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Who Belongs in Math? Gendered Peer Math Beliefs and Girls' Gender Beliefs, Math Beliefs, and Achievement

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Abstract

This paper studies how exposure to gendered peer math beliefs shapes girls' gender-math beliefs, their own math beliefs, and mathematics achievement. I exploit quasi-random variation in girls' exposure to peer math beliefs generated by random classroom assignment at entry into Chinese middle schools. Exposure to girls' and boys' peer math beliefs has opposite effects on gender-math beliefs: girls' peer math beliefs reduce the probability that girls believe boys are better than girls at mathematics, while boys' peer math beliefs increase it. These peer signals also affect later outcomes on different margins. Boys' peer math beliefs lower girls' subsequent math beliefs, whereas girls' peer math beliefs are more likely to translate into achievement gains. The effects are strongest among girls who enter middle school with low math beliefs or who already believe that boys are better at math; these girls benefit less from girls' peer math beliefs and respond more negatively to boys' peer math beliefs.

Keywords: gender, belief formation, human capital, behavioral economics

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1 Introduction

In many societies, the view that boys are better at mathematics continues to circulate even when average performance differences are limited. This belief matters because gender inequality is shaped not only by resources and institutions, but also by cultural norms and social beliefs (Dhar, Jain, & Jayachandran, 2018; Jayachandran, 2015; Nollenberger, Rodríguez-Planas, & Sevilla, 2016). Such beliefs emerge early and can affect children's interests, effort, and aspirations (Bian, Leslie, & Cimpian, 2017; Fryer & Levitt, 2010). Mathematics is a particularly important setting because beliefs about who belongs in the subject may shape how girls interpret their own ability and whether they continue to invest in math (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Buser, Niederle, & Oosterbeek, 2014). Girls do not necessarily perform worse than boys, yet they often report lower confidence in their own math ability (Breda et al., 2023). This paper distinguishes between gender-math beliefs, or beliefs about gender differences, and math beliefs, or girls' assessments of their own ability, both of which may matter for later educational and labor market trajectories (Antecol, 2000, 2001; Eble & Hu, 2022; Tsui, 2007).

This paper asks whether part of that gap is shaped by the gendered peer signals girls observe in the classroom. Specifically, it studies whether girls respond differently to girls' and boys' math beliefs. For girls, peers may matter not only through classmates' performance, but also through who appears confident in mathematics and what these signals imply about who belongs in the subject. Existing studies show that peer environments affect academic and noncognitive outcomes, often with a gendered structure (Cools, Fernández, & Patacchini, 2022; Gong, Lu, & Song, 2021; Hu, 2015; Lavy & Schlosser, 2011). In mathematics, a subject often coded as male-typed, high math beliefs among boys may reinforce the belief that boys are better at math, intensify unfavorable social comparison, and weaken girls' own sense of fit (Cools et al., 2022; Spencer, Steele, & Quinn, 1999). By contrast, high math beliefs among girls may provide nearby evidence against gender beliefs, helping girls reassess who belongs in mathematics and whether they themselves belong there (Asgari, Dasgupta, & Gilbert

Cote, 2010; Beaman, Duflo, Pande, & Topalova, 2012; Greene, Sullivan, & Beyard-Tyler, 1982; Pagani & Pica, 2026; Porter & Serra, 2020; Qin, Wang, & Zhang, 2026).

This paper studies how gendered peer math beliefs shape girls' gender beliefs, their own math beliefs, and mathematics achievement. It asks whether girls respond differently to exposure to girls' and boys' peer math beliefs in the classroom. I examine this question using the China Education Panel Survey (CEPS), a nationally representative longitudinal survey of Chinese middle school students, from the 2013 to 2015 academic years. The empirical design exploits quasi-random classroom assignment at entry into middle school, which creates within-school variation in girls' exposure to girls' and boys' peer math beliefs across classrooms. I use school fixed effects so that identification comes from comparing girls assigned to different classrooms within the same school. Peer math belief is measured as the leave-one-out classroom average of classmates' Grade 6 math beliefs, constructed separately for girl and boy peers; I refer to these measures as PMB below. I then estimate how these two classroom belief environments affect whether girls endorse the view that boys are better than girls at mathematics, their later beliefs about their own mathematics ability, and their later mathematics achievement.

The paper delivers four main findings. First, gendered peer math beliefs in the classroom shape girls' beliefs about who belongs in mathematics. A one standard deviation increase in girls' PMB lowers the probability that a girl agrees that boys are better than girls at mathematics by 6.1 percentage points. By contrast, a one standard deviation increase in boys' PMB raises this probability by 10.1 percentage points. These opposite-signed estimates suggest that girls are not simply responding to general classroom quality. Instead, peer math beliefs carry gender-specific social signals: stronger math beliefs among girl classmates weaken male-typed views of mathematics, while stronger math beliefs among boy classmates make those views more salient.

Second, these gendered peer signals also affect how girls evaluate their own mathematical ability. Boys' PMB has a large negative effect on girls' subsequent math beliefs. A one standard deviation increase in boys' PMB lowers girls' Grade 8 math belief by 0.126 standard deviations. By contrast, the average association between girls' PMB and girls' Grade 8 math belief is positive but small and not statistically distinguishable from zero. Thus, in the pooled specification, boys' PMB is more clearly related to girls' own belief margin than girls' PMB.

Third, not all classroom belief signals carry through equally to achievement. The signal that survives into the achievement margin is mainly girls' PMB. A one standard deviation increase in girls' PMB raises girls' Grade 8 math test scores by 0.103 standard deviations, while the corresponding estimate for boys' PMB is close to zero and statistically insignificant. These estimates suggest that positive same-gender peer belief environments are more likely to translate into later achievement gains.

Fourth, belief updating is highly heterogeneous for girls' prior beliefs. Girls with low Grade 6 math belief or a Grade 7 gender belief that boys are better at math benefit less from girls' PMB and respond more negatively to boys' PMB. Among girls without the Grade 7 gender beliefs, girls' PMB raises Grade 8 math beliefs by 0.093 standard deviations, about 54 percent of the within-school gender gap. Among girls with the belief, this benefit disappears, while boys' PMB lowers Grade 8 math beliefs by 0.175 standard deviations, approximately the size of the gender gap.

This paper makes three main contributions. First, it advances the literature on the formation and updating of gender beliefs by showing how judgments about who belongs in mathematics are shaped in everyday classroom settings. Existing work shows that gendered beliefs about ability and gender gaps in math performance emerge early (Bian et al., 2017; Jayachandran, 2015; Martinot, Colnet, Breda, Grenet, and Sarron, 2025). Yet this literature is less well suited to identifying how such beliefs are formed and revised through repeated exposure in real-world environments. Laboratory settings are also limited in this respect, both because repeated exposure to naturally occurring peer signals is difficult to reproduce and because directly inducing disadvantageous gendered cues may raise ethical concerns. Using quasi-random classroom assignment, this paper provides causal evidence that gender beliefs are shaped not only by broad cultural norms but also by gendered PMB signals encountered in ordinary classrooms.

Second, the paper contributes to the literature on stereotype formation and its consequences by showing that prior gender beliefs shape how girls absorb subsequent classroom signals. Existing research shows that gendered beliefs about mathematics can affect achievement, math beliefs, and later sorting into math-related paths, and also examines how such beliefs are formed and transmitted (Eble & Hu, 2022; Niederle & Vesterlund, 2007; Spencer et al., 1999). This paper extends that literature by showing that prior gender beliefs influence not only girls' outcomes directly, but also the weight they place on later same-gender peer signals. Higher girls' PMB raises later own math belief among girls who do not initially endorse the gender belief that boys are better than girls at mathematics, but has little effect among those who already do.

Third, the paper provides a distinct channel contribution to the peer effects literature. Existing studies largely focus on how peer gender composition, peer ability, and classroom environment affect student outcomes (Cools et al., 2022; Gong et al., 2021; Lavy & Schlosser, 2011; Pagani & Pica, 2026). This paper shows that what matters is not only who peers are, but also the math beliefs they hold in a specific subject and the gendered social meaning of those beliefs. More specifically, girls' PMB is more likely to enter girls' beliefs updating as evidence against the gender beliefs that boys are better at mathematics, whereas boys' PMB is more likely to reinforce that beliefs and intensify unfavorable social comparison (Porter & Serra, 2020; Spencer et al., 1999). The paper therefore moves the peer effects literature from general peer composition toward a more specific belief-signal channel.

2 Data and Variables

This paper uses the baseline wave of the China Education Panel Survey (CEPS) for the 2013–2014 academic year, combined with follow-up data from 2014–2015 (NSRC, 2015).

CEPS is a nationally representative longitudinal survey of junior high school students in China conducted by the National Survey Research Center at Renmin University of China. The baseline survey follows a multistage probability proportional-to-size sampling design, selecting counties, schools, and classes in sequence, with all students in sampled classes surveyed. The analysis sample includes 5,472 students first observed in Grade 7 and followed into Grade 8, spanning 120 classrooms across 72 schools that retain institutionally random classroom assignment over this transition. Because the analysis focuses on girls' responses to gendered peer math beliefs, the main estimating sample is restricted to 2,638 female students.[1]

In the Chinese education system, students enter middle school (Grades 7–9) after completing Grade 6, the final year of primary school. At the beginning of seventh grade, many schools use computer-based allocation or lottery procedures to assign students to classrooms. Once assigned, students typically remain in the same classroom throughout middle school and are not regrouped on the basis of prior achievement or ability.[2] This institutional arrangement provides a quasi-experimental setting for the study of peer effects. Because classroom assignment occurs at school entry and is approximately random, students do not sort into peer groups on the basis of their own academic ability or family background. Classroom-level peer characteristics can therefore be treated as plausibly exogenous at the time of school entry (Gong et al., 2021).

