
Disparities in Mathematics Performance between Rural and Urban Girls in Togo: An Analysis by the Recentered Influence Functions (RIF)

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ABSTRACT

Science subjects remain a significant barrier to students' academic achievement, particularly among girls who often perceive them as a challenge. This study investigates gender- and territory-based learning inequalities in primary education across developing countries, focusing on Togo. Using PASEC 2019 data, it analyzes disparities in mathematics performance between rural and urban girls. A dual econometric approach is applied: the Blinder–Oaxaca decomposition distinguishes effects related to students' observable characteristics from those associated with differential returns, while Recentered Influence Function (RIF) regressions provide a nuanced view of disparities across the score distribution. Results reveal an average gap of 97 points in favor of urban girls, two-thirds of which are explained by observable factors such as preschool attendance, housing conditions, child labor, and access to learning materials. The remaining gap reflects contextual inefficiencies, underscoring the need for targeted, context-specific policies to foster equitable inclusion.

Keywords: Academic performance, Blinder-Oaxaca, RIF, PASEC, Togo

JEL Classification: I21, I24, J16

Introduction

Inclusive and equitable access to quality education is a fundamental lever for the formation of human capital, a pillar of economic development, technological innovation, and social progress (Romer, 1986; Lucas Jr., 1988). According to human capital theory, productivity gaps between countries can result from differences in the accumulation of knowledge, skills, and education levels (Becker, 1975). In this context, improving school performance becomes a priority for educational policies, in line with the objectives of equity and efficiency.

Sustainable Development Goal 4 (SDGs 4), adopted by the United Nations, emphasizes quality education for all, especially for vulnerable groups such as girls and children in rural areas. While significant progress has been made in terms of access to primary education in sub-Saharan African countries, particularly through free education policies, persistent disparities lead us to ask the question of the quality and equity of the education system (Sifuna and Sawamura, 2011).

Togo is a good example of this dual dynamic of massification and structural fragility of the education system. Since the introduction of free education in 2008, the gross enrolment rate has increased from 98% to 126.8% between 2007 and 2018 (MEPSTA). However, this expansion has been accompanied by major challenges in terms of quality, school endowments, and governance (CONFEMEN, 2019). Education remains marked by a strong heterogeneity of resources between institutions, whether urban or rural, public or private.

PASEC 2019 data show a stagnation in the average performance of Togolese students in reading and mathematics between 2014 and 2019, in contrast to the progress recorded in comparable countries such as Benin or Niger. Apart from the difference between the public and private sectors, geographical and gender inequalities are receiving increasing attention, especially when looking at girls' educational outcomes. In reality, girls living in rural areas often face many barriers: difficult learning conditions, remote infrastructure, economic hardship, and social norms that do not favour them. Heyneman (2022) and Kobul (2023) confirm marked differences in performance between rural and urban areas, but few of them intersect the spatial dimension with gender. This gap calls for a targeted investigation, considering the contextual specificities of Togo.

One of the originalities of this research lies in the methodological approach adopted. Contrary to classical descriptive approaches or multilevel models, we use here the method of decomposition of the Recentered influence functions (RIF) proposed by Firpo *et al.* (2018), making it possible to distinguish between endowment effects (observable

characteristics) and structural effects (performance of these characteristics) on the overall distribution of school performance. This approach refines the understanding of the mechanisms underlying educational inequalities.

On the theoretical level, this work is rooted in both the theory of human capital (Becker, 1964; Hanushek, 1979) and in the field of educational production, by exploring how educational resources and environments influence performance differently according to geographical setting and gender. Thus, our study contributes to the scientific literature by linking the empirical understanding of inequalities to the theoretical foundations of educational policies. The central question of this research is: what are the determinants of the differences in mathematics performance between girls in rural and urban schools in Togo? The objective of this study is to examine the disparities in mathematics performance between these two groups, identifying the observable and structural explanatory factors that contribute to these inequalities.

The rest of the article is organized as follows. Section 2 presents a literature review. Section 3 describes the analytical method and the empirical specification. Section 4 presents the results and discussions. Section 5 is devoted to the conclusion and proposes avenues for future research.

II. Literature review

The gap in educational performance between girls in rural and urban areas is a multi-dimensional problem, influenced by socio-economic, educational, and cultural factors. Several empirical studies have highlighted the extent and complexity of these disparities across different contexts.

Ayub *et al.* (2016), in Malaysia, find that urban students score higher average scores than rural students in all three dimensions of mathematics engagement (affective, cognitive, and behavioral). Their study also highlights a greater involvement of girls in all these dimensions compared to boys. Apaza *et al.* (2024), based on data from Peru, estimate an average gap of 63.28 points in mathematics between urban and rural areas, of which 82.58% is due to differentiated endowments, mainly socio-economic conditions and school resources.

