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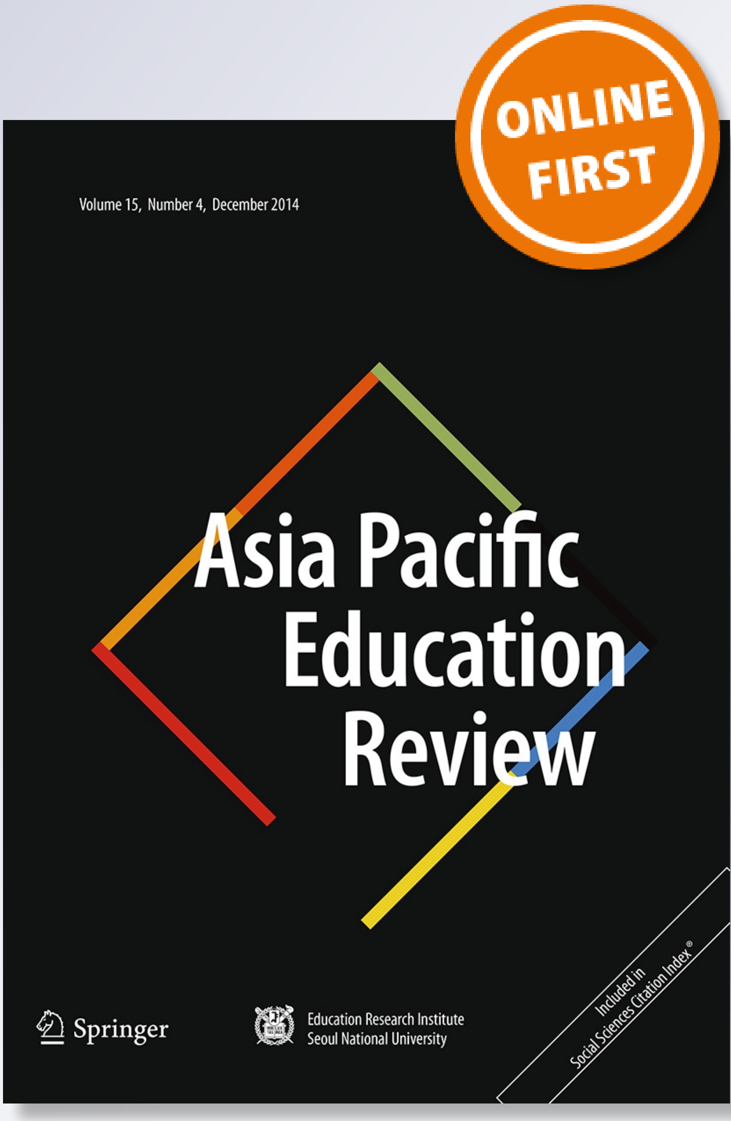

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Gender gap in the National College Entrance Exam performance in China: a case study of a typical Chinese municipality

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Abstract This is one of the first studies to investigate gender achievement gap in the National College Entrance Exam in a typical municipality in China, which is the crucial examination for the transition from high school to higher education in that country. Using ordinary least square model and quantile regression model, the study consistently finds that the gender difference on average is not significant in mathematics, but is significantly negative (females worse) at the top of the distribution and is significantly positive (females better) in Chinese and English. Negative gender gaps are found among some disadvantaged subgroup such as urban female students with sibling. For students at the bottom of the distribution, boys perform significantly worse than girls.

Keywords Gender gap · Academic achievement · National College Entrance Exam · China

Introduction

Academic achievement gender gaps are widely recognized as a factor in future career advancement as correlations have been studied and are shown to exist between these gender gaps, educational level attained, and consequential career status (Christie and Shannon 2001; Bedard and Ferrall 2003; Rose 2006). Specifically, gender disparity in mathematics has received focused attention as mathematics test scores serve as significantly positive predictors of future income (e.g., Altonji and Blank 1999; Currie and Thomas 2012; Grogger and Eide 1995; Murnane et al. 1995, 2000; Paglin and Rufolo 1990). Addressing education equity improvement through focusing on sources of gender gap discrepancies has been pursued in many countries.

International focus on education disparity is distinguished from the disparity in China because of historical intrafamily gender discrimination. Although scholars conclude that after two decades of implementation of the one-child policy, there is no gender difference related to education between single-girl and single-boy families in urban China (Fong 2002; Tsui and Rich 2002), this study finds that even in urban areas, gender disparity in mathematics remains in socioeconomically disadvantaged families, i.e., urban families with more than one child. Identification of girls in such subgroups thus is crucial for developing an effective approach for reducing academic inequalities.