The transition from primary school to middle school is also a useful setting for studying belief updating. In China, this transition coincides with a substantial increase in the difficulty of the mathematics curriculum, making it a salient moment for students to update beliefs about their own mathematical ability and about gender differences in mathematics. This interpretation is consistent with the descriptive evidence in Table 1, where average math belief declines from 2.9 in grade 6 to 2.4 in grade 7. The start of middle school thus provides a

[1]This paper restricts the sample to schools that retain random classroom assignment in grade 8 in order to facilitate student follow-up and preserve a cleaner setting for identification.

[2]Section 3 describes in detail how we identify schools that retain institutionally random classroom assignment.

setting in which both peer exposure and belief revision are likely to be especially important.[3]

The main outcomes are gender beliefs, math beliefs, and math achievement. Math achievement is measured using administrative midterm test scores. Within a school, students follow the same curriculum and take exams at the same time, making scores comparable within schools. I use math achievement in Grades 7 and 8. Gender belief is measured by an indicator for whether a student agrees that boys are better than girls at mathematics; this measure is available in Grade 7. Math belief is constructed from students' reported difficulty in learning mathematics, coded so that higher values indicate lower perceived difficulty and therefore stronger math belief. This measure is available in Grades 6, 7, and 8. The Grade 6 measure is retrospective and asks students to recall their pre-middle-school math belief.

In the regression analysis, achievement and psychological outcomes are standardized to have mean zero and standard deviation one. Table 1 reports descriptive statistics in raw units for ease of interpretation.

The key explanatory variables are classroom-level measures of girls' and boys' peer math beliefs. These measures are constructed from the retrospective Grade 6 math belief item, "Recalling sixth grade, did you find learning mathematics difficult?" This item captures perceived math difficulty before middle school and therefore before Grade 7 classroom assignment.[4] Higher values indicate lower perceived difficulty, with 4 denoting "not difficult at all," so I interpret higher values as stronger math belief.

For each student, I construct leave-one-out classroom means separately for girl and boy classmates. For student i in classroom c, girls' PMB is the average Grade 6 math belief among girl classmates in classroom c, excluding student i when the student is a girl. Boys' PMB is defined analogously. This leave-one-out construction ensures that the student's own response does not mechanically enter the peer measure and helps mitigate the reflection problem.

[3]Compared with the primary-school curriculum, middle school mathematics includes algebra, geometry, and more advanced logical and spatial reasoning.

[4]Because this measure is reported retrospectively, Section 6 examines whether it is affected by subsequent middle-school experiences.

Table 1: Summary Statistics

Variable	(1) All Students	(2) Girls Only	(3) Boys Only	(4) Girls − Boys
Panel A. Demographic and family background				
Age	13.252	13.187	13.312	−0.125***
	(0.009)	(0.013)	(0.013)	
Ethnic minority(1=YES)	0.119	0.123	0.116	0.007
	(0.004)	(0.006)	(0.006)	
Agricultural *hukou*(1=YES)	0.448	0.437	0.459	−0.022
	(0.007)	(0.010)	(0.010)	
Mother's education (years)	10.037	10.158	9.925	0.233**
	(0.050)	(0.071)	(0.070)	
Father's education (years)	10.763	10.842	10.689	0.153*
	(0.045)	(0.065)	(0.063)	
Family socioeconomic status	2.873	2.882	2.864	0.018
	(0.008)	(0.011)	(0.011)	
Only child (1=YES)	0.489	0.463	0.513	−0.050***
	(0.007)	(0.010)	(0.009)	
Local birth indicator (1=YES)	0.665	0.686	0.646	0.040***
	(0.006)	(0.009)	(0.009)	
Panel B. Beliefs				
Math belief (G6)	2.895	2.749	3.032	−0.282***
	(0.014)	(0.019)	(0.019)	
Math belief (G7)	2.442	2.357	2.521	−0.165***
	(0.013)	(0.017)	(0.018)	
Math belief (G8)	2.479	2.409	2.546	−0.137***
	(0.012)	(0.017)	(0.018)	
Gendered belief (G7) (1=YES)	0.509	0.425	0.587	−0.162***
	(0.007)	(0.010)	(0.009)	
Parent gendered belief (G7) (1=YES)	0.401	0.365	0.435	−0.070***
	(0.007)	(0.010)	(0.010)	
Panel C. Standardized math achievements				
Grade 7 math score	70.173	71.030	69.369	1.661***
	(0.135)	(0.189)	(0.192)	
Grade 8 math score	70.000	71.067	68.987	2.080***
	(0.139)	(0.187)	(0.202)	
Observations	5,472	2,638	2,834	
Classrooms	120	120	120	
Schools	72	72	72	

Notes: This table reports summary statistics for the analytic sample. Columns (1)–(3) report means for all students, girls, and boys, with standard errors in parentheses. Column (4) reports the girls-minus-boys difference. Indicator variables are coded as 0 = No and 1 = Yes. Age, parental schooling, household economic status, and math belief measures are reported in original units; test scores are normalized to have a mean of 70 and a standard deviation of 10 for comparability across grades. Agricultural hukou indicates rural/agricultural household registration. The gap between girls' math performance and math beliefs is consistent with prior work on gender, self-efficacy, overconfidence, and competitive choices (Barber & Odean, 2001; Bussey & Bandura, 1999; Lundeberg et al., 1994; Niederle & Vesterlund, 2007).

I use three related versions of PMB in the empirical analysis: the gender-specific levels of girls' and boys' PMB, the standardized girls-minus-boys PMB gap, and high- and low-PMB peer-group measures. The gap summarizes the relative strength of girls' PMB compared with boys' PMB in the same classroom. The high- and low-PMB measures distinguish exposure to classmates with especially strong versus especially weak Grade 6 math beliefs. All peer measures are standardized for ease of interpretation.

3 Estimation Strategy

3.1 Random Classroom Assignment

This study exploits a subset of Chinese middle schools in which students are randomly assigned to classrooms at seventh-grade entry and are not reassigned in grade 8, providing a setting to identify the effect of peer belief environments on students' beliefs and academic outcomes. Thus, a school is included in the estimation sample only if three conditions are met. First, the principal reports that students are randomly assigned to classrooms at school entry. Second, the principal reports that no classroom reassignment takes place after the beginning of eighth grade. Third, homeroom teachers within the same grade report that students are not systematically grouped by prior academic performance or ability. Under these conditions, classroom peer composition can be treated as plausibly exogenous within schools.

Identification comes from cross-class variation in peer math belief within the same school, following the broader classroom peer-effects literature that exploits across-classroom variation in peer exposure under plausibly exogenous assignment (Gong et al., 2021; Eble & Hu, 2022). This design-based approach follows the broader emphasis in modern empirical economics on credible causal inference through transparent quasi-experimental variation (Angrist & Pischke, 2010). Because assignment occurs within schools, all specifications include school fixed effects to absorb common school-level factors, including institutional environment, teacher quality, and other unobserved characteristics shared by students in the same school. The identifying assumption is that, conditional on school fixed effects, classroom-level peer math belief is orthogonal to unobserved determinants of individual beliefs and achievement.

To assess the plausibility of this assumption, the paper relates classroom-level girl and boy peer math belief measures to student characteristics determined prior to classroom assignment, including parental education, only-child status, household economic conditions, and related background variables, while controlling for school fixed effects. Table 2 indicates no systematic association between peer math belief and these background characteristics within schools, consistent with approximate balance on observable dimensions.

3.2 Estimation Framework

I estimate the effect of exposure to peers' math beliefs using the following specification:

$$Y_{icb} = \beta_g PMB^g_{-i,cb} + \beta_b PMB^b_{-i,cb} + X'_{icb}\gamma + \delta_b + \varepsilon_{icb}, \tag{1}$$

where i indexes students, c indexes classrooms, and b indexes schools. The outcomes Y_{icb} are gender beliefs, math beliefs, math achievement, and school experiences. $PMB^g_{-i,cb}$ denotes the leave-one-out classroom average of girl peers' Grade 6 math beliefs, and $PMB^b_{-i,cb}$ denotes the corresponding leave-one-out average for boy peers. The leave-one-out construction excludes student i's own response from the peer measure and helps mitigate the reflection problem (Manski, 1993). The vector X_{icb} includes predetermined student and family background controls, and δ_b denotes school fixed effects. School fixed effects absorb all school-level differences that are common to students in the same school, so identification comes from comparing students assigned to different classrooms within the same school. The error term ε_{icb} captures unobserved determinants of outcome Y_{icb}. Standard errors are clustered at the classroom level.