In Malaysia, Mohammadpour and Yon (2024) have shown that mathematics scores are influenced by factors related to students in rural areas, and more so by those related to schools in urban areas. Compositional effects, such as socioeconomic status, also seem to be more pronounced in urban areas. In the BTR region of India, Karim *et al.* (2024) highlight significant differences in performance by gender and location

(rural or urban), whether in grade 10 or 12. Lu *et al.* (2017), in China, note that boys outperform girls, with a more pronounced gap in rural areas, although gaps in anxiety, self-perception, or family investment are not enough to explain this difference.

Dean *et al.* (2023), in New South Wales, explain that rurality does not act solely through socio-economic conditions, but that it structures other, often neglected, educational dynamics, calling for the recognition of rural specificities in education policies. Ahmed *et al.* (2023) also identify a strong disparity in mathematics results between rural and urban girls and boys in the state of Assam (India). Nagi and Sridevi (2022) confirm the significant influence of variables such as gender, mother's level of education, study time, or educational expenditure on mathematics results, emphasizing the gender-differentiated effect.

This review of the literature reveals contrasting findings depending on the national context, without a clear consensus on the dominant mechanisms of the gaps. It justifies the adoption of more robust econometric approaches, such as decomposition by the Recentered influence functions (RIFs), which is still little used in the African context. This method allows separating the effects related to endowments (characteristics of students and schools) and those related to returns (effectiveness of these endowments on performance), in a multidimensional and inclusive perspective by taking gender, territory, and type of school into account.

III. Methodology

3.1. Conceptual framework and specification of the educational production function

The student's performance is influenced by a complex combination of individual, family, and academic factors. This process can be represented by an educational output function, which models school performance in mathematics as a function of educational inputs. Inspired by the work of Arteaga and Glewwe (2019), our approach is based on a linear econometric modeling of this function. Academic performance in mathematics A is then a function of the following inputs:

$$A = \beta (S, Q, C, F, I) \quad (1)$$

Where S is number of years of schooling; Q , characteristics of the school (infrastructure, class size, teacher qualifications, management method); C , individual characteristics of the pupil (age, sex, initial level); F , family socio-economic profile

(parents' level of education, income, parental commitment); I, Additional educational inputs (textbooks, private support, external educational resources).

This conceptual framework provides an analytical basis for identifying the channels through which educational resources influence learning outcomes.

Econometric specification and estimation technique:

The empirical implementation of the educational production function is based on a linear specification such as:

$$A_i = \alpha_0 + \alpha_1 S_i + \sum_{j=1}^J \alpha_{qj} Q_{ij} + \sum_{k=1}^K \alpha_{ck} C_{ik} + \sum_{m=1}^M \alpha_{fm} F_{im} + \sum_{n=1}^N \alpha_{in} I_{in} + \varepsilon_i \quad (2)$$

In equation (2), the student's academic achievements, A_i , measured here by his or her performance in mathematics, are modelled as a function of several groups of explanatory variables: J groups the characteristics of the school and the teacher, K those of the student, M those of the household, and N the complementary educational inputs. The error term ε captures both measurement errors and unobserved factors that may influence academic performance in mathematics, such as intrinsic motivation or unmeasured cognitive abilities.

Estimating the effect of explanatory variables on learning outcomes can be performed using the ordinary least squares (OLS) method, provided that the exogeneity assumption is respected, i.e., that ε is uncorrelated with the explanatory variables. However, this condition is often faulted in empirical analyses in education. In particular, endogeneity biases may occur when one or more relevant variables are omitted, or when certain explanatory variables are measured with error. For example, the exclusion of the student's cognitive abilities, if they are correlated with both academic performance and certain observed variables such as the parents' level of education, leads to a specification bias. To mitigate these biases, we include an extensive set of control variables capturing relevant pedagogical, individual, and socioeconomic dimensions (Ammermüller, 2007). This strategy aims to reduce endogeneity biases by omission and improve the validity of the estimates.

2.1. Blinder-Oaxaca decomposition

The Blinder-Oaxaca decomposition method decomposes the average gap in mathematics performance between urban and rural girls into two components: one part attributable to differences in observable characteristics (staffing effects) and the other part related to differences in the performance of these characteristics (coefficient effects). This

approach thus makes it possible to identify whether the observed gap is mainly the result of disparities in access to educational resources and background characteristics, or rather of the differentiated effectiveness of these factors depending on whether the girl lives in rural or urban areas. The basic model can be written as follows:

$$A_i = \beta' X_i + \varepsilon_i \quad (3)$$

Where A_i represents the mathematics score of student i , X_i is the vector of his individual, family, and school characteristics, β are the coefficients associated with these characteristics, and ε_i is the error term. The educational production function is estimated separately for girls in rural (r) and urban (u) areas:

$$A_i^r = \beta^{r'} X_i^r + \varepsilon_i^r \quad (4)$$

$$A_i^u = \beta^{u'} X_i^u + \varepsilon_i^u \quad (5)$$

The average gap in mathematics performance between girls in the two backgrounds is defined as

$$A^u - A^r = \beta^{u'} X^u - \beta^{r'} X^r \quad (6)$$

The right-hand side of equation (6) can be reformulated as follows, taking into account the average difference in mathematics performance between girls in the two backgrounds:

$$= \{(X^u - X^r)\}' \beta^r + (X^r)' (\beta^u - \beta^r) + \{(X^u - X^r)\}' (\beta^u - \beta^r) \quad (7)$$

