

The sins of the parents: Persistence of gender bias across generations and the gender gap in math performance

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Abstract

We study the transmission of gender bias from adults to children and how this contributes to the gender gap in mathematics. We exploit plausibly exogenous variation in the proportion of a child's middle school classmates whose parents believe boys are better than girls at learning mathematics. An increase in exposure to peers whose parents report this belief increases a child's likelihood of believing it, with similar effects for boys and girls and greater transmission from peers of the same gender. This exposure affects children's perceived difficulty of math, aspirations, and academic performance, generating gains for boys and losses for girls.

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1 Introduction

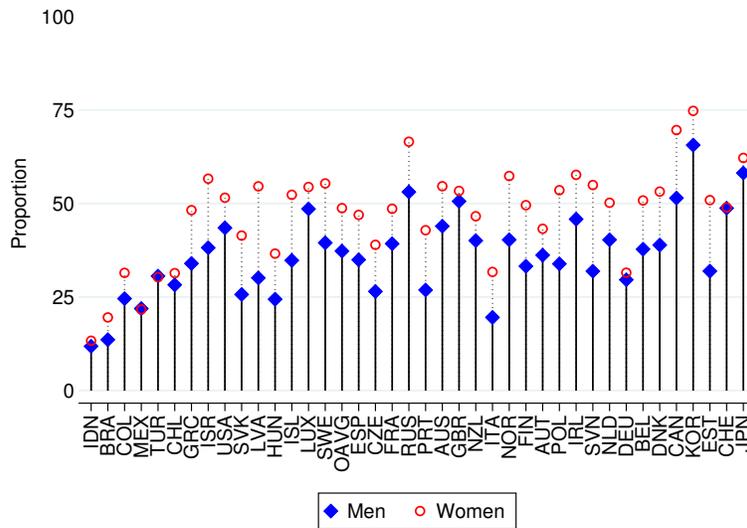
Historically, average levels of education among men far exceeded those of women (Goldin et al., 2006). Over the past 30 years, however, this gender gap in educational attainment has closed and then reversed in a large number of countries (Asadullah and Chaudhury, 2009; Bailey and Dynarski, 2011; Rosenzweig and Zhang, 2013). To illustrate this, in Panel A of Figure 1 we plot the tertiary graduation rates for men and women in a set of OECD countries where this data is available. In all but three of the 40 cases, women are more likely to earn tertiary credentials than men, often by more than fifteen percentage points.

Despite this reversal of the gender gap in educational attainment, the gender gap in mathematics and STEM achievement persists (Ellison and Swanson, 2010; Cheryan, 2012; González de San Román and de la Rica Goiricelaya, 2016). In Panel B of Figure 1, we show performance on the 2015 PISA math tests for boys and girls in the same countries studied in Panel A. In this plot, we see that boys almost always outperform girls in math, often by more than 0.1 SD (10 points). Such gender gaps in developing countries are often even more pronounced, as documented in Jayachandran (2015). This pattern is also reflected in children's beliefs about themselves: in many of these countries, the majority of children continue to believe that boys are better than girls at learning math (Beilock et al., 2010; OECD, 2015).

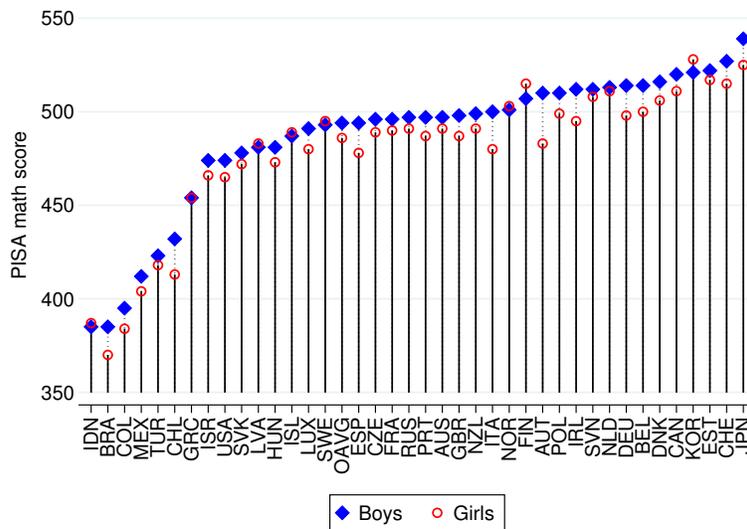
In this paper, we use nationally representative data from China to study the transmission of biased beliefs across generations and how this affects girls' academic performance relative to boys. We exploit the random assignment of children to classrooms in Chinese middle schools to estimate the effects of a novel channel for the intergenerational transmission of gender bias - exposure to bias from peers' parents. We study how this transmission varies across types of peer and show how it affects girls' and boys' performance on mathematics assessments.

A series of recent papers shows a clear picture that gender gaps in academic performance are at least partially driven by cultural norms and their transmission across gener-

Figure 1: Educational attainment and PISA scores of men and women in OECD countries



Panel A: Proportion of 25-34 year olds with tertiary credential, 2016



Panel B: 2015 PISA math scores

Note: These data were downloaded from <https://data.oecd.org/education.htm> on February 28th, 2018. The formatting of these two figures follows that of the OECD. We include only countries for which there are both PISA math scores and data on tertiary attainment. Countries are ordered by rank in boys' 2015 PISA math scores.

ations. Several of these papers demonstrate that children from societies which have more prevalent male-favoring gender norms have greater gender gaps in academic performance (González de San Román and de la Rica Goiricelaya, 2016; Nollenberger et al., 2016; Rodríguez-Planas and Nollenberger, 2018). The authors also find that these gaps persist among those who immigrate to OECD countries, and that some of this transmits within families through the mother's decision to participate in the labor market¹. We know far less about the channels driving these effects. Likely candidates include parents' investment decisions, parental encouragement or discouragement of the child in different activities, and direct transmission of beliefs, to name only a few. Much of the difficulty in pinning these down stems from two facts: one, it is logistically and ethically infeasible to randomize parent or societal bias; two, comparison of children whose parents express bias to those whose parents do not is challenging because of issues of temporality (bias leads to differences in parent investment, encouragement, and other behaviors) and omitted variables (Dhar et al., 2015).

We address this problem by exploiting random assignment of children to classes within Chinese middle schools, which gives us plausibly exogenous variation in the proportion of a child's peers whose parents hold gender bias. This, in turn, allows us to present what we believe are the first causal estimates of the intergenerational transmission of gender bias and its role in depressing girls' academic performance relative to boys.

Our data is a nationally representative sample of Chinese middle schools which surveys all students and their parents in four classes (two classes randomly selected from grade seven and from grade nine, respectively) in each school. In addition to data on classrooms, academic performance, and demographics, it also collects data on gender bias. Specifically, it asks children and their parents whether they believe that boys are better than girls at learning mathematics. We use this to generate a measure, for each student, of the proportion of peers whose parents are biased against girls, and study the effects of variation in this measure on child bias, aspirations, and performance.

¹A separate series of papers shows that gender gaps in labor force participation and wage rates of second generation immigrants often mirror those in immigrants' countries of origin (Antecol, 2000, 2001).

We find that a one standard deviation, or roughly 11 percentage point, increase in the proportion of peers whose parents are biased increases the likelihood that a child holds the bias by 4.2 percentage points, from a baseline of 52 percent. Moving a child from the least biased classroom in our sample (no peer parent bias) to the most biased classroom in our sample (where more than 83 percent of parents express bias) would generate an increase of 32 percentage points in the likelihood of the child holding this bias. These effects are similar for boys and for girls.

Our subsequent results show that the transmission of gender bias affects children's beliefs about themselves as well as their performance in mathematics. Furthermore, these effects embody the message of the bias: an increase in peer parents' bias improves outcomes for boys and worsens them for girls. We estimate that a one SD increase in peer parent bias increases girls' likelihood of perceiving math to be difficult, relative to boys', by 2 percentage points (a 28 percent increase in the gap between boys' and girls' perceived difficulty), and worsens their relative performance on standardized math exams by 0.06 SD. These effects are monotonic over the distribution of the peer parents' bias measure, suggesting much larger effects for larger changes in peer parents' bias. The effects on test scores are also remarkably similar to the 0.07 SD (7.47 point) change in the gender test gap in PISA scores that both Nollenberger et al. (2016) and Rodríguez-Planas and Nollenberger (2018) find is associated with a one standard deviation change in a country's gender equality index².

Our measure of peer parent bias captures the average levels of peers' parents' bias and any factors which have contributed to it, which may include a variety of other well-known sources of peer effects such as peer ability or parental education/occupation. We conduct a series of horse race regressions to distinguish between two possible explanations for our estimated effects. Explanation one is that peer parent bias is merely a new measure for a broader latent variable, also captured by other sources of peer effects documented

²Rodríguez-Planas and Nollenberger (2018) find that a country's overall gender norms influence girls' preferences for math but do not appear to affect math-specific gender stereotypes. In this paper, we focus instead on math-specific stereotypes because that is what is collected in the data we use.

in prior studies (c.f. Sacerdote et al., 2011). Explanation two is that there is sufficient variation in our peer parent bias measure, independent of other known sources of peer effects, to generate the patterns we observe. In line with the latter explanation, we find that our coefficient estimates for bias transmission and test performance are stable, both in magnitude and significance, to adding proxies for several other sources of peer effects, including peer ability (as in Feld and Zölit, 2017, among many others), peer parents' education (Fruehwirth, 2017), and class gender composition (Hu, 2015).

We next study how the transmission of bias works across individuals and across time. We first examine how peer identity affects bias transmission and its effects on performance. We create separate measures of peer parent bias by the gender of a child's peers, generating one measure for girl peers' parents' bias and another for boy peers' parents' bias. We find that girl peers' parents' bias has larger effects on girls' beliefs and performance than on boys', and vice versa, consistent with the notion of homophily (Currarini et al., 2009). We then study whether effect sizes vary with duration of exposure. To do so, we compare children who have spent more than two years with their randomly assigned peers to those who have only spent three to six months with these peers. While we find no evidence that more time spent with peers increases bias transmission, we do see a larger negative effect on test scores among girls who have been exposed to bias for a longer period of time³.