Table 2: Balance Test

Dependent Variable:	(1) Girl Peer Math belief	(2) Girl Peer Math belief	(3) Boy Peer Math belief	(4) Boy Peer Math belief
Age	-0.0897^{***}	-0.0099	-0.0787^{***}	-0.0178
	(0.0256)	(0.0108)	(0.0210)	(0.0108)
Ethnic minority (1=YES)	-0.0569	0.0140	-0.0269	0.0090
	(0.0622)	(0.0113)	(0.0732)	(0.0111)
Mother's education (years)	0.0200^{***}	-0.0009	0.0170^{***}	0.0000
	(0.0042)	(0.0011)	(0.0038)	(0.0012)
Father's education (years)	0.0113^{**}	0.0021	0.0133^{***}	-0.0002
	(0.0044)	(0.0016)	(0.0045)	(0.0015)
Agricultural *hukou*(1=YES)	-0.0657^{**}	-0.0305^{**}	-0.0706^{**}	-0.0219^{*}
	(0.0269)	(0.0126)	(0.0294)	(0.0123)
Family socioeconomic status	0.0849^{***}	0.0099	0.0925^{***}	0.0178
	(0.0206)	(0.0109)	(0.0197)	(0.0114)
Only child (1=YES)	0.0788^{**}	0.0067	0.0263	0.0096
	(0.0325)	(0.0094)	(0.0329)	(0.0081)
Local birth indicator (1=YES)	-0.0414	0.0018	-0.0041	0.0004
	(0.0355)	(0.0082)	(0.0272)	(0.0064)
School Fixed Effects	No	Yes	No	Yes
Observations	2,352	2,352	2,352	2,352
Joint F-statistic	10.04	1.366	12.52	1.420
Joint p-value	<0.001	0.218	<0.001	0.195

Notes: This table presents a balance test for the girls' sample that assesses whether predetermined student and family background characteristics jointly predict the peer math belief measures. I regress each peer math belief measure on the predetermined characteristics using the main estimating equation and report the joint F-statistic and its p-value. Across Columns (2) and (4), after controlling for school fixed effects, the null hypothesis of no joint predictive power cannot be rejected ($p = 0.218$ and $p = 0.195$, respectively). This pattern is consistent with conditional random assignment of peers across classrooms within the same school. The *hukou* variable refers to household residency registration.

In the baseline specifications, the controls include students' pre-assignment math belief, demographic characteristics, and family background. For Grade 8 outcomes, I additionally control for Grade 7 math belief, Grade 7 math achievement, and Grade 7 cognitive ability. When the outcome has a Grade 7 analogue, I also include the corresponding Grade 7 outcome as a lagged outcome control. These controls account for baseline differences in prior beliefs, achievement, and ability, which are closely related to later beliefs and performance. In robustness specifications, I further add classroom peer controls, including peer socioeconomic status, peer hukou, peer parental gender beliefs, classroom gender composition, and peer cognitive ability.

The coefficients of interest are β_g and β_b. They capture the effects of exposure to girl and boy peer math belief environments on students' beliefs and achievement, conditional on school fixed effects and the control set. I distinguish between girl and boy PMB because the same level of peer math belief may convey different social information in a gendered subject environment. High girl PMB may provide a same-gender signal that girls belong in math, while high boy PMB may increase the salience of gender belief about male advantage in math (Spencer et al., 1999). An aggregate peer-belief measure could therefore mask offsetting effects across girl and boy peer groups.

4 Main Results

In this section, I present the main estimates of the effect of exposure to gender-specific peer math beliefs on girls' beliefs and outcomes. Peer exposure is constructed from peers' pre-assignment Grade 6 math beliefs and realized through random assignment to Grade 7 classrooms. I study three outcomes: girls' beliefs about gender differences in math ability, their own math beliefs, and math achievement. The CEPS measure of beliefs about gender differences in math ability is available in Grade 7, so estimates for this outcome capture responses during the first year of peer exposure. Girls' own math beliefs and math achievement are observed in both Grade 7 and Grade 8, so the analysis estimates both contemporaneous and subsequent responses to the same peer-belief exposure. Section 5 examines mechanisms related to school experience and peer interaction. Section 6 reports robustness checks, and Section 7 presents heterogeneity analyses.

4.1 Beliefs about who belongs in math

I first examine whether the gender structure of peer math beliefs shapes girls' beliefs about who belongs in math. The outcome is an indicator equal to one if a girl agrees that boys are better than girls at learning math. This outcome captures girls' beliefs about the gendered distribution of mathematics ability, rather than their assessment of their own ability. This analysis speaks to a stereotype-threat channel: in a highly gendered subject environment, exposure to boys with strong math beliefs may increase the salience of gender belief about male advantage in math, thereby shaping girls' beliefs about who belongs in the domain (Spencer et al., 1999).

Table 3 reports the results. PMB denotes peer math belief, measured as the standardized leave-one-out classroom mean of classmates' Grade 6 math belief. Panel A reports estimates using gender-specific PMB, constructed separately for girl and boy peers. A one standard deviation increase in girls' PMB reduces the probability that a girl believes boys are better than girls at math by 6.1 percentage points. Boys' PMB moves beliefs in the opposite direction: a one standard deviation increase in boys' PMB raises this probability by 10.1 percentage points.

Panel B summarizes the same comparison using the standardized girls-minus-boys PMB gap. A one standard deviation increase in this gap reduces the probability that a girl believes boys are better at math by 6.2 percentage points. Panel C examines low- and high-belief peer groups. Exposure to high-PMB boys increases girls' endorsement of the belief by 8.4 percentage points, while exposure to high-PMB girls reduces it by 5.1 percentage points. Low-PMB boys reduce endorsement of the belief, while low-PMB girls increase it, though the latter estimate is not statistically distinguishable from zero.

These patterns suggest that girls are not responding only to average peer quality. If PMB simply captured a stronger academic classroom environment, girls' and boys' PMB should move beliefs in the same direction. Instead, the estimates differ sharply by peer gender. Girls become less likely to view math ability as male-typed when girls' math beliefs are more visible in the classroom, and more likely to do so when boys' math beliefs are more visible. This pattern is consistent with a stereotype-threat channel, in which gendered peer cues shape the perceived gender-typing of mathematics (Spencer et al., 1999).

Table 3: Effect of exposure to peer math beliefs on girls' gender belief

	Believes boys are better than girls at math			
	(1)	(2)	(3)	(4)
Panel A. Gender-specific peer math belief				
Girl PMB	-0.0609**			
	(0.0303)			
Boy PMB	0.101***			
	(0.0204)			
Panel B. Relative female versus male peer math belief				
Girl PMB − Boy PMB		-0.0615***		
		(0.0203)		
Panel C. Low- and high-belief peer groups				
Girl low PMB			0.0341	
			(0.0255)	
Boy low PMB			-0.0779***	
			(0.0258)	
Boy high PMB				0.0837***
				(0.0209)
Girl high PMB				-0.0511**
				(0.0243)
Observations	2,299	2,299	2,299	2,299
R-squared	0.117	0.114	0.116	0.117
Adjusted R-squared	0.085	0.084	0.081	0.084

Notes: The table estimates the effect of peer math belief exposure on girls' gender beliefs. The dependent variable is an indicator equal to one if the student agrees that boys are better than girls at mathematics, and zero otherwise. PMB denotes peer math belief, and all peer variables are standardized. All specifications control for baseline controls and school fixed effects. Standard errors are clustered at the classroom level and reported in parentheses.

