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IDENTIFYING AND EXPLAINING GENDER PEER EFFECTS IN ELEMENTARY SCHOOLS

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The aim of this paper is to investigate the casual relationship and the mechanisms behind school gender composition and scholastic achievement. We use four cohorts of 5th grade student's assessment of Math and Portuguese in Brazilian elementary public schools and apply an identification strategy relying on school level gender peer effects and school fixed effects combined with school-specific linear time trends to control for self-selection of students across schools. We identify a positive relationship between scholastic achievement and the proportion of female students. This effect is underlined by improvements in student behavior, as indicated by teachers' assessment of student's academic potential, self-esteem, interest, discipline, absenteeism, and perception about syllabus coverage and school violence. Hence, this research draws attention to gender as an important factor in the allocation of students and teachers within schools. The consideration of our findings in the formulation and execution of policies can result in effective low-cost measures aimed at increasing achievement.

KEYWORDS: Gender inequality, Academic achievement in Brazil, Peer effects.

1. INTRODUCTION

The idea that the interaction among students influences behavior and the learning environment, thus, affecting school productivity is quite intuitive. In this sense, studies that emphasize the determinants of school achievement and educational progress should address the role played by individual and by group effects. The latter, according to Sacerdote (2011), can be broadly defined as any externality in which peers background characteristics, current behavior, or outcomes affect an educational outcome.

The magnitude of this phenomenon is of great interest among educators, researchers and policymakers who are seeking to enhance the efficiency of schools by designing classrooms and schools in such a way that the grouping of peers takes into account students' characteristics. However, providing a credible measurement and identification on the nature and size of peer effects has been regarded as a steep challenge to researchers.[1]

In a seminal paper, Manski (1993) distinguishes three kinds of social effects that are relevant to the identification of social interactions among peers. Correlated effects, which according to Sacerdote (2011) corresponds to selection, so that similar individuals join or are assigned to

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[1] See Sacerdote (2011), Epple and Romano (2011) and Sacerdote (2014) for a review of the theoretical and applied literatures.

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the same group. Endogenous effects, expressing the influence of the behavior of the group on the behavior of an individual, which might translate to, for example, the influence of average peers' achievement on individual student achievement. Lastly, exogenous or contextual effects represent the relevance of group exogenous characteristics on individual behavior. This can be illustrated by the influence of peers' average background characteristics on student achievement.

Disentangle these effects is important for policy implications.[2] However, this paper's major concern is with establishing the presence and magnitude of the gender peer effects in Brazil or, in other words, with the extent of gender peer effects in the Brazilian educational production function. For that, we explore a census-based national public schools' assessment of 5th grade students on Math and literacy between 2009 and 2015, and follow Hoxby (2000) and Lavy and Schlosser (2011), employing an identification strategy that relies on idiosyncratic variations in the proportion of female students across adjacent cohorts within the same school. This strategy cannot separately identify endogenous and exogenous effects. Nonetheless, since it assumes that any cohort variability in the gender composition is exogenous to student's, parent's and school's characteristics, using repeated observations on schools in a school fixed effects framework we are able to control for unobserved and unchanging characteristics that may act as confounders in the estimation of the effect of peer gender composition.

In order to assess the validity of this identification strategy, first it is important to note that we restrict self-selection bias, since we are using a large sample of public schools. Elementary public schools in Brazil represent 80% of enrollment and most adopt the place of residence as their main admission criteria. We also demonstrate that substantial variability exists within schools, and that this variability is identified regardless of school size. Thus, the fixed effect framework is able to attain precise estimates. Moreover, we are also able to demonstrate that within-school variation in the proportion of girls is not related to within-school variation in student's or teacher's characteristics, nor with school size, providing further evidence supporting the validity of our identification strategy.

We also investigate if the gender peer effect is influenced by school size, students' socioeconomic background, nonlinearities in the proportion of girls and the gender distribution across classrooms. In the latter, we seek to go beyond the proportion of girls at school level and assess whether schools that tend to overly allocate boys and girls into different classrooms present further influences on achievement.

In addition to estimating gender peer effects, another concern of this study is with how the peer gender composition influences test scores. There are two major ways through which the composition of a classroom might influence learning. First, by the congestion effects, which are negative externalities created when one student impedes the learning of all other classmates (Lazear, 2001). This effect, in the gender context, can take place when a more disruptive boy is replaced by a girl, or when girls exert such an influence that reduces the chances of boys to misbehave. Second, teachers may treat boys and girls differently, in such a way that this influences grading, the content and the organization of what is taught (Dee, 2006). To assess these hypotheses and elucidate the drivers of the influence that girls have, we confront school gender composition with information on teachers' expectations over students' progress, their perception of the learning environment, job performance and satisfaction, as well as with pedagogical practices.

In two closely related papers Lavy and Schlosser (2011) and Gong et al. (2021) also explore the mechanisms through which gender peer effects influence test scores. In general, their findings suggest that students' perceived improvements of classroom environment, inter-student,

[2]See Hoxby and Weingarth (2005), Sacerdote (2011), Epple and Romano (2011), and Sacerdote (2014).

teacher-student relations and, specifically for the latter, that students' and teachers' own behavior are all relevant towards this influence. In the present paper, besides exploring a distinct cultural context than the previous authors, we base our estimates on a wide array of measures of teachers' views on classroom and school climate which, therefore, may or may not be aligned with the students' perceptions.

Our findings suggest that the proportion of girls positively affects Math and Portuguese test scores of boys and girls. Despite the fact that these effects are quite similar, they are slightly larger for Math, a subject that girls tend to be outperformed by boys (OECD, 2019). Furthermore, we found evidence that these estimates do not rely solely on the size of the school, or on the socioeconomic background of the school's students. Moreover, we find that girls' achievements are higher when they attend schools with classes that tend to group them in the same classroom. This effect, however, does not hold for boys, implying that despite both genders profit from coexisting, girls benefit even more if clustered together. This has an important policy implication since the composition of classrooms is more easily managed by the public schools' authorities than the gender composition at the time of enrollment.

In addition, our results indicate that the benefits of having a greater proportion of girls are associated with greater teacher expectations over student's academic future, improvements of teachers' perception of students' self-esteem, disinterest, indiscipline and absenteeism, as well as syllabus coverage and violence exposure. However, differently from Gong et al. (2021), we find no evidence of changes on teachers' behavior, as measured by the adoption of a distinct pedagogical methods. This research, nonetheless, builds upon previous literature and draws attention to gender as an important factor in the allocation of students and teachers within schools, suggesting new ways of increasing school efficiency, especially in Brazil, a country that already performs below OECD average, and worse than countries with similar expenditure per student (OECD, 2016).

This paper is structured as follows. The next section describes our empirical strategy, discusses the data and the construction of the samples used throughout the analysis. Section 3 begins with evidences of the validity of our identification strategy, then presents our main estimates of the gender peer effects, and the possibility of heterogeneous and non-linear effects. In its last part, Section 3 shows the estimates of gender composition on learning environment indicators, teacher's expectations and student behavior. Section 4 presents the concluding remarks.

