, repeating a year, which is a relevant variable for explaining differences in test performance in the mean and for students at the 90<sup>th</sup> percentile, is irrelevant at the lowest tail of the distribution. In other words, poor performing students who have repeated a year obtain similar results to poor performing students who have not repeated a year. However, repeating a year makes the difference for average and top students. A similar conclusion is reached when home educational resources is considered. Household possessions are relevant for urban students in all percentiles of the distribution, being more statistically significant for those at the highest percentile. In rural areas, this variable is only significant in the mean. This may obey to the fact that higher income inequality is observed in urban areas in Colombia. Rural areas are populated almost entirely by poor households. Significant variables tend to be more significant for students in the highest percentile than in the lowest percentile. These, and other examples, illustrate the importance of considering different distribution quantiles for understanding PISA test results

and gaps. An effective public policy aimed at improving student performance and closing relevant gaps must consider the differential effects that several covariates have at distinct segments of the performance distribution.

Gender gaps, however, behave similarly in the three quantiles considered in this study. Specifically, boys outperform girls in mathematics and sciences in all cases, except for rural students in the 10<sup>th</sup> percentile. In contrast, in reading gender is only important for rural students in the 10<sup>th</sup> percentile.

## **5. Conclusions**

This paper studies the rural-urban student performance gap, using individual data from the PISA 2018 tests results for Colombian students. Three contributions are made to the literature. In the first place, we estimate a student-level education production function at different points along the achievement distribution. Performing quantile regressions, we identify the main determinants of observed differences in score performance focusing on the rural-urban gap. Second, we estimate how much of the achievement differential between urban and rural students can be explained by different aspects including individual characteristics, family characteristics, and school characteristics. Third, using survey data on subjective factors such as bullying, teacher support, positive feelings, and resilience included in the PISA 2018 student data, we are among the first studies in estimating, using the Oaxaca–Blinder decomposition, how much of the rural-urban differential is explained by these factors.

Regression results indicate that rural-urban differences in performance are high and significant in mathematics, reading, and science. Importantly, observable factors account for almost all the observed performance gap. Among these factors, school characteristics are the most relevant factors, explaining more than 40% of differences in student performance. Family characteristics also matter, explaining over 20% of the gap in mathematics and science, and 32% in reading. Individual characteristics explain 10% of the gap but are statistically significant only in mathematics and science. The unexplained component does not contribute to explaining differences in performance between rural and urban students. Results by gender indicate that the

effects of family and school characteristics are higher for girls than for boys, while the opposite holds for individual factors.

Results from quantile regressions indicate that important differences are observed when different test percentiles are considered. Mean estimations indicate that all individual characteristics and almost all family characteristics are relevant in explaining differences in scores both for rural and urban students. Interestingly, while Oaxaca-Blinder decomposition results indicate that school characteristics are the most relevant in explaining score gaps, quantile regression results show that the only school characteristic that matters is whether the school is publicly or privately owned. As in most studies for developing countries, students from private schools outperform their peers in public schools.

Results of this study have relevant implications both for research in the field and for public policy implementations. On the one hand, they clearly show that the effect of different covariates on student performance depends importantly on the quantile of the performance distribution. Therefore, studies focusing on the mean of the performance distribution may present misleading results, especially in highly educational unequal countries such as Colombia. On the other hand, rural-urban differences in test outcomes mostly respond to differences in observable factors, with school and family characteristics being most important. This result is very relevant as school characteristics, which account for a high percentage of the gap, can be modified and improved by public policy actions. Rural schools in Colombia have higher student-teacher ratios, poorer physical endowments, and lower teacher quality than schools in urban areas. Educational policy should seek to close the gap by investing in improving school quality and promoting more private schools supply in rural areas in Colombia.