Finally, we look more closely at how exposure to bias affects girls. We find that exposure to bias is more harmful for girls whose own parents are also biased. We also find that girls who have no close friends in their randomly assigned classroom experience much greater harm in aspirations and test scores from increases in peer parent bias, while girls whose five closest friends are all in the classroom appear to be immune to the negative knock-on effects of bias transmission, corroborating the findings of Lavy and Sand (Forthcoming) and Hahn et al. (2017). We then present suggestive evidence to try to distinguish

³This result is consistent with the following hypothesis: bias transmission affects beliefs rapidly, but effects for performance may take time to gestate through differences in enthusiasm and exerted effort, which lead to marginally worse performance. This performance signal then provides information about the returns to subsequent effort, which can affect future enthusiasm/effort allocation decisions and lead to a cycle of effects compounding over time. This is similar to the model we outline in Eble and Hu (2017).

between two distinct ways girls might respond to high levels of gender bias: one, that exposure to bias would cause girls to reallocate effort away from math towards other subjects (e.g., language arts); and two, that exposure to bias may cause girls to change their beliefs about their own ability in subjects beyond math. We show suggestive evidence in support of the second story, finding small reductions in performance on standardized Chinese and English tests and weak evidence of a drop in girls' confidence about their future.

We aim to contribute to ongoing research on the formation of beliefs, the causes and consequences of gender disparity, and peer effects. First, we add to a series of papers studying the formation of beliefs among children and belief transmission from parent to child (e.g., Akerlof and Kranton, 2000; Fernández et al., 2004; González de San Román and de la Rica Goiricelaya, 2016; Olivetti et al., Forthcoming; Rodríguez-Planas and Nollenberger, 2018). The closest paper to ours in this literature is Dhar et al. (2015), who also study intergenerational transmission of gender bias. We further their work by exploiting a data set with universal coverage of classmates, random assignment of children to classrooms, and administrative performance data. Second, we add to the vibrant literature on gender gaps, both overall and in STEM fields (e.g., Niederle and Vesterlund, 2010; Ellison and Swanson, 2010; Jayachandran, 2015; Nollenberger et al., 2016). Third, we contribute to the rich literature on peer effects (c.f. Sacerdote et al., 2011; Lavy and Schlosser, 2011; Feld and Zölitz, 2017), and, specifically, work on the impact of peers' parents on children's performance (e.g., Carrell and Hoekstra 2010; Bifulco et al. 2011; Fruehwirth 2017; Olivetti et al. Forthcoming).

The rest of the paper proceeds as follows. In Section 2, we describe the setting we study, our data, and our empirical approach. In Section 3 we present our main empirical results on bias transmission and its effects on performance. In Section 4 we present evidence of the channels and mediators for the effects presented in the previous Section, and in Section 5 we conclude.

2 Data and empirical methodology

In this section we describe the setting we study, the data we use, and our empirical approach. Our analysis takes place in a nationally representative sample of Chinese middle schools. This setting has two features which facilitate causal inference and the study of gender bias. The first feature is common but not universal presence of anti-girl gender bias (henceforth “bias”) - 58.4 percent of boys and 47.4 percent of girls in our sample of middle school students agree with the statement “boys are better than girls at learning math.” The second feature is the random assignment of children to classrooms within schools. Students are usually allotted to middle schools by their local educational authority based on geographic proximity to schools. China’s compulsory education law requires that, within middle schools, students be randomly assigned to classes⁴. Several previous studies have used this policy and the random assignment it creates as a source of exogenous variation in classroom characteristics to study peer effects and the effects of teacher-student gender match on child performance (Hu, 2015; Eble and Hu, 2017; He et al., 2017; Gong et al., 2018).

2.1 Data

We use the first wave of the China Education Panel Studies for our empirical analysis. The CEPS is a nationally representative sample of Chinese middle school students, collecting a series of data from the students, their parents, their teachers, and their principals, planned to continue over several waves. The CEPS follows all students in two randomly selected seventh grade classes and two randomly selected ninth grade classes in each of 112 randomly selected schools⁵. These schools were selected using a nationally representative random sampling frame with selection probability proportional to size. The

⁴We discuss the potential for and extent of deviation from this rule below.

⁵Chinese middle schools typically span three grades: seven, eight, and nine. The median school in our dataset has six seventh grade classrooms and six ninth grade classrooms (mean: 7.3 and 6.9, respectively). There are not enough schools in our sample with only two classes per grade, i.e., where we would have all students in a grade, to study those as a separate subgroup.

dataset comprises approximately 20,000 students, and the first wave data was collected in the 2013-2014 academic year. The second, latest available wave collects data only for a subset of children, and so we do not use it here.

The CEPS student data includes administrative data on the child's academic performance in mathematics, Chinese, and English, as well as the child's responses to a survey about her beliefs, hobbies, social life, and aspirations. The parent data include a variety of demographic data as well as parent beliefs. The teacher and administrator data include information on teacher behavior, training, school facilities, and the method used to assign children to classes. Restricting our sample to within-grade classroom pairs using random assignment of children to classrooms⁶, we are left with 8,912 children in 215 classrooms spread across 87 schools. This is the estimation sample we use for our analysis. The excluded classrooms are those which report using methods other than random assignment to place children in classes. These are predominantly ninth grade classrooms, where enforcement is often more lax due to administrative concerns about placing children in good high schools; and classrooms in rural areas, where the enforcement of the law is less strict overall. Hu (2015) and Gong et al. (2018), among others, use this same dataset and sample restriction, and exploit random assignment of students to classrooms in a manner similar to that which we describe below.

Table 1 presents summary statistics for students, by gender, for those students randomly assigned to classrooms. The girls in our sample are slightly younger than the boys, and they are more likely to have wealthier, more educated parents. These girls also have a higher number of siblings, consistent with traditional norms and fertility responses to birth control policy in China which permits further parity, in some cases, if the first child is a girl (Chan et al., 2002). Finally, there is a "reverse gender gap" in mathematics, i.e., girls

⁶Across China, various methods are used for assignment of children to classes, including use of a random number generator, alphabetical assignment based on surname, and the system described in He et al. (2017) wherein an alternating sequence assigns students to classrooms sequentially based on their scores on an entrance exam in a way that preserves mean test score balance and avoids stratification across classrooms. The randomness of assignment of children to classrooms in Chinese middle schools and its appropriateness for causal inference has been probed in several recent papers, many of which use this same dataset (Hu, 2015; Eble and Hu, 2017; He et al., 2017; Gong et al., 2018).

Table 1: Summary statistics

	(1) All	(2) Girls	(3) Boys
Age	13.21	13.17	13.26
Holds agricultural hukou	0.50	0.49	0.51
Number of siblings	0.70	0.76	0.65
Household is poor	0.19	0.18	0.20
<i>Father's highest credential</i>			
Middle school	0.41	0.41	0.42
High school	0.26	0.25	0.26
College	0.19	0.20	0.18
<i>Mother's highest credential</i>			
Middle school	0.38	0.40	0.37
High school	0.23	0.23	0.23
College	0.16	0.16	0.15
Ethnic minority	0.11	0.12	0.11
Math test score	70.2	71.0	69.5
Number of observations	8,912	4,335	4,577

Note: this table presents summary statistics for observations in our estimation sample, that is, observations in the subset of grade-by-school pairs in the CEPS data which report random assignment of children to classes. The variables are all coded as 0 = No, 1 = Yes, except for age and number of siblings, which are self-explanatory, and test score (mean = 70, SD = 10).

perform better than boys in our sample. This is in contrast to the 2009 PISA results for Shanghai, where boys outperformed girls. While we are unable to pin down the reason for this discrepancy, our dataset is nationally representative of China and includes rural and urban areas, whereas the 2009 PISA data covers only Shanghai, one of the wealthiest urban centers in the country.

2.2 Empirical approach

In our empirical analysis, we focus on estimating two key relationships: the effect of a child’s peers’ parents’ beliefs on her or his outcomes (e.g., own bias, perceived difficulty of mathematics, aspirations, and academic performance) and how this varies with the child’s gender. Our identification strategy is to exploit random variation between classrooms in a given grade, within a given school, in the composition of peers’ parents’ gender biases. We use this variation to generate causal estimates of the effects of exposure to peer parents’ bias on outcomes. Our main estimating equation is as follows:

$$Y_{icgs} = \beta_0 + \beta_1 PPB_{icgs} + \beta_2 PPB_{icgs} * F_{icgs} + \beta_3 OPB_{icgs} + \beta_4 OPB_{icgs} * F_{icgs} + \beta_5 F_{icgs} + \beta_6 SC_{icgs} + \eta_{gs} + \varepsilon_{icgs} \quad (1)$$

In this equation, Y_{icgs} refers to the outcome of interest for child i in class c in grade g in school s . PPB_{icgs} is the proportion of child i ’s peers in her or his classroom who have parents who believe that boys are better than girls at learning math, henceforth “peer parents’ bias.” This is a leave-one-out measure: in calculating the bias of the child’s peers’ parents, we exclude her own parent’s reported bias. In our data, this measure varies from zero to 0.833 (mean 0.411). We follow the example of Chetty et al. (2014) in normalizing the variable to have a mean of zero and standard deviation of one. This ensures that our coefficient estimates for β_1 and β_2 are easily interpretable and more policy-relevant than the raw variable (which would capture the effect of moving from a classroom with no biased parents to one with only biased parents, the latter of which does not appear in our data). F_{icgs} is an indicator for the child being female. SC_{icgs} is a vector of characteristics

specific to the student⁷, including household residency status, parents' education, income level, the child's ethnicity, her number of siblings, and her perceived ability, proxied by her perceived difficulty of mathematics in the sixth grade. η_{gs} is a grade-by-school fixed effect⁸, and ε_{icgs} is a standard error, clustered at the grade-by-school level.

We include an indicator for whether the child's own parent believes that boys are better than girls at learning mathematics, OPB_{icgs} , which we will refer to from here onward as "own parent's bias," and its interaction with the child's gender. We include own parent's bias for two reasons: one, to follow recent work studying peers' parents' impact on children which includes the child's own parents' characteristic of interest in addition to those of peers (Bifulco et al., 2011; Fruehwirth, 2017; Olivetti et al., Forthcoming); two, because this correlation is an object of separate interest - it is the main focus of Dhar et al. (2015) - and helps benchmark the relative importance of peer parents' and own parent's bias. In the appendix we present a series of parallel tables for our main analyses which show the results generated by excluding the own parent's bias variables from the list of controls. Our findings are robust to choice of specification.

Our main coefficients of interest are β_1 (peer parents' bias) and β_2 (its interaction with the female child dummy). We further differentiate between two closely related but separate types of effect estimate for girls. The first type is the overall effect of peer parents' bias on girls' outcomes, captured by $\beta_1 + \beta_2$. The second type is the effect of peer parents' bias on the gender gap, captured by β_2 .