The one-child policy in China inadvertently creates a setback for urban families with more than one child. Noncompliance results in heavy penalties such as dismissal from work, loss of promotional opportunity, and substantial fines (Hesketh et al. 2005). Therefore, families with higher socioeconomic backgrounds or those demonstrating commitment to achieve upper society status will avoid penalties by compliance. Lower socioeconomic background families, having little to lose, often exceed the one-child policy as the traditional preference for boys prevails. Discrimination with regard to household education investment is often the result for girls in these families (Hannum et al. 2009). On the contrary, since rural area families commonly have more than one child (Hesketh et al. 2005), the number

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of children cannot indicate the socioeconomic status of rural families.

This study assesses and studies three components of the educational gender disparity issue in China. First, evidence is presented with detailed analysis of heterogeneous disparity in score distribution revealing more boys than girls in the lower decile of the distribution. Second, for the first time in China, gender disparity in mathematics favoring boys is identified in socioeconomically disadvantaged families in urban areas. Third, the National College Entrance Exam (NCEE) score, the primary examination for college entrance in China, is utilized as the measurement of academic achievement. Gender disparity in NCEE performance is studied to reveal potential gender inequity in college access.

Literature review on gender achievement gap

Increasing numbers of empirical studies have been completed in the past two decades focusing on the gender gap in students' achievement, including both studies of individual countries and comparative studies examining cross-national trends (Schmidt and Kifer 1989; Bedard and Cho 2010). Studies have focused on gender gap achievement by subject and gap changes over time.

Gender gap in student achievement is essentially defined as the mean difference in test scores between female and male students. Performance results demonstrate generalized trends with girls outperforming boys in language and art (e.g., Ma 2008), boys' traditional advantage in mathematics and science decreasing over time and across countries (Bedard and Cho 2010; Holmlund and Sund 2008), and girls performance in mathematics and science even exceeding boys in some countries (Schmidt and Kifer 1989).

Utilizing international data from the 1995, 1999, and 2003 trends of the Third International Mathematics and Science Study (TIMSS), Bedard and Cho (2010) discovered that gender gap varies across countries but tends to favor boys in grades 4 and 8 in mathematics and science across OECD (i.e., Organization for Economic Cooperation and Development) countries.

Evidence of reduction in gender gaps has been found in the USA and other OECD countries. Marks (2008) reveals that among 15-year-old students in 31 countries, while the gender gap in reading favoring girls may have increased over time, the gender gap in mathematics favoring boys may have decreased. Beaton et al. (1996) found no significant gender difference between grade 7 and grade 8 students, utilizing the 1995 data from TIMSS, and the Trends in Mathematics and Science Study (1999) also agrees that gender gap in mathematics achievement is negligible. Mullis et al. (2000) discovered little gender gap in mathematics achievement in most countries using 1999 data from TIMSS.

Studies completed in several countries actually reveal a reverse fact, finding a gender gap favoring girls in mathematics. Schmidt and Kifer (1989) discovered that in the Second International Mathematics Study (SIMS), gender gap favoring boys could only be found in France, while the gender gap favoring girls could be found in several countries including Hungary, Sweden, England, and Belgium (Flemish). Lai (2010) reviewed a sample from an urban district of Beijing and observed that girls outperformed boys in primary and lower secondary education on total score for both Middle School Graduation Exams (MSGE) and High School Entrance Exams (HSEE) including the Chinese language score and the English language score. Females also outperformed males in MSGE mathematics, while boys outperformed girls in HSEE mathematics, possibly related to a high dropout rate for boys at the end of middle school.

Studies have focused increasingly on gender disparity along different distributions. Boys performances at the right tail of the distribution (i.e., among the top performers) are greater, as supported by evidence from the AP calculus test, the mathematics SAT, and the Graduate Record Exam (GRE) in the USA (Hedges and Nowell 1995; Xie and Shauman 2003) and the NCEE in China (Tsui 2007).

Analytical methods applied to identify gender gap include the ordinary least square (OLS) regression, the earliest and most common method (Marks 2008; Bedard and Cho 2010; Lai 2010), the increasingly utilized hierarchical linear model (HLM) (e.g., Fuller et al. 1994; Arnold 1995), and a few studies which examine the heterogeneity in gender gap over the distribution using quantile regression (Angrist and Pischke 2009; Robinson and Lubienski 2011).