2. EMPIRICAL STRATEGY

One of the main challenges in estimating peer effects is that schools and classrooms are not formed randomly, so that the composition of schools and classes may reflect, among other factors, the family background of students. This may occur, for example, when affluent parents are more active in the search of the best school for their children, or when principals organize the composition of classes so that better performers or students with the same socio-economic background can study together. Many other classroom and school characteristics can influence their composition, and some of them may not be observed by the researcher. These factors, therefore, act as confounders in the estimation of peer effects, since they may influence peer composition and the outcomes of the students in a given school.

The identification strategy used in this paper builds on the works of Hoxby (2000) and Lavy and Schlosser (2011), relying on school level gender peer effects and using school fixed effects and school specific time trend to control for sorting and self-selection of students across schools. The idea behind this strategy is that the variation in adjacent cohorts' peer composition within a grade within a school is idiosyncratic and beyond the easy management of parents and

schools (Hoxby, 2000). This happens because of the difficulty associated with predicting the gender composition of a specific cohort, and to the fact that it is expensive for the parents to react to this variation by changing schools, as opposed to the classroom composition.

Therefore, by using repeated observations on schools in a school fixed effects framework we are able to control for unobserved and unchanging characteristics that are related both to achievement and peer gender composition. Also, by including school-specific linear time trends, we are able to address the concern with within school correlations that are not fixed, such as trends in unobserved factors that may be correlated with the proportion of female students.[3] Therefore, we account for sorting and selection, such that after these controls a student achievement should be related to his own peers when peers are randomly distributed, that is, we are able to obtain the causal estimate of the peer gender composition. We employ this technique on two sets of estimates. The first assesses the impact of peer gender composition on test scores, while the second aims to identify the possible channels through which this gender composition influences test scores. As to these possible channels, we explore teachers' expectations over the students' academic progress, their perception of the learning environment, violence, and adoption of different pedagogical methods.

In the first set of estimates, concerning the identification of gender peer effects, we estimate Equation (1), as shown below, separately for boys and girls.

$$y_{ist} = \alpha_s + \tau_t + \delta_s + \lambda P_{st} + \beta x_{ist} + \theta \bar{X}_{(-i)st} + \varepsilon_{ist}, \tag{1}$$

where i denotes the individuals, s the schools, and t time. y_{ist} is the normalized Math or Portuguese score of each student; α_s and τ_t are the school and time effects, respectively; δ_s are school-specific linear time trends; P_{st} is the proportion of girls in 5th grade for each school, such that λ measures the gender peer effect; x_{ist} are the individual characteristics, which comprises of race, which is defined by white or non-white, a socioeconomic status index (SES), the number of people living in student household, and dummies for the cases where the father lives with the student, and if at least one of the parents graduated from university, as well as the student's school enrollment and enrollment squared; $\bar{X}_{(-i)st}$ are the school averages, excluding the own student, of the individual characteristics; and ε_{ist} is the error term. All estimations of Equation (1) consider school level clustered standard errors.

The coefficient of interest is λ, which captures the effects of having more female peers on student achievement on either Math or Portuguese. Moreover, once we are conditioning on school-fixed effects and school-specific time trends, we eliminate confounders in the estimation of the effect of peer gender composition and are able to compare students who have similar characteristics and face the same school environment, except for the fact that one cohort has more female students than the other due to purely random factors (Lavy and Schlosser, 2011). In other words, we are able to obtain the Average Treatment Effect (ATE) within the subpopulations of boys and girls.

It is worth noting that the SES index is built using the first component of Principal Component Analysis, a procedure commonly used as a dimensionality reduction technique (Jolliffe, 2002). It takes into consideration the number of bedrooms, bathrooms, computers, cars and televisions in the student household. With regard to missing[4] observations in any of these variables, we imputed the correspondent classroom mean of the characteristic, and added indicator dummies for these missing values in the model estimation. This procedure accounts for the

[3] For more on that, see Lavy and Schlosser (2011).

[4] A total of 11% of the individuals in our sample had missing observations that needed to be imputed in order to build the SES index.

possibility of non-random missing values and, also, avoids drastic reductions in the sample size (Allison, 2001).

In similar fashion, in the second part of this paper we estimate Equation (2), below, to assess the mechanisms by which the gender composition influences test scores.

$$\bar{y}_{st} = \alpha_s + \tau_t + \delta_s + \lambda P_{st} + \theta \bar{X}_{st} + \varepsilon_{st}, \tag{2}$$

where s denotes the schools, and t time. y_{st} is the school average of the indicator variable built from the teachers' answers to relevant questions in the inquiry; α_s and τ_t are the school and time effects, respectively; δ_s are school-specific linear time trends; P_{st} is the gender peer effect variable, which corresponds to the proportion of girls in 5th grade for each school; $\bar{X}_{st}$ consists of the average school cohort controls which, again, are race (white or non-white), a socioeconomic status index (SES), the number of people living in the student household, and dummies for the cases where the father lives with the student, and if at least one of the parents graduated from university, as well as the school enrollment and enrollment squared; it also contains the school averages of the teacher characteristics, that is, if whether the teacher has a graduate degree, a postgraduate degree, if he works in any other activity besides teaching, if he has more than 10 years of experience being a teacher, works more than 40 hours per week and a dummy indicating if he has a permanent teaching contract with the school; ε_{st} is the error term. All estimates of Equation (2) consider school level clustered standard errors.

2.1. *Data*

This paper uses four cohorts of the Brazilian Ministry of Education (Inep/MEC, 2019) assessment of Math and Portuguese learning for 5th grade public school students (2009, 2011, 2013 and 2015). This assessment is biannual, and also includes questionnaires for Principals, Teachers, Schools and Students. The latter, besides comprising of a test for each subject, collects information on the background of the students, and it is where we gather most of the variables used as controls in our estimates. We match the dataset from these four assessments to the corresponding Brazilian Education Census, in order to obtain data on enrollment and on the percentage of girls at the 5th grade school level, which is the variable of interest in the study.

We focus on 5th grade as we are pursuing a casual effect and need to reduce the influence of dropouts and school retention, two factors associated with gender that play an important role in the Brazilian school system, especially at more advanced school grades (OECD, 2016; 2019). The final sample only takes into account students in mixed gender regular education schools that appear in all the years of the assessment. We also exclude schools that base their admission criteria on an exam, as this is a source of selection, which could bias our estimates. Also, in order to avoid changes in the gender composition that might be a result of structural changes in the school, we drop schools that have an annual enrollment lower than 10 students, and those that experienced a change in enrollment of 80% or more between two consecutive years. Table I[5] below presents the descriptive statistics by cohort for the main variables of interest used to estimate gender peer effects on test scores.

This sample comprises of almost 6 million students, fairly distributed across the years, and in 23,689 schools. On average, as mentioned in the Introduction, boys tend to outperform girls in Math, while the gap in score favors women in literacy. The mean proportions of girls in all cohorts are slightly below 50%, without any time trend. Our estimates regarding the possible channels through which the gender composition influences test scores, in the second part of the paper, is slightly different since some of the teacher's questionnaires are missing. Below, Table II, presents the descriptive statistics of this sample.