For causal interpretation of our estimates of β_1 and β_2 , we need to establish that within a school, across classrooms within a grade, the peer parents' bias measure is uncorrelated with other determinants of our outcome variables. If this assumption holds, we can use OLS to estimate the effect of peer parents' bias on child outcomes. We evaluate this assumption by regressing peer parents' bias on the (predetermined) characteristics in SC_{icgs} . This approach follows Antecol et al. (2015), Hansen and Bowers (2008), and Bruhn

⁷All results are robust to adding teacher characteristics as controls, as we show in column 3 of Table 4 and in Table A.6.

⁸We do not use classroom fixed effects because we wish to exploit the variation in peer parent bias between classrooms within a grade within a school.

Table 2: Test for randomization / balance

	(1)	(2)
Age	0.119*** (0.050)	-0.010 (0.008)
Holds agricultural hukou	-0.112 (0.069)	0.012 (0.016)
Number of siblings	-0.085** (0.041)	-0.009 (0.009)
Household is poor	-0.071 (0.073)	0.041* (0.022)
Female	0.017 (0.030)	0.017 (0.012)
<i>Mother's highest credential</i>		
Middle school	-0.069 (0.073)	0.016 (0.016)
High/technical school	0.063 (0.084)	0.030 (0.020)
College or above	0.087 (0.086)	0.024 (0.025)
<i>Father's highest credential</i>		
Middle school	-0.021 (0.049)	0.006 (0.017)
High/technical school	0.061 (0.071)	0.012 (0.029)
College or above	0.046 (0.083)	0.018 (0.032)
Ethnic minority	0.160 (0.265)	-0.024 (0.025)
Number of observations	8,345	8,345
R-squared	0.05	0.68
Joint test F-statistic	2.14	1.06
[p-value]	[0.02]	[0.41]

Note: this table presents a balancing test, as in Antecol et al. (2015), which tests for our set of predetermined characteristics' joint ability to predict the peer parent bias measure. Column 1 presents a regression without netting out grade-by-school fixed effects, and column 2 presents this same regression with these fixed effects netted out. The variables are all coded as 0 = No, 1 = Yes, except for age and number of siblings, which are self-explanatory, and test score (mean = 70, SD = 10). The dependent variable, peer parent bias, is standardized (mean = 0, SD = 1).

and McKenzie (2009). We present two sets of results in Table 2: in column 1, we show the results for regressing peer parents' bias on the vector of predetermined characteristics without any fixed effects; in column 2, we present results from a similar regression, now including the grade-by-school fixed effects we use in our main empirical specification. At the bottom of the table, we report the F-statistic and p-value from a Wald Test of the joint significance of the regressors. In column 2, we fail to reject the null that the regressors do not significantly predict peer parents' bias. We find similar results if we conduct the test separately by the grade a student is in. These are reported in Table A.2.

To include own parent's bias on the right hand side of our regression, we need that it be predetermined with respect to peer parents' bias. To test this, we regress peer parents' bias on own parent's bias using our core specification. Note that regressing an individual's given characteristic on the leave-one-out average of this same characteristic in an individual's randomly assigned cluster yields a mechanical negative correlation. The intuition behind this is as follows: given the random assignment of students into classes, the law of large numbers predicts that, in a given class, the proportion of students with a certain characteristic (e.g., average parent bias or percent female) will be distributed normally. A student's characteristic is thus negatively correlated with the leave-one-out average because the proportion (including the student herself) is equivalent to the sum of the student's characteristic and this average.

To formalize this intuition, we conduct a permutation test, randomly assigning 1,000 random variables with the same potential values (0/1) and mean (0.411) as the parent bias variable. We then standardize this and regress the student's random variable on the leave-one-out average of her peers' random variable values within her class, its interaction with the female dummy, and the controls given in Equation 1. This generates $\tilde{\gamma}$, the mean of our permutation test estimates. We find $\tilde{\gamma} = -0.107$ ($SE = 0.026$). In our regression using the true data, we find $\hat{\gamma} = -0.072$, well within the 95% confidence interval around $\tilde{\gamma}$ generated by the permutation test.

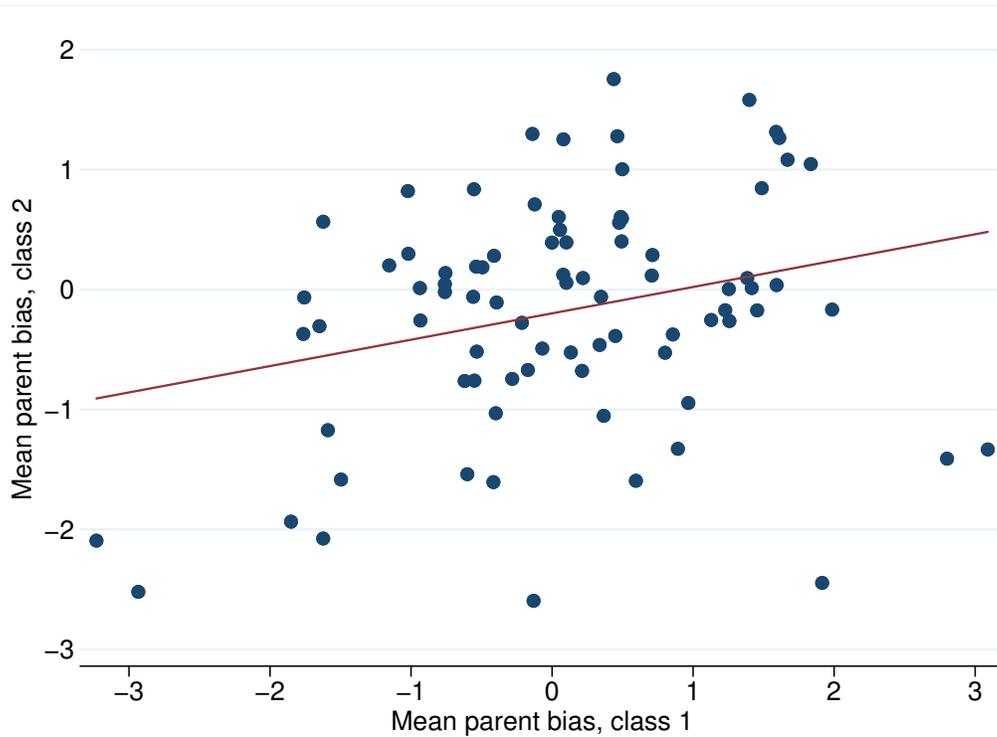
2.3 The peer parent bias measure

In this subsection we describe our peer parent bias measure, a key innovation of our paper, in greater detail. First we show summary statistics of predetermined characteristics separately for children of parents who do and do not hold biased beliefs. These results, given in Table A.1, show similarity between the two groups on these observable traits. This comparison suggests that at least some of the variation in exposure to gender bias we observe is idiosyncratic to the other traditional determinants of child success (and sources of peer effects), such as parental education and family wealth (Fruehwirth, 2017; Olivetti et al., Forthcoming). Next, we describe variation in the peer parent bias measure between children. At the child level, the maximum value of the peer parent bias measure is 0.833, the minimum is 0, and the mean is 0.411 (at three significant figures, the mean is the same for girls and boys). Once standardized, the variable ranges from -3.69 SD to 3.64 SD. We plot the distribution of this variable in Figure A.1.

Another object of interest is the variation in classroom-level bias between classes in a grade within a given school, the level of comparison we study by removing grade-by-school fixed effects in our regression specification. Here the central concern is to what extent the variation we observe in peer parent bias stems from variation between schools as opposed to variation between classes, within schools. If it were predominantly between-school variation that generates dispersion in our measure of peer parents' bias, we would be able to precisely estimate the effects of small changes in peer parent bias but would have less to say about larger changes, as they would necessitate out of sample predictions.

To address this, we first show how bias varies within the 87 within-school, within-grade pairs of classrooms in our data. In Figure 2, we plot each of the pairs, with the standardized class-average parent bias for class 1 shown on the x-axis, and that for class 2 on the y-axis. The figure shows a wide dispersion of bias across classrooms, within grades within schools. While there is evidence of a positive correlation (the slope of the line of best fit is 0.352), consistent with the idea that characteristics of schools and regions contribute to the level of bias within a school, school-level characteristics explain a small portion of variation

Figure 2: Dispersion of parent bias across within-school, within-grade classroom pairs



Note: this figure shows the average (standardized) parent bias in classroom 1 and classroom 2 in each of our 87 within-grade, within-school pairs. The slope of the regression line is 0.352 and the R-squared is 0.087.

in our bias measure. The R-squared of the line of best fit (i.e., regressing class two's average bias on that of class one) is only 0.087, and a decomposition of variance finds that between-school variation explains less than a third of the overall variation between classes in the parent bias measure. A separate way to capture the differences between classrooms within grades, within schools, is to calculate the absolute value of the difference in parent bias between classroom 1 and classroom 2. We calculate this value for every grade-by-school pair of classrooms. This value varies between 0.1 and 4.35 SD, with a mean of 1 SD, and we plot its distribution across the 87 classroom pairs in Figure A.2.

3 Estimated effects of exposure to bias

In this section, we present our estimates of the effect of peer parents' bias on children's beliefs and performance in mathematics. We also discuss the correlation between own parent's bias and child outcomes. In the section that follows, we explore the possible channels behind the estimates presented here.

First, we estimate the relationship between exposure to peer parent bias and children's beliefs. In this analysis, we study three latent variables related to children's beliefs about the world and themselves. The first latent variable is the extent to which the child herself holds bias. As with parents, we proxy for child bias with the child's response to the prompt: "do you agree that boys are better than girls at learning mathematics?" The second latent concept is the child's perceived ability in mathematics, for which we use the child's response to the prompt "how difficult do you find your current math class?" The possible responses are very difficult, somewhat difficult, a little difficult, and not difficult at all. We code this as a 0/1 variable, equal to one for those children who respond that the current math class is very or somewhat difficult. The third latent concept we study is the child's aspirations for the future. To measure this, we use the child's response to a prompt asking for her ideal level of completed schooling (e.g., high school, BA, master's, PhD), coding the variable as one for those who aspire to complete a BA or higher, and zero otherwise.