Extensive gender disparity debates are generally divided into three categories: biological, sociological, and psychological. Biological theories argue that genetic determinants of sex-related behaviors, differences in sex hormones, and differences in the structure or function of the brain lead to specified ability levels between males and females (Halpern 1986; Wilder and Powell 1989). Sociology explanations focus on socialization of girls and boys and the resulting formation of mathematical and language learning beliefs in their early sex-role development (Lewis and Freedle 1973; Zill 1985) and in school experiences (Brooks-Gunn and Matthews 1979; Leinhardt et al. 1979). Niederle and Vesterlund (2010) provide a psychological view by presenting the argument that larger gender gaps in mathematics scores exaggerate true gender difference in mathematics skills as a factor related to gender difference in competition response where females are more likely to fail in competitions or shy away from competitive environments. Stereotype threat (Spencer et al. 1999) is also

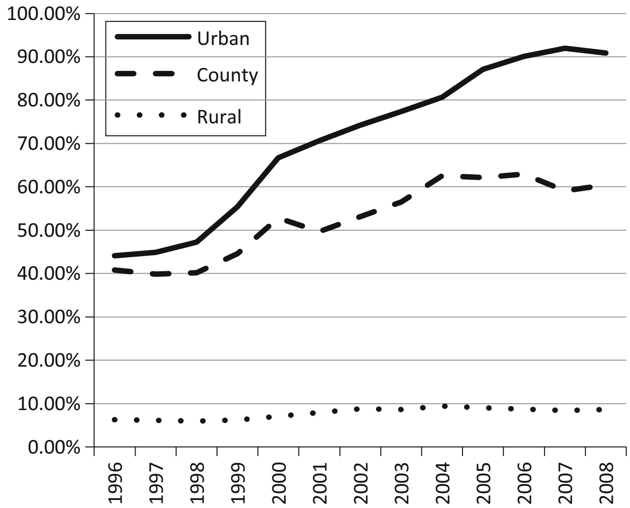


Fig. 1 Urban–rural disparities in high school promotion rate. *Data source*: Yearbooks of China Education Statistics (2000–2008). High school promotion rate is the percentage of middle school graduates who finally go to high schools

one popular explanation of gender gap from the perspective of social psychology. When females are stereotyped as inferior in mathematics achievement, this social identity raises inhibiting doubts and high-pressure anxieties in female students' mind during mathematics test, resulting in lower scores (Osborne 2001; Schmader 2002).

Existing gender achievement gap research indicates a gender gap with girls excelling in language, but provides mixed evidence in mathematics. Increasing studies indicate a shrinking mathematics gender gap and even cases with girls excelling above boys in some countries. Few gender gap studies exist for educational achievement in China, especially as measured by NCEE performance.

This study is among the first to explore gender achievement gap in the NCEE in China, the crucial examination for transition from high school to college. Heterogeneity in gender gaps is explored in this study as an attempt to contribute to research as it presents achievement difference findings between males and females by various demographic features.

Key research study questions are as follows:

1. Does gender difference exist in NCEE achievement?
2. Does gender difference vary by student achievement and demographic characteristics, such as urban and rural residence and the number of children in the family?

The findings are presented by NCEE score of school subjects including mathematics, Chinese language, and English language.

Methodology is explained as models, and estimation equations for the empirical study are presented and described in "Methodology: models and estimation equations" section with a data set provided in "Data" section. Empirical findings based on the methodology are presented in "Gender differences in educational achievement" section and a summary with discussion of policy implications follows in "Conclusion and policy suggestion" section.

Table 1 Percentage of students with siblings in different subgroups

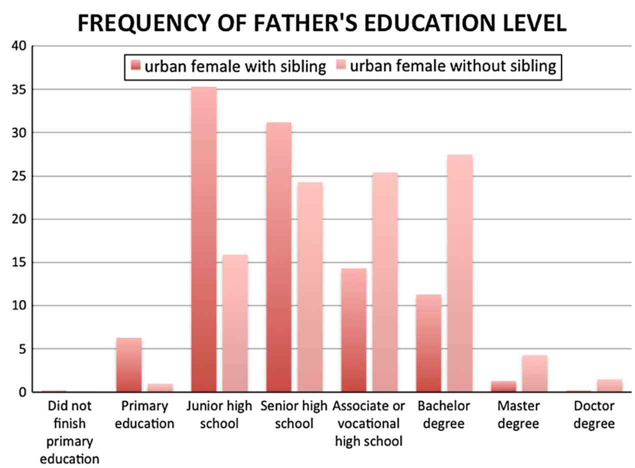
Sample	Male [% ($N = 2{,}863$)]	Female [% ($N = 2{,}964$)]
Among urban male/urban female subgroups, respectively	19.39	26.50
Among rural male/rural female subgroups, respectively	42.90	92.20

Table 2 Student background comparison among subgroups

	HSEE			SES	Father's education level
	Mathematics (1)	Chinese (2)	English (3)	(4)	(5)
Male, urban, no sibling (base)	0.26***	0.06*	0.10***	1.32***	4.83***
Difference between each group with base group					
Male, urban, sibling	−0.05	−0.06	−0.05	−0.73***	−0.56***
Male, rural, no sibling	0.07	−0.16***	−0.05	−2.24***	−1.64***
Male, rural, sibling	0.1	−0.09	−0.05	−2.29***	−1.53***
Female, urban, no sibling	−0.1***	0.49***	0.25***	0.13*	0.11*
Female, urban, sibling	−0.32***	0.26***	0.02	−1.09***	−0.79***
Female, rural, no sibling	−0.07	0.25**	0.27***	−2.19***	−1.52***
Female, rural, sibling	−0.14***	0.12***	0.15***	−2.38***	−1.68***