Equation (7) shows three components: E, C, and I

The first is the endowment effect (E) = $(X^u - X^r)' \beta^r$, which characterizes the portion of the gap explained by differences in observable characteristics (e.g., socioeconomic level, educational resources) between urban and rural girls. The second component, C = $((X^r)' \beta^u - \beta^r)$, represents the share attributed to differences in the returns of these characteristics, i.e., the efficiency with which these resources translate into academic results, "coefficient effect"; and the third component is: I = $\{(X^u - X^r)\}' (\beta^u - \beta^r)$, which simultaneously combines differences in characteristics and differences in performance.

A simplified version, known as "*double decomposition*" distinguishes between a part explained by observable differences and an unexplained part linked to differentiated returns or unobserved factors (Jann, 2008). This formulation is:

$$A^u - A^r = \beta^{u'} X^u - \beta^{r'} X^r = \{(X^u - X^r)\}' \beta^* + \{(X^u) (\beta^u - \beta^*)' + (X^r)' (\beta^* - \beta^r)\} = E + U \quad (8)$$

Where β^* is a vector of reference coefficients, often defined as a weighted average of rural and urban coefficients β^* . In this framework, E represents the share explained by the observable differences between the two groups, and U denotes the unexplained part, which reflects either differentiated returns or possible unobserved factors.

2.2. Decomposition based on the Recentered influence functions (RIF)

To analyze the differences in mathematics performance between rural and urban girls throughout the distribution, and not only on average, we use the RIF-regression decomposition method proposed by Firpo, Fortin, and Lemieux (2009). This approach consists of modeling the effect of characteristics on different q_τ quantiles of the score distribution, via the Recentered influence functions (RIF), defined as follows:

$$\text{RIF}(Y; q_\tau; F_Y) = q_\tau + \frac{\tau - 1(Y \leq q_\tau)}{f_Y(q_\tau)} \tag{9}$$

Where $f_Y(q_\tau)$ is the density of Y at the quantile q_τ , and $1(Y \leq q_\tau)$ is an indicator function.

By estimating RIF regressions (RIF-regressions), it becomes possible to identify the effect of individual, family, and school characteristics on a student's position in the distribution, and thus to measure the differences at the different levels of performance (low, median, high). The functions of educational production in the quantile q_τ are specified separately for girls in rural (r) and urban (u) areas:

$$E[\text{RIF}(A_i^r; q_\tau; F_Y) | X_i^r] = \beta_\tau^r X_i^r + \varepsilon_i^r \tag{10}$$

$$E[\text{RIF}(A_i^u; q_\tau; F_Y) | X_i^u] = \beta_\tau^u X_i^u + \varepsilon_i^u \tag{11}$$

The performance gap in mathematics at the quantile can then be broken down as follows q_τ :

$$A_\tau^u - A_\tau^r = \beta_\tau^u X_\tau^u - \beta_\tau^r X_\tau^r = \{(X^u - X^r)\}' \beta_\tau^* + \{(X^u)'(\beta_\tau^u - \beta_\tau^*) + (X^r)'(\beta_\tau^* - \beta_\tau^r)\} \tag{12}$$

Where: $\beta_\tau^* = \Omega_\tau \beta_\tau^u + (I - \Omega_\tau) \beta_\tau^r$ is a weighted average of the coefficients at the quantile τ .

This decomposition makes it possible to distinguish, for each level of performance, the part of the gap due to differences in endowment (observable characteristics), the part linked to the differentiated returns of these characteristics, as well as the interaction

effects. The analysis is conducted taking into account the hierarchical structure of the data (pupils embedded in schools). Standard errors are corrected by clustering at the school level, according to the recommendations of Wößmann (2003). In addition, certain variables, such as the experience of teachers, are introduced in quadratic form to capture possible non-linear effects.

3. Description of data and variables

3.1. Data source

The data come from recent national surveys on the education system in Togo, taken specifically from CONFEMEN's Education Systems Analysis Program (PASEC 2019). The 2019 PASEC survey involved more than 6,000 students from 180 schools. This database contains various information, such as plausible scores in reading and mathematics, test components, variables related to the characteristics of the student and his/her family, variables assessing the teacher's personal characteristics and classroom learning conditions, variables concerning the principal's individual characteristics and learning conditions in the school, indices derived from different questions, school weight and final student weight, as well as replicated weights. In the context of this study, only performance in mathematics is retained as the main indicator of academic success. The score used corresponds to the average of the plausible mathematics scores provided by PASEC, thus allowing a reliable and comparable measure of student achievement. For reasons of better representativeness, estimates were made using weightings and clusters.

