Decomposing the rural-urban differential in student achievement in Colombia using PISA microdata*

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Abstract: Despite the large number of studies that draw on Programme for International Student Assessment (PISA) microdata in their analyses of the determinants of educational outcomes, no more than a few consider the relevance of geographical location. In going some way to rectify this, our paper examines the differences in educational outcomes between students attending schools in rural areas and those enrolled in urban schools. We use microdata from the 2006 and 2009 PISA survey waves for Colombia. The Colombian case is particularly interesting in this regard due to the structural changes suffered by the country in recent years, both in terms of its political stability and of the educational reform measures introduced. Our descriptive analysis of the data shows that the educational outcomes of rural students are worse than those of urban students. In order to identify the factors underpinning this differential, we use the Oaxaca-Blinder decomposition and then exploit the time variation in the data using the methodology proposed by Juhn-Murphy-Pierce. Our results show that most of the differential is attributable to family characteristics as opposed to those of the school. From a policy perspective, our evidence supports actions addressed at improving conditions in the family rather than measures of positive discrimination of rural schools.

Keywords: educational outcomes, rural-urban differences, decomposition methods.

JEL codes: J24, I25, R58

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1 Introduction

One of the branches of the economics of education that has aroused greatest interest among researchers in recent decades has been the analysis of the factors influencing students' educational outcomes. The greater availability of statistical information has facilitated the analysis of this question in a greater number of countries and, more particularly, for a wider number of developing countries (see, for instance, Montt 2011 or Gamboa and Waltenberg 2012). A key concern in this regard is the analysis of possible differences in student performance at schools in rural and urban areas and the factors that account for this differential.

In the various studies conducted to date numerous factors have been identified as determinants of students' educational outcomes and, according to their nature, they can be categorised into three groups. The first group is made up of individual characteristic, among which, variables related to the student's nationality and main language stand out. It has been reported that the educational outcomes of immigrants are worse than those of native students (Meunier 2011, Chiswick & DebBurman 2004) and it is argued that this effect is related to the different home environments of each of the groups under analysis (Ammermueller, 2007a and Entorf & Lauk, 2008). In the case of languages, there is evidence that immigrants improve their academic outcomes when they speak the official language of the country in their home domain (Entorf & Minoiu, 2005).

The second group of variables refers to the family background. Coleman et al. (1966) was one of the earliest studies to show the impact of family variables on students' educational attainment. A number of studies, including Haveman & Wolfe (1995) and Feinstein & Symons (1999), claim that variables of this type have the greatest impact on educational performance. It is found that students whose parents have a high educational level obtain better outcomes than students whose parents have a lower level of education (Häkkinen et al. 2003, Woßmann 2003). In addition, the families' socio-economic level is also related to a student's academic performance – the outcomes improving the higher the parents' social and economic level. The genetic transmission of cognitive skills is one of the most frequently presented arguments for explaining the better performance of those students whose parents have a high level of education. Moreover, the presence of a good cultural environment and a stable family environment also contribute to enhance students' academic outcomes. In fact, there is usually a positive correlation between the parents' level of education and the family's socio-economic and cultural levels.

Finally, the third group of variables is related with different characteristics of the school attended by the students including, for example, its urban or rural location, the type of school – public or private, the teacher-student ratio, school size and peer effects.

The studies typically coincide in identifying the influence of individual characteristics and of family background on educational outcomes. However, this consensus is not so broad in studies that analyse the influence of variables relating to the schools attended by the students. Studies undertaken by Heyneman & Loxley (1983), Harbison & Hanushek (1992), Fuller & Clarke (1994), Gamoran & Long (2006), Banerjee et al. (2007) and Behrman (2010) found that the characteristics of the school have an important impact on academic performance in developing countries. Studies such as Coleman & Hoffer (1987), Hanushek (1986), Stevans & Sessions (2000), Vandernberghe & Robin (2004) and Opdenakker & Van Damme (2006) among others, find that students attain better outcomes in private than in public schools. Yet, other studies including, for example, Noell (1982), Sander (1996), Fertig (2003), Somers et al. (2004) and Smith & Naylor (2005), report no effect of school type on student outcomes. Likewise, the effect of school size on student outcomes is unclear. While Barnett et al. (2002) and Howely (2003) find a positive relation between school size and educational attainment, Hanushek & Luque (2003) do not observe any significant impact of this variable in the majority of countries analysed. Results regarding the impact of the number of students per teacher are similarly inconclusive. Arum (2000) and Krueger (2003) show that students perform better in small classes, while Hanushek (2003) and Rivkin et al. (2005) fail to find a statistically significant effect of this variable on students' educational outcomes. By contrast, most studies, including Coleman et al. (1966), Henderson et al. (1978), Caldas & Bankston (1997), Lee et al. (1997), Feinstein & Symons (1999) and Hanushek et al. (2003) to mention just a few, agree on the importance of the characteristics of a student's peers on his or her educational outcomes.