Significant level of *t* test between each subgroup with the base group. *** Significant at 0.01 level; ** significant at 0.05 level; * significant at 0.1 level

Among urban female students



Among rural female student

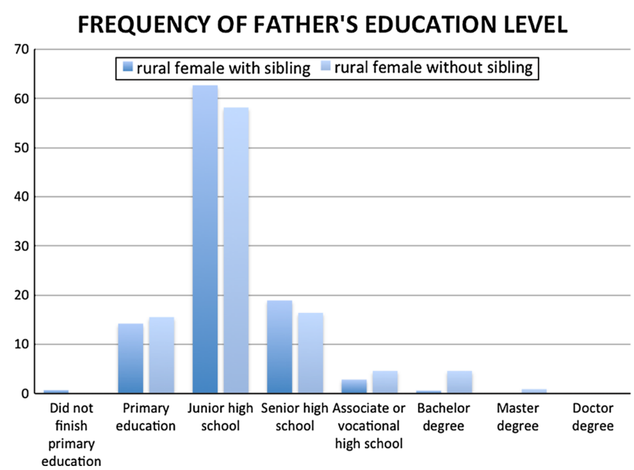


Fig. 2 Frequency of father's education level by subgroups

Methodology: models and estimation equations

Average gender gaps and gaps for particular subgroups are examined in this study. The empirical model applied for identification of gender gaps within NCEE scores originates with the ordinary least square (OLS) model. Equation (1) includes three key demographic characteristics (i.e., gender, urban–rural residency, and number of siblings) and five control variables [i.e., HSEE score, academic track, socioeconomic status, key class[1] status versus non-key class status, and the high school HSEE admission line (the measurement of school quality)]. The socioeconomic status (SES) is a continuous index constructed from both parents' education levels and professional status utilizing the reliability-tested principal component analysis. All continuous variables are transformed to standardized scores with mean of zero and standard deviation of one.

Based on Eq. (1), Eq. (2) encompasses gender, urban–rural residency, and number of siblings to investigate gender gaps in subgroups. Using a linear combination, the estimation will derive achievement differences between each subgroup and the base group, i.e., urban male students without siblings. Based on Eq. (1), Eq. (3) encompasses interaction between gender and HSEE scores to observe the gender gap at varying ability distributions.

$$\begin{aligned} Y = {} & \beta_0 + \beta_1 \times \text{HSEE} + \beta_2 \times \text{Female} + \beta_3 \times \text{Rural} \\ & + \beta_4 \times \text{Siblings} + \gamma_1 \times \text{Science Track} + \gamma_2 \times \text{SES} \\ & + \gamma_3 \times \text{Key class} + \gamma_4 \times \text{HSEE admission line} + e \end{aligned} \tag{1}$$

$$\begin{aligned} Y = {} & \beta_0 + \beta_1 \times \text{HSEE} + \beta_2 \times \text{Female} \times \text{Rural} \times \text{Siblings} \\ & + \gamma_1 \times \text{Science track} + \gamma_2 \times \text{SES} + \gamma_3 \times \text{Key class} \\ & + \gamma \times \text{HSEE admission line} + e \end{aligned} \tag{2}$$

$$\begin{aligned} Y = {} & \beta_0 + \beta_1 \times \text{HSEE} + \beta_2 \times \text{Female} + \beta_{12} \\ & \times \text{HSEE} \times \text{Female} + \beta_3 \times \text{Rural} + \beta_4 \times \text{Siblings} + \gamma_1 \\ & \times \text{Science track} + \gamma_2 \times \text{SES} + \gamma_3 \times \text{Key class} + \gamma_4 \\ & \times \text{HSEE admission line} + e \end{aligned} \tag{3}$$

Quantile regression is adopted to examine the heterogeneous gender disparity in the achievement distribution, contributing to determinations of gender gap changes from lower decile to higher decile.

Data

The dataset employed in this study is a cross-sectional dataset collected in 2010 in Jinan, a typical municipality in China with over 6 million people of diversified socioeconomic background with over 50 % of residents living in the rural area of Jinan. Non-proportional stratified sampling strategy was applied for data collection purposes to address various class types (i.e., science track and humanity track, key class and non-key class), schools with different quality, and districts with various socioeconomic contexts. Twenty-five schools out of the 34 public regular high schools in Jinan were selected, and 166 classes were selected within these 25 schools. Sampling weights were calculated and applied in the analysis, and sample size was approximately 6,000 students. A questionnaire was designed to collect detailed information for grade 12 students' characteristics, family background, and school information. NCEE scores and HSEE scores were obtained from the administrative dataset, and merged into the survey dataset through student ID. The data collection

[1] Key class usually recruits students with high academic performance.