We present these results in Table 3. This table follows the convention that we will use for most of our main result tables: we present coefficient estimates for peer parents' bias (β_1) and its interaction with whether the child is female (β_2). We also present the coefficient's for parents' own bias (β_3) and its interaction with the female dummy (β_4). Finally, we present the coefficient on the child's own gender (β_5). At the bottom of our result tables we show the sample mean of the dependent variable and the number of observations used for estimation. Unless otherwise noted, variation in the number of observations comes from variation in the number of missing values across dependent variables. Our results are robust to restricting the sample to only those observations who have non-missing values for

Table 3: Effects on beliefs

	(1)	(2)	(3)
	Holds anti-girl bias	Perceives current math class to be difficult	Aspires to complete at least a BA
Peers' parents' gender bias (PPB)	0.042*** (0.013)	-0.015 (0.015)	0.003 (0.017)
PPB x female	0.002 (0.015)	0.020** (0.009)	0.006 (0.010)
Own parent's gender bias (OPB)	0.289*** (0.015)	-0.061*** (0.016)	0.014 (0.014)
OPB x female	0.030 (0.020)	0.150*** (0.022)	-0.013 (0.020)
Female	-0.119*** (0.019)	-0.039*** (0.015)	0.135*** (0.014)
Mean in sample	0.526	0.569	0.662
Number of observations	8,720	8,891	8,853

Note: this table shows results from estimating equation 1 using the dependent variable named in the column heading and described in the text. Variation in the number of observations across columns stems from differences in missing values for the dependent variables. The dependent variables are coded as 0 = No, 1 = Yes. In Table A.3, we show the analog to these results generated without own parent's bias on the right hand side.

all dependent variables.

In the first column, we present our estimates for the intergenerational transmission of bias. We estimate that a one standard deviation increase in peer parents' bias causes a 4.2 percentage point (8%) increase in the likelihood that a child will hold the bias (β_1). This transmission of bias appears to occur for both girls and boys in roughly the same manner; that is, β_2 is not statistically distinguishable from zero. While this is a moderate effect for a modest change in peer parent bias, we calculate that going from roughly 25 percent of peers' parents being biased to 75 percent of peers' parents being biased⁹ generates an 18.9 percentage point (34%) change in the likelihood that a child will also hold that bias.

The coefficients on own parent's bias and its interaction with gender are larger in magnitude. Children whose parents hold anti-girl bias are 29 percentage points (52%) more likely to also hold that bias, and again the transmission appears to hold equally for boys and for girls¹⁰. The coefficient on the female gender dummy shows a pattern that we also see in the raw data: overall, girls are less likely to be biased against women than boys.

In the next column, we show results for perceived difficulty of math. Here the signs of the estimates diverge for boys and girls, and we observe a significant effect of peer parents' bias on the gender gap in perceived difficulty. This pattern is the first in a series of evidence we present that bias transmission affects both children's beliefs about the world, but also their beliefs about themselves, in ways that embody the message of the bias that boys are better than girls at learning math. We estimate that an increase in peer parent bias increases the gender gap (β_2) in girls' perceived difficulty of math relative to boys' by two percentage points, or 28 percent of the 7.2 percentage point gap between boys and girls in this variable. This pattern also holds for own parents' bias, and the estimates are again more stark: our estimated coefficient of own parent's bias on the gender gap is a 15.0 percentage point increase in the likelihood that a girl perceives math to be difficult, relative to the likelihood for boys. For boys, own parent's bias is associated with a 6.1 percentage

⁹This comprises a 4.48 SD change in peer parent bias.

¹⁰This estimate is substantially larger than the 11 percentage point increase found among Indian secondary school children in Dhar et al. (2015).

point decrease in the likelihood the child will perceive math to be difficult; the “total effect” for girls is an 8.9 percentage point increase in this likelihood (the coefficient on OPB plus the coefficient on OPB x female, i.e., $\beta_3 + \beta_4$). Finally, for the aspirations measure, we find no evidence that this is affected by peer parents’ bias, though in the next section we show that these results mask important heterogeneity among girls.

Next, we study the effect of parent bias on a child’s performance in mathematics. Recall that the same midterm math test is administered across all classes within a grade, within a school. Within each grade-by-school cell, test scores are standardized to have a mean of 70 and a standard deviation of 10. We estimate the effect of peer parent bias on performance in these midterm math tests and present the results in Table 4. Column 1 shows the results without grade-by-school fixed effects, column 2 shows the results with these fixed effects added, and column 3 shows the results when we add controls for teacher characteristics to the specification used in column 2.

As with perceived difficulty, our estimates of the effect of peer parents’ bias on boys’ and girls’ test scores, respectively, differ in sign. Boys appear to gain slightly (a statistically insignificant 0.05 SD increase) from a one standard deviation increase in the proportion of peers whose parents believe that boys are superior to girls in learning math. For girls, on the other hand, we estimate that a one SD increase in peer parent bias increases the gender gap - that is, reduces girls’ performance relative to boys’ - by a statistically significant 0.063 SD. Column 3 shows that adding teacher characteristics reduces the estimated effect of peer parents’ bias for boys but leaves the estimate for girls largely unchanged.

Here again the correlation between own parent’s bias and performance is much larger in magnitude - the scores of boys whose parents believe that boys are better than girls at learning math are 0.16 SD higher than for boys whose parents do not believe this, and for girls, having a parent who holds this bias pushes the child’s test score down, relative to boys’ scores, by 0.28 SD. This highlights an empirical regularity that will appear in later results as well. Our estimate of β_2 is roughly one fourth of the magnitude of that for β_4 ; in

Table 4: Effects on performance

	(1)	(2)	(3)
Peers' parents' gender bias (PPB)	0.746* (0.415)	0.527 (0.390)	0.426 (0.395)
PPB x female	-0.610** (0.277)	-0.628*** (0.258)	-0.619*** (0.260)
Own parent's gender bias (OPB)	2.172*** (0.296)	1.622*** (0.258)	1.677*** (0.271)
OPB x female	-4.444*** (0.435)	-2.785*** (0.400)	-2.915*** (0.410)
Female	2.955*** (0.317)	3.458*** (0.303)	3.519*** (0.308)
Mean in sample	70.2	70.2	70.2
Number of observations	8,699	8,699	8,699
<i>Specification</i>			
Grade-by-school fixed effects		X	X
Teacher characteristics			X

Note: in all regressions, the dependent variable is the student's test score on a midterm math test. This variable is continuous with a standard deviation of 10. In Table A.4, we show the analog to these results generated without own parent's bias on the right hand side.

other words, having a parent who holds bias has roughly the same negative impact on girls as a four SD (45 percentage point) increase in the proportion of peers whose parents hold bias. Finally, we see clear evidence of the “reverse” gender gap in spite of the prevalence of anti-girl bias: after conditioning on our set of controls and removing grade-by-school fixed effects, on average girls score 0.35 SD better than boys on these midterm math tests.

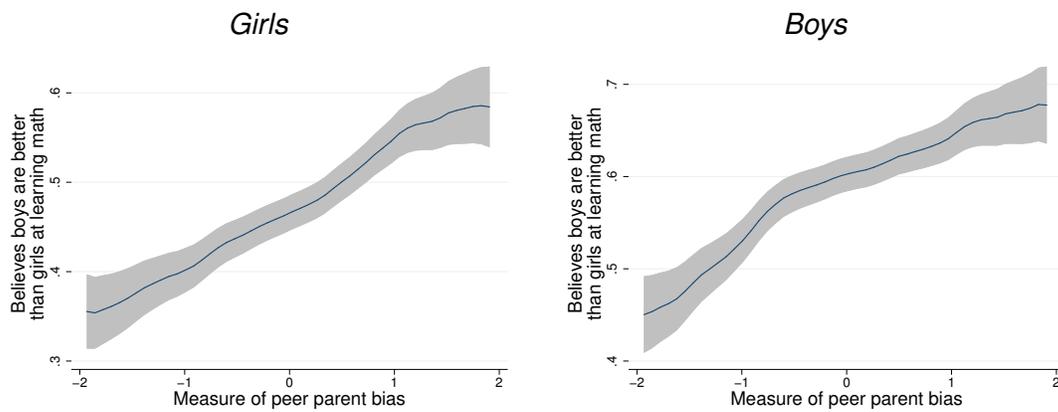
To conclude this section, we plot the nonparametric relationship between peer parents’ bias and our two main outcomes of interest - own bias and performance in mathematics. We show the relationships, separately by gender, in Figure 3, fitting a locally estimated polynomial and its confidence interval on the data¹¹. The patterns match our coefficient estimates from Tables 3 and 4. For both boys and girls, the likelihood of holding bias increases monotonically with the proportion of peers’ parents who hold the bias. For test scores, on the other hand, increased exposure to bias corresponds with test score gains for boys and losses for girls.

4 Channels, mediators, and implications of bias transmission

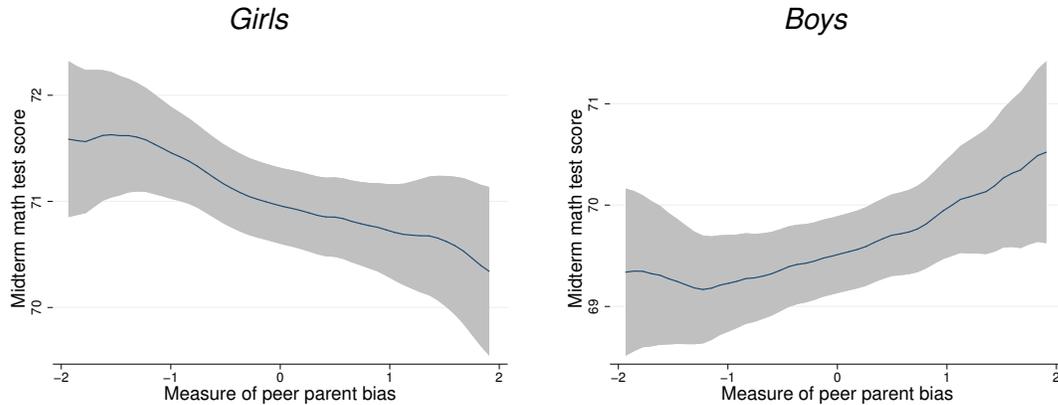
In this section, we conduct a series of analyses to paint a richer picture of how bias is transmitted via this channel, to whom, and what conditions its effects on other child outcomes. First, we conduct a series of regressions to test whether our patterns are driven by independent variation in our peer parents’ bias measure or, conversely, whether the peer parents’ bias measure is in fact a proxy for another, more important peer characteristic, such as peers’ parents’ education, peer ability, or gender composition of the class. Second, we run a series of tests to answer specific questions about how bias is transmitted, including whether a longer duration of exposure to peers translates into a larger effect size for either bias transmission or performance and whether bias transmission is characterized by homophily. Third, we try to understand whether girls respond to the message of

¹¹Consistent with our description of variance between and within our same-school, same-grade classroom pairs in Section 2.3, if we instead plot the relationships in Figure 3 using outcome variable residuals after removing grade-by-school fixed effects, the sign and monotonicity of each correspondence remains.