[5]Descriptive statistics for the rest of the variables are in Table A.I in the Appendix.

TABLE I

DESCRIPTIVE STATISTICS OF NUMBER OF SCHOOLS, STUDENTS, PROPORTION OF FEMALES AND AVERAGE MATH AND PORTUGUESE SCORES BY COHORT

Cohort	Students	Schools	% of girls	Math Score				Portuguese Score			
				Females		Males		Females		Males	
				Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
2009	1,605,822	23,689	48.2	205.87	45.35	207.58	48.37	191.11	44.60	181.03	43.62
2011	1,491,958	23,689	48.0	209.55	46.03	212.81	48.69	198.37	45.69	185.44	45.14
2013	1,338,303	23,689	47.9	212.66	49.52	213.82	52.55	203.32	49.00	190.82	48.45
2015	1,369,161	23,689	48.1	218.53	44.47	221.36	46.90	213.31	46.24	202.68	46.91
All	5,805,244	23,689	48.1	211.38	46.55	213.61	49.36	201.03	47.01	189.52	46.64

Note: Elaborated by the authors using INEP/MEC (2009-2015).

TABLE II

DESCRIPTIVE STATISTICS OF THE SECOND SAMPLE, WITH NUMBER OF SCHOOLS, TEACHERS AND PERCENTAGE OF FEMALES BY COHORT

Cohort	Students	Schools	% of girls
2009	20,824	55,686	48.1
2011	20,824	89,020	47.9
2013	20,824	65,390	47.7
2015	20,824	88,992	48.1
All	20,824	299,088	48.0

Note: Elaborated by the authors using INEP/MEC (2009-2015).

The second set of estimates has a sample of almost 300 thousand teachers, in 20,824 schools. The variation in the number of teachers on each cohort, as already mentioned, is due to missing valid questionnaires. The mean proportions of girls in all the cohorts are fairly similar to our fist sample, that is, slightly below 50% and without any noticeable time trend.

As to the possible channels through which the gender composition influences test scores, we gathered over thirty questions in the teachers' questionnaire that relate to their perception of the learning environment, separating them by topics, which are: expectations over students' academic progress; syllabus progress and job satisfaction; student behavior; violence exposure; and, pedagogical methods. Since they are mostly yes or no questions, we transform them into dummy variables and calculate the yearly school average of each, creating an indicator that stands between 0 and 1.[6]

3. RESULTS

3.1. *Evidence on the validity of the identification strategy*

The main coefficient of interest in Equations 1 and 2 is λ, which can be understood as the average treatment effect of having more female peers in a given school. In order for this interpretation to hold, changes in the unobserved factors that could affect the student's achievement must be uncorrelated with changes in the proportion of females within a school. Also, there must be enough variation in the percentage of females at the different cohorts to enable a precise estimate of the gender peer effects on achievement. Table III report the variance decomposition of the proportion of females used on both set of estimates of this paper. In the first, where

[6]Descriptive statistics for these variables are in Table A.I in the Appendix.

TABLE III

DECOMPOSITION OF VARIANCE IN THE PROPORTION OF FEMALE STUDENTS

	Gender peer effects sample						Teachers' learning environment sample		
	Math			Portuguese					
	SSQ	% of total	Df	SSQ	% of total	Df	SSQ	% of total	Df
Between	1288761.7	22.11	23686	1032691.5	17.74	23688	373013	32.90	20823
Within	4539005.4	77.89	5779269	4789048.1	82.26	5780156	760831	67.10	278264
Total	5827767.1		5802955	5821739.6		5803844	1133844		

Note: SSQ: Sum of squares. DF: Degrees of freedom. Elaborated by the authors using INEP/MEC (2009-2015).

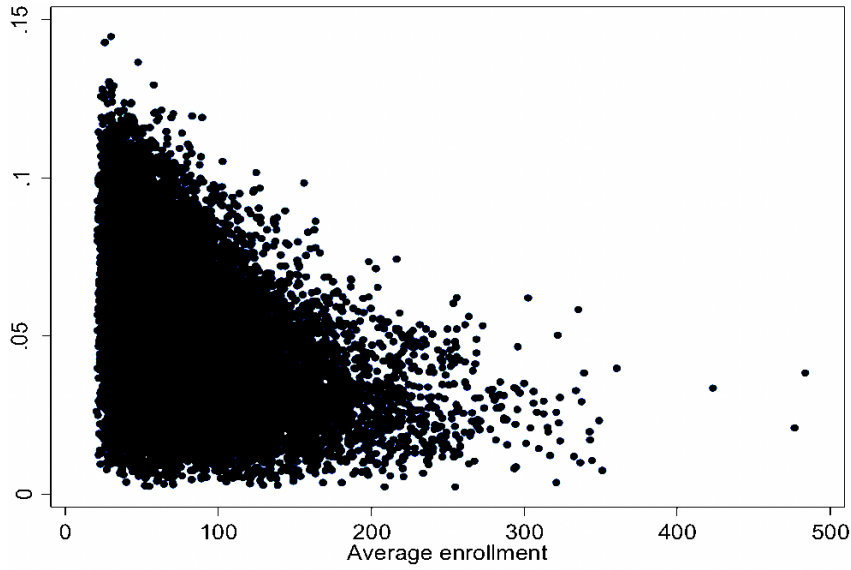

FIGURE 1.—Standard deviation of the proportion of females and school average enrollment. Source: Elaborated by the authors using INEP/MEC (2009-2015).

we seek to identify gender peer effects on test scores, the variance within schools is 78% in the Math sample and 82% in Portuguese, while in the second set of estimates, those regarding teacher's perception of the learning environment, 67% of the variance is within schools.

In addition to this substantial within school variance, Figure 1 depicts the correlation between the standard deviation of the proportion of girls in each school and its average enrollment.[7] This enables a better evaluation if there is a specific size of school that is responsible for this variability. The graph, in turn, shows that despite the fact that smaller schools account for the majority of the variance, there is still significant variability in schools whose average 5th grade enrollment is up to 300 students.

Another concern addressed by the identification strategy is to whether this within school variation in the proportion of female students is indeed random. If somehow unobserved characteristics as well as characteristics of the students, parents and schools influence the gender composition of a cohort within a school, the estimated peer effects will be biased. In this regard, we assume that parents are not able to predict the gender composition of their child's cohort

[7]Figure 1 is drawn from the sample used to identify gender peer effects. A graph for the sample used in the second set of estimates is not shown due to its similarity but is available upon request from the authors.