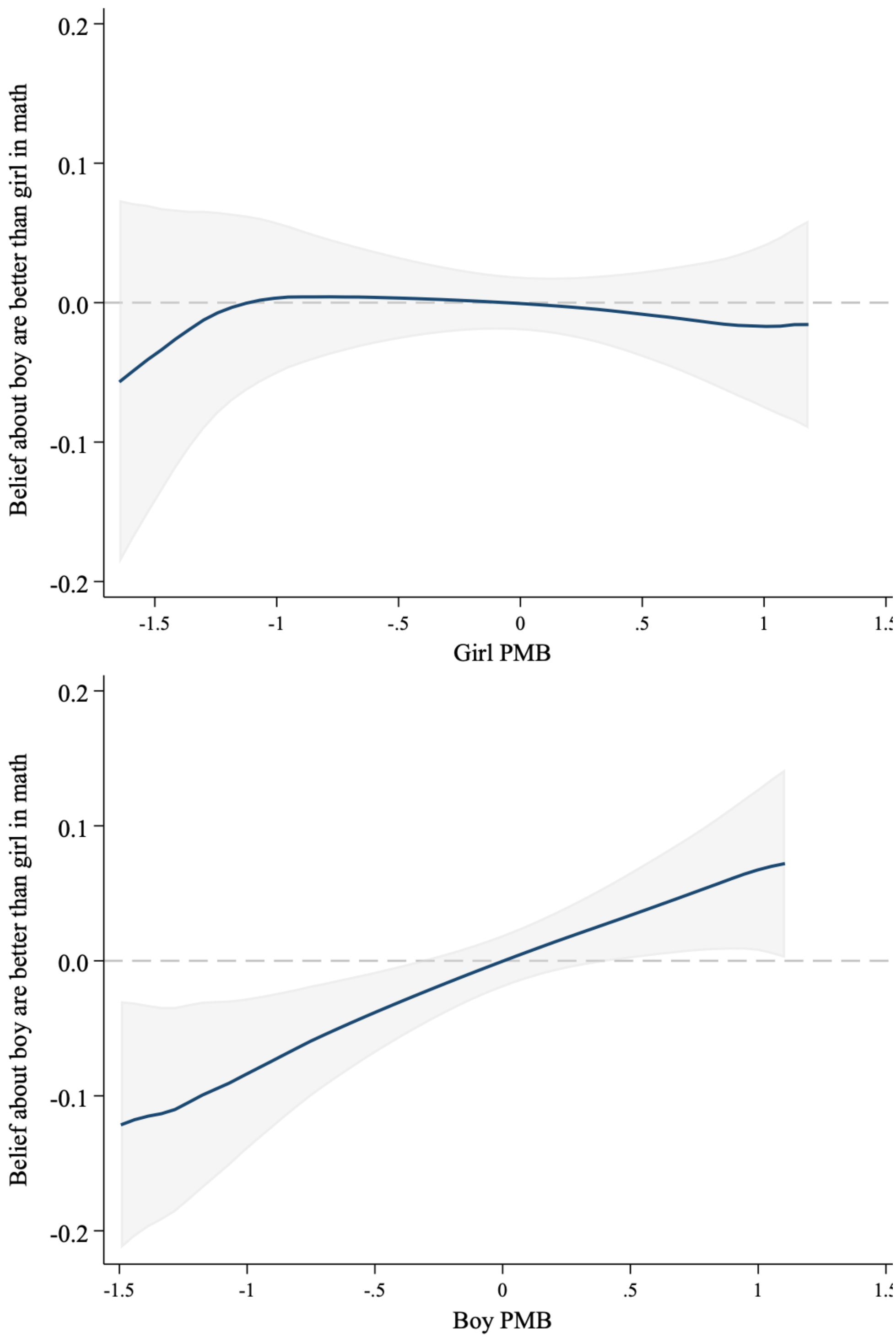

Figure 1: Effect of exposure to peer math beliefs on girls' gender belief

Notes: The figure plots kernel-weighted local linear regressions of the residualized belief outcome on residualized peer math belief measures. Residuals are obtained after controlling for baseline control and school fixed effects. The shaded areas report 95 percent confidence intervals.

Figure 1 provides graphical evidence on the same relationships. I residualize the belief outcome and each PMB measure using the controls and school fixed effects from Table 3, and plot kernel-weighted local linear fits of the residualized outcome against residualized girls' and boys' PMB. The relationship is flat to downward sloping for girls' PMB and upward sloping for boys' PMB. Although the figure is descriptive, it shows that the gender-specific pattern in Table 3 is not driven by a small number of extreme observations.

4.2 Own Beliefs about Math

I next examine whether gendered peer math beliefs affect girls' beliefs about their own ability in math. This outcome differs from the belief outcome in the previous subsection. The previous outcome measures whether girls believe boys are better than girls at learning math. The outcome here measures girls' own Grade 8 math belief. The question is therefore whether gendered peer beliefs affect not only girls' views about gender differences in math, but also their beliefs about their own place in the subject.

Table 4 presents the results. Panel A reports estimates using gender-specific peer math beliefs. A one standard deviation increase in girls' PMB is associated with a 0.042 standard deviation increase in girls' own math belief in Grade 8, though the estimate is not statistically distinguishable from zero. Boys' PMB moves in the opposite direction. A one standard deviation increase in boys' PMB reduces girls' own math belief by 0.128 standard deviations.

Panel B summarizes the same comparison using the standardized girls-minus-boys PMB gap. A one standard deviation increase in this gap is associated with a 0.064 standard deviation increase in girls' math belief. Panel C shows that this pattern is driven mainly by boys' peer beliefs. Exposure to high-PMB boys reduces girls' own math belief by 0.088 standard deviations, while exposure to low-PMB boys increases it by 0.107 standard deviations. The corresponding estimates for girls' high and low PMB are positive but small and not statistically distinguishable from zero.

Figure 2 presents graphical evidence on these relationships. The relationship between

Table 4: Effects of peer math beliefs on girls' own math beliefs

	Own math belief in Grade 8			
	(1)	(2)	(3)	(4)
Panel A. Gender-specific peer math beliefs				
Girl PMB	0.0418			
	(0.0403)			
Boy PMB	-0.128***			
	(0.0419)			
Panel B. Relative female versus male peer math beliefs				
Girl PMB − Boy PMB		0.0636**		
		(0.0251)		
Panel C. Low- and high-belief peer groups				
Girl low PMB			0.0402	
			(0.0394)	
Boy low PMB			0.107**	
			(0.0459)	
Boy high PMB				-0.0882**
				(0.0347)
Girl high PMB				0.0280
				(0.0338)
Math achievement, Grade 7	Yes	Yes	Yes	Yes
Math belief, Grade 7	Yes	Yes	Yes	Yes
Cognitive ability, Grade 7	Yes	Yes	Yes	Yes
Observations	2,149	2,149	2,149	2,149
R-squared	0.440	0.439	0.441	0.439

Notes: The table estimates subsequent responses of girls' math beliefs to peer math belief exposure. The dependent variable is girls' Grade 8 math belief, standardized to have mean zero and standard deviation one. Because the outcome is measured in Grade 8, all specifications control for girls' Grade 7 math belief, Grade 7 math achievement, Grade 7 cognitive ability, baseline controls, and school fixed effects. These controls account for baseline differences in prior beliefs, achievement, and cognitive ability, which are closely related to later math beliefs. Standard errors are clustered at the classroom level and reported in parentheses.

girls' PMB and girls' own Grade 8 math belief is positive at the lower end of the distribution but relatively flat over much of the support. The relationship for boys' PMB is downward sloping over most of the support. The figure does not replace the regression estimates in Table 4; rather, it shows that the negative relationship between boys' PMB and girls' own math belief is not driven by a small number of extreme observations.

These estimates show that gendered PMB predicts both types of belief outcomes, but not in identical ways. Girls' beliefs about whether boys are better than girls at math respond to both girls' and boys' PMB, while girls' own math beliefs are more strongly related to boys' PMB. This difference motivates the heterogeneity analysis below, where I examine whether girls' prior beliefs shape how they respond to these peer signals. The next subsection asks whether the same patterns appear in realized math performance.

4.3 Math Achievement

I next examine whether gendered peer math beliefs affect girls' subsequent math achievement. This outcome is more downstream than the belief outcomes studied above. The question is whether the same peer belief environment that predicts girls' gender-math beliefs and own math beliefs also predicts realized performance.

Table 5 presents the results. Panel A reports estimates using gender-specific PMB. A one standard deviation increase in girls' PMB raises girls' Grade 8 math scores by 0.103 standard deviations. The corresponding estimate for boys' PMB is close to zero and not statistically significant. This pattern differs from the own-belief results above, where boys' PMB was more strongly predictive. On the achievement margin, girls' PMB is the peer belief measure most strongly related to girls' later math performance.

Panel B summarizes the same comparison using the standardized girls-minus-boys PMB gap. A one standard deviation increase in this gap is associated with a 0.042 standard deviation increase in girls' Grade 8 math achievement. Panel C examines low- and high-belief girl peer groups. Exposure to low-PMB girls reduces girls' Grade 8 math scores by