## References

- Abadía, L., Bernal Nisperuza, and Muñoz González. 2018. "Gaps in Students' Performance in Pisa: What Explains Colombia's Difference from Finland and Chile?" [S.I.], v. 26, p. 82, July 2018. ISSN 1068-2341. Available at: <<https://epaa.asu.edu/ojs/article/view/3423>>. Date accessed: 08 Feb. 2021. doi:<https://doi.org/10.14507/epaa.26.3423>.
- Benos, N., and S. Zotou. 2014. "Education and Economic Growth: A Meta-Regression Analysis." *World Development* 64:669–689.
- Betts, Julian R., and Laurel L. McFarland. 1995. "Safe Port in a Storm: The Impact of Labor Market Conditions on Community College Enrollments." *The Journal of Human Resources*.
- Blinder, Alan S. 1973. "Wage Discrimination: Reduced Form and Structural Estimates." *The Journal of Human Resources*.
- Brunello, Giorgio, and Daniele Checchi. 2005. "School Quality and Family Background in Italy." *Economics of Education Review*.
- Correa-Fonnegra, J. B., and C. A. Orejuela-Ríos. 2017. "Incidence of context factors in basic high school mathematical performance in Colombia." *Semestre Económico* 20(44): 159–188. <https://doi.org/10.22395/seec.v20n44a8>.
- De Jorge-Moreno, Justo, Javier Díaz Castro, Diana Victoria Rodríguez Vega, and José Miguel Segura Gutiérrez. 2018. "Analysis of Educational Efficiency and Its Explanatory Factors Considering the Effect of Ownership in Colombia with Pisa 2012 Data." *Desarrollo y Sociedad*.
- Dietrich, Lars & Cohen, Jonathan. (2019). *Understanding Classroom Bullying Climates: the Role of Student Body Composition, Relationships, and Teaching Quality*. *International Journal of Bullying Prevention*. 10.1007/s42380-019-00059-x.
- Di Gropello, V., & Yanez-Pagans, A. 2019. What are the main lessons from the latest results from PISA 2018? *World Bank Blogs*.
- Dixon, R., Arndt, C., Mullers, M., Vakkuri, J., Engblom-Pelkkala, K., & Hood, C. 2013. A lever for improvement or a magnet for blame? Press and political responses to

international educational rankings in four EU countries. *Public Administration* 91, 484-505.

Echazarra, A. and T. Radinger (2019), "Learning in rural schools: Insights from PISA, TALIS and the literature", OECD Education Working Papers, No. 196, OECD Publishing, Paris, <https://doi.org/10.1787/8b1a5cb9-en>.

Fuentes, Noe. (2007). Desigualdades de Crecimiento Municipal en México: Un Análisis Mediante Regresión Cuantílica. *Ensayos Revista de Economía*. XXVI. 19-42.

Gertel, Héctor, Roberto Giuliodori, Florencia Cámara, and Gonzalo Decándido. 2012. "Doble-Descomposición de La Brecha de Puntajes Entre Estudiantes de Argentina, Chile y México En PISA 2009: Aplicando Oaxaca-Blinder En Regresiones Cuantílicas." In XXI Jornadas de La Asociación de Economía de La Educación.

Hanushek E.A. (1997) Assessing the Effects of School Resources on Student Performance: An Update. *Educational Evaluation and Policy Analysis*. 19(2):141-164.  
doi:10.3102/01623737019002141

Hanushek, E. A. 2005. "Por Qué Importa La Calidad de La Educación." *Finanzas y Desarrollo: Publicación Trimestral Del Fondo Monetario Internacional y Del Banco Mundial* 42(2): 15.

Hanushek, E. A., and Ludger Woessmann. 2011a. "How Much Do Educational Outcomes Matter in OECD Countries?" *Economic Policy*.  
<http://hanushek.stanford.edu/publications/how-much-do-educational-outcomes-matter-oecd-countries>

———. 2011b. "The Economics of International Differences in Educational Achievement". In Eric A. Hanushek, Stephen Machin, and Ludger Woessmann, editor: *Handbooks in Economics*, Vol. 3, The Netherlands: North-Holland, 2011, pp. 89-200. ISBN: 978-0-444-53429-3.

Hawkes, D., and M. Ugur. 2012. "Evidence on the relationship between education, skills and economic growth in low-income countries." *EPPI-Centre Systematic Reviews*.

Heyneman, Stephen & Lee, B.. (2012). *Impact of international studies of academic*

achievement on policy and research. *Handbook of International Large Scale Assessment: Background, Technical Issues, and Methods of Data Analysis*. 37-74.