TABLE IV

BALANCING TESTS OF SCHOOLS' PROPORTION OF FEMALE STUDENTS ON STUDENT AND TEACHERS' CHARACTERISTICS

Student chacacteristics					
	OLS	SFE + time trend		OLS	SFE + time trend
race	$1.1\times10^{-3***}$	-3.2×10^{-5}	parents univdg	$2.9\times10^{-3***}$	-1.1×10^{-4}
	(1.6×10^{-4})	(6.7×10^{-5})		(1.6×10^{-4})	(7.1×10^{-5})
num people	$-6.6\times10^{-4***}$	-2.6×10^{-5}	father	-9.2×10^{-5}	-7.7×10^{-5}
	(5.7×10^{-5})	(2.9×10^{-5})		(9.7×10^{-5})	(5.6×10^{-5})
sesz	$2.0\times10^{-3***}$	-3.1×10^{-5}	enrollment	$2.5\times10^{-5***}$	3.0×10^{-6}
	(1.0×10^{-4})	(3.0×10^{-5})		(4.0×10^{-6})	(9.0×10^{-6})
Teachers characteristics					
	OLS	SFE + time trend		OLS	SFE + time trend
graduate dgr	$2.5\times10^{-3***}$	-1.8×10^{-4}	+10yrs experience	$2.0\times10^{-3***}$	4.5×10^{-4}
	(4.1×10^{-4})	(3.2×10^{-4})		(3.8×10^{-4})	(3.2×10^{-4})
postgraduate	$9.8\times10^{-4***}$	1.3×10^{-4}	type of contract	$1.8\times10^{-3***}$	3.7×10^{-4}
	(3.8×10^{-4})	(3.2×10^{-4})		(3.6×10^{-4})	(3.0×10^{-4})
other activity	2.8×10^{-4}	-1.8×10^{-4}	+ 40hr/week	-1.0×10^{-4}	-2.3×10^{-4}
	(3.6×10^{-4})	(3.0×10^{-4})		(3.5×10^{-4})	(2.8×10^{-4})

Note: Each cell on the table reports estimates of the effects of each control variable used in the estimates on the school level proportion of 5th grade female students. Robust standard errors clustered at the school level in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include year dummies. Source: Elaborated by the authors using INEP/MEC (2009-2015).

and hence, are not able to respond to it. This is corroborated by the fact that we use a national representative sample of public schools, which corresponds to 80% of the enrollment in elementary schools in Brazil, and that the majority of these schools have the place of residence as main admission criteria. Both these features diminish the possibility that any unobserved characteristic will influence the gender composition of a cohort within a given school.

Aside from that, in Table IV, shows if proportion of female students within schools is correlated with any of the control variables in our first set of models. We perform this balancing test by performing separate regressions of the treatment variable on each of the controls using School Fixed Effects (SFE) combined with school-specific linear time trend, and also using Ordinary Linear Squared (OLS), as a benchmark for comparison.

In the first sample, almost all observable characteristics are correlated with the proportion of females under Ordinary Least Squares, the exception being the presence of the student's father at home. Nonetheless, these correlations became statistically insignificant when we look within schools, with the addition of School Fixed Effects and school-specific linear time trends. Thus, most of the sorting and selection are accounted for, enabling a proper identification of the effect of the proportion of girls on achievement.

In a similar fashion, the bottom of Table IV tests whether the proportion of female students within schools is correlated with any of the teachers' characteristics we use in our second set of estimates. Again, under Ordinary Least Squares most of the observable teacher characteristics are correlated with the proportion of females, the exception being having another activity besides teaching and working more than 40 hours per week. However, with the addition of School Fixed Effects and school specific linear time trends, again, we account for the sorting and selection.

TABLE V

ESTIMATES OF THE EFFECT OF PROPORTION FEMALE ON STUDENT ACHIEVEMENT

	Females			Males		
	Proportion of Females in Cohort			Proportion of Males in Cohort		
	(1)	(2)	(3)	(4)	(5)	(6)
Math	0.89***	0.29***	0.27***	1.03***	0.27***	0.25***
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Portuguese	0.89***	0.31***	0.28***	0.97***	0.25***	0.24***
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Year effects	✓	✓	✓	✓	✓	✓
School fixed effects		✓	✓		✓	✓
School time trend			✓			✓
Individual Controls		✓			✓	
Cohort controls		✓			✓	

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on student achievement. These estimates are based on Equation (1), with dependent variable being the standardized test scores such that its distribution is the standard normal, $Z \sim N(0,1)$. Robust standard errors clustered at the school level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Elaborated by the authors using INEP/MEC (2009-2015).

3.2. *Estimates of gender peer effects in Brazilian elementary schools*

After analyzing the feasibility of the identification strategy in the last subsection, Table V reports the effects of the proportion of female peers on 5th grade achievement in Math and Portuguese. Each cell in the table shows the estimated coefficient, and its corresponding standard deviation, from separate regressions for boys and girls.

Columns 1-3 report the effects of the proportion of females in Math and Portuguese on the achievement of girls, while Columns 4-6 report these effects on boys. Three different specifications are considered, in order to assess how sensitive these estimates are to the control of school, individual and cohort characteristics. Columns 1 and 4 shows OLS estimates with only year dummies included as controls. Columns 2 and 5 include school fixed effects and school-specific linear time trends as controls, reducing drastically the size of the coefficients and their standard deviations. This decline suggests that selection and sorting across schools play a significant role in the estimation of peer effects and, therefore, controlling for these characteristics avoid estimation bias. The most complete specification, with the inclusion of individual and mean cohort characteristics as controls, are seen in Columns 3 and 6, and further reduces the size of the estimated coefficients and, to a less substantial degree, their standard deviation.[8]

Focusing on the more complete specification, the estimated coefficients show that both females and males tend to perform better in each of the subjects when they are in schools with a higher proportion of females. All estimates are statistically significant and indicate that an additional 10 percentage points in the proportion of girls would lead to increases of 2.72 and 2.83 percent of a standard deviation on the average of the Math and Portuguese tests for women.[9] For boys, the rise would be of 2.51 of a standard deviation for Math and 2.41 for Portuguese. Therefore, overall, the effect of having more female peers is slightly larger among girls than boys.

[8]We assessed the reliability of our estimates by applying a method suggested by Ferman (2022), testing if our clustered standard errors could be leading to overrejection of the null hypothesis. The results indicate there is no substantial risk, since for a test of size 5%, the probabilities were all below 10%.

[9]In comparison with the descriptive statistics shown on Table I, using the actual SAEB scale, the increase on girls' average test scores would be of 1,27 points in Math and 1,33 points in Portuguese. As for boys, the increase would be of 1,24 and 1,12 points, respectively for Math and Portuguese.

It is important to highlight that, despite being quite similar, a comparison between the subjects for boys, shows that the peer effects are slightly larger for Math, a subject that boys tend to outperform girls, as we have seen on Table I. This suggests that the gender peer effects are not solely associated with spillovers that arise from having higher achieving peers.

In terms of comparison, our results are moderate when compared to other estimates of gender peer effects. For example, Cabezas (2010) found that the same increase in the proportion of girls leads to a 0.53 percent of a standard deviation higher Math scores for Chilean students. While Hoxby (2000) found that a 10 percentage point increase in the proportion of females on Texas elementary schools leads to scores 1 to 2% of a standard deviation higher in Math and English. Lavy and Schlosser (2011) despite not finding any significant impact of the proportion of female students on 5th grade Israeli students in language tests, encountered that a 10 percentage point increase of female students raises average Math score by 3.7 percentage points of a standard deviation for girls and 2.18 for boys. A much larger effect was found by Gong et al. (2021) where the same increase in the proportion of female classmates raised Chinese students' test scores by 10.2% of a standard deviation.