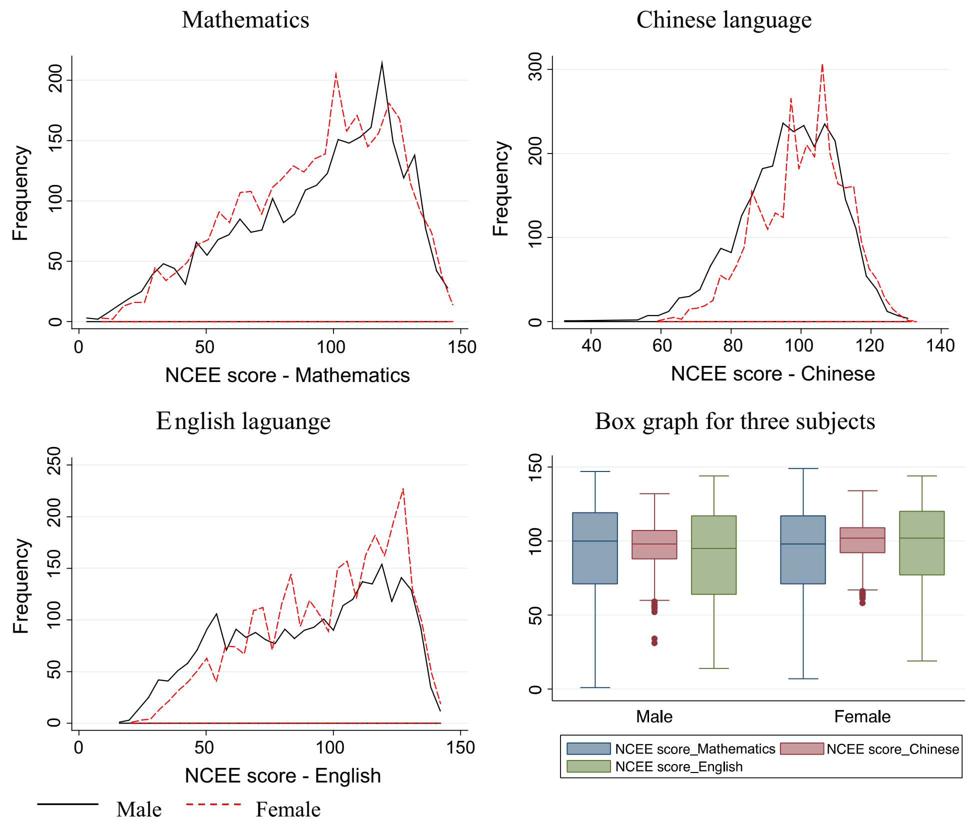


Fig. 3 NCEE score distribution by gender

effort was effectively carried out, and missing values were minimal (below 5 %).

Gender differences in educational achievement

Figure 1 reveals urban–rural disparities in the high school promotion rate[2] in China for the last 15 years. Promotion rates of urban students by 2008 had reached 90 %, while only 10 % of rural students were admitted, proving that most urban students had access to high school education, while only top-performing rural students could gain access. Urban–rural disparity comparisons among high school students must factor in admission of the majority of urban students with only top rural students gaining access.

Table 1 presents the percentage of students with siblings in different subgroups (weighted by the sampling weights). Among urban female students, 26.5 % of them have siblings; while among urban male students, only 19.39 % of them have siblings. Among rural female students, 92.2 % of them have siblings, while only 42.9 % of rural male students having siblings. Evidence then suggests that families with daughters are more likely to have another child than families with sons and the one-child policy in rural areas is not strictly adhered to.

Subgroups are further explored as Table 2 reports the average HSEE scores, SES, and father's education level of urban male students without siblings, and the gap between this base group and other subgroups. Compared with the base group, urban male students with siblings hold significantly lower SES and their fathers possess lower education levels on average, but there is no significant difference in HSEE scores. Urban female students without siblings hold both superior SES and father's education level compared to their male counterparts. Across the four urban subgroups, urban females with siblings have the lowest average SES and father's education level, and their average HSEE mathematics scores are also the lowest, which is 32 % standard deviation lower than that of the base group.

The first panel of Fig. 2 compares father's education level between urban females with siblings and without siblings. Among urban female students with siblings, fathers' education levels attained are heavily concentrated at the secondary school level, while the distribution for those without siblings migrates upward to the tertiary education level. According to the second panel of Fig. 2, however, among rural female students, the distribution difference of father's education level attained between those with siblings and without siblings is minor.