Figure 3: Non-parametric relationships between peer parents' bias and outcomes, by gender



Panel A: Own gender bias



Panel B: Test scores

Note: This figure shows the mapping from the individual-level measure of peer parent bias and our two main outcomes of interest - whether the child herself holds gender bias (Panel A), and her performance on a math test (Panel B). For clarity, we limit the range of the peer parent bias measure shown in this figure to $[-2 \text{ SD}, 2 \text{ SD}]$. The left column presents these mappings for girls in our sample, and the right column presents them for boys.

the gender bias by reallocating effort to non-math subjects or, instead, if exposure to peer parents' bias causes a more global reduction in performance.

4.1 Distinguishing between peer parent bias and other sources of peer effects

In this subsection, we attempt to disentangle two competing explanations for the results presented in Section 3. Explanation one is that a latent peer effect variable, as studied in many other analyses of peer effects (for example, peer ability or peer parent education; c.f. Sacerdote et al. 2011 and Feld and Zölitz, 2017), is driving our results and peer parent bias is merely a good proxy for (or symptom of) it. Explanation two is that there is a direct channel of bias transmission from peers' parents to peers and on to the child which causes the differences in beliefs and math performance we measure in the previous section. This second explanation does not claim that other factors make no contribution to the transmission of bias or gender gap, but rather that variation in the peer parent bias measure, independent of the other known sources of peer effects and observable characteristics of parents who are and are not biased against girls, generates the patterns we observe.

To disentangle these possible mechanisms, we conduct a series of horse race regressions where we add controls for peers' parents' education, peers' performance, peers' perceived ability, and the gender composition of the child's classroom to see how their inclusion affects our estimates of the impact of exposure to peer parents' bias. We present these results in Table 5. Panel A shows that our estimates of bias transmission from a child's peers' parents to the child are largely stable to the inclusion of controls for peer parent education, peer ability, and gender composition of the classroom (suggested by Fruehwirth, 2017, Feld and Zölitz, 2017, and Hu, 2015, respectively). Panel B shows that the effects of bias transmission on the gender gap in math performance are stable across these specifications as well, though the effect of peer parents' bias on boys' math test scores reduces by half in magnitude.

Table 5: Disentangling the effects of peer parent bias and other sources of peer effects

	(1)	(2)	(3)	(4)	(5)
<i>Panel A outcome: Holds anti-girl bias</i>					
Peers' parents' gender bias (PPB)	0.042*** (0.013)	0.037*** (0.012)	0.037*** (0.012)	0.035*** (0.013)	0.035*** (0.013)
PPB x female	0.002 (0.015)	0.009 (0.013)	0.009 (0.013)	0.012 (0.013)	0.011 (0.013)
R-squared	0.162	0.166	0.168	0.166	0.167
<i>Panel B outcome: Midterm math test score</i>					
Peers' parents' gender bias (PPB)	0.527 (0.390)	0.367 (0.363)	0.359 (0.366)	0.262 (0.306)	0.261 (0.307)
PPB x female	-0.628*** (0.258)	-0.538** (0.247)	-0.526** (0.247)	-0.515** (0.241)	-0.519** (0.242)
R-squared	0.188	0.193	0.192	0.195	0.195
<i>Specification</i>					
Baseline controls	X	X	X	X	X
Peers' parents' education		X	X	X	X
Peers' perceived ability			X		
Peers' midterm math scores				X	X
Proportion of peers female					X

Note: this table shows a series of horse-race regressions, including additional independent variables as listed in the “specification” legend at the bottom of the table, to assess the relative importance of peer parent bias and other determinants of peer effects, such as peer parent education (Fruehwirth, 2017), peer ability (Sacerdote et al., 2011), and gender composition of peers (Hu, 2015). The dependent variable in Panel A is coded as 0 = No, 1 = Yes (mean 0.526), and, in Panel B, the mean of the dependent variable is 70, SD = 10. There are 8,720 observations in the Panel A regressions and 8,699 in those of Panel B. In Table A.5, we show the analog to these results generated without own parent’s bias on the right hand side.

4.2 Channels of effect transmission and mitigation

In this section, we present results from a series of analyses studying variation in bias transmission and knock-on effects. First, we study how peer gender conditions bias transmission. We then estimate the relationship between duration of exposure to peers and effect size. Next, we evaluate whether the effect of exposure to peer parent bias varies by a child's own parent's reported beliefs. Finally, we study whether having more friends in the randomly assigned classroom increases or dampens the effects of exposure to peer parent bias.

We first study how bias transmits through peers of different genders. For each child, we compute separate class-specific measures of the level of bias among girl and boy peers' parents, respectively. This is a test for homophily, the idea that children who share an identity (e.g., gender) are more likely to interact and thus are more "influential" in the transmission of bias than children outside the identity group (Currarini et al., 2009). We present these results in Table 6. Our estimates confirm the predictions of homophily, i.e., that a child is more susceptible to bias transmission from children of the same gender than from those of the opposite gender. The total effect of girl peer parents' bias on girls' own bias is 68 percent larger than the effect of boy peer parents' bias on girls' own bias; the effect of boy peers' parents on boys' own bias is more than twice as large as that of girl peers' parents on boys' own bias. The pattern in coefficient estimates for test scores is similar.

Following Dhar et al. (2015), we perform a slightly different test for homophily, testing the hypothesis that the proportion of peers' mothers' who hold bias may have larger impacts for girls and that of peers' fathers' who hold bias may have larger impacts for boys. Dhar et al. (2015) randomly select survey respondents to be the mother or the father to isolate the importance of mothers' and fathers' biases, allowing clear interpretation of the test. Unfortunately, the adult respondent in the CEPS household survey was whomever was present and available at the time of survey. Families where the mother responded were richer and more educated than those where the father responded; as a result, these

Table 6: Evidence of homophily among peers

	<i>Girl peers' parents' bias</i>		<i>Boy peers' parents' bias</i>	
	(1) Holds anti- girl bias	(2) Midterm math test score	(3) Holds anti- girl bias	(4) Midterm math test score
Peers' parents' gender bias (PPB)	0.014 (0.014)	-0.356 (0.410)	0.042*** (0.011)	0.784** (0.360)
PPB x female	0.028* (0.015)	-0.356 (0.284)	-0.017 (0.014)	-0.417* (0.236)
Own parent's gender bias (OPB)	0.286*** (0.015)	1.648*** (0.253)	0.288*** (0.015)	1.704*** (0.259)
OPB x female	0.031 (0.020)	-2.937*** (0.417)	0.028 (0.020)	-2.944*** (0.406)
Female	-0.116*** (0.020)	3.549*** (0.312)	-0.118*** (0.019)	3.561*** (0.299)
Mean in sample	0.526	70.2	0.526	70.2
Number of observations	8,720	8,699	8,720	8,699

Note: this table shows results for estimating the effects of girl and boy peers' parents' biases separately. The dependent variable in columns 1 and 3 are coded as 0 = No, 1 = Yes. In columns 2 and 4, the dependent variable is continuous with SD = 10. In Table A.7, we show the analog to these results generated without own parent's bias on the right hand side.

estimates of peer parent-to-child homophily should be treated as less clearly causal than our estimates of peer-to-child homophily. The results are given in Table A.8, which show similar patterns to those shown in Table 6, though there is more evidence of peer parent-to-child homophily in our estimated impacts for test scores than for belief transmission.

Next, we look at the relationship between duration of exposure to the peer group and effect size. In Table 7, we present coefficient estimates for three outcomes - holding anti-girl bias, perceiving the current math class to be difficult, and standardized midterm math test score - estimated separately by the grade the student is in. This captures the child's duration of exposure to her peers: those in grade seven will have only spent three to six months with their peers when they are observed in our data, while those in grade nine will have spent over two years with the same randomly assigned peer group.

We find no detectable difference between the grade seven and grade nine estimated coefficients on transmission of biased beliefs about gender. While both are statistically significant, the effect of peer parents' bias on the likelihood of holding bias among boys in grade seven is slightly larger than that among boys in grade nine. The total effect for girls ($\beta_1 + \beta_2$) is almost identical across grades. We do, however, estimate larger effects of peer parents' bias on both math test scores and perceived difficulty of math for those in grade nine than for those in grade seven. This is consistent with the notion discussed in footnote 3 that early belief shocks may gestate into performance differences over time due to the compounding effects of reductions in enthusiasm and effort. Finally, our estimates suggest that the role of own parents' bias does not vary meaningfully by the child's grade.

Do the effects of exposure to peer parent bias vary by the beliefs the child is exposed to in her own home? To answer this question, we add two variables to our estimating equation: one, the interaction of peer parents' bias and own parent's bias; two the interaction of this variable with the child's gender. We present our results in Table 8. We find that increased exposure to peer parents' bias appears to generate greater harms for girls whose parents also believe that boys are better than girls at learning math, both in terms of the likelihood of the child holding that belief and her performance in mathematics. The stan-

Table 7: Effect size by duration of exposure to peers

	<i>Holds anti-girl bias</i>		<i>Perceived difficulty of current math class</i>		<i>Math test score</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
	Grade 7	Grade 9	Grade 7	Grade 9	Grade 7	Grade 9
Peers' parents' gender bias (PPB)	0.054*** (0.018)	0.036** (0.019)	0.001 (0.024)	-0.032* (0.017)	0.475 (0.611)	0.657 (0.412)
PPB x female	-0.017 (0.019)	0.004 (0.022)	0.009 (0.012)	0.030** (0.015)	-0.240 (0.295)	-1.173*** (0.386)
Own parent's gender bias (OPB)	0.282*** (0.019)	0.303*** (0.026)	-0.054*** (0.019)	-0.071*** (0.027)	1.794*** (0.304)	1.223*** (0.494)
OPB x female	0.024 (0.025)	0.028 (0.033)	0.135*** (0.027)	0.181*** (0.038)	-2.750*** (0.512)	-2.771*** (0.653)
Female	-0.158*** (0.023)	-0.038 (0.033)	-0.051*** (0.019)	-0.019 (0.020)	3.709*** (0.336)	3.168*** (0.576)
Mean in sample	0.504	0.571	0.546	0.617	70.2	70.2
Number of observations	5,899	2,821	6,031	2,860	5,917	2,782

Note: This table presents results for the effect of peer parents' bias on children's beliefs and performance, estimated separately for those in grade seven and those in grade nine. Those in grade nine have been exposed to their peers for two years longer than those in grade seven. The dependent variable in columns 1-2 are coded as 0 = No, 1 = Yes. In columns 3-4, the dependent variable is coded as 0 for low perceived difficulty and 1 for high perceived difficulty. In columns 5 and 6, the dependent variable is continuous with SD = 10. In Table A.9, we show the analog to these results generated without own parent's bias on the right hand side.

dard errors in this analysis are large, however, suggesting that adding further interaction terms to our main specification pushes the limits of what we can precisely estimate using a dataset with this sample size.