3.2.1. *Heterogeneous effects*

In order to gain further insights on the extent of the gender peer effects, in Table VI we explore heterogeneous effects of the proportion of girls across different dimensions. First, we investigate differences by school size, by stratifying our sample into quartiles of the enrollment variable, from lowest (q1) to highest (q4) and running the baseline model for each subsample. This can be viewed as providing additional evidence that the mean effect we are capturing does not merely apply to small schools.

Second, we calculate the mean of the Socioeconomic Status index for each school and stratify the sample into quartiles of this variable's distribution,[10] in order to investigate whether the background of the students within each school interfere with the effect of the proportion of female students.

The estimations by school size, on the upper part of Table VI, indicate that higher proportions of female students lead to increases in achievement in all school sizes, for both Math and Portuguese. Also, by comparing the columns for each higher quartile of the enrollment distribution, the effect is increasing for both genders. The fact that the highest quartiles have the greatest impact is especially interesting, since there is not much of a difference in the proportion of female students for each quartile.[11] This, therefore, provides evidence that larger schools, despite the higher standard deviations, are also important to the estimation of the mean effect.

The bottom columns on Table VI present the estimates for the socioeconomic status index indicating that the effect on both subject is positive, and of similar magnitude across the quartiles of the index. Hence, suggesting that the effect of the gender composition does not strongly rely on the socioeconomic background of the school's students.

We also investigate nonlinearities in the proportion of females on Table VII, following Lavy and Schlosser (2011), by replacing the treatment variable by quartile identifier dummies of the proportion of girls. Therefore, the source of variation necessary for the identification of these non-linear effects consists in the dynamics of the schools in switching from each quartile in the different years of our sample. Table A.II on the Appendix report summary statistics on each quartile and a matrix with information on the extent to which schools switch from quantile to quantile. It shows that there is substantial variance in the quantiles, for example, only 342

[10] We exclude from these estimates all students with missing values for the SES index.

[11] The first quartile has, on average, 47.82% of females, while the last has 48.30%.

TABLE VI

HETEROGENEOUS EFFECTS OF THE PROPORTION OF FEMALES ON STUDENT ACHIEVEMENT BY SCHOOL SIZE AND SCHOOL STUDENT SOCIOECONOMIC STATUS

	School Size							
	q1		q2		q3		q4	
	Female	Male	Female	Male	Female	Male	Female	Male
Math	0.17***	0.14***	0.24***	0.18***	0.29***	0.33***	0.56***	0.58***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.06)
Schools	10234	10234	6213	6213	4425	4425	2815	2815
Students	709556	741489	712078	738637	715243	735802	715882	734269
Portuguese	0.17***	0.13***	0.25***	0.24***	0.32***	0.32***	0.56***	0.49***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.06)
Schools	10235	10235	6213	6213	4425	4425	2816	2816
Students	709647	741565	712116	738673	715283	735843	716166	734552
	School Students Socioeconomic Status							
	q1		q2		q3		q4	
	Female	Male	Female	Male	Female	Male	Female	Male
Math	0.27***	0.23***	0.27***	0.24***	0.24***	0.24***	0.23***	0.19***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)
Schools	7240	7240	6058	6058	5308	5308	5081	5081
Students	606713	618249	641300	644589	653577	660683	658660	669845
Portuguese	0.28***	0.21***	0.24***	0.27***	0.25***	0.25***	0.27***	0.20***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Schools	7240	7240	6059	6059	5308	5308	5082	5082
Students	606756	618263	641534	644834	653612	660725	658736	669895

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on student achievement. These estimates are based on Equation (1), with dependent variable being the standardized test scores such that its distribution is the standard normal, $Z \sim N(0,1)$. Regressions also includes year effects, school fixed effects, school specific linear time trends, individual and cohort means as controls. Robust standard errors clustered at the school level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Elaborated by the authors using INEP/MEC (2009-2015).

schools are in the first quantile on all four years of our sample, while 9,852 appears on the first and second quantiles during the four year period. Overall, of the total[12] 71,067 possible changes, 57,349 (80.7%) occurred.

The results on Table VII indicate that the effect of the proportion of females increases as schools switch to higher quartiles, as compared to the first. The effects do not seem to differ by subject, as the estimates for each quartile and gender are very similar. A move from the first to the second quartiles increases Math achievement by 0.012 and 0.017 percentage points of a standard deviation, respectively, for girls and boys, while in Portuguese, this increase would be of 0.014 for girls and 0.015 for boys.

Nonetheless, as on Hoxby (2000), for Texas elementary students, and Lavy and Schlosser (2011), for high schools in Israel, the greatest estimated effect on achievement is from moving to the highest quartile, where girls are the strict majority. In our case, this raises Math scores by 0.043 percentage points of a standard deviation for girls and 0.04 for boys, while the Portuguese scores are raised by 0.041 and 0.038 percentage points of a standard deviation.

[12]Total possible changes are calculated multiplying the total number of schools (23,689) with the three remaining years it could switch quantiles.

TABLE VII

NONLINEAR ESTIMATES OF THE EFFECT OF THE PROPORTION OF FEMALE ON STUDENT ACHIEVEMENT

	q2		q3		q4	
	Female	Male	Female	Male	Female	Male
Math	0.012***	0.017***	0.033***	0.029***	0.043***	0.040***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Portuguese	0.014***	0.015***	0.028***	0.024***	0.041***	0.038***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Range	0.442—0.481		0.481—0.519		0.519—1	
Mean	0.463		0.499		0.557	

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on student achievement. These estimates are based on Equation (1), with dependent variable being the standardized test scores such that its distribution is the standard normal, $Z \sim N(0,1)$. Regressions also includes year effects, school fixed effects, school specific linear time trends, individual and cohort means as controls. Robust standard errors clustered at the school level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Elaborated by the authors using INEP/MEC (2009-2015).

3.2.2. *Gender clustering schools*

Lastly, we ask whether the school's classroom formation interfere with the main effect of the proportion of girls. That is, we look beyond the proportion of girls at the school level and assess whether schools that tend to overly allocate boys and girls into different classrooms present further influences on achievement. To state it clearly, we are now concerned with the distribution of the girls within schools. Say, for example, if a school with two identical sized classrooms has 100 students, and 50% of them are girls, it is one thing to have all 50 girls in a single classroom, and another if they are evenly distributed across classrooms.

In order to assess that, we drop from our sample all schools with only one classroom, and build an indicator variable for those schools that have a standard deviation of the allocation of girls across classrooms larger than the national average.[13] Note that, the greater the standard deviation of a school gender composition across classrooms, the more uneven is the allocation of girls amongst these classrooms. Therefore, we identify those schools that tend to cluster girls in different classrooms from boys. Therefore, by interacting this indicator variable with the proportion of girls we are able to go beyond the mean treatment effect and assess if the gender composition of the school's classrooms interferes with it.

As we can see on Table VIII, increasing the proportion of girls in schools that tend cluster girls and boys in different classrooms boosts achievement only for females. That is, increasing the number of girls where they are grouped together further enhances the impact on achievement by 0.016 of a standard deviation in Math and 0.015 in Portuguese. Therefore, for girls, the total effect of having more females in schools that tend to cluster them together is around 0.3 standard deviations for both, Math and Portuguese. As for boys, the coefficient for the interaction with clustering schools is nonsignificant, indicating that the grouping of boys does not share the same boost in achievement.