3.2. Study variables

Table 1 presents the description of the variables in the model, as well as Figure 1, which illustrates the density of mathematics scores by place of residence.

Table 1: Summary statistics of variables by school location (rural and urban)

<i>Variable</i>	<i>Rural</i>	<i>Urban</i>
Dependent variable		
Math scores	458.35(82.05)	556.23(99.09)
Individual and family characteristics		
Preschool attendance	1.72(0.45)	1.38(0.48)
Homework help	1.22(0.41)	1.15(0.35)
Reads at home	1.14(0.35)	1.08(0.27)

Eats at home	0.65(0.48)	0.58(0.49)
Interest in reading	0.85(0.36)	0.97(0.17)
Books at home	0.38(0.49)	0.68(0.46)
Agricultural work	0.73(0.44)	0.34(0.47)
Domestic work	0.95(0.22)	0.97(0.18)
Father can read	0.58(0.49)	0.75(0.43)
Mother can read	0.35(0.48)	0.62(0.49)
Health problems	0.17(0.38)	0.21(0.41)
Socioeconomic status (SES)	44.45(7.59)	54.86(7.51)
School and teacher characteristics		
Teacher education level	0.32(0.47)	0.23(0.42)
Teacher experience	0.48(0.50)	0.69(0.46)
Teacher in service training	0.51(0.50)	0.59(0.49)
Student-teacher ratio	8.44(10.43)	6.17(9.23)

Source: Created by authors based on data from the 2019 PASEC survey

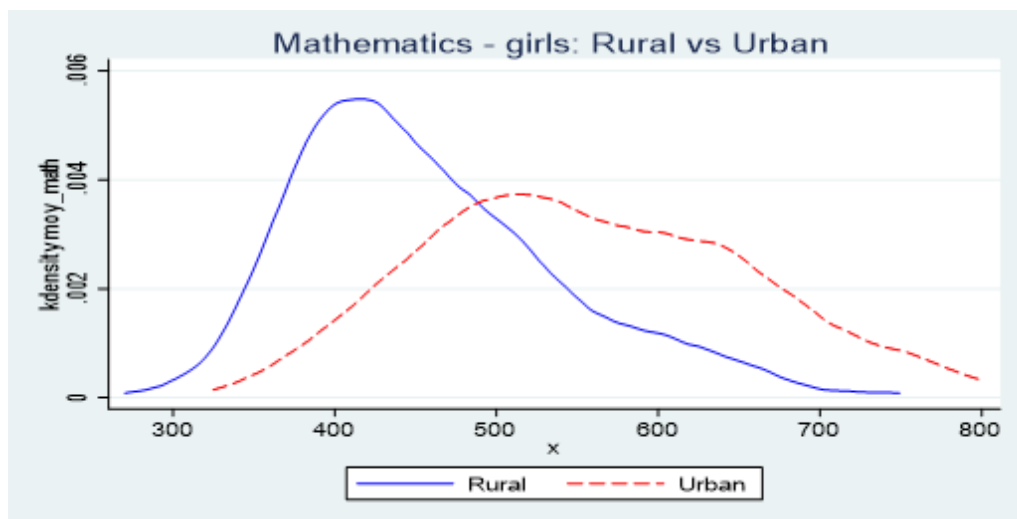


Figure 1: Distribution of mathematics scores of girls in urban and rural schools

Table 2: Summary of variables and definitions

Variable Name	Coding	Definition
Dependent variable		
Mathematics score	Continuous variable	Student's score in mathematics
Student and household characteristics		
Preschool attendance	1 = Yes, 0 = No	Did the student attend preschool?
Gender	1 = Girl, 0 = Boy	Student's gender
Homework support	1 = Yes, 0 = No	Does the student receive help with homework?

Variable Name	Coding	Definition
Reads at home	1 = Yes, 0 = No	Does the student read at home?
Eats at home	1 = Yes, 0 = No	Does the student eat meals at home?
Interest in reading	1 = Yes, 0 = No	Is the student interested in reading?
Books at home	1 = Yes, 0 = No	Are there books available at home?
Agricultural work	1 = Yes, 0 = No	Does the student engage in agricultural work?
Domestic work	1 = Yes, 0 = No	Does the student perform domestic chores?
Father can read	1 = Yes, 0 = No	Can the student's father read?
Mother can read	1 = Yes, 0 = No	Can the student's mother read?
Health issues	1 = Yes, 0 = No	Does the student experience health problems?
Socioeconomic status (SES)	Continuous	Composite index of the student's socioeconomic status
School and teacher characteristics		
Teacher education level	1 = Higher than high school 0 = Less than high school	Highest level of education attained by the teacher at the school,
Teacher experience	1 = More than 10 years, 0	The teacher's years of experience are less than 10 years
In-Service training	1 = Yes, 0 = No	Has the teacher received in-service training?
Student-to-textbook ratio	Continuous variable	Ratio of students to mathematics textbooks
Urban School	1 = Urban, 0 = Rural	Is the school located in an urban or rural area?