Few studies have examined the impact of a school's rural or urban location on students' educational outcomes. The first were conducted in the United States in the mid-80s and to date there would appear to be no consensus on the significance of this characteristic. Thus, Edington & Martellaro (1984) and Ward & Murray (1985) find no significant differences in the outcomes of students at urban and rural schools in the state of New Mexico; similar findings are reported by Monk & Haller (1986) for the state of New York. Williams (2005) finds that, after controlling for the International Socio-Economic Index of Occupational Status (SES), the urban/rural location variable remains a statistically significant predictor of mathematics scores in only four of a sample of 24 countries. By contrast, Kleinfeld et al. (1985), in Alaska; Young (1998), in Western Australia; and Blackwell & McLaughlin (1999) and Roscigno and Crowley (2001), for the whole of the United States, do find the rural-urban location variable to be significant in explaining performance. The debate on the impact of this variable centres on the possibility that the differences in the performance of students in rural and urban schools are not due to the location *per se*, but rather to the fact that the characteristics of the students, their families and the schools differ in these two groups. Students in rural zones typically belong to families with few financial resources, their parents have low levels of education and the schools they attend are usually poorly endowed in terms of facilities and they are, generally, smaller than urban schools. Studies such as Hannaway & Talbert (1993) and Tayyaba (2012) claim that, rather than the location variable itself, it is these differences in the characteristics of urban and rural areas that account for most of the differences in the performance of students at rural and urban schools. The question is, therefore, in which cases (regions or countries), the location variable continues to be significant when it is studied in conjunction with other situational variables.

Over the last decade, attention has turned to various countries of South America, due to the greater availability of data and the importance of the rural sector in this region. Table 1 summarises the studies conducted. With the exception of the results obtained by Woßmann (2010), who reported no significant differences in the outcomes of students attending rural and urban schools in Argentina, and Santos (2007), who, in the same country, found no differences in the respective outcomes on reading tests; the other studies confirm the significance of the location variable.

TABLE 1

To the best of our knowledge, only one study has been undertaken for the Colombian case examining the rural-urban differential in student attainment (Woßmann, 2010) – a study that was based on the test results of the *Progress in International Reading Literacy Study* of 2001. In this study, it was found that students living in settlements with more than three thousand inhabitants obtain outcomes that are 26 points higher than those obtained by students in rural zones[1].

The 2009 PISA report, compiled by the OECD, analyses in part the importance of a school's location in accounting for differences in the results obtained on the reading test after controlling for the socioeconomic characteristics of the students' families (see Table II. 2.4 of OECD, 2010). The results show that while for the OECD as a whole the mean difference in the scores obtained by students in the least and most populated zones differed by around 4%, in Colombia this difference was over 8% (although it is true that in other countries, such as Panama, Peru and Argentina, the differentials were even more marked).

[1] Other studies of educational attainment undertaken in Colombia indicate that the main factors accounting for academic performance are socioeconomic level and the school's resources (Piñeros & Rodríguez, 1998; Gaviria & Barrientos, 2001a and Rangel & Lleras, 2010). The level of education of the parents also has a significant impact on the students' performance (Gaviria & Barrientos 2001b). As their main source of information these studies use results from ICFES tests taken by all students in the final year of secondary schooling.

However, an important aspect to take into account in the case of Colombia is that the study of differences in students' outcomes as a function of the rural-urban location of the school that they attend takes on special relevance if we consider the enormous gap between these two environments resulting from the armed conflict that for more than forty years has affected rural communities above all. Forced migration of the population; the recruitment of minors by guerrilla groups[2]; confrontations between the army, guerrilla and paramilitary groups; attacks on school premises and the use of the schools as centres for military operations and recruitment; numerous murders of teachers[3]; among others, have constituted an obstacle to the normal development of schooling in the rural zones of Colombia.

According to Inter-American Commission on Human Rights (2006) and the UN Educational, Scientific and Cultural Organisation (2011) countries experiencing internal armed conflicts have poor performance in terms of education because of two main reasons: (1) the need to allocate significant resources into military spending, which reduces the available budget for education, and (2) the normal development of educational skills in youth is hampered because family income and cohesion is deeply affected by the conflict. This last reason is particularly evident in Colombian rural areas, where the actors in an armed, and dehumanized, conflict have used family disintegration as a strategy to gain control over the territory. According to Ibáñez & Vélez (2008), 29.1% of the Colombian rural population has been victim of forced migration.

Although both schools and families have been affected during the armed conflict, the Colombian government has decided to implement strategies on the supply-side (i.e., investing in schools) rather than on the demand-side (subsidies to families). One of the most successful initiatives within this strategy was the "Rural Education Project" (PER) implemented in 2002 by the National Government and the World Bank. This program included pedagogical models and teaching material designed for the specific needs of students in rural areas, as well as specialized training for teachers. Rodriguez et al. (2009) measured the impact of the PER program and they found it to be a very successful project: it increased the passing rates, lowered the dropout rates and increased the quality of education.

Although the supply-side intervention proved to be effective, there still exists a gap between urban-rural students' outcomes. Is this gap the reflection of the need for an intervention on the demand side? Or, even if we discount the effects attributable to differences in student and family profiles and the

[2] According to War Child (2007), one in every four members of the illegal armed groups is under the age of fifteen; many of whom have been recruited in villages and rural schools.

[3] Colombia, together with Iraq, Nepal and Thailand, appears among the countries with the highest numbers of killings of teachers (O'Malley, 2010).

characteristics of the schools, may the location variable well be a determinant of differences in student performance?