Our findings imply that despite the fact that boys profit from coexistence, indicating that the gender composition also influences achievement, girls benefit even more if clustered together, thereby increasing school efficiency. Other authors in the peer effects literature find positive effects of grouping girls together. For example, Lu and Anderson (2015), who explore micro-environments in Chinese middle schools, find that being surrounded by classroom desks occupied by female peers increases female's test scores, but it can have a potentially negative effect on males.

[13] Descriptive statistics of this variable is found on Table A.III, on the Appendix.

TABLE VIII

IMPACT OF GENDER CLUSTERING SCHOOLS ON STUDENT ACHIEVEMENT

	Math		Portuguese	
	Female	Male	Female	Male
proportion of girls	0.276***	0.277***	0.278***	0.252***
	(0.020)	(0.021)	(0.017)	(0.017)
clustering school × proportion of girls	0.016***	–0.008	0.015***	–0.005
	(0.004)	(0.005)	(0.005)	(0.004)
Schools	22822	22822	22824	22824
Students	2692765	2785016	2693210	2785436

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on student achievement. These estimates are based on Equation (1), with dependent variable being the standardized test scores such that its distribution is the standard normal, $Z \sim N(0,1)$. Regressions also includes year effects, school fixed effects, school specific linear time trends, individual and cohort means as controls. Robust standard errors clustered at the school level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Elaborated by the authors using INEP/MEC (2009-2015).

This result is of special interest for Brazil, where the schooling system is composed of mostly coed schools that allocate students within classrooms predominantly by age and achievement, and not by gender. It also adds on the previous results of this paper, since the gender composition of classrooms is more easily managed by the public school authorities than the enrollment gender composition. Also, going beyond efficiency concerns, because clustering girls further benefit them, it could help narrow the gap between males and females in Math, which contributes towards the equality between genders.

3.3. *Exploring possible mechanisms of gender peer effects*

In order to further explore how the gender composition of schools helps to boost learning, this section of the paper concerns the estimates of Equation (2), that uses over thirty questions in the teachers' questionnaire, separating them into two subsections. The first is concerned with the relationship between gender school composition and teachers' perception of student effort, job satisfaction and their sense of job performance. These are measured by teachers' expectations over their students' academic progress, student behavior, syllabus coverage and two indicators of job satisfaction. The second subsection is devoted to the relationship between gender composition and teachers' violence exposure, and with the adoption of distinct pedagogical methods.

3.3.1. *The relationship between gender composition and teachers' perception of the learning environment and job performance and satisfaction*

The effects of the proportion of female students on 5th grade teacher expectations about his students, perception about disciplinary climate, and job satisfaction are shown on the three panels of Table IX, below. In panel A of Table IX, we assess whether teachers feel that more than half of his 5th grade students are going to graduate from elementary school, high school and will attend a college degree. Each cell in the panel shows the estimated coefficient, and its corresponding standard deviations, from separate regressions. Our most robust estimates are presented on Column 3, where year dummies, school fixed effects, school specific time trends, and teachers' and cohort mean characteristics are included as controls. We also present OLS estimates on Column 1, and a version of our school fixed effects model on Column 2, without controlling for teachers and cohort characteristics.

The estimates from Panel A of Table IX indicates that regardless of the complexity of the model we estimate, the proportion of girls in school tend to influence positively all measures of

TABLE IX

ESTIMATION OF THE EFFECT OF PROPORTION OF FEMALES ON TEACHERS' EXPECTATIONS OF STUDENT ACADEMIC PROGRESS, DISCIPLINARY CLIMATE AND JOB PERFORMANCE AND SATISFACTION

	A		
	(1)	(2)	(3)
Finish elementary school	0.064***	0.047***	0.032**
	(0.017)	(0.016)	(0.016)
Finish high school	0.145***	0.089***	0.076***
	(0.020)	(0.021)	(0.022)
Attend college	0.256***	0.143***	0.139***
	(0.028)	(0.028)	(0.028)
	B		
Student low self-esteem	–0.143***	–0.061**	–0.057**
	(0.027)	(0.026)	(0.026)
Student disinterest	–0.076***	–0.041**	–0.043**
	(0.016)	(0.018)	(0.019)
Student indiscipline	–0.245***	–0.195***	–0.190***
	(0.027)	(0.026)	(0.026)
Student absenteeism	–0.218***	–0.088***	–0.091***
	(0.027)	(0.028)	(0.029)
	C		
+80% syllabus coverage	0.407***	0.155***	0.149***
	(0.030)	(0.026)	(0.027)
Teacher work burnout	0.008	0.043*	0.036
	(0.025)	(0.025)	(0.025)
Teacher dissatisfaction	–0.043*	0.008	0.001
	(0.024)	(0.025)	(0.026)

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on teachers' outcomes. These estimates are based on Equation (2). Panel A reports the effects of the proportion of female students on teacher's expectation over student academic progress. Panel B reports the effects on teacher's perception of the disciplinary climate. Panel C reports the effects on teacher performance and job satisfaction. Regressions also includes year effects, school fixed effects, school specific linear time trends, teachers and cohort means as controls. Robust standard errors clustered at the school level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Elaborated by the authors using INEP/MEC (2009-2015).

teacher expectations regarding his students' academic progress. The effects seem stronger for finishing high school and attending college, leading, respectively, to 0.076 and 0.139 increases on average teacher's expectance. In order to assess if these expectations are affected by the gender of the teacher, as evidenced by (Dee, 2006), we separate our sample and estimate two distinct models[14] for each gender, but no statistical significant difference was found.

These results provide the first set of evidence that teaching environment improves with the proportion of girls. A conclusion shared with Lavy and Schlosser (2011) and Gong et al. (2021), who found positive spillovers from female peers in the quality of the teacher-student relationship. However, since our database refers to teachers' opinions, the results should not be taken as definite, as they may be reflecting teachers' stereotypes, which may constitute an important factor on student academic lives and even have long lasting consequences (Fennema et al., 1990). Even though we cannot rule this possibility out entirely, below we generate more evidence that at least part of this effect we are capturing is due to a better learning environment.

In order to measure the relationship between female students and the disciplinary climate, we use four questions of the teachers' questionnaire about their perception whether 5th grade

[14] We estimated conditional logit models, grouped by school and controlling for teachers and cohort characteristics.

student learning difficulties arise due to students' low self-esteem, disinterest and lack of effort, indiscipline or absenteeism.

The estimates, as shown in Panel B of Table IX, indicate that the proportion of girls is associated with an improvement in all measures of disciplinary climate and student behavior. The greatest effect is on teachers' perception of indiscipline, which is consistent with Bertrand and Pan (2013), Becker et al. (2010) and DiPrete and Jennings (2012) that emphasizes the positive consequences of girls' more advanced social and behavioral skills on education. Moreover, as underlined by Figlio (2007) and Blank and Shavit (2016), a disruptive classroom has negative effects on the learning process and lowers achievement. This has a special meaning in Brazil, where instructional time has been regarded as one of the biggest challenges the country needs to overcome in the pursuit of a better education Bruns et al. (2011).