Hopfenbeck, T. (2018). Assessment and learning in an uncertain world. *Assessment in Education: Principles, Policy & Practice*. 25. 351-354. 10.1080/0969594X.2018.1507247.

Hopfenbeck, T.N., Lenkeit, J., El Masri, Y., Cantrell, K., Ryan, J., & Baird, J.A. 2018. Lessons learned from PISA: A systematic review of peer-reviewed articles on the Programme for International Student Assessment. *Scandinavian Journal of Educational Research* 62, 333-353.

Jann, Ben. 2008. "The Blinder-Oaxaca Decomposition for Linear Regression Models." *Stata Journal*.

Krüger, Natalia, and María Marta Formichella. 2019. "¿Las Competencias No Cognitivas Actúan Como Mediadoras En El Proceso de Enseñanza y Aprendizaje? Evidencia Para Argentina." *Cuadernos de Economía*.

Lounkaew, Kiatanantha. 2013. "Explaining Urban-Rural Differences in Educational Achievement in Thailand: Evidence from PISA Literacy Data." *Economics of Education Review*.

Oaxaca, Ronald. 1973. "Male-Female Wage Differentials in Urban Labor Markets." *International Economic Review*.

OECD. 2009. *Analysis PISA Data Analysis Manual: SAS, Second Edition*.

———. 2018. *PISA 2018 Principales Resultados Para Colombia*.  
[https://www.oecd.org/pisa/publications/PISA2018\\_CN\\_COL\\_ESP.pdf](https://www.oecd.org/pisa/publications/PISA2018_CN_COL_ESP.pdf).

Pinto, Joaquim, Teresa B. Neto, and Jaime Carvalho e Silva. 2019. "Fatores Influenciadores Do Desempenho de Estudantes Portugueses, Singaporenses, Holandeses, Espanhóis e Brasileiros Em Literacia Matemática No PISA: Revisão Integrativa." *Revista de Estudios y Experiencias en Educación*.

Ramos Lobo, Raúl, Juan Duque Cardona, and Sandra Nieto. 2016. "Decomposing the Rural-Urban Differential in Student Achievement in Colombia Using PISA Microdata."

Estudios de economía aplicada.

Ramos, Raul, Juan Carlos Duque, and Sandra Nieto. 2012. "Un Análisis de Las Diferencias Rurales y Urbanas En El Rendimiento Educativo de Los Estudiantes Colombianos a Partir de Los Microdatos de PISA\*." International Conference on Regional Science. The Challenge of Regional Development in a World of Changing Hegemonies: knowledge, competitiveness and austerity.

Rivero, Leonel. 2019. "Analizando El Clima Educativo En Uruguay: Un Estudio Exploratorio de La Cohorte PISA 2012." Cuadernos de Investigación Educativa.

Rodríguez-Burbano, Aura Y.; Cepeda, Isabel; Vargas-Martínez, Ana M.; De-Diego-Cordero, Rocío. 2021. "Assessment of Ambivalent Sexism in University Students in Colombia and Spain: A Comparative Analysis" *Int. J. Environ. Res. Public Health* 18, no. 3: 1009.  
<https://doi.org/10.3390/ijerph18031009>

Sherman, J., Rasmussen, C. & Baydala, L. (2008) The impact of teacher factors on achievement and behavioural outcomes of children with Attention Deficit/ Hyperactivity Disorder (ADHD): a review of the literature, *Educational Research*, 50:4, 347-360, DOI: 10.1080/00131880802499803

Sosa Escudero, W., P. I. Giovagnoli, and A. Porto. 2009. "The Effects of Individual Characteristics on the Distribution of College Performance." *Económica LV*: 100–129.

Sánchez, J. (2018), OECD Review of Policies to Improve the Effectiveness of Resource Use in Schools: Country Background Report for Colombia, Ministerio de Educación Nacional [Ministry of National Education], Bogotá, DC,  
<http://www.oecd.org/education/schoolresourcesreview.htm>.

Woessmann, Ludger. (2016). The Importance of School Systems: Evidence from International Differences in Student Achievement. *Journal of Economic Perspectives*. 30. 3-32.  
10.1257/jep.30.3.3.