In order to analyse the possible existence of differences in educational outcomes for students attending schools in the rural and urban areas of Colombia, we draw on data from the 2006 and 2009 PISA survey waves to examine the results obtained in the subject areas of mathematics, science and reading. To do so, we apply methods of decomposition of the rural-urban differential by estimating an educational production function that includes explanatory variables related to the characteristics of the students, their families and the schools they attend. The application of the decomposition proposed by Oaxaca (1973) and Blinder (1973), which has been widely used in the framework of labour economics, for example, to try to explain the causes of wage differentials between men and women, should enable us to identify which variables contribute most to explain the differences in educational outcomes between rural and urban areas. Additionally, the extension of this methodology as proposed by Juhn, Murphy and Pierce (1993) allows us to determine the factors that explain the changes in the differential between rural and urban areas over time, thereby providing the ideal framework for exploiting the time dimension in the data[4]. The results obtained show that most of the rural-urban differential is related to the characteristics of the family and not so much to the characteristics of the school. From an educational policy perspective, this evidence supports the suitability of measures aimed at improving the conditions of the family rather than positive discrimination of rural schools as a means to improve educational performance.

The rest of the paper is organized as follows. Section 2 presents the database and defines the variables of interest for the study. Then, section 3 describes the methodological approach used and the results obtained. Finally, we summarize the main findings and propose some methods for improving this study.

2 Educational performance and the characteristics of students, their family background and school environment.

The data source drawn on in this study is the Programme for International Student Assessment (PISA), coordinated by the OECD, which aims to assess students on reaching the end of compulsory

[4] These techniques have been rarely used in this context. Some exceptions include Barrera-Osorio et al. (2011), Burger (2011), Zhang & Lee (2011) and Ammermueller (2007b). Of these three studies, the only one to examine the rural-urban differential is Burger (2011) who uses data on educational performance in Zambia obtained from a survey that is distinct to that of PISA. Her results suggest that both the characteristics of students as well as the outcomes obtained are important in explaining the rural-urban differential.

education, at the age of 15, in the subject areas of mathematics, science and reading, providing, in addition, information about the students themselves, their family background and the school as a learning environment. It is a triennial survey that currently provides data for four waves: 2000, 2003, 2006 and 2009. The set of countries analyzed in each of the years has grown over time to include 65 countries in 2009. Colombia is one of the countries included in the latest waves. Specifically, data are available for 2006 and 2009, which are the sources we use here.

As mentioned above, the main objective of PISA is to assess student attainment on reaching the end of compulsory education in the subject areas of mathematics, science and reading. To this end, the survey provides five plausible values for each subject area. Plausible values are not the students' actual test scores and should not, therefore, be treated as such; rather, they are random numbers drawn from the distribution of scores that could be reasonably assigned to each individual. This methodology was developed by Mislevy and Sheehan (1987, 1989) and is based on Rubin's theory for imputing missing or lost values (1987). The idea is that each individual responds to a limited number of test questions, and, for this reason, it is necessary to estimate their behaviour as if they had answered all the questions on the test. To do this, their results are predicted using the responses to the questions they have actually answered and other variables obtained from the context questionnaire. Instead of predicting a single score, a distribution of values is generated for each individual with their associated probabilities and five plausible values are obtained randomly for each individual. In this way, the bias introduced when estimating the outcomes from a small number of test questions is avoided. Plausible values contain random error variance components and are not optimal as individual test scores. Thus, while unsuitable for the diagnosis of subjects they are well suited to the consistent estimation of population parameters. In this analysis, we use these values to conduct our proposed empirical analysis; however, in the descriptive statistics shown below the mean values are used. We have also used, in all cases, the raising factors provided by the survey itself both for 2006 and for 2009.

As regards the other variables of interest, the individual characteristics provided in the survey and considered in our analysis are gender, age and nationality (native and first and second generation immigrants). We have been unable to control for the type of family structure (nuclear, single parent and mixed race), as this information was not included in the 2006 questionnaire. As for the variables related to the family, as in other studies, we include the educational level of the parents (Meunier 2011, Martins & Veiga, 2010, among others) and the students' cultural background, which is based on the number of books found in the home. Finally, we also included variables related to the school including its location in urban or rural areas (the key variable in this study), school size, the number of students per teacher and whether the school is public or private. We also try to control for peer effects on student achievement through the mean socioeconomic level of classmates at each of the schools analyzed. Specifically, we use the mean economic, social and cultural status (ESCS) index of students enrolled at the same school as that of the student being evaluated. The ESCS index captures student status and is constructed on the basis of three variables relating to their family background: the highest level of education attained by their parents according to the International Standard Classification of Education (ISCED) coding, the highest International Socio-Economic Index (ISEI) occupational status of parents and an index of cultural possessions in the home. Subsequently, the values are standardized so that the index has a mean equivalent to 0 and a standard deviation equal to 1 for OECD countries.

Table 2 shows the main descriptive statistics for the variables described above. The first four columns in this table contain information relating to all the samples analysed for 2006 and 2009, while the other columns provide disaggregated data for urban and rural areas for each of the two years analysed. Figures 1 and 2 also show the differences between rural and urban areas for the variables of interest (educational outcomes in mathematics, science and reading) throughout the entire distribution for 2006 and 2009, respectively.