Source: Created by the authors using data from the PASEC 2019 survey

IV. Results and Discussion

The analysis of the gaps in mathematics performance between girls in rural and urban schools in Togo, based on data from the 2019 PASEC survey and the method of decomposition by the Recentered influence functions (RIF), reveals several significant results. We first present the estimated effects of the main observable characteristics on mathematics scores at different levels of the distribution (Table 3), and then we discuss the contribution of differences in yields and unobserved characteristics to the explanation of the differences in performance between rural and urban girls.

Effect of pre-schooling and homework help: Girls who have not been in pre-school perform significantly worse, particularly in urban areas, where losses reach -38.2 points at the 90th percentile and -22.4 points at the 70th percentile. In rural areas, the gap is more moderate, around -10 to -12 points. This difference in impact can be explained by a more structured urban environment, which makes it possible to better capitalize on early achievements. Conversely, in rural areas, primary school facilities are sometimes too weak to make the most of the advances linked to pre-schooling. Our results corroborate those of Heckman (2006) or Gormley Jr *et al.* (2005), which have shown that

the effects of early childhood programmes are amplified in contexts where subsequent educational resources are robust.

The lack of homework help is highly penalizing in rural areas (16.3 points on average) but has a negligible, or even slightly positive, effect in urban areas. This result may seem counterintuitive. It could be explained by the very variable quality of the help depending on the environment: in the city, the help could be provided by people who are poorly qualified, or too supervising, which would limit its effectiveness. Conversely, in rural areas, even minimal support can make a real difference. Duflo *et al.* (2011) insist on the fact that the quality of the pedagogical supervision is more important than its mere presence. Laval (2003) also stresses that homework assistance can accentuate inequalities if it is based on unevenly distributed family capital.

Reading at home and availability of books: Not reading regularly at home is associated with significant losses in urban areas, as low as -55.8 points at the 90th percentile, but this effect is almost zero in rural areas. This contrast can be explained by the differentiated access to written resources: rural families often have very limited access to quality books or media. Thus, the marginal effect of a lack of reading is small. On the other hand, in an urban environment, where the supports are present, not using them is a disadvantage. Evans *et al.* (2010) show that the written culture of the home is a key determinant of success, provided that it is accessible and valued in the context.

The lack of books at home is highly unfavorable, particularly at the top of rural distribution, where the gap reaches -46.8 points at the 90th percentile. This result shows that, even in mathematics, the presence of written materials in the home contributes to learning, probably through the general cognitive stimulation they provide.

Nutrition (eating at home): Girls who eat at home do much better in rural areas (+20 to +41 points). This may reflect unequal access to the school canteen. In rural areas, where school catering is not very developed, the quality of meals taken at home becomes an essential factor for concentration and learning.

Interest in reading: The interest expressed in reading is strongly associated with better performance, especially in urban areas, with gains exceeding +100 points at the 70th percentile. In rural areas, the effects remain positive, between +24 and +37 points. This may be because intrinsic motivation to learn is more easily converted into success when it is accompanied by an environment that values reading and academic effort. Our results are in line with Evans *et al.* (2010b), who emphasize that interest in reading is an amplifying factor, but that its effect also depends on the structures that support it.

Child labor (agricultural and domestic): Participation in agricultural work is very unfavorable in urban areas, with losses ranging from -38 to -61 points, depending on the quantile. In rural areas, the effects are more attenuated, although still negative. Domestic work mainly affects rural girls, with the best performance: -87 points in the 90th percentile. These results reflect an internalization of work as a norm in rural areas. Girls adapt better to it. But for the best students, these tasks become a hindrance when they reduce the time available for studying. In the same vein, Patrinos and Psacharopoulos (1997) indicate that children in rural areas often get used to combining school and work. The ILO (2013) notes that the impact depends strongly on the type and intensity of work performed.)

Mother's literacy: Girls whose mothers can read do not systematically benefit from it. In rural areas, there are even significant negative differences (up to -20 points). These results could reflect a dissonance between the level of maternal literacy and its actual mobilization in the service of education, or an imperfect measure of the ability to support learning. Chudgar & Luschei (2009) have shown that the effects of parental literacy depend on its effective use in the education of the child and for the development of children. Strauss & Thomas (2007), in rural contexts, educational capital is not always mobilized.

Child health: Reporting health problems is not associated with systematic declines in performance. A few one-off effects are observed, particularly in rural areas at the 90th percentile (-30.9 points), but the overall trend remains insignificant. This suggests that only serious and recurrent health problems have a measurable effect on learning, which is consistent with other studies. Alderman *et al.* (2001) indicate that the effect of health on schooling is non-linear and depends on the frequency and severity of conditions.