We next conduct an analysis building on the work of Lavy and Sand (Forthcoming) and Hahn et al. (2017), who show that proximity to friends, either in class or in a study group, has positive impacts on girls' academic performance. The CEPS asks the child about whether her five closest friends are in the same randomly assigned class as the child¹². We add the number of friends in the class, its interactions with the child's own gender and our measure of peer parents' bias, and the triple interaction, as additional independent variables in our estimating equation. We study the estimated coefficients on these new explanatory variables to determine whether having friends in class affects bias transmission or performance in our context. Note that this set of results is also only suggestive. Our survey data on the number of friends in/outside of the class are collected during the school year; as a result, who the child regards as one of her five closest friends is potentially endogenous to other factors, such as a child's overall experience in the school and the classroom, which may also affect, or be determined by, our outcome variables.

We present our results in Table 9, using the following four dependent variables: holding biased beliefs, perceived difficulty of math, aspirations to finish at least a BA, and midterm math test score. This analysis reveals substantial heterogeneity in the effect of peer parent bias on girls' aspirations and performance. We find a much stronger negative effect of peer parent bias on aspirations to complete college and on performance in mathematics (columns 3 and 4). These negative effects, however, decrease with the number of friends the child has in her class; a child with five close friends in her class appears to be entirely immune to the negative effects of peer parent bias that we have shown throughout this study¹³. We observe no heterogeneity by the number of friends in class in either bias

¹²Unfortunately, we do not have names and so cannot link a child's list of friends to other children in our dataset.

¹³To arrive at this conclusion, we take the [peer parent bias x female] coefficient and add to it the [peer parent bias x female x number of friends in class] coefficient multiplied by five, to capture the impact of all five friends being in the class.

Table 8: The interaction of own and peer parents' biases

	(1) Holds anti- girl bias	(2) Midterm math test score
Peers' parents' gender bias (PPB)	0.052*** (0.016)	0.477 (0.425)
PPB x female	-0.013 (0.017)	-0.424 (0.286)
Own parent's gender bias (OPB) x PPB	-0.024 (0.016)	0.139 (0.260)
OPB x PPB x female	0.041** (0.020)	-0.566* (0.320)
Own parent's gender bias (OPB)	0.287*** (0.015)	1.634*** (0.255)
OPB x female	0.033* (0.019)	-2.812*** (0.397)
Female	-0.121*** (0.020)	3.494*** (0.302)
Mean in sample	0.526	70.2
Number of observations	8,720	8,699

Note: This table presents results for the effect of peer parents' bias on children's beliefs and performance, including an interaction term between own parent's bias and our measure of peer parents' bias. The dependent variable in column 1 is coded as 0 = No, 1 = Yes. In column 2, the dependent variable is continuous with SD = 10.

Table 9: The moderating role of friends in class

	(1) Holds anti- girl bias	(2) Perceived difficulty	(3) Aspires to BA or higher	(4) Math test score
Peers' parents' gender bias (PPB)	0.026 (0.019)	0.006 (0.018)	0.009 (0.023)	0.123 (0.513)
PPB x female	0.024 (0.025)	0.008 (0.022)	-0.045** (0.021)	-1.534*** (0.606)
PPB x number of friends in class (FIC)	0.005 (0.004)	-0.006 (0.005)	-0.002 (0.004)	0.137 (0.102)
PPB x female x FIC	-0.006 (0.007)	0.003 (0.006)	0.017*** (0.006)	0.298** (0.148)
FIC	0.011** (0.005)	-0.008* (0.004)	0.014*** (0.004)	0.119 (0.097)
FIC x female	-0.006 (0.007)	-0.004 (0.006)	-0.009 (0.006)	0.041 (0.130)
Own parent's gender bias (OPB)	0.291*** (0.016)	-0.064*** (0.016)	0.017 (0.014)	1.610*** (0.255)
OPB x female	0.028 (0.020)	0.151*** (0.023)	-0.017 (0.020)	-2.750*** (0.398)
Female	-0.101*** (0.027)	-0.028 (0.023)	0.165*** (0.022)	3.262*** (0.553)
Mean in sample	0.526	0.569	0.662	70.2
Number of observations	8,720	8,891	8,853	8,699

Note: this table shows results from estimating equation 1 with the addition of four variables: number of close friends in the child's class (FIC), FIC interacted with child gender, FIC interacted with peer parent bias, and FIC interacted with peer parent bias and child gender. Note that in this new specification, the estimate on peer parent bias now shows the effect for a child with no friends in her randomly assigned class, and the FIC coefficients show the estimated effect of one additional friend being in the class or the interaction of this with other variables, as specified. The dependent variables in columns 1 and 3 are coded as 0 = No, 1 = Yes. In column 2, the dependent variable is coded as 0 for low perceived difficulty and 1 for high perceived difficulty. In column 4, the dependent variable is continuous with SD = 10. In Table A.10, we show the analog to these results generated without own parent's bias on the right hand side.

transmission or perceived difficulty of math.

Related work from sociology and psychology (Wentzel, 1998; Roseth et al., 2008) suggests a possible explanation: friendship may increase children's resilience in the face of stressors, e.g., for a girl, exposure to the message that girls like you are worse than boys at learning math. This finding may provide (weak) evidence of the potential for outreach to vulnerable children, particularly girls, in minimizing the harm caused by the intergenerational transmission of gender bias. The greater problem to resolve, of course, is how to prevent this transmission altogether. This question is beyond the scope of the current research.

We also test for the possibility that other predetermined factors might importantly condition our results. For the sake of brevity, we describe the results but do not include the tables in this manuscript. We consider family income, parents' education, and whether the family lives in a rural or urban area. For the first two, we interact a dummy for low income and low parental education, respectively, with peer parents' bias to test for potential heterogeneity. Our main coefficient estimates do not differ substantially in magnitude, and the interaction coefficients do not have a significant impact on either belief transmission or performance in math. For the rural/urban comparison, we estimate results separately for urban and rural schools, as we did for seventh and ninth graders in Table 7. For this comparison as well, we find no evidence of meaningful heterogeneity in either bias transmission or knock-on effects.

4.3 How do girls respond to bias exposure?

We have shown that girls exposed to high levels of peer parents' bias, *ceteris paribus*, are more likely to believe that boys are better at math than girls, are more likely to perceive math as difficult, and score worse on math exams. In this subsection, we try to understand girls' behavioral response to this information shock. Specifically, we provide suggestive evidence towards answering whether these negative effects on math performance lead to a reallocation of effort and enthusiasm towards other subjects, or whether instead they

lead to a broader decrease in the student's beliefs about her own ability and performance.

The clearest test for this is to look at the child's performance in other subjects. The first explanation predicts a gain in scores in subjects other than math, as girls reallocate effort away from mathematics and towards other subjects in which the bias suggests they have a comparative advantage. The second explanation is that exposure to anti-girl bias would instead depress girls' scores globally, as they may infer from the message of the bias that they are inferior to boys in ability overall, not just in mathematics.

In Table 10, we present our estimates of the effects of peer parents' bias on midterm test scores in Chinese and English (also standardized within grades, within schools, to a mean of 70 and SD of 10). We display the same "horse race" results as in Table 5 to try to isolate the independent contribution of peer parents' bias to these patterns from other sources of peer effects. For brevity, we will focus on the results in column 5. These results show evidence in support of the second theory - test scores for Chinese and English decrease for girls. Though the measured decreases are not statistically significant, they are 41 and 67 percent, respectively, of the magnitude of the estimated coefficient on the gender gap for math test scores¹⁴ shown in Table 5. In contrast to the math results, we see no evidence of any benefit of increases in peer parents' bias for boys, either in Chinese or English test scores. This aligns with the reduction in girls' aspirations we show in Table 9.

We conduct a series of other empirical tests to look for evidence of a reduction in enthusiasm or effort for girls. We find a small effect on girls' expressed confidence in their own future¹⁵, but no evidence of any impact on time use (hours spent studying, in cram school, and on hobbies) or beliefs that math, English, or Chinese are helpful for their future. Nonetheless, these results suggest that the reversal in the gender gap in educational attainment, to say nothing of the reversal of the gender gap in math performance in Chinese middle schools, is all the more remarkable as it appears to have happened in spite of the

¹⁴We can make this comparison because of the standardization of test scores within a grade within a school.

¹⁵For the dependent variable in this analysis, we use a child's response to the question "how confident are you in your own future," with responses coded on a four point scale ranging for "not at all confident" to "very confident." Our estimate of β_2 is 0.06, with a p-value 0.087.

Table 10: The impact of peer parent bias on Chinese and English test scores

	(1)	(2)	(3)	(4)	(5)
<i>Panel A outcome: Midterm Chinese test score</i>					
Peers' parents' gender bias (PPB)	0.296 (0.447)	0.130 (0.404)	0.154 (0.410)	0.065 (0.385)	0.063 (0.384)
PPB x female	-0.400 (0.268)	-0.345 (0.261)	-0.338 (0.260)	-0.343 (0.258)	-0.347 (0.261)
R-squared	0.162	0.169	0.169	0.170	0.171
<i>Panel B outcome: Midterm English test score</i>					
Peers' parents' gender bias (PPB)	0.397 (0.435)	0.187 (0.414)	0.196 (0.416)	0.090 (0.356)	0.088 (0.350)
PPB x female	-0.410 (0.270)	-0.218 (0.261)	-0.209 (0.261)	-0.206 (0.260)	-0.212 (0.264)
R-squared	0.167	0.174	0.174	0.176	0.177
<i>Specification</i>					
Baseline controls	X	X	X	X	X
Peers' parents' education		X	X	X	X
Peers' perceived ability			X		
Peers' midterm math scores				X	X
Proportion of peers female					X

Note: this table shows a series of horse-race regressions, including additional independent variables as listed in the “specification” legend at the bottom of the table, to assess the relative importance of peer parent bias and other determinants of peer effects, such as peer parent education (Fruehwirth, 2017), peer ability (Sacerdote et al., 2011), and gender composition of peers (Hu, 2015), in driving differences in Chinese and English midterm test scores. For both Panels, the mean of the dependent variable is 70 (SD = 10) and the number of observations in each regression is 8,696. In Table A.11, we show the analog to these results generated without own parent’s bias on the right hand side.

downward pressure that exposure to bias exerts on girls' academic performance, both in mathematics and other subjects.

5 Conclusion

Gender bias persists across generations despite clear and growing evidence in contradiction of its main messages. Understanding how such bias is transmitted, the impacts of this transmission, and what can be done to prevent it, are issues of central importance to policymakers in both developed and developing countries. Our results highlight that the intergenerational transmission of bias occurs both within and across families and shed light on how these biases reinforce their messages by affecting children's beliefs about themselves and their performance in mathematics.