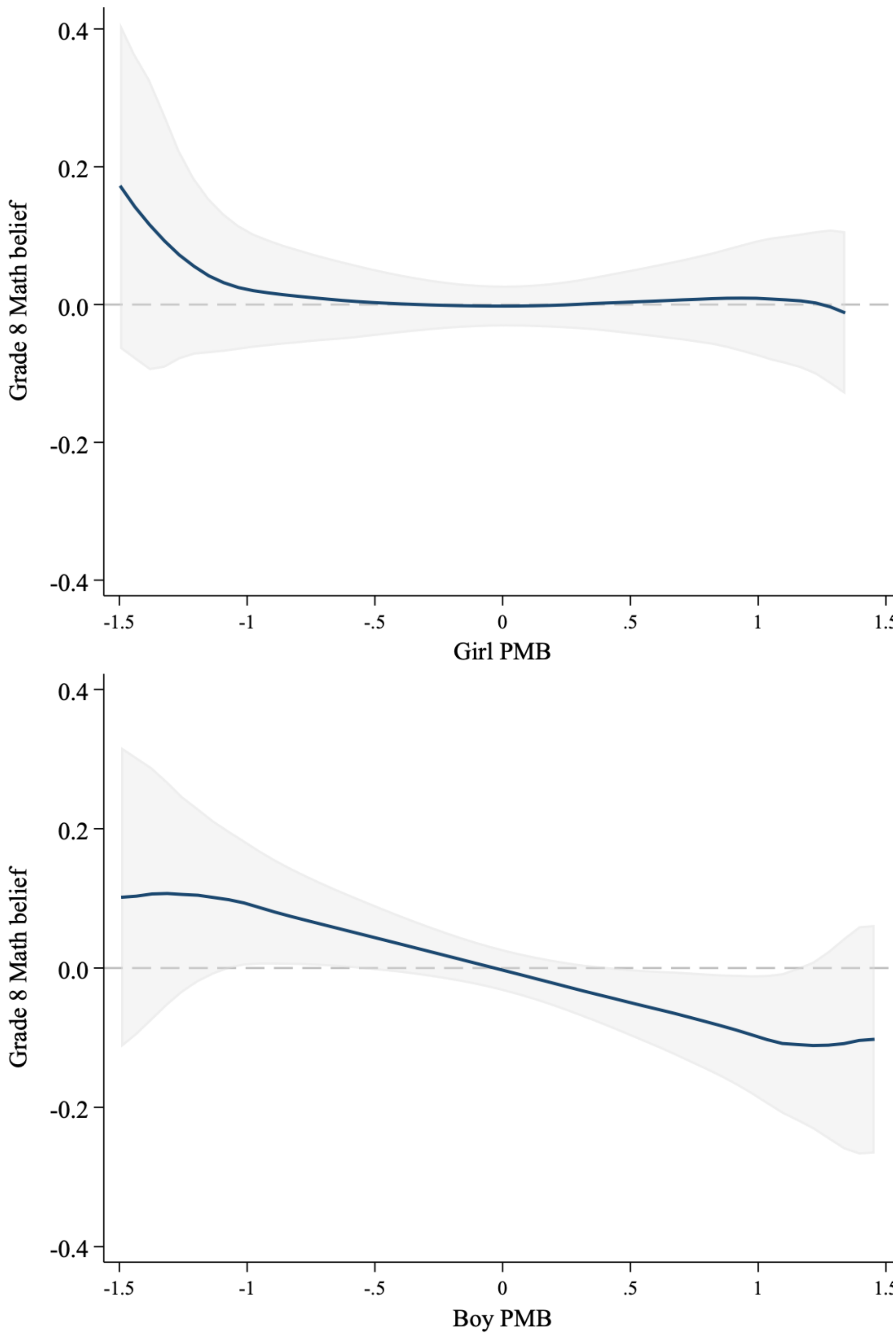

Figure 2: Effects of peer math beliefs on girls' own math beliefs

Notes: The figure plots the relationship between gender-specific PMB and girls' own Grade 8 math belief. The shaded areas report 95 percent confidence intervals. PMB denotes peer math belief.

Table 5: Effects of peer math beliefs on girls' math achievement

	Math test score in Grade 8			
	(1)	(2)	(3)	(4)
Panel A. Gender-specific peer math beliefs				
Girl PMB	0.103***			
	(0.0357)			
Boy PMB	0.00396			
	(0.0263)			
Panel B. Relative female versus male peer math beliefs				
Girl PMB − Boy PMB		0.0420*		
		(0.0226)		
Panel C. Low- and high-belief girl peer groups				
Girl low PMB			-0.0691**	
			(0.0300)	
Girl high PMB				0.0697**
				(0.0347)
Math achievement, Grade 7	Yes	Yes	Yes	Yes
Math belief, Grade 7	Yes	Yes	Yes	Yes
Cognitive ability, Grade 7	Yes	Yes	Yes	Yes
Observations	2,176	2,176	2,176	2,176
R-squared	0.559	0.557	0.557	0.557

Notes: The table estimates subsequent responses of girls' math achievement to peer math belief exposure. The dependent variable is girls' Grade 8 math test score, standardized to have mean zero and standard deviation one. Because the outcome is measured in Grade 8, all specifications control for girls' Grade 7 math belief, Grade 7 math achievement, Grade 7 cognitive ability, baseline controls, and school fixed effects. These controls account for baseline differences in prior beliefs, achievement, and cognitive ability, which are closely related to later math achievement. Standard errors are clustered at the classroom level and reported in parentheses.

0.069 standard deviations, while exposure to high-PMB girls raises them by 0.070 standard deviations. These estimates are similar in magnitude and opposite in sign.

Figure 3 summarizes these coefficient estimates graphically. The positive estimate for girls' PMB, the near-zero estimate for boys' PMB, and the opposite-signed estimates for low- and high-PMB girl peers show that the achievement results are concentrated among same-gender peer belief measures. The figure is not a separate test; it provides a compact visual summary of the estimates in Table 5.

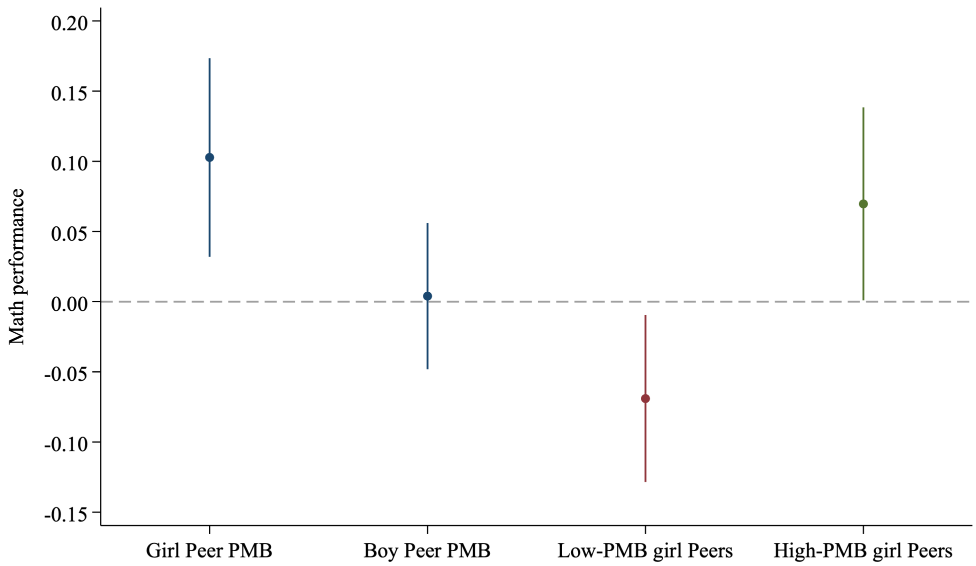

Figure 3: Effects of peer math beliefs on girls' math achievement

Notes: The figure reports coefficient estimates from Table 5. The dependent variable is girls' Grade 8 math test score, standardized to have mean zero and standard deviation one. Vertical bars report 95 percent confidence intervals.

These results show that different peer belief signals matter at different margins. Boys' PMB is more predictive of girls' own math beliefs, while girls' PMB is more predictive of realized math achievement. This pattern is consistent with the idea that boys' PMB may operate more as a gendered signal, while girls' PMB may also reflect same-gender peer interaction in the classroom. I interpret this distinction cautiously. The mechanism and heterogeneity analyses below examine these interpretations more directly.

5 Mechanisms: School Experience and Peer Interaction

In this section, I assess whether girls' school experiences move in ways predicted by the framework. The framework implies two empirical patterns. First, if boys' PMB operates mainly as a gendered signal about who fits in math, then boys' PMB should affect girls' beliefs about the gender-typing of math but need not improve their broader peer relations or classroom integration. This prediction is consistent with a stereotype-threat channel, in which gendered cues make gender belief about male advantage in math more salient (Spencer et al., 1999). Second, if girls' PMB captures a same-gender peer environment, then girls' PMB should predict more favorable school experiences across both math-specific and social margins. This prediction follows from homophilous interaction: children may be more likely to interact with, attend to, or treat same-gender peers as credible sources of information (Currarini, Jackson, & Pin, 2009). It is also consistent with evidence that exposure to same-gender high achievers in mathematics improves later academic outcomes through a role-model channel (Pagani & Pica, 2026; Qin et al., 2026). These margins are important because peer interaction and classroom integration may translate peer beliefs into achievement even when average effects on math beliefs are muted. I therefore examine perceived future usefulness of math, teacher interaction, and peer relations.

Table 6 reports the results. The estimates are consistent with these predictions. Girls' PMB positively predicts all five school-experience outcomes. A one standard deviation increase in girls' PMB raises girls' belief that math helps their future by 0.130 standard deviations. It also increases reports that the math teacher asks the student to answer questions by 0.139 standard deviations and that the math teacher praises the student by 0.082 standard deviations. The estimates for peer relations are also positive: girls' PMB increases reports that classmates are nice by 0.122 standard deviations and that the student is easy to get along with by 0.105 standard deviations.

Boys' PMB shows a different pattern. It is not meaningfully related to the perceived future usefulness of math, and it is negatively associated with both teacher-interaction measures. A one standard deviation increase in boys' PMB reduces reports that the math teacher asks the student to answer questions by 0.066 standard deviations, although the estimate is only marginally significant. The estimate for math teacher praise is also negative but not statistically distinguishable from zero. The estimates for peer relations are small and imprecise. Thus, boys' PMB does not predict the broad improvements in school experience associated with girls' PMB.

I do not interpret these estimates as a formal mediation test. Rather, the table shows that the school-experience margins move in ways consistent with the framework. Girls' PMB predicts both math-specific and social margins that may support achievement, consistent with a same-gender peer environment. Boys' PMB, by contrast, is more consistent with a gendered signal that affects beliefs and math-specific comparison, but does not improve girls' broader classroom integration. This distinction also helps interpret the weaker average estimates for girls' own math beliefs: the pooled effect may mask heterogeneity in which peer beliefs matter most for girls whose baseline confidence or classroom position makes them more responsive to same-gender peer cues. Section 7 examines this possibility directly.

6 Robustness and Interpretation

This section addresses two threats to the interpretation of the main results. The first is measurement contamination: because grade 6 math belief is reported retrospectively, later classroom experiences may shape how girls recall their earlier beliefs. I address this concern using placebo tests that ask whether current teachers and current peer achievement signals predict the retrospective grade 6 measure. The second is omitted peer composition. I address this concern by adding these peer controls sequentially and examining whether the PMB coefficients remain stable.