Socio-economic status (SES): The standard of living has a clear influence in urban areas, with significant and increasing positive effects depending on the quantile (+2.6 to +5.6 points), but little effect in rural areas. This divergence can be explained by greater economic homogeneity in rural areas: when everyone is poor, the standard of living does not significantly differentiate educational opportunities. In cities, the wealth gap is more pronounced and therefore more influential. Our results corroborate those of Filmer and Pritchett (2001) and Sahn & Stifel (2003), which confirm that the SES has a greater impact in economically heterogeneous environments.

Academic factors (qualification, experience, continuing education, book ratio): Holding a diploma higher than the Baccalaureate is not systematically beneficial. In urban areas, it is even associated with a significant drop in the 50th percentile (-31.9

Table 1: Estimates of factors influencing mathematics results among rural and urban girls at the main quantiles of the distribution

Variables	Mean (OLS)		Perc.10		Perc.30		Perc.50		Perc.70		Perc.90	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Presco (Not)	-7.69 (7.06)	-13.74 (9.17)	-10.32 (9.36)	-11.38 (12.16)	-1.05 (8.42)	-18.88 (12.32)	-11.95 (7.96)	-9.08 (12.93)	-10.05 (10.95)	-22.39* (11.87)	-11.35 (18.36)	-38.20** (18.47)
Homework Help (No)	-16.30** (8.18)	0.36 (11.87)	-0.16 (10.84)	1.14 (15.75)	-11.33 (9.76)	11.08 (15.96)	-15.44* (9.23)	1.86 (16.73)	-18.89 (12.69)	-7.99 (15.37)	-20.11 (21.28)	-20.93 (23.92)
Reading at home (Not)	-10.78 (9.87)	-50.21** (15.88)	-9.40 (13.08)	-39.21* (21.07)	-5.31 (11.77)	-55.76** (21.35)	3.48 (11.13)	-44.53** (22.39)	-11.52 (15.31)	-52.07** (20.56)	-22.85 (25.67)	-55.80† (31.99)
Eat at Home (Yes)	-27.56*** (6.26)	-2.34 (8.62)	-20.84* (8.30)	-12.16 (11.44)	-25.05*** (7.47)	-19.92 (11.60)	-33.50*** (7.07)	-1.71 (12.16)	-33.70*** (9.72)	0.18 (11.17)	-41.06** (16.29)	12.64 (17.38)
Interest in reading (Yes)	31.99*** (8.67)	52.31 (30.03)	26.64* (11.49)	74.14* (39.85)	24.21** (10.34)	71.11 (40.38)	37.71*** (9.78)	81.94† (42.35)	36.82*** (13.45)	103.47*** (38.88)	29.75 (22.55)	-137.70** (60.52)
Book at Home (Yes)	17.22** (6.82)	15.14 (10.14)	3.76 (9.05)	21.29 (13.46)	12.01 (8.14)	12.86 (13.64)	18.04* (7.70)	19.49 (14.30)	13.71 (10.59)	21.69† (13.13)	46.85*** (17.75)	8.55 (20.44)
Agricultural Work (Yes)	-13.44* (7.53)	-38.77*** (9.66)	-8.44 (9.98)	-61.37*** (12.81)	-7.86 (8.98)	-38.91*** (12.98)	-4.35 (8.50)	-28.69** (13.62)	-9.97 (11.68)	-11.70 (12.50)	-4.49 (19.59)	-43.64** (19.46)
Domestic Work (Yes)	-29.68** (13.71)	10.57 (23.87)	1.44 (18.18)	-1.64 (31.67)	-6.56 (16.36)	19.24 (32.09)	-27.92* (15.48)	-5.54 (33.65)	-52.86** (21.28)	5.78 (30.90)	-87.25** (35.68)	57.56 (48.09)
Mother can read (Yes)	-20.48*** (6.67)	12.06 (9.19)	-15.46 (8.85)	24.70* (12.19)	-20.60** (7.96)	7.39 (12.35)	-15.49* (7.53)	3.96 (12.96)	-9.08 (10.36)	-0.47 (11.90)	-30.82* (17.36)	13.78 (18.52)
Health Condition (Yes)	-11.88 (8.06)	-6.81 (10.39)	0.96 (10.68)	-7.09 (13.78)	-4.37 (9.62)	1.79 (13.97)	-10.07 (9.09)	-0.18 (14.65)	-20.52 (12.50)	-3.95 (13.45)	-30.92 (20.96)	-19.59 (20.94)
HIS	0.84 (0.53)	4.40*** (0.66)	0.06 (0.70)	2.62*** (0.87)	0.89 (0.63)	4.16*** (0.88)	0.98* (0.59)	4.20*** (0.93)	1.36* (0.82)	5.66*** (0.85)	1.42 (1.37)	5.04*** (1.32)
Master's level of study (Higher than the BAC)	-7.54 (6.94)	-16.64 (10.90)	-1.12 (9.20)	-16.44 (14.46)	1.12 (8.28)	-3.09 (14.65)	-7.33 (7.83)	-31.93** (15.36)	-16.33 (10.76)	-22.84 (14.11)	-16.74 (18.04)	-14.13 (21.96)