We know much less about how to address this. We find that the negative effects of peer parents' bias on girls' performance and aspirations are ameliorated by the number of close friends the child has in her class, in line with prior work finding similar benefits to randomly assigning girls to classes or study groups with their friends. In other work we have shown that positive role models such as female math teachers can counter the message of gender bias for particularly vulnerable girls (Eble and Hu, 2017). The larger problem of how to prevent bias transmission, however, remains unresolved. Our results, taken from a context where there is a reverse gender gap in mathematics, suggest that the trend towards girls outperforming boys in math and other subjects is likely insufficient to remedy the widely held belief that women are inferior to men at learning math and in STEM fields more broadly. This suggests that deliberate policy intervention is required to ensure that this source of misinformation does not continue to harm the development of young women across the many contexts where it persists.

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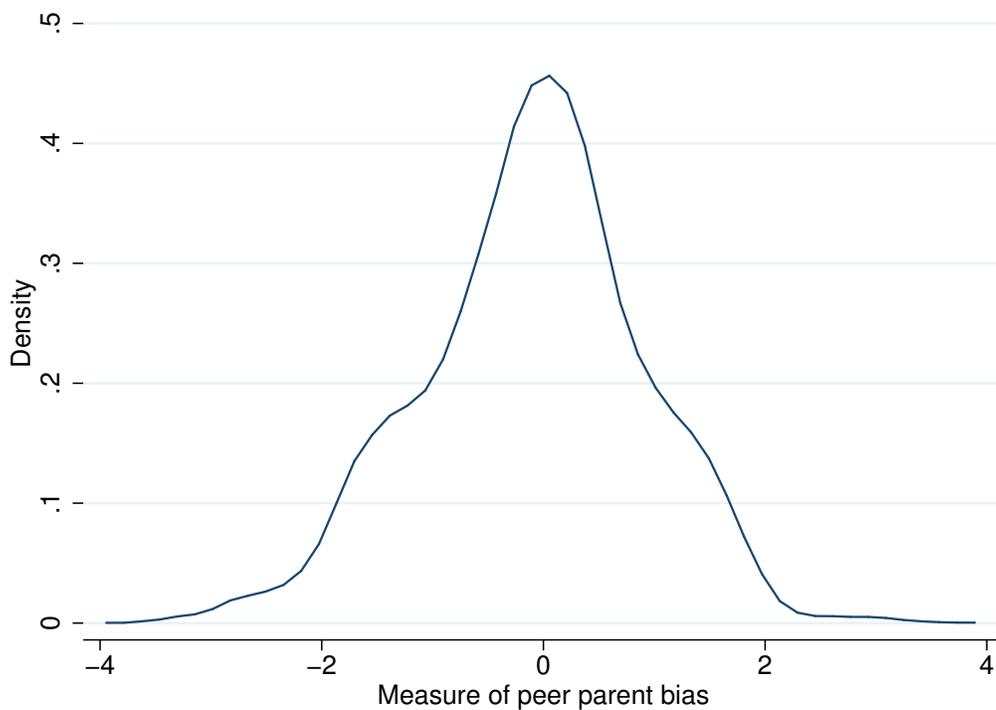
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Appendix - for online publication only

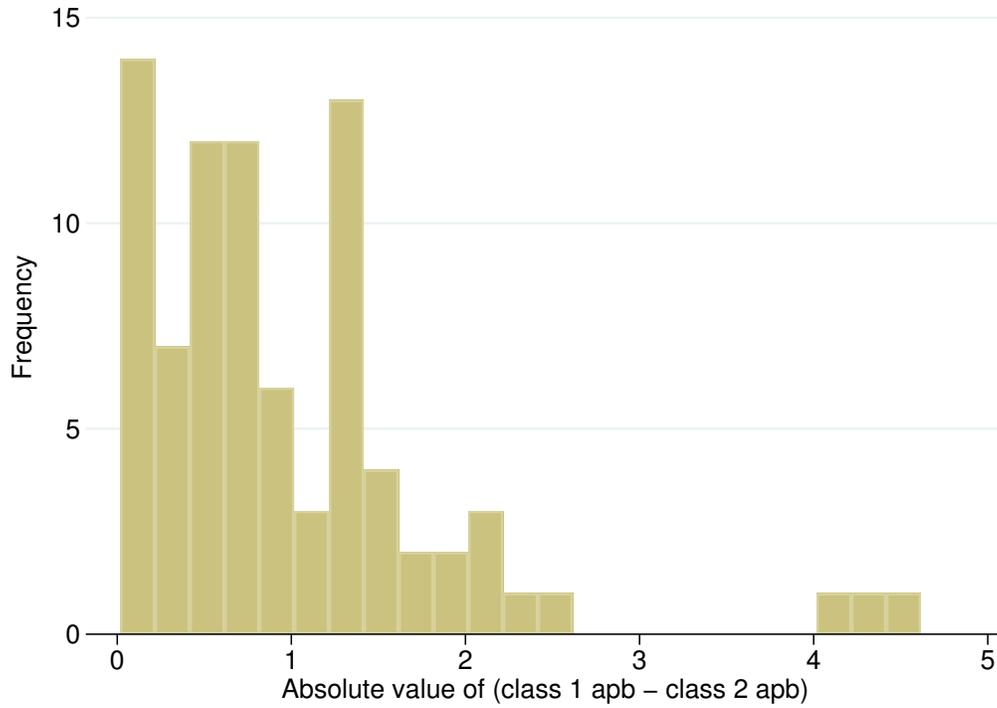
Appendix figures

Figure A.1: Distribution of bias measure



Note: this figure plots the distribution of our standardized measure of peer parent bias among our 8,912 child-level observations in our estimation sample.

Figure A.2: Distribution of difference between average parent bias in within-school, within-grade class pairings



Note: this shows the distribution of the value $\| Bias_{c_1} - Bias_{c_2} \|$ across our 87 within-school, within-grade class pairs, where $Bias_{c_x}$ is the mean of all parents' responses to the question "do you believe that boys are better than girls at learning math" in class x . On the x-axis, apb is an abbreviation for average parent bias, i.e., $Bias_{c_x}$.

Appendix tables

Table A.1: Characteristics of children whose parents do and do not report gender bias

	(1) Full sample	(2) Does not express bias	(3) Does express bias
Age	13.21	13.19	13.25
Ethnic minority	0.11	0.11	0.12
Holds agricultural hukou	0.50	0.50	0.48
Number of siblings	0.70	0.69	0.66
Low household income / poor	0.19	0.19	0.17
<i>Father's highest credential</i>			
Middle school	0.41	0.42	0.38
High school	0.26	0.26	0.27
College	0.19	0.19	0.21
<i>Mother's highest credential</i>			
Middle school	0.38	0.40	0.36
High school	0.23	0.23	0.24
College	0.16	0.16	0.18
Number of siblings	0.70	0.69	0.66
Household is poor	0.19	0.19	0.17
Number of observations	8,912	5,265	3,647

Note: this table gives summary statistics for children in our estimation sample, separately for those whose parents do (column 2) and do not (column 3) claim to believe that boys are better than girls at learning math. The variables are all coded as 0 = No, 1 = Yes, except for age and number of siblings, which are self-explanatory, and test score (mean = 70, SD = 10).

Table A.2: Balancing test conducted separately by grade

	(1) Grade 7	(2) Grade 9
Age	-0.057* (0.029)	-0.007 (0.015)
Holds agricultural hukou	-0.064 (0.061)	-0.022 (0.036)
Number of siblings	-0.100*** (0.041)	-0.005 (0.021)
Household is poor	-0.023 (0.064)	0.027 (0.044)
Female	0.019 (0.029)	0.022 (0.027)
<i>Mother's highest credential</i>		
Middle school	0.010 (0.021)	0.031 (0.023)
High/technical school	0.009 (0.021)	0.078 (0.053)
College or above	0.028 (0.027)	0.018 (0.044)
<i>Father's highest credential</i>		
Middle school	-0.011 (0.024)	0.040 (0.025)
High/technical school	-0.004 (0.038)	0.046 (0.060)
College or above	-0.016 (0.036)	0.092 (0.078)
Ethnic minority	-0.001 (0.028)	-0.073 (0.050)
Number of observations	5,577	2,768
R-squared	0.71	0.61
Joint test F-statistic	0.74	1.09
[p-value]	[0.71]	[0.39]

Note: this table presents a balancing test, as in Antecol et al. (2015), which tests for our set of predetermined characteristics' joint ability to predict the peer parent bias measure. Column 1 presents the results for seventh graders and Column 2 presents those for ninth graders. Both regressions include grade-by-school fixed effects. The variables are all coded as 0 = No, 1 = Yes, except for age and number of siblings, which are self-explanatory, and test score (mean = 70, SD = 10). The dependent variable, peer parent bias, is standardized to be mean 0, SD 1.

Table A.3: Analog to Table 3 - effects on beliefs

	(1)	(2)	(3)
	Holds anti-girl bias	Perceives current math class to be difficult	Aspires to complete at least a BA
Peers' parents' gender bias (PPB)	0.020 (0.017)	-0.019 (0.015)	0.003 (0.017)
PPB x female	0.005 (0.016)	0.028*** (0.009)	0.005 (0.010)
Female	-0.129*** (0.018)	0.021* (0.011)	0.129*** (0.011)
Mean in sample	0.526	0.569	0.662
Number of observations	8,720	8,891	8,853

Note: this table is the analog to Table 3 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. It shows results from estimating equation 1 using the dependent variable named in the column heading and described in the text. Variation in the number of observations across columns stems from differences in missing values for the dependent variables. The dependent variables are coded as 0 = No, 1 = Yes.

Table A.4: Analog to Table 4 - effects on performance

	(1)	(2)	(3)
Peers' parents' gender bias (PPB)	0.866** (0.414)	0.576 (0.386)	0.470 (0.391)
PPB x female	-0.839*** (0.280)	-0.770*** (0.258)	-0.767*** (0.261)
Female	1.101*** (0.275)	2.304*** (0.250)	2.309*** (0.255)
Mean in sample	70.2	70.2	70.2
Number of observations	8,699	8,699	8,699
<i>Specification</i>			
Grade-by-school fixed effects		X	X
Teacher characteristics			X

Note: this table is the analog to Table 4 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. In all regressions, the dependent variable is the student's test score on a midterm math test, and we exclude the child's own parent's bias variable and its interaction with student gender. This variable is continuous with a standard deviation of 10.