TABLE 2

FIGURES 1 and 2

From these results, it can be clearly seen that the educational achievement of students in rural areas is worse than that of students in urban areas. This marked differential is approximately 30 points in both periods, although when we compare the evolution in outcomes between 2006 and 2009 we find a clear improvement in both locations. There is also greater variability in the scores on the reading test than on those on the science and mathematics tests. Indeed, the differential on the reading test is the highest of the three in both 2006 and 2009 and, moreover, the score increases notably from 2006 to 2009, a trend that is not noted for either science (where the differential remains almost constant) or mathematics (where the differential is considerably reduced). These results are also confirmed by analysing Figures 1 and 2.

If we focus on the rest of the variables included in Table 2, it can be seen that the percentage of females is slightly higher than that of males with the exception of the rural areas in 2009. It can also be seen that the level of education of parents is much higher in urban areas than it is in rural areas, with no major changes being recorded in this variable between 2006 and 2009. Finally, as regards the location of the schools and their characteristics, about 70% of schools are located in urban areas and most of them are public, while the percentage of public schools is significantly higher in rural areas (above 90%) than in urban areas (where it does not climb above 80%). It can also be noted that urban schools have, on average, a greater number of students (although this number has fallen sharply between 2006 and 2009) and also a higher ratio of students per teacher than in rural schools, although in the period studied there was a marked increase in this variable in the latter area. As for the mean socioeconomic level of peers in each of the schools studied, it can be seen that as the average values for the whole countrywide sample present negative values for both 2006 and 2009, the socioeconomic situation of families in Colombia is well below the OECD average. However, the value of this index in rural areas is notably below that recorded for urban areas, being almost twice that of both the 2006 and 2009 waves.

In the next section, we apply statistical and econometric techniques to analyse the influence of these variables on the differences in educational performance recorded between students in rural schools and those in urban schools.

3 Methodology and results

Thus, the first step in determining whether the differences observed in the educational outcomes of students attending schools in rural and urban areas of Colombia are related to individual factors or to characteristics of the family or school environment, we specify and estimate an educational production function which includes various controls at the individual, family and school levels. Specifically, the educational production function for each of the subject areas used in this study is based on the following expression:

$$RTest_i = \alpha + \beta \cdot Z_i + e_i \qquad (1)$$

where $RTest_i$ refers to the five plausible values of the test results in each subject area for student i, Z_i is a vector of control variables related to the characteristics of the individuals, their family backgrounds and school environment, while e_i is a random error term.

Given the nature of the endogenous variable (described in detail above), in order to estimate this model we need a method that will allow us to make multiple estimations of the dependent variable[5], which refers to the five plausible values of the educational outcomes in each subject area. Additionally, and due to the complex sample design used in PISA, a replication procedure has to be

[5] To do so we employed the Stata module for performing estimations with plausible values. http://ideas.repec.org/c/boc/bocode/s456951.html

applied to calculate the variance of the estimators. For data of this type, the OECD (2009) recommends the Fay-modified balanced repeated replication (BRR) method (Fay, 1989), which improves the accuracy of the variance estimator without modifying the coefficients. This was the procedure adopted in this study.

Table 3 shows the results of estimating this model (1) for the main variables of interest using 2009 PISA microdata and for the three subject areas tested (mathematics, science and reading). The results for 2006 are not included here for reasons of space, but they were similar to those presented in Table 3 and are available on request from the authors. Our results are quite similar to those obtained in other studies using PISA microdata. Specifically, and as expected, a student's gender has a statistically significant effect on his or her academic outcomes, although the sign differs depending on the subject area under analysis. Girls record poorer academic outcomes than boys in mathematics, but present better results in reading. The age of the students, around 15 years and 9 months with small variations either way of 3 months, has a positive impact as it increases in all three subject areas. In the case of the set of variables related to a student's family background, we see that the dummy variables referring to the number of books in the family home, included as an indicator of the cultural environment, have a positive effect on the student's educational performance, which improves as the number of books in the home increases. Likewise, the mother's educational level has a positive effect on the academic performance of her children, being most relevant in the case of students with the worst educational outcomes. However, the same does not hold for the father's educational level, since this variable is not statistically significant. As for the variables related to the characteristics of the school, it can be seen that none of the usual characteristics (public/private, size and student-teacher ratio) is statistically significant. In fact, the only relevant variable is the mean socioeconomic level of the peer group, which has a positive and statistically significant effect at the usual levels of confidence. The influence of friends on academic success is a well known result in the literature (Flashman, 2012)

TABLE 3

Returning again to the main focus of this study, the existence of differences between rural and urban areas, the rest of this section involves a decomposition of the differences in educational outcomes between students attending schools in rural areas and those enrolled in schools in urban areas by applying the Oaxaca-Blinder methodology followed by the Juhn-Murphy-Pierce method.

As discussed in the introduction, the wage decomposition methodology of Oaxaca-Blinder has been widely used to analyze employment discrimination on grounds of gender, race or other worker characteristics. As is well known, the technique allows us to decompose the difference between two groups in the mean level for a given variable into a part that is explained by group differences in the observed characteristic and a part caused by differences in the outcomes associated with these characteristics. The Juhn-Murphy-Pierce extension of this methodology represents an important advance in these decomposition techniques, to the extent that it enables us to decompose the changes in the differences over time between the two groups studied.