Variables	Mean (OLS)		Perc.10		Perc.30		Perc.50		Perc.70		Perc.90	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Master Experience (10 years +)	-3.43 (6.59)	7.60 (9.98)	-15.20 (8.73)	26.57* (13.24)	-7.50 (7.86)	19.68 (13.41)	-2.65 (7.43)	3.21 (14.07)	-8.87 (10.22)	-8.10 (12.92)	-8.16 (17.13)	-10.75 (20.10)
Continuing education (Yes)	2.26 (6.19)	2.27 (9.00)	-0.82 (8.21)	-11.35 (11.94)	3.08 (7.39)	4.04 (12.10)	0.40 (6.99)	-7.28 (12.69)	-2.07 (9.61)	-1.94 (11.65)	-10.56 (16.12)	1.17 (18.14)
Student-to-book ratio	-0.11 (0.29)	0.16 (0.45)	0.16 (0.39)	0.55 (0.60)	0.37 (0.35)	0.69 (0.61)	0.18 (0.33)	-0.18 (0.64)	-0.56 (0.45)	0.69 (0.59)	-1.88** (0.76)	0.07 (0.92)
Constant	466.78*** (32.28)	253.88*** (54.75)	385.12*** (42.81)	231.37** (72.64)	390.19*** (38.53)	185.16* (73.61)	441.16*** (36.43)	263.27*** (77.20)	509.51*** (50.10)	192.19*** (70.88)	631.62*** (84.00)	495.45*** (110.33)

Standard deviation in parentheses; p < 0.01, ** p < 0.05, * p < 0.1.

points). This could indicate a mismatch between academic training and field-based pedagogical practices, especially if highly qualified teachers do not receive training in active pedagogy. Hanushek (2003) insists that the diploma is not a good predictor of the quality of teaching, while Froelich *et al.* (2007) remind us of the importance of contextualized training.

Experience (10 years or more) does not have a strong effect, except at the bottom of the urban distribution (+26.6 points at the 10th percentile), suggesting that experienced teachers may be better able to help students who are struggling. Participation in continuing education has no significant effect on performance in any setting. This raises the question of their real content and their anchoring in daily practices.

Finally, the high ratio of students to books is slightly unfavorable at the top of the rural distribution (-1.88 points at the 90th percentile), with no effect elsewhere. This result suggests that the most advanced students are those who actively use textbooks, and that their absence can hinder their progress. Evans *et al.* (2010c) emphasize that access to educational resources is a differentiated lever according to the profile of students.

Decomposition of differences and role of unobserved factors (Contribution of unobserved characteristics)

In mathematics, the share of the performance gap between rural and urban girls attributable to unobserved factors shows significant variability by skill level. On average, about 33% of the overall gap (MCO model) remains unexplained, suggesting that unmeasured or structural elements contribute substantially to inequalities in educational outcomes.

This unexplained share is particularly marked at the extremes of the distribution: it reaches 53.5% in the 10th quantile, i.e., among the lowest-performing students, and 37.6% in the 90th quantile, i.e., among the most successful students (Figure 1). On the other hand, it fell to 25.6% in the 30th quantile and 20.1% in the 70th quantile, indicating a lesser influence of these factors at the centre of the distribution. These results highlight a dynamic of differentiated inequalities:

For girls at the bottom of the distribution, the high weight of the unexplained could reflect factors such as the lack of pedagogical supervision, family precariousness, or unstimulating school environments in rural areas. At the other extreme, for the most successful students, the unexplained share suggests that urban girls benefit from favourable contexts that are less captured by the variables observed: increased family

support, cultural resources, or differentiated teaching practices. Thus, educational inequalities between places of residence do not manifest themselves uniformly, but vary according to the level of competence. These «invisible» gaps underline the need to integrate more qualitative and contextual variables into the analyses, and to orient educational policies towards targeted interventions: reinforced support for the most disadvantaged and strategies to enhance the potential of high-level students, particularly in rural areas.