[2] High school promotion rate is the percentage of middle school graduates who finally go to high schools.

Table 3 Regression coefficients using OLS

	Mathematics			Chinese			English		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
HSEE	0.612***	0.612***	0.644***	0.451***	0.451***	0.475***	0.640***	0.639***	0.609***
	(0.018)	(0.018)	(0.026)	(0.018)	(0.018)	(0.021)	(0.015)	(0.015)	(0.016)
Female	0.001		0.014	0.087***		0.097***	0.128***		0.107***
	(0.023)		(0.024)	(0.027)		(0.028)	(0.021)		(0.023)
Female × HSEE			−0.062**			−0.051*			0.093***
			(0.028)			(0.030)			(0.027)
Rural	0.214***		0.215***	0.223***		0.223***	0.105***		0.100***
	(0.030)		(0.030)	(0.031)		(0.031)	(0.027)		(0.027)
Has sibling	−0.025		−0.026	−0.038		−0.041	−0.009		−0.005
	(0.026)		(0.026)	(0.030)		(0.030)	(0.024)		(0.024)
Female × rural × sibling (urban male without sibling as baseline)									
Male, urban, sibling		0.046			−0.033			0.064	
		(0.061)			(0.061)			(0.054)	
Male, rural, no sibling		0.200***			0.247***			0.090**	
		(0.044)			(0.049)			(0.039)	
Male, rural, sibling		0.197***			0.201***			0.155***	
		(0.046)			(0.056)			(0.043)	
Female, urban, no sibling		0.029			0.108***			0.180***	
		(0.034)			(0.039)			(0.030)	
Female, urban, sibling		**−0.105****			0.067			0.058	
		(0.046)			(0.051)			(0.042)	
Female, rural, no sibling		0.183**			0.233***			0.312***	
		(0.079)			(0.085)			(0.059)	
Female, rural, sibling		0.200***			0.280***			0.227***	
		(0.039)			(0.044)			(0.035)	
Science track	−0.278***	−0.281***	−0.276***	0.041	0.042	0.042	0.143***	0.141***	0.140***
	(0.025)	(0.025)	(0.025)	(0.026)	(0.026)	(0.026)	(0.021)	(0.020)	(0.021)
SES	0.018**	0.016*	0.019**	0.015	0.015	0.015	0.037***	0.034***	0.036***
	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)
Key class	0.363***	0.363***	0.363***	0.342***	0.342***	0.343***	0.380***	0.380***	0.377***
	(0.022)	(0.022)	(0.022)	(0.026)	(0.026)	(0.026)	(0.020)	(0.020)	(0.020)
HSEE admission line	0.142***	0.142***	0.144***	0.179***	0.179***	0.180***	0.186***	0.186***	0.182***
	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.012)	(0.012)	(0.012)
Constant	0.057**	0.055	0.046	−0.150***	−0.162***	−0.150***	−0.246***	−0.260***	−0.239***
	(0.029)	(0.033)	(0.029)	(0.033)	(0.037)	(0.033)	(0.026)	(0.029)	(0.026)
N	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841
F	324.8	254.0	305.3	197.2	154.8	188.6	582.6	459.3	546.0
Prob > *F*	0	0	0	0	0	0	0	0	0
R^2	0.472	0.473	0.473	0.372	0.373	0.373	0.605	0.606	0.606

SE in parentheses

*** Significant at 0.01 level; ** significant at 0.05 level; * significant at 0.1 level

Consistent with the research indicating that the one-child policy is strictly adhered to in urban areas and that urban families with superior backgrounds are less likely to violate this rule, urban female students with siblings are found to have disadvantaged family backgrounds and lower initial academic performance.

Gender differences in NCEE scores: descriptive statistics

Figure 3 compares the NCEE score distribution by gender. The black solid line is the frequency of male students and the dash line is the frequency of female students. In

Table 4 Gender gaps for students at different distributions—results from quantile regression