Based on the educational production function estimated jointly for students in rural and urban areas as the reference structure in the decomposition, the difference in the educational performance of both groups can be expressed as:

$$\overline{RTest}_R - \overline{RTest}_U = (\bar{Z}_R - \bar{Z}_U) \cdot \beta_R + \bar{Z}_U \cdot (\beta_R - \beta_U) + (\bar{\varepsilon}_R - \bar{\varepsilon}_U) \qquad (2)$$

where the subindices *R* and *U* correspond to rural and urban areas respectively. Equation (2) enables us to quantify the extent to which the cause of the differences between students in rural and urban areas is related to differences observed in individual factors or in characteristics of the family or the school environment, or to the influence of unobserved factors. More specifically, the first term on the right-hand side of the equation corresponds to that part of the differential in educational performance attributable to the group differences in the observed characteristics, coinciding with the "explained" component of the Oaxaca-Blinder decomposition, while the second and third terms correspond to the difference in coefficients and differences in unobservable skills and capture, basically, the discriminatory or "unexplained" component of this decomposition.

The results obtained when applying the Oaxaca-Blinder decomposition[6] for the 2009 PISA wave, using as our reference structure the estimation of the educational production function for the whole of the sample, are presented in Table 4[7]. The results for 2006 are not presented here owing to reasons of space but they are similar to those reported in Table 4 and are available on request from the authors. As can be seen from this table, and in line with the descriptive statistics presented in the previous section, in 2009 the mean educational attainment in mathematics, science and reading was poorer for students in rural areas than it was for those in urban zones. Much of this difference is attributed to the poorer characteristics of students in rural areas, although not so much to their individual characteristics but rather to those of their family. However, the most relevant characteristics are those related to the school because they contribute most when accounting for the rural-urban differential, although

[6] To do so we employed the Stata module to compute the Blinder-Oaxaca decomposition, http://ideas.repec.org/c/boc/bocode/s456936.html

[7] Various tests of robustness were conducted on different regressions but the results remained largely unchanged. The advantage of working with the whole sample rather than with the information as it relates separately to students in urban and rural areas is that our results are directly comparable with those obtained when conducting the Juhn-Murphy-Pierce decomposition.

traditional variables such as public/private school, school size and the student-teacher ratio play a relatively minor role compared to that of the mean socioeconomic level of students in the school[8]. In all three subject areas, this variable accounts for over 90% of the “explained” part of the differential. We should also stress that the “unexplained” part helps to reduce the rural-urban differential, i.e., there a different return to the characteristics of rural and urban schools that contributes to reduce the role that accentuates the differential in the observed characteristics

TABLE 4

The Juhn-Murphy-Pierce decomposition assumes that the contribution of the individual characteristics is the same for both groups. Thus, the starting point for this decomposition is the following:

$$\overline{RTest}_R \quad \overline{RTest}_U = (\bar{Z}_R \quad \bar{Z}_U)\cdot \beta_R \quad \bar{e}_U = (\bar{Z}_R \quad \bar{Z}_U)\cdot \beta_R \quad \bar{\theta}_U \cdot \sigma_R \qquad (3)$$

where σ_R is the standard deviation of the residues (e_R) and $\theta_U = e_U/\sigma_R$. The interpretation of both terms is similar to that described above in the Oaxaca-Blinder decomposition. If on the basis of this equation we compare the changes in the educational performance differential between two different points in time (for example, t and t’), we obtain the following expression:

$$D_{t'} - D_t = (\Delta Z_{t'} - \Delta Z_t)\cdot \beta_{Rt} + \Delta Z_{t'}(\beta_{Rt'} - \beta_{Rt}) + \\ + (\Delta\theta_{t'} - \Delta\theta_t)\cdot \sigma_{Rt} + \Delta\theta_{t'}(\sigma_{Rt'} - \sigma_{Rt}) \qquad (4)$$

where $D_{t'}$ represents the differential in the mean educational performance of students in rural and urban areas at time t’, D_t represents the same differential but at time t and the symbol Δ denotes the variation between rural and urban areas for each of the associated variables or parameters. The rest of the elements follow exactly the same notation as in (3). The first term in (4) corresponds to the change observed in the characteristics (quantity effect); the second term is related to changes in the coefficients and, therefore, with variations in prices (price effect); the third is related to the interaction between the two; while, the last term captures the unexplained variation.

Table 5 shows the results of applying this methodology[9] in order to explain the variations in the educational performance differential between rural and urban areas in 2006 and 2009 in each of the

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[8] The relevance of parental involvement in educational outcomes has been widely acknowledged in the literature. See, for instance, Benett et al. (2012).

[9] To do so we employed the Stata module JMPIERCE2 to compute trend decomposition of outcome differentials, http://ideas.repec.org/c/boc/bocode/s448804.html

subject areas (mathematics, science and reading). As can be seen from this table, between 2006 and 2009 the differential has been reduced in mathematics, it has remained virtually constant in science and it has increased in reading. In all cases the variation in the "explained" part has served to increase the differential, both as regards changes in the characteristics as in changes in prices, albeit that this second component has had a greater impact during the period analysed. However, both effects have been partially or completely compensated for (as is the case of mathematics) by changes in the "unexplained" part. Thus, these results corroborate those obtained with the Oaxaca-Blinder decomposition in that they reinforce the idea that changes in the characteristics are not responsible for the positive development of the schools in rural areas, but rather that the development is probably due to another type of change associated with unobservable variables, such as the improvement in the country's institutional framework, the cessation or reduction in the intensity of armed conflict and other unobservable aspects, which, as such, are not included in the model.