In regard to the literature on gender peer effects, Lavy and Schlosser (2011) and Gong et al. (2021) explored students' self-reported measures[15] of classroom climate associated with indiscipline and disinterest, and also identified them as mechanisms though which gender peer effects influences achievement. In addition, Oosterbeek and van Ewijk (2014) identified a modest effect of the proportion of girls in reducing absenteeism in post-secondary education.

To further investigate the effects of the gender composition, we consider three questions about the teachers' performance and job satisfaction. That is, if he or she was able to cover more than 80% of the syllabus during this school's calendar year, and if she feels that the learning problems among her students are due to her job stress, which makes difficult to plan and prepare her class, or if whether she feels dissatisfied and discouraged by her profession. The relationship between these answers and the proportion of girls are shown on Panel C of Table IX.

The results indicate that a greater percentage of girls at school positively affect teachers capacity to cover the syllabus, as indicated by the teachers' school average response to the inquiry of whether they managed to teach more than 80% of the syllabus. This result builds on the evidence that girls lead to a better learning environment and, therefore, combined with Panel B results, provides clearer evidence of the positive climate spillovers of having more girls.

It is interesting to note that we do not find evidence of a relationship between the proportion of girls and teacher work satisfaction or job stress and burnout. This is in contrast with Lavy and Schlosser (2011), who focus on Israel educational data, and find a negative relationship between them.

3.3.2. *Teacher violence exposure and adoption of distinct pedagogical methods*

We also explore teachers' exposure to violence at school. First, by compiling the answers over a more direct connection, that is, if the teacher was a victim of theft, armed robbery, or if he or she had his life threatened, or was threatened by a student inside the school. In another part of the inquiry, we are able to gather information about the exposure to violence through the students' conduct, exploring answers regarding if the students attended class under the effect of alcohol, drugs or either carrying melee weapons or fire arms.

Our results indicate that a higher proportion of girls is associated with lower exposure to violence, as measured by the negative relationship with teachers' average response of being a victim of threats by their students and by having less students attending class carrying a melee weapon or under the effect of drugs. These results are closely related to the literature on the

[15] Lavy and Schlosser (2011) use measures of classroom disruption, such as: "frequently the classroom is noisy and not conducive to learning". Both papers also have measures of self-discipline and study efforts, such as hours spent on homework.

TABLE X

EFFECTS OF THE PROPORTION OF FEMALE STUDENTS ON TEACHERS' VIOLENCE EXPOSURE

	(1)	(2)	(3)		(1)	(2)	(3)
Life-threat.	−0.011	−0.008	−0.011	Stud. alcohol	−0.035***	−0.016	−0.016
	(0.007)	(0.012)	(0.012)		(0.011)	(0.015)	(0.015)
Theft	−0.009	−0.008	−0.003	Stud. drugs	−0.025	−0.025*	−0.027**
	(0.010)	(0.015)	(0.016)		(0.017)	(0.013)	(0.014)
Armd robbery	0.012*	0.013	0.012	Stud. weapon	−0.036***	−0.019	−0.025**
	(0.007)	(0.012)	(0.013)		(0.009)	(0.013)	(0.013)
Threatened	−0.106***	−0.090***	−0.090***	Std fire arms	−0.009	−0.006	−0.007
	(0.013)	(0.017)	(0.017)		(0.008)	(0.011)	(0.012)
Year effects	✓	✓	✓	Year effects	✓	✓	✓
School fixed effects		✓	✓	School fixed effects		✓	✓
School time trend			✓	School time trend			✓
Teach. cont.			✓	Teach. cont.			✓
Cohort cont.			✓	Cohort cont.			✓

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on teachers' indicators of violence exposure. These estimates are based on Equation (2). Robust standard errors clustered at the school level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Elaborated by the authors using INEP/MEC (2009-2015).

gender differences in behavioral and non-cognitive skills, where boys tend to be more disruptive (Bertrand and Pan, 2013), in such a way that, as highlighted in the previous subsections, girls tend to increase the learning environment.

Nonetheless, violence is a major problem in Brazil, studies that relate it to school outcomes have found that it directly reduces achievement, and is also associated with higher teacher and principal absenteeism, turnover, and to temporary school closings, which exacerbate its negative direct impact (Dalcin, 2016; Severnini and Firpo, 2010). Other factors related to violence in schools are its surroundings, students' background and teacher quality Tavares and Pietrobom (2016).

Overall, the results regarding our measures of student behavior indicate that a higher share of females in school generate improvements in student behavior, which reflects in less violence, greater teacher expectations over the student's academic future, and improves the teaching environment. Thus, we generate evidence that the gender mix should be directly taken into consideration when school authorities decide classroom composition. The same can be said about the teacher's allocation, as those who are better prepared to deal with behavioral problems could be assigned to classes that have a higher proportion of boys. This is an interesting result, especially in a country like Brazil, where most of the schools allocate students within classrooms by taking into consideration only the students' age and achievement, and not their gender. Moreover, on a wider perspective, the country should welcome policies aimed towards boys, as they are associated with a range of issues, regarding behavior, violence and school progress.

Lastly, we investigate if there is any relationship between the proportion of girls and some key pedagogical methods applied by the teachers. For that, we use conditional logit models, grouped by the schools in order to assess separately if Math and Portuguese teachers implement any one of the distinct pedagogical methods evaluated in the inquiry.

The estimated results indicate that there is no influence of the proportion of girls in any of the teaching methods inquired, regardless of the subject. Therefore, we provide evidence that teaching methods are not necessarily related to gender class or school composition. This result, however, is not shared by Gong et al. (2021) who find support of a more interactive teaching style and gender classroom composition. Nonetheless, the fact that teachers do not change the way they conduct a class based on gender, does not eliminate the possibility that teachers can

TABLE XI

ESTIMATES OF THE EFFECT OF THE PROPORTION OF GIRLS AND PEDAGOGICAL METHODS EMPLOYED BY TEACHERS, SEPARATED BY SUBJECT

Math Teachers		Portuguese Teachers	
familiar situations for students	0.14	copy texts from books or blackboard	–0.11
	(0.16)		(0.14)
reinforce procedures and rules	0.24	discuss texts from papers & magaz.	–0.04
	(0.16)		(0.12)
discuss solutions	0.21	use papers & magazines for grammar	0.03
	(0.21)		(0.12)
memorize rules to solve exercises	0.19	read chronicles, poetry & novels	–0.11
	(0.15)		(0.14)
content from papers & magazines	–0.06	use poetry and novels for grammar	0.06
	(0.13)		(0.13)
discuss methods	–0.06	reinforce grammar concepts	0.17
	(0.21)		(0.13)
try new actions to solve exercises	0.18		
	(0.14)		
Year effects	✓	Year effects	✓
School fixed effects	✓	School fixed effects	✓
School time trend	✓	School time trend	✓
Teacher controls	✓	Teacher controls	✓
Cohort controls	✓	Cohort controls	✓

Note: Each cell on the table reports estimates of the effects of the school level proportion of 5th grade female students on each indicator of teachers' pedagogical methods. These estimates are based on Equation (2). Robust standard errors clustered at the school level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Elaborated by the authors using INEP/MEC (2009-2015).

play an important role in shaping gender interactions or even display stereotype bias, which can contribute to the gender gap on achievement (Dee, 2006; Fennema et al., 1990). These latter effects, despite consisting in interesting research questions, remain a challenge for future work, as it extrapolates the objective of this paper.