	Mathematics					Chinese language					English language				
	0.9 (1)	0.75 (2)	0.5 (3)	0.25 (4)	0.1 (5)	0.9 (6)	0.75 (7)	0.5 (8)	0.25 (9)	0.1 (10)	0.9 (11)	0.75 (12)	0.5 (13)	0.25 (14)	0.1 (15)
HSEE score	0.517***	0.562***	0.604***	0.609***	0.594***	0.367***	0.402***	0.416***	0.475***	0.494***	0.560***	0.606***	0.616***	0.641***	0.627***
	(0.014)	(0.013)	(0.014)	(0.016)	(0.021)	(0.019)	(0.017)	(0.017)	(0.017)	(0.023)	(0.014)	(0.011)	(0.009)	(0.012)	(0.015)
Female	**−0.090*****	**−0.035***	**−0.010**	**0.087*****	**0.134*****	**0.016**	**0.090*****	**0.125*****	**0.128*****	**0.176*****	**−0.003**	**0.040****	**0.120*****	**0.224*****	**0.299*****
	(0.022)	(0.021)	(0.024)	(0.031)	(0.042)	(0.034)	(0.032)	(0.032)	(0.033)	(0.042)	(0.021)	(0.017)	(0.017)	(0.027)	(0.037)
Rural	0.227***	0.247***	0.269***	0.307***	0.281***	0.211***	0.275***	0.313***	0.325***	0.260***	0.087***	0.111***	0.149***	0.210***	0.169***
	(0.027)	(0.026)	(0.029)	(0.039)	(0.053)	(0.037)	(0.037)	(0.038)	(0.038)	(0.048)	(0.023)	(0.020)	(0.021)	(0.033)	(0.045)
Has sibling	−0.015	−0.023	−0.053**	−0.050	−0.070	−0.036	−0.053	−0.025	−0.082**	−0.066	0.024	0.012	−0.029	−0.050*	−0.057
	(0.024)	(0.023)	(0.026)	(0.034)	(0.048)	(0.035)	(0.034)	(0.034)	(0.035)	(0.043)	(0.022)	(0.019)	(0.019)	(0.030)	(0.040)
Science track	−0.414***	−0.379***	−0.355***	−0.285***	−0.230***	−0.047	0.004	0.032	0.057*	0.093**	0.020	0.060***	0.100***	0.144***	0.184***
	(0.022)	(0.022)	(0.024)	(0.033)	(0.044)	(0.031)	(0.030)	(0.031)	(0.031)	(0.040)	(0.020)	(0.017)	(0.017)	(0.027)	(0.035)
SES	0.018**	0.013	0.018**	0.002	0.005	0.004	0.006)	0.013	0.000	−0.016	0.028***	0.033***	0.033***	0.033***	0.005
	(0.008)	(0.008)	(0.009)	(0.012)	(0.016)	(0.012)	(0.012	(0.012)	(0.012)	(0.015)	(0.007)	(0.006)	(0.006)	(0.010)	(0.013)
Key class	0.239***	0.304***	0.400***	0.482***	0.595***	0.332***	0.304***	0.364***	0.397***	0.361***	0.180***	0.256***	0.360***	0.462***	0.494***
	(0.025)	(0.024)	(0.027)	(0.035)	(0.048)	(0.037)	(0.035)	(0.036)	(0.036)	(0.046)	(0.023)	(0.019)	(0.019)	(0.031)	(0.041)
HSEE admission line	0.134***	0.185***	0.237***	0.271***	0.257***	0.258***	0.268***	0.273***	0.279***	0.276***	0.190***	0.218***	0.262***	0.279***	0.276***
	(0.012)	(0.012)	(0.014)	(0.019)	(0.028)	(0.016)	(0.016)	(0.017)	(0.019)	(0.026)	(0.010)	(0.009)	(0.010)	(0.016)	(0.023)
Constant	0.934***	0.525***	0.062**	−0.518***	−1.052***	0.774***	0.293***	−0.252***	−0.784***	−1.301***	0.585***	0.235***	−0.208***	−0.757***	−1.218***
	(0.027)	(0.026)	(0.029)	(0.039)	(0.051)	(0.038)	(0.037)	(0.037)	(0.038)	(0.047)	(0.024)	(0.020)	(0.020)	(0.032)	(0.043)
N	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841
Pseudo R^2	0.250	0.309	0.361	0.374	0.339	0.219	0.237	0.261	0.272	0.269	0.338	0.409	0.457	0.448	0.401

SE in parentheses. Results are shown at the 10th, 25th, 50th, 75th, and 90th percentiles

*** Significant at 0.01 level; ** significant at 0.05 level; * significant at 0.1 level

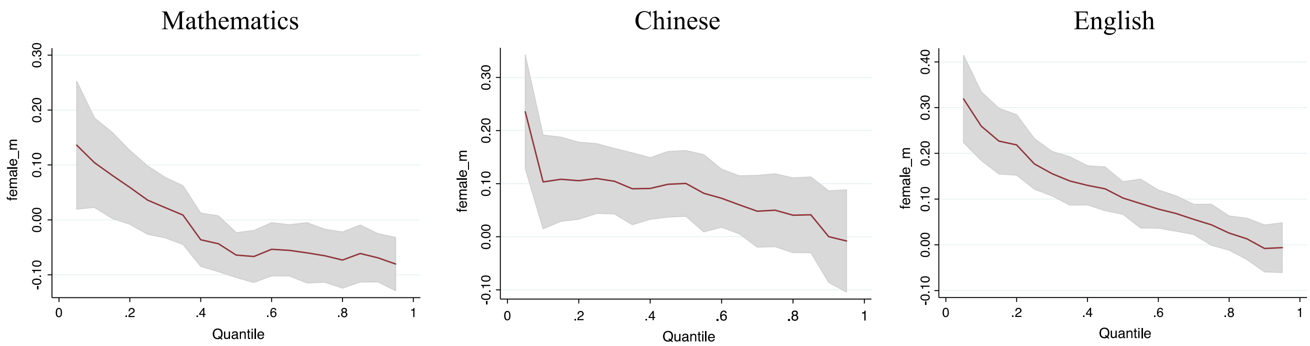


Fig. 4 Heterogeneous gender disparity in NCEE score along the distribution—quantile regression