## Appendix (Detailed results for quantile regressions)

Table 3: Quantile Regression results for Mathematics in Colombia Stratifying by Rural-Urban Students

	OLS		P10		P90	
	Rural	Urbano	Rural	Urbano	Rural	Urbano
Student grade	21.23*** (2.758)	19.42*** (2.974)	20.96*** (4.675)	21.64*** (4.851)	24.80*** (5.459)	17.01*** (5.099)
Gender	27.54*** (4.644)	29.31*** (4.054)	18.29* (8.891)	26.33*** (6.891)	38.88*** (8.151)	32.80*** (7.462)
Grade repetition	-16.92** (5.945)	-21.19*** (4.758)	-19.13 (11.48)	-15.34 (8.725)	-11.54 (12.32)	-26.35* (10.36)
Parental education	-0.679 (0.695)	-0.671 (0.695)	-0.512 (1.418)	-1.511 (1.305)	-0.658 (1.548)	-0.0203 (1.460)
Home possessions	30.87** (10.24)	46.03*** (9.050)	30.21 (20.88)	32.36 (19.40)	29.69 (18.14)	45.05* (19.86)
Cultural possessions	-2.386 (3.980)	-4.742 (3.211)	-3.591 (8.724)	-2.111 (6.850)	1.578 (7.477)	-5.373 (7.068)
Home educational resources	-5.009 (4.014)	-8.576** (3.192)	-3.082 (10.54)	-4.940 (6.433)	-6.442 (7.166)	-7.780 (6.581)
Family wealth	-15.95* (6.719)	-30.53*** (6.347)	-18.88 (12.96)	-22.53 (13.72)	-13.63 (13.27)	-27.93* (14.24)
Highest parental occupational status	0.149 (0.106)	0.345*** (0.0789)	0.209 (0.202)	0.347* (0.153)	0.0878 (0.257)	0.387* (0.185)
School Ownership	-21.49*** (5.285)	-18.14*** (3.826)	-23.40 (13.02)	-18.14*** (4.905)	-17.88 (10.04)	-16.91** (6.057)
Student-Teacher ratio	-0.0652 (0.351)	-0.387 (0.507)	-0.188 (0.701)	-0.448 (0.662)	0.0336 (0.683)	-0.539 (0.876)
School Size	0.0134	-0.00120	0.0131	0.00308	0.0148	-0.00184

	(0.0139)	(0.00929)	(0.0248)	(0.0124)	(0.0269)	(0.0131)
Number of available computers per student at modal grade	-8.372 (5.829)	5.096 (5.004)	-5.619 (8.930)	7.385 (7.454)	-7.429 (11.33)	1.270 (8.831)
Proportion of available computers that are connected to the Internet	3.664 (9.341)	1.762 (10.50)	2.734 (12.25)	5.105 (14.35)	7.647 (14.94)	-1.142 (13.50)
Total number of all teachers at school	0.0808 (0.374)	0.145 (0.254)	0.0470 (0.639)	0.0546 (0.336)	0.0853 (0.641)	0.123 (0.353)
Proportion of all teachers fully certified	0.584 (8.018)	-2.113 (5.349)	2.128 (11.41)	0.393 (7.897)	-0.989 (11.73)	-0.954 (7.687)
Class Size	0.0237 (0.294)	0.599 (0.321)	-0.0592 (0.460)	0.378 (0.400)	-0.221 (0.446)	0.682 (0.455)
Student's experience of being bullied	-8.040** (2.501)	-5.536** (1.844)	-7.370 (4.295)	-5.466 (3.222)	-9.011* (3.876)	-5.800 (3.380)
Teacher support	-6.192* (2.910)	-5.748* (2.347)	-6.846 (5.704)	-5.865 (3.336)	-7.531 (4.845)	-6.607 (4.175)
Resilience	4.621* (2.141)	1.724 (1.641)	3.134 (3.713)	3.697 (3.296)	8.537 (4.851)	0.589 (3.889)
Constant	243.9*** (35.70)	239.3*** (41.75)	174.0** (63.57)	145.8* (65.45)	279.2*** (71.42)	345.1*** (73.18)

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Standard errors in parentheses

Source: Authors elaboration based on PISA 2018 microdata.