4. CONCLUDING REMARKS

This paper investigates gender peer effects among 5th grade public school students in Brazil. It analyzes if the assignment of a student to a school with a higher proportion of girls influences Math and Portuguese achievement. It also investigates if this effect is influenced by school size, students' socioeconomic background, nonlinearities in the proportion of girls and at classroom gender composition, identifying those schools that tend to overly allocate boys and girls to different classes in order to verify if this also influences achievement.

Our findings indicate a positive causal relationship between the proportion of girls and achievement for both genders and on both subjects, especially for Math. They also indicate that this effect does not depend on school size, background of the students and that it is increasing with higher proportions of females. Moreover, we also find that girls' achievements are higher when they attend schools with classes that tend to segregate the two genders, implying that despite both genders profit from coexisting, girls benefit even more if clustered together. Therefore, it is not only having more girls in a school that is beneficial to achievement, but the actual coexistence between males and females also plays an important role in test score improvement, especially for women.

This result is not entirely shared by the literature on peer effects, and a more definitive evaluation of whether coeducational or single-sex schools are better for student achievement remains

a challenge for future works. Yet, our findings highlight that once we consider coeducational schools, the formation of the gender mix of classes is important to increase school efficiency, as it benefits especially girls.

We also investigate the mechanisms through which girls positively affect test scores. For that, we relate school average teacher expectations over the students' academic progress, and their perception of the learning environment, violence, as well as their pedagogical methods with the school gender composition. Our findings highlight that the benefits of having a greater proportion of girls at school are mainly through improvements in the learning environment, which reflects in greater teacher expectations over student's academic future, improvements of teachers' perception of students' self-esteem, disinterest, indiscipline and absenteeism, as well as syllabus coverage and violence exposure.

As the proportion of girls positively influences behavior, and therefore achievement, the gender composition of classrooms and schools should be taken into consideration in the decision regarding the placement of low achievers and student with behavioral problems. Teachers who are better prepared to deal with behavioral problems could be assigned to classes that have a higher proportion of boys. Nonetheless, this association of boys with violence and other behavioral issues also highlights the need for policies aimed towards the improvement of their conditions.

These are interesting results in terms of public policies, especially in a country like Brazil, where the schooling system is composed of mostly coed schools that allocate students within classrooms predominantly by age and achievement, and not their gender. Therefore, taking these findings into consideration can result in an effective and low cost measure aimed at increasing achievement.

APPENDIX A: DESCRIPTIVE STATISTICS: ADDITIONAL TABLES

TABLE A.I

DESCRIPTIVE STATISTICS

Cohort	Avg SES		Avg father		Avg parents univ dg		Avg race		Avg num. of people	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
2009	0.02	0.11	0.70	0.72	0.19	0.21	0.38	0.38	3.69	3.70
2011	0.03	0.11	0.81	0.83	0.21	0.24	0.37	0.37	3.69	3.70
2013	0.03	0.10	0.69	0.71	0.22	0.24	0.37	0.37	3.92	3.89
2015	0.02	0.08	0.70	0.72	0.26	0.27	0.35	0.35	3.90	3.88
All	0.02	0.10	0.73	0.74	0.22	0.24	0.37	0.37	3.79	3.79

Note: Elaborated by the authors using INEP/MEC (2009-2015).

TABLE A.II

DESCRIPTIVE STATISTICS OF THE QUARTILES OF THE PROPORTION OF FEMALES

	q1	q2	q3	q4
Range	0—0.442	0.442—0.481	0.481—0.519	0.519—1
Mean	0.405	0.463	0.499	0.557
Median	0.413	0.463	0.500	0.548
Students	1451387	1454291	1448863	1450703
	School Transition Across Quartiles			
	q1	q2	q3	q4
q1	342	9852	9473	10687
q2		83	8475	9439
q3			56	9423
q4				205

Note: Elaborated by the authors using INEP/MEC (2009-2015).

TABLE A.III

PROPORTION OF GIRLS FOR CLUSTERING AND NONCLUSTERING SCHOOLS

Cohort	Clustering		Nonclustering	
	Female	Male	Female	Male
2009	0.488	0.476	0.488	0.477
2011	0.487	0.473	0.487	0.475
2013	0.485	0.471	0.487	0.473
2015	0.488	0.474	0.489	0.476
All	0.487	0.474	0.488	0.475
Schools	21,606		20,602	
Students	2,845,888		2,959,356	

Note: Elaborated by the authors using INEP/MEC (2009-2015).

TABLE A.IV

DESCRIPTIVE STATISTICS OF TEACHERS' PERCEPTION OF CLASSROOM CLIMATE

Variable/Topic	Mean	Std. Dev.	Min	Max
Teacher Expectations				
Attend college	0.420	0.402	0	1
Finish elementary school	0.769	0.388	0	1
Finish high school	0.703	0.402	0	1
Teacher Performance and Job Satisfaction				
80% Syllabus	0.473	0.403	0	1
Teacher work burnout	0.299	0.358	0	1
Teacher dissatisfaction	0.273	0.343	0	1
Teachers' Perception of Student Behavior				
Student low self-esteem	0.692	0.356	0	1
Student indifference	0.870	0.255	0	1
Student indiscipline	0.644	0.374	0	1
Student absenteeism	0.413	0.388	0	1
Teacher Violence Exposure				
Teacher victim of life-threatening situation	0.026	0.136	0	1
Teacher victim of theft	0.048	0.168	0	1
Teacher victim of armed robbery	0.030	0.153	0	1
Teacher threatened by student	0.089	0.230	0	1
Student attended class under alcoholic influence	0.093	0.252	0	1
Student attended class under drugs influence	0.048	0.180	0	1
Student carrying melee weapon in class	0.049	0.174	0	1
Student carrying fire arms in class	0.041	0.173	0	1
Teacher Pedagogical Methods				
Copy texts from books or blackboard	0.680	0.383	0	1
Use familiar situations for students	0.823	0.298	0	1
Discuss texts from papers & magazines	0.682	0.366	0	1
Use papers & magazines for grammar	0.653	0.375	0	1
Read chronicles, poetry & novels	0.759	0.347	0	1
Use poetry and novels for grammar	0.678	0.377	0	1
Reinforce grammar concepts	0.658	0.382	0	1
Reinforce procedures and rules	0.843	0.283	0	1
Discuss solutions	0.893	0.243	0	1
Memorize rules to solve exercises	0.744	0.356	0	1
Content from papers & magazines	0.594	0.397	0	1
Discuss methods	0.896	0.241	0	1
Try new actions to solve exercises	0.728	0.354	0	1

Note: Elaborated by the authors using INEP/MEC (2009-2015).

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