TABLE 5

In short, our results highlight the limited impact of policies of positive discrimination for schools in rural areas (at least via the characteristics included in this study: public/private ownership, size and teacher/student ratio) but, on the other hand, they provide evidence of the favourable impact of the socio-economic conditions on rural schools as well as other unobservable factors that might have contributed to an improvement in Colombia's education system.

4 Conclusions

This paper has analysed the possible existence of differences in the educational performance of students in rural and urban areas of Colombia in the subject areas of mathematics, science and reading. To do so, we have used data from the 2006 and 2009 PISA survey waves and we have specified and estimated an education production function that includes variables related to the location of the school and to the typical controls at the individual and family levels. Additionally, and so as to identify the factors that account for any differences, we have used Oaxaca-Blinder decomposition and the Juhn-Murphy-Pierce decomposition method to analyse the time variation in these differences. The results obtained from the application of both methods show that most of the rural-urban school differential is related to family characteristics and not so much to those of the school, although the analysis of the time dimension has enabled us to highlight the role of other unobservable factors in the reduction of the rural-urban differential.

From the perspective of educational policy, the evidence obtained reinforces the suitability of adopting measures aimed at improving the general educational situation and conditions in the family and, perhaps, as opposed to adopting measures of positive discrimination in rural schools as a means to improve educational performance (at least as regards the indicators considered in this study: public/private ownership, size and teacher/student ratio). These results are in line with the evidence by Rodriguez et al. (2010), who found that the success of a programme addressed to Colombian rural school was mainly due to the fact that it took into account the specific characteristics and situation of rural students in each municipality it was implemented. A potential tool that could be used to achieve this goal is conditional cash transfers that have already proved to be effective in Colombia (Barrera-Osorio et al 2011).

Based on these results, several future paths of research are opened up. However, such studies will require a richer database as regards the information needed to capture the characteristics of the areas in which the students are resident. Such data would enable us to analyse the mechanisms via which the geographical environment can have an impact on a student's educational outcomes and the extent to which this fails to capture the importance of other variables that we have been unable to control for adequately in this study (omission of relevant variables). These might be found to include the institutional improvements that have occurred in Colombia in the period under review and which may have had a greater impact on rural than they have had on urban zones.

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6. Tables and figures

Table 1. Studies conducted in countries of South America in which student outcomes in rural and urban schools are compared.

Study	Country	Data	Subject areas	Method	Characteristics
Harbison & Hanushek (1992)*	Brasil	EDURURAL data collection 1981, 1983, 1985. Second and fourth grades	Portuguese and mathematics	longitudinal value-added** with and without sample selection correction, cross-sectional level form with and without sample selection correction, and value-added with instrumental variables and sample selection.	individual, family, teachers, peers, infrastructure, study materials
Mizala & Romaguera (2000)	Chile	SIMCE Educational Quality Measurement System (average) 1996 fourth and eighth grade	Mathematics and Spanish	OLS	family, personal, teachers, SIMCE 1994
Abdul_Hamid (2004)	Argentina	PISA 2000	Mathematics, reading and science	Generalized Least Squares (GLS) and quantile regression	family, individual, school
Cueto et al. (2005)	Peru	Project: “Young Lives” 2002 (children between the ages of 7.5 and 8.5)	Reading, writing and mathematics	OLS	family, individual, home and community social capital
Woßmann (2010)	Argentina, Colombia,	Progress in International Reading Literacy Study (PIRLS). Fourth-grade students in 2001	Reading	Weighted least squares and clustering-robust linear regressions (CRLR) for standard errors	family, individual, school, test score in the previous period
Santos (2007)***	Argentina	PISA 2000	Reading and mathematics	Linear regression for survey data and quantile regression	family, individual, school