Table 4: Quantile Regression results for Reading in Colombia Stratifying by Rural-Urban Students

	OLS		P10		P90	
	Rural	Urbano	Rural	Urbano	Rural	Urbano
Student grade	24.81*** (2.835)	19.44*** (2.731)	24.32*** (4.994)	19.31*** (5.045)	26.70*** (5.872)	16.70** (5.167)
Gender	-2.005 (3.736)	-1.991 (3.997)	-11.36 (8.053)	-10.94 (7.739)	8.843 (9.166)	5.685 (7.152)
Grade repetition	-18.71*** (5.414)	-21.77*** (4.684)	-16.97 (10.37)	-17.08 (9.479)	-15.72 (14.26)	-31.56** (9.657)
Parental education	-0.325 (0.601)	-0.495 (0.601)	-0.807 (1.336)	-1.131 (1.107)	-0.196 (1.373)	-0.448 (1.687)
Home possessions	30.30** (10.15)	58.43*** (9.419)	29.72 (18.52)	43.63* (19.55)	18.87 (18.29)	63.42** (19.75)
Cultural possessions	-3.656 (3.892)	-5.849 (3.128)	-7.930 (7.838)	-6.405 (6.530)	6.077 (8.861)	-6.340 (6.457)
Home educational resources	-8.472* (3.796)	-16.79*** (3.260)	-10.03 (7.981)	-12.66 (6.642)	-4.095 (8.468)	-19.78** (6.574)
Family wealth	-12.45 (6.589)	-38.29*** (6.186)	-14.00 (12.04)	-29.40* (13.70)	-3.787 (12.89)	-39.49** (13.58)
Highest parental occupational status	0.259** (0.100)	0.407*** (0.0848)	0.304 (0.192)	0.382* (0.192)	0.287 (0.270)	0.462* (0.209)
School Ownership	-23.90*** (5.167)	-22.67*** (4.112)	-28.86** (11.04)	-25.01*** (5.678)	-17.90 (11.37)	-18.30** (6.040)
Student-Teacher ratio	-0.115 (0.458)	-0.215 (0.520)	-0.320 (0.800)	-0.0204 (0.820)	-0.0615 (0.683)	-0.400 (0.895)
School Size	0.0187 (0.0172)	-0.00160 (0.0103)	0.0175 (0.0226)	0.00110 (0.0134)	0.0225 (0.0243)	-0.00715 (0.0148)

Number of available computers per student	-12.07 (6.266)	8.296 (5.288)	-11.17 (7.192)	11.51 (6.440)	-15.26 (11.82)	8.100 (8.685)
Proportion of available computers that are connected to the Internet	0.804 (8.628)	-1.249 (12.51)	-6.342 (12.90)	1.237 (18.98)	1.084 (15.69)	-10.55 (16.05)
Total number of all teachers at school	-0.0652 (0.429)	0.191 (0.287)	-0.107 (0.597)	0.119 (0.370)	-0.121 (0.602)	0.363 (0.424)
Proportion of all teachers fully certified	-0.00964 (8.020)	-2.965 (6.537)	3.993 (12.41)	-0.284 (9.056)	-4.403 (11.61)	-2.373 (8.098)
Class Size	-0.324 (0.282)	0.499 (0.355)	-0.133 (0.477)	0.414 (0.458)	-0.932 (0.501)	0.385 (0.459)
Student's experience of being bullied	-9.983*** (2.019)	-7.782*** (1.628)	-7.935* (3.342)	-8.213* (3.276)	-10.33* (4.776)	-7.149 (3.847)
Teacher support	1.711 (2.670)	-3.124 (2.055)	1.117 (5.083)	-0.519 (4.190)	2.026 (5.742)	-4.175 (4.014)
Resilience	6.112** (2.143)	2.236 (1.280)	7.267 (4.644)	2.724 (3.566)	5.296 (4.597)	-1.226 (3.086)
Constant	262.3*** (37.82)	283.6*** (40.90)	199.2** (63.86)	200.7** (65.91)	334.2*** (73.30)	407.0*** (71.00)

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Standard errors in parentheses

Source: Authors elaboration based on PISA 2018 microdata.