Table 6: Effects of peer math beliefs on girls' school experiences

	Dependent variables in Grade 8				
	Math future help	Math teacher ask	Math teacher praise	Classmates nice	Easy to get along
	(1)	(2)	(3)	(4)	(5)
Girl PMB	0.130***	0.139***	0.0818**	0.122***	0.105**
	(0.0413)	(0.0422)	(0.0332)	(0.0397)	(0.0502)
Boy PMB	-0.0161	-0.0662*	-0.0636	0.0179	0.0312
	(0.0412)	(0.0383)	(0.0394)	(0.0461)	(0.0571)
Math achievement, G7	Yes	Yes	Yes	Yes	Yes
Math belief, G7	Yes	Yes	Yes	Yes	Yes
Cognitive ability, G7	Yes	Yes	Yes	Yes	Yes
Lagged outcome controls	Yes	Yes	Yes	Yes	Yes
Observations	2,146	2,134	2,140	2,131	2,129
R-squared	0.164	0.259	0.219	0.172	0.230

Notes: The table estimates subsequent responses of girls' school experiences to peer math belief exposure. Each column reports a separate regression for the listed Grade 8 outcome, standardized to have mean zero and standard deviation one. Because the outcomes are measured in Grade 8, all specifications control for girls' Grade 7 math beliefs, Grade 7 math achievement, Grade 7 cognitive ability, baseline controls, school fixed effects, and the corresponding Grade 7 outcome measure. These controls account for baseline differences in prior beliefs, achievement, cognitive ability, and lagged school experiences, which are closely related to later classroom integration and math-specific experiences. Standard errors are clustered at the classroom level and reported in parentheses.

6.1 Falsification test

A central concern is that the retrospective grade 6 belief measure may be contaminated by students' later classroom experiences. This concern matters because the measure is reported after students have already been exposed to their grade 7 classroom environment. If girls' memories of their earlier math belief are shaped by current classroom signals, then the grade 6 measure would no longer provide a clean pre-exposure benchmark.

There are three versions of this concern. First, teachers may affect girls' current math confidence and also lead them to recall their earlier confidence more favorably. This concern is especially relevant because prior work using the same data shows that female math teachers improve low math confidence among girls (Eble & Hu, 2020). Second, peers may affect girls' current math beliefs and also lead them to reconstruct their earlier beliefs in the same direction; for example, exposure to high-achieving male peers may lower girls' current math belief and lead them to recall their earlier math belief as lower. The third concern is broader. If recall bias shifts the grade 6 measure for all students, it would mainly affect the level of the placebo outcome rather than generate systematic correlations with specific grade 7 classroom signals. If recall bias is heterogeneous, it is most likely to be concentrated among students at the high or low ends of the belief distribution.

Appendix Table A1 examines the first concern. A female math teacher in grade 7 is associated with a lower probability that girls report low math confidence in grade 8. The corresponding estimate for grade 6 low math confidence is close to zero and statistically insignificant. This pattern is informative because the outcome is defined at the low-confidence margin, where heterogeneous recall bias would be most likely to matter. If later exposure to a female math teacher mechanically reshaped girls' recalled earlier confidence, the placebo coefficient should move in the same direction. It does not.

Appendix Table A2 examines the second concern. The male share among high-achieving math peers is negatively related to girls' math belief in grades 7 and 8. In contrast, the estimates for grade 6 math belief are small and statistically insignificant across all three definitions of the peer. This holds when high achievement is defined using the top 10 percent, top 5 percent, or top 3 percent of the math achievement distribution. The same classroom signal predicts post-exposure beliefs, but not the retrospective pre-exposure measure.

The third concern is recall bias itself. The tests cannot show that the Grade 6 measure is free of individual recall error. They can, however, assess whether recall error is likely to bias the main estimates. If recall bias is common across students, it would shift the level of the recalled Grade 6 measure but would not systematically change the relative differences across classrooms that identify the estimates. If recall bias is concentrated at the low end of the belief distribution, it should be most visible in the placebo check using the indicator for low Grade 6 math confidence. The results do not show this pattern. In the main regressions, both the continuous PMB measures and the high- and low-PMB peer-group measures predict girls' Grade 7 and Grade 8 beliefs. When the same measures are used to predict the retrospective Grade 6 belief measure, however, the estimates are small and statistically insignificant. This contrast suggests that the main estimates reflect responses to classroom exposure rather than recall-driven differences in the pre-exposure measure. Overall, the evidence suggests that recall error is unlikely to be the main source of the results. Current teachers and peer signals predict girls' post-exposure beliefs, but not the retrospective Grade 6 measure, supporting the use of Grade 6 beliefs as a pre-exposure benchmark.

6.2 Stability with additional peer controls

Another concern is that PMB may proxy for other peer characteristics rather than a distinct classroom belief signal. Table 7 addresses this by sequentially adding controls for peer socioeconomic status, achievement, parental beliefs, and gender composition.

The PMB coefficients are stable across these richer specifications. Panel A shows that girls' PMB remains negatively associated with girls' gender beliefs: the coefficient changes from -0.0609 in the baseline specification to -0.0849 after all peer controls are included. Boys' PMB remains positive throughout, moving from 0.101 to 0.101 across the same specifications. Panel B shows a different pattern for girls' own math belief. Girls' PMB is positive but imprecisely estimated, increasing from 0.0418 to 0.0641. Boys' PMB remains negative in every specification, although its magnitude falls from -0.128 to -0.0767 after the full set of peer controls is added. Panel C shows that girls' PMB is consistently related to girls' Grade 8 math achievement. The coefficient changes only slightly, from 0.103 to 0.110 standard deviations. Boys' PMB remains close to zero, increasing from 0.00396 to 0.0247 and remaining statistically insignificant.

This stability is informative. If PMB were mainly a proxy for peer advantage or peer ability, the coefficients should weaken once the model absorbs those characteristics. Instead, the gendered pattern remains. Girls' PMB is most closely related to later achievement, while boys' PMB is more strongly related to girls' own math belief and gender beliefs. The results therefore suggest that PMB is not reducible to standard peer background measures. It captures a gendered classroom belief signal that remains visible after controlling for broader peer composition.

Table 7: Horse-Race Specifications with Additional Peer Controls

	Sequentially adding peer controls					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. G7 gender-math belief						
Girl PMB	-0.0609**	-0.0834**	-0.0795**	-0.0811***	-0.0858***	-0.0849***
	(0.0303)	(0.0323)	(0.0322)	(0.0292)	(0.0259)	(0.0261)
Boy PMB	0.101***	0.104***	0.0956***	0.0893***	0.0873***	0.101***
	(0.0204)	(0.0206)	(0.0228)	(0.0242)	(0.0245)	(0.0244)
Observations	2,299	2,299	2,299	2,299	2,299	2,299
R-squared	0.117	0.122	0.122	0.123	0.123	0.124
Panel B. G8 math belief						
Girl PMB	0.0418	0.0558	0.0434	0.0439	0.0628	0.0641
	(0.0403)	(0.0419)	(0.0419)	(0.0418)	(0.0415)	(0.0412)
Boy PMB	-0.128***	-0.117***	-0.0960***	-0.0944**	-0.0875***	-0.0767**
	(0.0419)	(0.0392)	(0.0357)	(0.0363)	(0.0325)	(0.0334)
Observations	2,149	2,149	2,149	2,149	2,149	2,149
R-squared	0.440	0.441	0.442	0.442	0.445	0.445
Panel C. Grade 8 math achievement						
Girl PMB	0.103***	0.105**	0.0994**	0.0980**	0.109***	0.110***
	(0.0357)	(0.0430)	(0.0431)	(0.0437)	(0.0384)	(0.0386)
Boy PMB	0.00396	0.00924	0.0191	0.0152	0.0194	0.0247
	(0.0263)	(0.0277)	(0.0280)	(0.0278)	(0.0274)	(0.0268)
Observations	2,176	2,176	2,176	2,176	2,176	2,176
R-squared	0.559	0.559	0.559	0.559	0.560	0.560
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Peer SES controls	No	Yes	Yes	Yes	Yes	Yes
Peer hukou controls	No	No	Yes	Yes	Yes	Yes
Peer parent belief controls	No	No	No	Yes	Yes	Yes
Peer female share	No	No	No	No	Yes	Yes
Peer cognitive ability	No	No	No	No	No	Yes

Notes: The table reports robustness checks that sequentially add peer controls to the main PMB specifications. Panel A estimates effects on girls' Grade 7 gender beliefs, where higher values indicate stronger agreement that boys are better than girls at mathematics. Panel B estimates effects on girls' Grade 8 math belief, and Panel C estimates effects on girls' Grade 8 math achievement. Column (1) reports the baseline specification. Columns (2)–(6) sequentially add peer socioeconomic background, peer hukou status, peer parental gender-math belief, peer female share, and peer cognitive ability. All specifications include baseline controls and school fixed effects. Panels B and C additionally control for Grade 7 math achievement and Grade 7 cognitive ability. Standard errors are clustered at the classroom level and reported in parentheses.

7 Heterogeneity by Prior Beliefs

The effects of peer math beliefs may depend on the beliefs girls bring into middle school. If PMB operates as social information about who belongs in math, then the same classroom signal should not affect all girls in the same way. Girls with low prior math belief may be especially vulnerable because they enter the classroom with weaker confidence in their own place in math. In this setting, strong math beliefs among boys may make gender beliefs about male advantage more salient, while strong math beliefs among girls may be less able to offset already weak priors. Girls who already endorse the view that boys are better at math may be similarly responsive to male-typed classroom signals. I examine this heterogeneity using interactions between gender-specific PMB and two belief moderators: low prior math belief and prior gender-math belief.