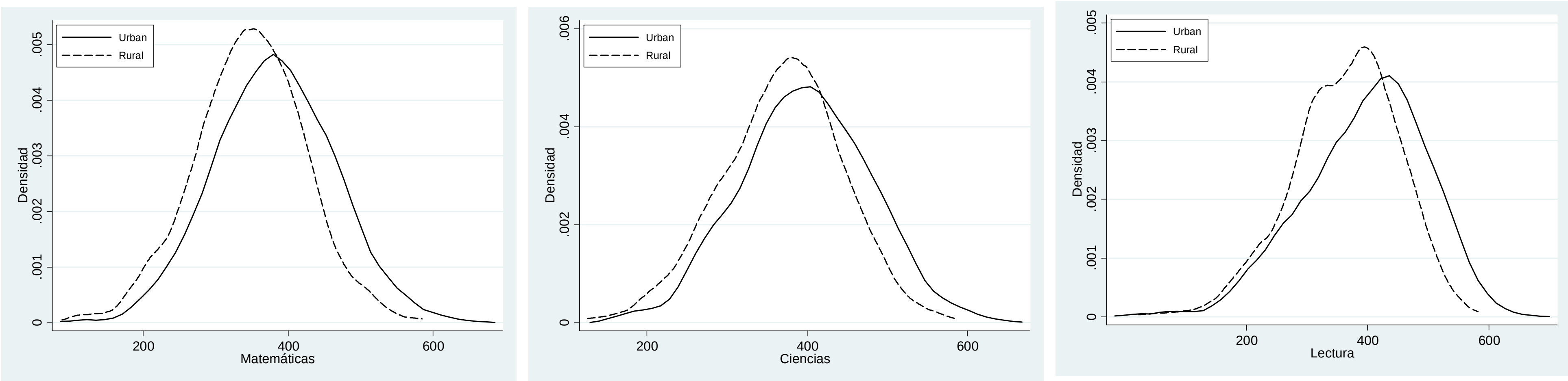
* Study centred on rural areas only (no urban-rural comparison undertaken).
** The aggregate value takes the variation in the student’s score between the two periods as the endogenous variable. The remaining models take the score obtained by the student on a single test as the endogenous variable.
*** Rural-urban differential significant for mathematics but not for reading.

Table 2. Descriptive analysis of the variables used in the study

	TOTAL 2006		TOTAL 2009		URBAN 2006		URBAN 2009		RURAL 2006		RURAL 2009	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Test scores:												
Mathematics	375.13	80.86	384.99	71.07	385.53	82.88	392.47	72.01	351.96	70.90	369.72	66.55
Science	392.09	79.02	406.63	75.78	400.44	80.57	415.78	75.18	373.50	72.06	387.93	73.53
Reading	390.89	96.43	416.86	82.92	400.91	99.88	429.33	81.26	368.59	84.05	391.41	80.43
Individual characteristics:												
Female	0.54	0.50	0.51	0.50	0.54	0.50	0.53	0.50	0.53	0.50	0.49	0.50
Age	15.84	0.29	15.85	0.28	15.84	0.29	15.84	0.28	15.86	0.28	15.87	0.28
First generation immigrant	0.01	0.04	0.00	0.02	0.00	0.04	0.00	0.03	0.00	0.00	0.00	0.00
Second generation immigrant	0.01	0.05	0.00	0.05	0.00	0.06	0.00	0.06	0.00	0.03	0.00	0.04
Home language	0.01	0.06	0.00	0.06	0.00	0.04	0.00	0.07	0.01	0.08	0.00	0.05
Family characteristics:												
Mother's education	9.14	4.56	9.48	4.67	9.78	4.55	10.38	4.52	7.72	4.28	7.65	4.42
Father's education	9.32	4.84	9.47	4.80	10.06	4.79	10.36	4.69	7.70	4.53	7.66	4.51
Cultural environment:												
Between 0 and 10 books in the home	0.34	0.47	0.33	0.47	0.26	0.44	0.27	0.44	0.50	0.50	0.46	0.50
Between 11 and 25 books	0.29	0.46	0.31	0.46	0.30	0.46	0.31	0.46	0.28	0.45	0.32	0.46
Between 26 and 100 books	0.26	0.44	0.26	0.44	0.31	0.46	0.30	0.46	0.16	0.36	0.17	0.38
Between 101 and 200 books	0.07	0.26	0.07	0.26	0.08	0.28	0.08	0.28	0.05	0.21	0.04	0.20
Between 201 and 500 books	0.03	0.17	0.02	0.15	0.04	0.19	0.03	0.17	0.01	0.11	0.01	0.08
More than 500 books	0.01	0.09	0.01	0.08	0.01	0.10	0.01	0.09	0.00	0.07	0.00	0.03
School characteristics:												
Urban location	0.69	0.46	0.67	0.47								
Public school	0.83	0.38	0.79	0.41	0.77	0.42	0.72	0.45	0.95	0.21	0.93	0.25
School size	1690.77	1330.57	1356.24	1003.85	2019.98	1362.72	1514.30	1058.02	957.32	893.40	1033.51	790.24
Student-teacher ratio	23.90	11.13	27.18	10.00	26.37	9.32	28.49	11.13	18.39	12.75	24.48	6.37
ESCS	-0.96	0.73	-1.08	.85	-0.71	0.69	-0.78	.79	-1.52	.47	-1.69	.60
Observations	409208		425758		282435		285787		126773		139971	