Table 5: Quantile Regression results for Science in Colombia Stratifying by Rural-Urban Students

	OLS		P10		P90	
	Rural	Urbano	Rural	Urbano	Rural	Urbano
Student grade	22.20*** (2.740)	18.17*** (2.939)	19.48*** (4.648)	18.06** (5.845)	23.16*** (5.811)	14.31* (6.327)
Gender	21.30*** (4.023)	21.80*** (3.855)	13.12 (8.059)	17.84** (6.752)	30.36** (9.328)	25.40** (7.964)
Grade repetition	-13.96* (5.888)	-18.05*** (5.016)	-15.27 (11.43)	-12.46 (9.352)	-12.06 (11.47)	-28.11** (10.43)
Parental education	-0.961 (0.710)	-0.877 (0.656)	-1.539 (1.232)	-1.019 (1.245)	-0.890 (1.553)	-0.679 (1.304)
Home possessions	25.24* (10.33)	56.43*** (9.224)	18.75 (16.35)	40.44 (22.63)	26.76 (25.77)	65.46** (20.02)
Cultural possessions	0.484 (3.632)	-3.727 (3.312)	1.574 (8.257)	-1.998 (7.059)	3.435 (8.912)	-5.552 (6.835)
Home educational resources	-6.865 (3.802)	-16.28*** (3.246)	-4.392 (7.952)	-11.92 (7.483)	-8.718 (9.910)	-20.67** (7.140)
Family wealth	-11.80 (7.078)	-39.46*** (5.945)	-9.371 (11.28)	-28.49 (15.62)	-8.906 (18.05)	-44.26** (14.55)
Highest parental occupational status	0.208 (0.110)	0.384*** (0.0922)	0.211 (0.238)	0.300* (0.153)	0.168 (0.278)	0.438* (0.206)
School Ownership	-22.42*** (5.852)	-21.74*** (4.084)	-21.64* (10.87)	-25.24*** (5.894)	-19.46 (13.34)	-15.89** (5.450)
Student-Teacher ratio	-0.142 (0.419)	-0.327 (0.463)	-0.116 (0.958)	-0.223 (0.745)	-0.188 (0.754)	-0.222 (0.919)
School Size	0.0203 (0.0168)	- (0.00947)	0.0100 (0.0268)	0.000300 (0.0140)	0.0237 (0.0281)	-0.00439 (0.0144)

Number of available computers per student at modal grade	-7.143 (6.137)	7.234 (5.085)	-3.822 (8.394)	7.505 (5.652)	-8.526 (12.87)	9.345 (8.765)
Proportion of available computers that are connected to the Internet	-0.674 (8.165)	-5.195 (12.30)	-4.680 (12.51)	-1.985 (17.29)	-4.442 (14.55)	-10.25 (15.69)
Total number of all teachers at school	-0.125 (0.403)	0.129 (0.261)	-0.0101 (0.662)	0.144 (0.366)	-0.120 (0.659)	0.210 (0.396)
Proportion of all teachers fully certified	-1.349 (8.213)	-3.380 (6.550)	1.996 (12.20)	-3.302 (9.122)	-3.285 (14.29)	-3.664 (8.173)
Class Size	-0.231 (0.281)	0.535 (0.342)	-0.0943 (0.506)	0.356 (0.392)	-0.388 (0.632)	0.463 (0.501)
Student's experience of being bullied	-6.879** (2.292)	-5.569** (1.863)	-6.386 (3.737)	-6.430 (3.437)	-6.880 (4.339)	-5.518 (3.619)
Teacher support	0.668 (3.108)	-4.995* (2.189)	-0.484 (4.556)	-2.166 (3.748)	0.805 (6.385)	-6.537 (4.159)
Resilience	4.785* (2.179)	1.792 (1.782)	5.838 (3.985)	4.273 (3.228)	6.432 (5.004)	-1.167 (3.266)
Constant	275.0*** (39.48)	288.8*** (42.99)	223.4** (71.35)	214.2** (76.94)	351.7*** (78.08)	405.2*** (79.40)

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Standard errors in parentheses

Source: Authors elaboration based on PISA 2018 microdata.