general, the distribution for boys has a longer and fatter tail on the left side, signifying that among the lowest performing students, there are more boys than girls and the lowest performing boys have lower scores than the lowest performing girls. In the middle of the score distributions, there are generally more female students than male students. On the right side of the distribution, the two lines essentially overlap, implying that girls and boys share similar distributions at the top. The box graphs for the three subjects indicate the same result.

Empirical findings

Table 3 presents the empirical findings using OLS. The three columns report, by subject, estimates of interest in Eqs. (1–3), respectively. A significant gender achievement gap exists, on average, favoring girls in Chinese and English, with no significant gender gap in mathematics. Rural students outperform urban students in all three subjects consistently across different subgroups.

According to column (2), all rural subgroups outperform urban male students without siblings in mathematics. The most disadvantaged subgroup—urban females with siblings—show significantly lower mathematics scores than urban males without siblings, while urban females without siblings have no significant achievement gap with their male counterparts.

Results are similar for Chinese and English. All rural subgroups and urban female students without siblings outperform the base group. Urban females with siblings demonstrate no significant difference with the base group.

According to columns (3) and (6), with regard to the heterogeneous effect of HSEE score on NCEE score, girls maintain a flatter slope than boys in mathematics and Chinese, although the main effect of HSEE is significantly positive and substantial. Girls, however, exhibit a steeper slope than boys for English.

Table 4 presents results from the quantile regression of Eq. (1), at the 10th, 25th, 50th, 75th, and 90th percentiles and Fig. 4 presents the trends along the NCEE distribution. A consistent trend from the lower decile to the higher decile is exhibited as the gender gap favoring girls diminishes, becomes insignificant, and even turns negative in mathematics. Specifically, for mathematics, in the 90th and 75th quantiles, females perform significantly lower than their male counterparts, and in the lowest 25 % distribution, girls perform significantly better than boys. Significant gender gaps favoring girls are in the lower 75 % distribution for Chinese and English with no significant gender difference in the 90th decile.

Conclusion and policy suggestion

Conclusively, gender disparity does not exist in mathematics, on average, while a gender gap favoring girls in Chinese and English is apparent and heterogeneity in the gender gap by subgroups is implied. The most disadvantaged subgroup, identified as urban female students with siblings, demonstrates significantly lower mathematics scores than urban male students without siblings. Girls perform significantly worse than boys at the top 25 % of the mathematics score distribution, and for those at the top 10 % of Chinese or English score distribution, there is no significant gender difference. However, for students at the bottom 50 % in mathematics or those at the lower 90 % in Chinese or English, there is a significant gender gap favoring girls.

Findings are consistent with research in China and other countries (e.g., Lai 2010). Results derived from quantile regression are consistent with Tsui (2007). Theories on stereotype threat perception and gender performance differences under competition would be suffice to explain findings on the gender gap favoring boys at the top distribution of mathematics scores. The new finding on the disadvantage of urban girls with siblings in mathematics could be attributed to demographic differences and requires further attention and investigation.

Gender equality may benefit from attention by education policymakers and practitioners to urban female students with sibling(s). Families having at least two children in urban areas, where the one-child policy is more strictly implemented, may experience significant SES disadvantages, manifested by lower parental expectation for girls and gender discrimination in education investment.

Education policymakers and practitioners may be especially interested in male students at the bottom of the distribution since this group of students is clearly inferior to their female counterparts in all the three subjects. Rationale for consistent lower performance of boys in this group should be explored in future studies.

The findings of this study must be viewed cautiously as this is a first attempt to research gender gap correlations as related to the NCEE. Limitations exist for the comparison of rural students and urban students, and bias is possible as students surveyed are high school students ,and thus, the majority of rural students who are not enrolled in upper-secondary education are excluded in the present research. Accurate community representation may present an additional point of caution as, although Jinan is a mid-size city in China, it may not most precisely representative Chinese demographics. Replication of this study in other Chinese metropolitan areas is necessary to test and compare findings. Further research is also necessary to discover patterns of gender gap in academic performance throughout the formal school years and to identify critical gender performance disparity emergence and/or intensification for designing timely education interventions.

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