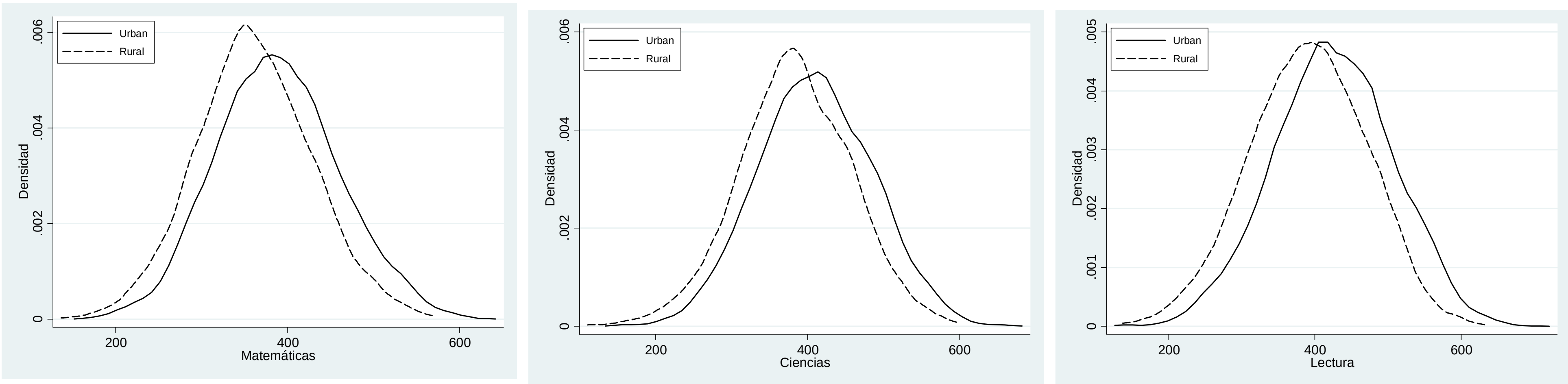
Source: Based on 2009 and 2006 PISA data.

Figure 1: Distribution of students' educational performance according to the rural-urban location of the school in 2006.



Source: Based on 2006 PISA data.

Figure 2: Distribution of students' educational performance according to the rural-urban location of the school in 2009.



Source: Based on 2009 PISA data.

Table 3. Estimates of the educational production function for Colombia with 2009 PISA data

Variables	Mathematics	Science	Reading
Female	-30.98***	-20.38***	10.65***
	[2.788]	[2.568]	[3.059]
Age	17.60***	1.557	8.873*
	[5.084]	[5.229]	[5.221]
Mother’s education	1.307***	1.034***	1.030***
	[0.366]	[0.398]	[0.372]
Father’s education	0.538	-0.0453	-0.432
	[0.344]	[0.440]	[0.396]
First generation immigrant	-69.59**	-46.09*	-84.54**
	[28.29]	[23.71]	[40.08]
Second generation immigrant	-67.22***	-63.75**	-98.32***
	[23.23]	[29.76]	[30.52]
Home language	-31.05*	-23.45	-50.46**
	[16.66]	[20.66]	[22.77]
Between 11 and 25 books in the home	15.29***	22.33***	17.42***
	[3.891]	[4.337]	[3.791]
Between 26 and 100 books in the home	34.97***	34.16***	30.28***
	[3.723]	[4.782]	[4.882]
Between 101 and 200 books in the home	31.11***	33.61***	35.11***
	[4.782]	[5.903]	[6.009]
Between 201 and 500 books in the home	38.23***	44.78***	25.95***
	[8.347]	[8.966]	[10.03]
More than 500 books in the home	20.39	20.07	18.71
	[16.79]	[16.85]	[17.66]
Public school	-5.362	-6.907	5.983
	[8.302]	[6.629]	[7.194]
School size	0.00298	-0.000147	0.000843
	[0.00207]	[0.00259]	[0.00228]
Student-teacher ratio	-0.410	-0.652*	-0.349
	[0.258]	[0.353]	[0.244]
Peer effects	27.52***	31.46***	44.93***
	[4.028]	[4.538]	[3.496]
Constant	128.9*	421.4***	301.3***
	[77.97]	[85.32]	[82.08]
Observations	425757	425757	425757

Source: Based on 2009 PISA data.

Table 4. Oaxaca-Blinder decomposition of the rural-urban differential for Colombia with 2009 PISA data

	Mathematics	Science	Reading
Rural (R)	369.7***	387.9***	391.4***
Urban (U)	392.5***	415.8***	429.3***
Overall difference (R-U)	-22.75***	-27.86***	-37.92***
"Explained" part (Q)	-34.82***	-37.39***	-48.15***
"Unexplained" part (N)	12.07*	9.532	10.23
Breakdown of the "explained" part (Q)			
Individual characteristics (QI)	1.71	0.6046	-0.031
Family characteristics (QF)	-10.15***	-8.918***	-8.007***
School characteristics (QE)	-26.38***	-29.073***	-40.116***
Breakdown of the school characteristics (QE)			
Public school	0.0205	-2.244	3.175
School size	-1.073	1.457	0.44
Student/teacher ratio	5.435	5.664	4.619
Peer effects	-30.76***	-33.95***	-48.35***

Source: Based on 2009 PISA data.

Table 5. Juhn-Murphy-Pierce decomposition of the rural-urban differential for Colombia with 2009 and 2006 PISA data

	Mathematics	Science	Reading
Rural-Urban Differential 2006 (RU_{2006})	-33.57	-26.94	-32.33
Rural-Urban Differential 2009 (RU_{2009})	-22.75	-27.86	-37.92
Overall difference (RU_{2009}-RU_{2006})	10.82	-0.91	-5.59
"Explained" part (QP)	-13.15	-22.66	-10.24
"Unexplained" part (N)	23.97	21.75	4.64
Breakdown of the "explained" part (QP)			
Quantity effect (Q)	-2.59	-3.78	-2.75
Price effect (P)	-13.63	-18.86	-10.58
Interaction (QxP)	3.08	-0.013	3.09

Source: Based on 2009 and 2006 PISA data.