Table 8 reports the results. Columns (1) and (2) use girls' Grade 7 gender-math belief as the dependent variable. Columns (3)–(6) use girls' Grade 8 math beliefs. The sample includes female students only, so the estimates ask whether girls with different prior beliefs respond differently to girls' and boys' PMB.

Columns (1) and (2) show that prior math confidence changes how girls respond to PMB in forming gender-math beliefs. In Column (1), girls' PMB reduces agreement that boys are better at math by 7.0 percentage points among girls without low prior math belief. The interaction with low prior math belief is positive and significant at 8.9 percentage points, implying that this protective association is essentially absent for girls who entered middle school with low math confidence. In Column (2), boys' PMB increases agreement that boys are better at math by 9.0 percentage points at baseline, and the interaction with low prior math belief adds another 5.5 percentage points. Thus, low-confidence girls are especially responsive to boys' PMB in the direction of stronger gender beliefs.

Columns (3)–(6) examine girls' own Grade 8 math belief. The pattern is consistent with asymmetric updating. In Column (3), girls' PMB is positively but imprecisely related to own math belief at baseline, while the interaction with low prior math belief is -0.135 standard deviations and statistically significant. In Column (5), boys' PMB reduces girls' own math belief by 0.111 standard deviations at baseline, and the interaction with low prior math belief is an additional -0.091 standard deviations. Thus, low-confidence girls appear less able to benefit from positive same-gender peer signals and more exposed to negative cross-gender signals.

Columns (4) and (6) use prior gender-math belief as the moderator. The results show that prior gender beliefs condition how girls absorb both same-gender and cross-gender peer signals. In Column (4), girls' PMB is associated with a 0.093 standard deviation increase in Grade 8 math belief among girls who do not initially agree that boys are better at math. This magnitude is about 54 percent of the average within-school gender gap in Grade 8 math belief, where girls' math belief is 0.171 standard deviations lower than boys. The interaction with prior gender belief is -0.127 standard deviations, implying that the positive association with girls' PMB is largely offset among girls who already hold the gender-math stereotype. For these girls, the implied association is approximately -0.035 standard deviations.

In Column (6), boys' PMB is associated with a 0.099 standard deviation reduction in Grade 8 math belief among girls who do not initially hold the stereotype, about 58 percent of the average gender gap. The interaction with prior gender belief is an additional -0.075 standard deviations, implying a total association of -0.175 standard deviations among girls who initially believe boys are better at math. This total association is approximately equal to the average within-school gender gap. Prior gender beliefs therefore appear to weaken girls' response to positive same-gender signals and amplify their response to negative cross-gender signals.

Table 8: Heterogeneous Effects of PMB by Girls' Prior Beliefs

	Gender belief in Grade 7		Math belief in G8			
	Girl PMB × Low math belief	Boy PMB × Low math belief	Girl PMB × Low math belief	Girl PMB × Prior gender belief	Boy PMB × Low math belief	Boy PMB × Prior gender belief
	(1)	(2)	(3)	(4)	(5)	(6)
Girl PMB	-0.0703**	-0.0600*	0.0535	0.0925**	0.0394	0.0356
	(0.0314)	(0.0304)	(0.0407)	(0.0441)	(0.0395)	(0.0404)
Girl PMB × Low math belief	0.0887***		-0.135***			
	(0.0271)		(0.0491)			
Girl PMB × Prior gender belief				-0.127***		
				(0.0435)		
Boy PMB	0.0951***	0.0899***	-0.120***	-0.134***	-0.111***	-0.0991**
	(0.0206)	(0.0215)	(0.0412)	(0.0430)	(0.0420)	(0.0398)
Boy PMB × Low math belief		0.0548*			-0.0909*	
		(0.0286)			(0.0463)	
Boy PMB × Prior gender belief						-0.0754*
						(0.0402)
Baseline own math belief	Yes	Yes	Yes	Yes	Yes	Yes
Math achievement, Grade 7	No	No	Yes	Yes	Yes	Yes
Cognitive ability, Grade 7	No	No	Yes	Yes	Yes	Yes
Observations	2,299	2,299	2,149	2,111	2,149	2,111
R-squared	0.121	0.119	0.442	0.444	0.441	0.441

Notes: The table estimates heterogeneous effects of PMB by girls' prior beliefs. Columns (1)–(2) use girls' Grade 7 gender beliefs as the dependent variable, where higher values indicate stronger agreement that boys are better than girls at mathematics. Columns (3)–(6) use girls' Grade 8 math belief as the dependent variable, standardized to have mean zero and standard deviation one. Low math belief is an indicator for low Grade 6 math belief. Prior gender belief is an indicator equal to one if the girl agreed in Grade 7 that boys are better than girls at mathematics. All specifications include baseline controls and school fixed effects. Columns (3)–(6) additionally control for Grade 7 math achievement and Grade 7 cognitive ability. Standard errors are clustered at the classroom level and reported in parentheses.

Figures 4 and 5 summarize these interaction patterns graphically. Figure 4 reports marginal effects on girls' gender-math beliefs by low prior math belief. Figure 5 reports marginal effects on girls' own math belief, separately by low prior math belief and prior gender-math belief. The figures show the same pattern as Table 8: PMB effects are not uniform across girls. The girls who enter middle school with weaker math beliefs or more gendered views of math are also the girls for whom classroom peer signals appear most consequential. This heterogeneity helps explain why average effects on math belief are muted: peer beliefs do not operate uniformly across girls, but are filtered through the gender belief and confidence girls bring into the classroom. The results suggest that gender beliefs are not only beliefs about ability; they also shape which peer signals girls absorb, weakening the benefits of positive same-gender peers and amplifying the costs of male-typed classroom signals.

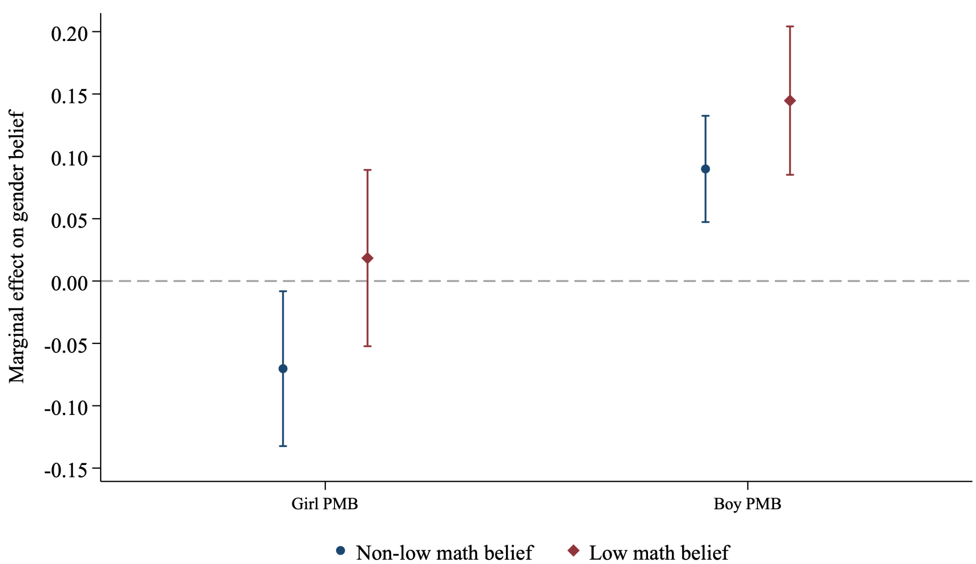

Figure 4: Marginal Effects of PMB on Girls' Gender Beliefs, by Prior Math Belief

Notes: The figure reports marginal effects from Columns (1) and (2) of Table 8. The dependent variable is girls' Grade 7 gender belief. Vertical bars report 95 percent confidence intervals.