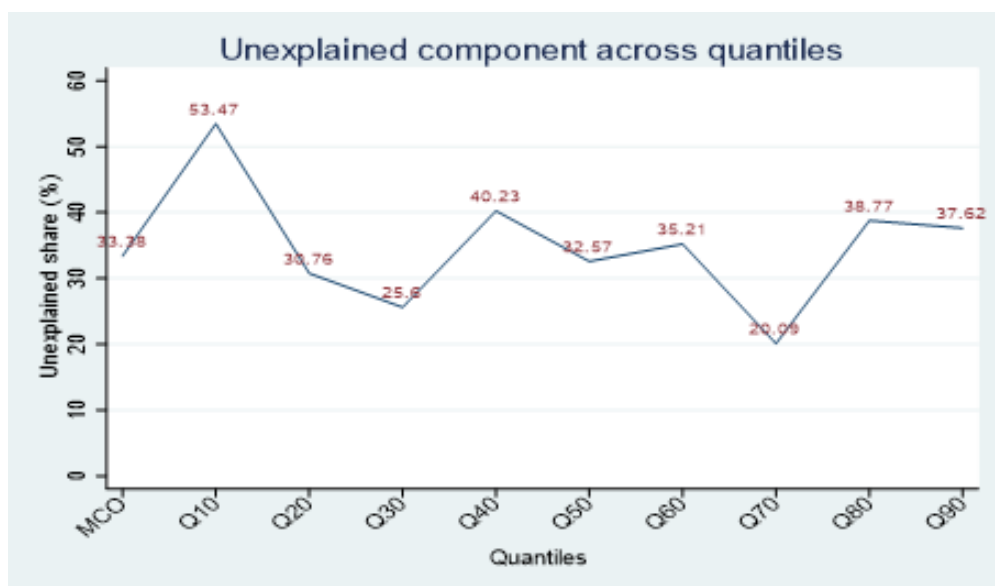


Figure 2: Unexplained Share of the Performance Gap between Rural and Urban Girls in Math by Quantile

Table 2: Performance gap in mathematics between girls in rural and urban areas attributable to unobserved factors

Estimation	Rural	Urban	Difference	Explained	Unexplained	% Unexplained
MCO	459.63*** (3.15)	556.99*** (4.97)	-97.36*** (5.88)	-64.85*** (6.65)	-32.51*** (5.42)	33.38%
Q10	368.18*** (3.41)	432.67*** (7.19)	-64.48*** (7.95)	-30.00*** (7.84)	-34.48*** (4.64)	53.47%
Q20	391.69*** (3.36)	470.12*** (6.39)	-78.43*** (7.22)	-54.30*** (7.69)	-24.13*** (5.44)	30,76%
Q30	410.26*** (3.46)	499.86*** (5.89)	-89.59*** (6.83)	-66.66*** (7.92)	-22.93*** (6.32)	25,60%

<i>Estimation</i>	<i>Rural</i>	<i>Urban</i>	<i>Difference</i>	<i>Explained</i>	<i>Unexplained</i>	<i>% Unexplained</i>
Q40	428.01*** (3.66)	519.94*** (6.09)	-91.92*** (7.10)	-54.95*** (8.25)	-36.97*** (6.66)	40,23 %
Q50	448.05*** (4.00)	545.74*** (6.99)	-97.68*** (8.05)	-65.87*** (8.88)	-31.81*** (6.78)	32,57 %
Q60	467.55*** (4.37)	578.19*** (7.92)	-110.63*** (9.05)	-71.68*** (9.66)	-38.94*** (7.04)	35,21 %
Q70	494.81*** (4.83)	610.69*** (7.45)	-115.88*** (8.88)	-92.60*** (9.34)	-23.28*** (7.42)	20,09 %
Q80	520.16*** (5.21)	645.11*** (8.00)	-124.94*** (9.55)	-76.50*** (12.75)	-48.44*** (11.22)	38,77 %
Q 90	574.50*** (8.31)	695.52*** (9.74)	-121.02*** (12.81)	-75.49*** (14.82)	-45.53*** (13.91)	37,62 %

Note: Robust standard deviation in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

Difference = private average – public average; Unexplained percentage = (unexplained/difference) × 100.

Conclusion

The analysis reveals a worrying disparity in mathematics performance between girls living in urban and rural areas, with a difference of about 97 points. This gap is not limited to a simple divergence in level: it illustrates fundamental inequalities, rooted in living conditions, access to educational resources, and learning opportunities. Nearly two-thirds of this gap comes from observable differences such as kindergarten attendance, the number of books at home, or the level of parental engagement, but the impact of these resources varies by setting. Their effectiveness seems to be closely linked to the environment in which they are found. As a result, some resources are more beneficial for girls in urban areas, not only because they are more accessible, but also because they are better valued, used effectively, and adequately supported. A third of the remaining gap, unexplained by the factors measured, highlights the influence of invisible but crucial factors: varied social norms, cultural constraints, implicit biases, as well as the uneven quality of school and learning environments. These non-visible elements maintain an inequality of opportunity, despite efforts to standardize resources. Therefore, education policies must go beyond the mere provision of materials. It is essential not only to ensure fair access to resources, but also to ensure that they are truly appropriate in contexts marked by specific vulnerabilities. This requires a localized approach to educational equity, which restores local realities and social dynamics unique to each environment.

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