Table A.5: Analog to Table 5 - horse race regressions

	(1)	(2)	(3)	(4)	(5)
<i>Panel A outcome: Holds anti-girl bias</i>					
Peers' parents' gender bias (PPB)	0.020 (0.017)	0.015 (0.016)	0.015 (0.016)	0.012 (0.017)	0.012 (0.016)
PPB x female	0.005 (0.016)	0.009 (0.014)	0.009 (0.014)	0.012 (0.014)	0.011 (0.014)
R-squared	0.076	0.081	0.085	0.081	0.081
<i>Panel B outcome: Midterm math test score</i>					
Peers' parents' gender bias (PPB)	0.576 (0.386)	0.412 (0.360)	0.404 (0.362)	0.305 (0.303)	0.304 (0.304)
PPB x female	-0.770*** (0.258)	-0.675*** (0.248)	-0.664*** (0.248)	-0.651*** (0.242)	-0.654*** (0.243)
R-squared	0.183	0.188	0.188	0.190	0.191
<i>Specification</i>					
Baseline controls	X	X	X	X	X
Peers' parents' education		X	X	X	X
Peers' perceived ability			X		
Peers' midterm math scores				X	X
Proportion of peers female					X

Note: this table is the analog to Table 5 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. It shows a series of horse-race regressions, including additional independent variables as listed in the "specification" legend at the bottom of the table, to assess the relative importance of peer parent bias and other determinants of peer effects, such as peer parent education (Fruehwirth, 2017), peer ability (Sacerdote et al., 2011), and gender composition of peers (Hu, 2015). We also include the following variables for teacher quality: teacher gender, whether the teacher attended a teacher's college, years of experience, whether the teacher is recognized as a "senior" teacher, and age.

Table A.6: Potential sources of peer parent bias with teacher-level controls

	(1)	(2)	(3)	(4)	(5)
<i>Panel A outcome: Holds anti-girl bias</i>					
Peers' parents' gender bias (PPB)	0.047*** (0.012)	0.042*** (0.012)	0.042*** (0.012)	0.041*** (0.013)	0.041*** (0.012)
PPB x female	0.001 (0.015)	0.006 (0.014)	0.006 (0.013)	0.009 (0.013)	0.009 (0.014)
R-squared	0.163	0.168	0.169	0.168	0.168
<i>Panel B outcome: Midterm math test score</i>					
Peers' parents' gender bias (PPB)	0.426 (0.395)	0.284 (0.365)	0.279 (0.362)	0.199 (0.314)	0.199 (0.313)
PPB x female	-0.619*** (0.260)	-0.517** (0.251)	-0.504** (0.252)	-0.502** (0.247)	-0.514** (0.248)
R-squared	0.192	0.197	0.197	0.198	0.199
<i>Specification</i>					
Baseline controls	X	X	X	X	X
Peers' parents' education		X	X	X	X
Peers' perceived ability			X		
Peers' midterm math scores				X	X
Proportion of peers female					X

Note: this table shows a series of horse-race regressions, including additional independent variables as listed in the “specification” legend at the bottom of the table, to assess the relative importance of peer parent bias and other determinants of peer effects, such as peer parent education (Fruehwirth, 2017), peer ability (Sacerdote et al., 2011), and gender composition of peers (Hu, 2015). We also include the following variables for teacher quality: teacher gender, whether the teacher attended a teacher’s college, years of experience, whether the teacher is recognized as a “senior” teacher, and age.

Table A.7: Analog to Table 6 - homophily effects

	<i>Girl peers' parents' bias</i>		<i>Boy peers' parents' bias</i>	
	(1) Holds anti- girl bias	(2) Midterm math test score	(3) Holds anti- girl bias	(4) Midterm math test score
Peers' parents' gender bias (PPB)	-0.009 (0.016)	-0.236 (0.409)	0.034*** (0.014)	0.750** (0.358)
PPB x female	0.041*** (0.016)	-0.460 (0.291)	-0.023 (0.015)	-0.536** (0.241)
Female	-0.125*** (0.018)	2.341*** (0.260)	-0.130*** (0.018)	2.350*** (0.253)
Mean in sample	0.526	70.2	0.526	70.2
Number of observations	8,720	8,699	8,720	8,699

Note: this table is the analog to Table 6 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. It shows results for estimating the effects of girl and boy peers' parents' biases separately. The dependent variable in columns 1 and 3 are coded as 0 = No, 1 = Yes. In columns 2 and 4, the dependent variable is continuous with SD = 10.

Table A.8: Evidence of homophily from peers' parents to children

	<i>Peers' mothers' bias</i>		<i>Peers' fathers' bias</i>	
	(1)	(2)	(3)	(4)
	Holds anti-girl bias	Midterm math test score	Holds anti-girl bias	Midterm math test score
Peers' parents' gender bias (PPB)	0.030** (0.013)	-0.167 (0.330)	0.029** (0.014)	0.802** (0.367)
PPB x female	0.011 (0.015)	-0.401* (0.212)	-0.012 (0.015)	-0.415 (0.264)
Own parent's gender bias (OPB)	0.288*** (0.015)	1.607*** (0.255)	0.287*** (0.015)	1.705*** (0.257)
OPB x female	0.029 (0.019)	-2.841*** (0.400)	0.032* (0.020)	-2.864*** (0.402)
Female	-0.117*** (0.019)	3.506*** (0.299)	-0.119*** (0.019)	3.528*** (0.301)
Mean in sample	0.526	70.2	0.526	70.2
Number of observations	8,720	8,699	8,720	8,699

Note: this table shows results for peer parents' bias calculated using only those peers whose mothers responded to the survey in the first two columns, and only those peers whose fathers responded in the second two columns. Note that respondents were chosen by availability, not randomly, and so we cannot separate the effects of parent gender from the conditioning effects of the determinants of which parent responded. Note that children whose fathers responded to the survey come from families which are poorer, more rural, and less educated than children whose mothers responded to the survey.

Table A.9: Analog to Table 7 - effects by duration of exposure

	<i>Holds anti-girl bias</i>		<i>Perceived difficulty of current math class</i>		<i>Math test score</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
	Grade 7	Grade 9	Grade 7	Grade 9	Grade 7	Grade 9
Peers' parents' gender bias (PPB)	0.026 (0.024)	0.021 (0.022)	-0.003 (0.024)	-0.036** (0.016)	0.504 (0.603)	0.718* (0.408)
PPB x female	-0.022 (0.019)	0.013 (0.023)	0.015 (0.011)	0.039*** (0.015)	-0.383 (0.295)	-1.312*** (0.389)
Female	-0.176*** (0.022)	-0.041 (0.028)	0.001 (0.014)	0.058*** (0.018)	2.570*** (0.269)	1.991*** (0.469)
Mean in sample	0.504	0.571	0.546	0.617	70.2	70.2
Number of observations	5,899	2,821	6,031	2,860	5,917	2,782

Note: this table is the analog to Table 7 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. It presents results for the effect of peer parents' bias on children's beliefs and performance, estimated separately for those in grade seven and those in grade nine. Those in grade nine have been exposed to their peers for two years longer than those in grade seven. The dependent variable in columns 1-2 are coded as 0 = No, 1 = Yes. In columns 3-4, the dependent variable is coded as 0 for low perceived difficulty and 1 for high perceived difficulty. In columns 5 and 6, the dependent variable is continuous with SD = 10.

Table A.10: Analog to Table 9 - the moderating role of friends in class

	(1) Holds anti- girl bias	(2) Perceived difficulty	(3) Aspires to BA or higher	(4) Math test score
Peers' parents' gender bias (PPB)	0.010 (0.022)	0.000 (0.018)	0.009 (0.023)	0.209 (0.515)
PPB x female	0.026 (0.027)	0.018 (0.021)	-0.046** (0.021)	-1.721*** (0.610)
PPB x number of friends in class (FIC)	0.003 (0.004)	-0.006 (0.004)	-0.002 (0.004)	0.126 (0.102)
PPB x female x FIC	-0.006 (0.007)	0.003 (0.006)	0.017*** (0.006)	0.313** (0.149)
FIC	0.010** (0.005)	-0.008* (0.004)	0.014*** (0.004)	0.112 (0.098)
FIC x female	-0.009 (0.007)	-0.005 (0.006)	-0.009 (0.006)	0.060 (0.131)
Female	-0.103*** (0.027)	0.037* (0.021)	0.158*** (0.020)	2.063*** (0.530)
Mean in sample	0.526	0.569	0.662	70.2
Number of observations	8,720	8,891	8,853	8,699

Note: this table is the analog to Table 9 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. It shows results from estimating equation 1 with the addition of four variables: number of close friends in the child's class (FIC), FIC interacted with child gender, FIC interacted with peer parent bias, and FIC interacted with peer parent bias and child gender. Note that in this new specification, the estimate on peer parent bias now shows the effect for a child with no friends in her randomly assigned class, and the FIC coefficients show the estimated effect of one additional friend being in the class or the interaction of this with other variables, as specified. The dependent variables in columns 1 and 3 are coded as 0 = No, 1 = Yes. In column 2, the dependent variable is coded as 0 for low perceived difficulty and 1 for high perceived difficulty. In column 4, the dependent variable is continuous with SD = 10.

Table A.11: Analog to Table 10 - effects on Chinese/English test scores

	(1)	(2)	(3)	(4)	(5)
<i>Panel A outcome: Midterm Chinese test score</i>					
Peers' parents' gender bias (PPB)	0.302 (0.443)	0.138 (0.401)	0.161 (0.407)	0.072 (0.383)	0.072 (0.382)
PPB x female	-0.411 (0.271)	-0.354 (0.264)	-0.348 (0.264)	-0.353 (0.261)	-0.355 (0.263)
R-squared	0.162	0.169	0.169	0.170	0.171
<i>Panel B outcome: Midterm English test score</i>					
Peers' parents' gender bias (PPB)	0.396 (0.430)	0.186 (0.409)	0.195 (0.411)	0.088 (0.352)	0.086 (0.345)
PPB x female	-0.437*** (0.273)	-0.244*** (0.264)	-0.236*** (0.263)	-0.231*** (0.262)	-0.237*** (0.266)
R-squared	0.167	0.173	0.174	0.176	0.176
<i>Specification</i>					
Baseline controls	X	X	X	X	X
Peers' parents' education		X	X	X	X
Peers' perceived ability			X		
Peers' midterm math scores				X	X
Proportion of peers female					X

Note: this table is the analog to Table 10 but excluding the own parent's bias variable and its interaction with student gender from the right hand side of the estimating equation. It shows a series of horse-race regressions, including additional independent variables as listed in the "specification" legend at the bottom of the table, to assess the relative importance of peer parent bias and other determinants of peer effects, such as peer parent education (Fruehwirth, 2017), peer ability (Sacerdote et al., 2011), and gender composition of peers (Hu, 2015), in driving differences in Chinese and English midterm test scores. For both Panels, the mean of the dependent variable is 70, SD = 10.