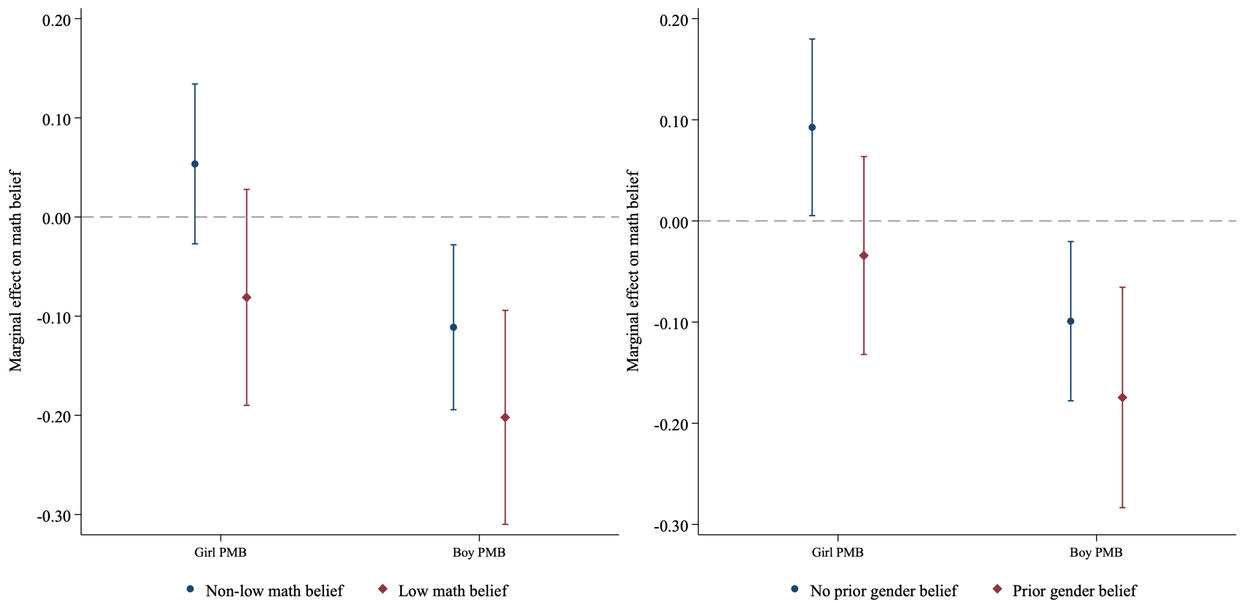

Figure 5: Marginal Effects of PMB on Girls' Own Math Beliefs, by Prior Beliefs

Notes: The figure reports marginal effects from Columns (3)–(6) of Table 8. The dependent variable is girls' Grade 8 math belief, standardized to have mean zero and standard deviation one. The left panel reports heterogeneity by low prior math belief. The right panel reports heterogeneity by prior gender-math belief. Vertical bars report 95 percent confidence intervals. PMB denotes peer math belief.

8 Conclusion

This paper studies how gendered peer math beliefs in the classroom shape girls' gender beliefs about mathematics, their own math beliefs, and later academic outcomes. Exploiting random classroom assignment at entry into Chinese middle schools, the paper shows that girls' and boys' peer math beliefs transmit different social signals. Higher girls' peer math beliefs make girls less likely to believe that boys are better at mathematics and improve later math achievement. Higher boys' peer math beliefs, by contrast, strengthen this gender belief and reduce girls' later math beliefs. These findings show that classroom peers shape not only skill formation, but also belief formation.

The results also show why this belief channel matters. In this setting, girls perform as well as or better than boys in mathematics, yet report lower math beliefs. Girls therefore do not form judgments only from their own scores; they also read social information from peers (Cools et al., 2022; Eble & Hu, 2022; Spencer et al., 1999). The effects are especially strong among girls who enter middle school with weaker math beliefs or who already believe that boys are better at math. Positive peer signals from girls have little effect for these students, while boys' peer math beliefs are more harmful. This suggests that prior gender beliefs can make classroom signals self-reinforcing rather than corrective.

These findings have direct implications for policy and future research. Improving girls' performance alone is unlikely to eliminate gender gaps in math beliefs if the classroom signal environment continues to make mathematics appear male-typed. The results suggest that policies aimed at reducing gender inequality in mathematics should attend not only to skills and achievement, but also to the social information girls receive from teachers and peers about who belongs in the subject. Interventions that increase exposure to confident girl peers, provide counter-stereotypical role models, or strengthen girls' math beliefs before middle school may make classroom signals less likely to reinforce existing gender beliefs. A key next step is to understand when these beliefs are most malleable and which classroom conditions make girls more responsive to positive same-gender signals.

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A Appendix

Table A1: Female Math Teacher and Girls' Low Math Confidence: Main and Placebo Outcomes

	(1) Low math belief, G8	(2) Low math belief, G6
Female math teacher	-0.0365**	-0.00488
	(0.0165)	(0.0264)
Observations	2,179	2,322
R-squared	0.135	0.128
School fixed effects	Yes	Yes
Controls	Yes	Yes

Notes: The table examines whether exposure to a female Grade 7 math teacher predicts girls' low math beliefs after exposure and in the retrospective pre-exposure measure. Column (1) uses low Grade 8 math confidence as the outcome, and Column (2) uses low Grade 6 math confidence as a placebo outcome measured before exposure to the Grade 7 math teacher. All regressions include school fixed effects and baseline controls. Standard errors are clustered at the classroom level and reported in parentheses.

Table A2: Robustness to Alternative Definitions of High-Achieving Male Peers

	(1) Top 10%	(2) Top 5%	(3) Top 3%
Panel A. Grade 6 math beliefs			
Male share among high-achieving math peers	-0.151	0.008	-0.046
	(0.147)	(0.109)	(0.108)
Observations	2,341	2,341	2,341
R-squared	0.162	0.161	0.161
Panel B. Grade 7 math beliefs			
Male share among high-achieving math peers	-0.372***	-0.274***	-0.213***
	(0.130)	(0.0769)	(0.0745)
Observations	2,342	2,342	2,342
R-squared	0.149	0.149	0.148
Panel C. Grade 8 math beliefs			
Male share among high-achieving math peers	-0.629***	-0.448***	-0.369***
	(0.208)	(0.140)	(0.104)
Observations	2,198	2,198	2,198
R-squared	0.174	0.174	0.174

Notes:The table examines whether the male share among high-achieving math peers predicts girls' math beliefs before and after classroom exposure. Panels A, B, and C report estimates for Grade 6, Grade 7, and Grade 8 math beliefs, respectively. Columns (1), (2), and (3) define high-achieving peers as students in the top 10 percent, top 5 percent, and top 3 percent of the classroom math achievement distribution. The pattern shows that high-achieving male peers predict girls' Grade 7 and Grade 8 math beliefs, but not the retrospective Grade 6 measure. All specifications control for baseline controls and school fixed effects. Standard errors are clustered at the classroom level and reported in parentheses.

Table A3: Effects of peer math beliefs on girls' Chinese and English achievement

	Grade 8 test score	
	Chinese (1)	English (2)
Girl PMB	-0.009	0.036
	(0.035)	(0.028)
Boy PMB	0.024	-0.001
	(0.027)	(0.026)
Observations	2,181	2,178
R-squared	0.491	0.674

Notes: The table estimates subsequent responses of girls' non-math achievement to peer math belief exposure. Dependent variables are Grade 8 Chinese and English test scores, standardized within school to have mean zero and standard deviation one. All specifications control for girls' Grade 7 math beliefs, Grade 7 math achievement, Grade 7 cognitive ability, baseline controls, the corresponding Grade 7 subject score, and school fixed effects. Standard errors are clustered at the classroom level and reported in parentheses.

Table A4: Balance test for the girls-minus-boys peer math belief gap

	girls-minus-boys PMB gap (1)
Age	0.025
	(0.018)
Minority	0.016
	(0.027)
Mother's years of education	-0.003
	(0.004)
Father's years of education	0.007*
	(0.004)
Agricultural hukou	-0.027
	(0.023)
Household income	-0.025*
	(0.015)
Only child	-0.009
	(0.026)
Local birth	0.005
	(0.026)
School fixed effects	Yes
Joint F-statistic	1.011
Joint p-value	0.431
Observations	2,352
R-squared	0.634

Notes: The table reports a balance test for the standardized girls-minus-boys peer math belief gap. The regression estimates whether predetermined student and family background characteristics predict the peer math belief gap after controlling for school fixed effects. The joint F-test assesses whether these characteristics have joint predictive power. The null hypothesis of no joint predictive power cannot be rejected ($p = 0.431$), consistent with conditional random assignment of students to classrooms within schools. Standard errors are clustered at the classroom level and reported in parentheses. *Hukou* refers to household residency registration.

Table A5: Robustness to additional peer controls for main school-experience outcomes

	Panel A. Math helps future development					
	(1)	(2)	(3)	(4)	(5)	(6)
Girl PMB	0.130***	0.113***	0.101**	0.098**	0.114***	0.113***
	(0.041)	(0.038)	(0.040)	(0.040)	(0.038)	(0.038)
Boy PMB	-0.016	-0.016	0.005	-0.005	0.001	-0.006
	(0.041)	(0.045)	(0.050)	(0.049)	(0.051)	(0.055)
Observations	2,146	2,146	2,146	2,146	2,146	2,146
R-squared	0.164	0.166	0.167	0.168	0.169	0.169
	Panel B. Classmates are nice					
	(1)	(2)	(3)	(4)	(5)	(6)
Girl PMB	0.122***	0.121***	0.111***	0.105**	0.106**	0.107**
	(0.040)	(0.040)	(0.041)	(0.042)	(0.041)	(0.041)
Boy PMB	0.018	-0.000	0.017	-0.002	-0.001	0.002
	(0.046)	(0.044)	(0.046)	(0.045)	(0.045)	(0.050)
Observations	2,131	2,131	2,131	2,131	2,131	2,131
R-squared	0.172	0.174	0.174	0.176	0.176	0.176
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcome control	Yes	Yes	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Peer SES controls	No	Yes	Yes	Yes	Yes	Yes
Peer hukou controls	No	No	Yes	Yes	Yes	Yes
Peer parent belief controls	No	No	No	Yes	Yes	Yes
Peer female share	No	No	No	No	Yes	Yes
Peer cognitive ability	No	No	No	No	No	Yes

Notes: The table reports robustness checks for two Grade 8 school-experience outcomes. Panel A uses whether math helps future development as the dependent variable. Panel B uses whether classmates are nice as the dependent variable. Outcomes are standardized to have mean zero and standard deviation one. Columns (2)–(6) sequentially add peer SES, peer hukou, peer parental gender beliefs, classroom gender composition, and peer cognitive ability. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.