High-Performing Peers and Female STEM Choices in School *

Pierre Mouganie[†] Yaojing Wang [‡]

May 30, 2019

Abstract

The purpose of this paper is to examine how social environment affects women's STEM choices as early as high school. Using administrative data from China, we find that exposure to high-performing female peers in mathematics increases the likelihood that women choose a science track during high school, while more high-performing males decrease this likelihood. We also find that peer quality has persistent effects on college outcomes. Overall, there is little evidence of peer effects for boys. Our results suggest that girls doing well in mathematics provide an affirmation effect that encourages female classmates to pursue a STEM track.

JEL Classification: I21, I24, I26, J24

Keywords: STEM, Peer Quality, Gender Peer Effects, China

*We would like to thank Serena Canaan, Stefanie Fischer, Mark Hoekstra, Ramzi Mabsout, Richard Murphy, Nisreen Salti and Douglas Webber for helpful comments and suggestions. We also thank seminar participants at the University of Texas-Austin Applied Microeconomics Brownbag Seminar, the University of California-Santa Barbara Labor Lunch, the 2nd Annual Lebanese Econometrics Group Meetings, Lingnan University and the Chinese University of Hong Kong. All errors are our own.

†American University of Beirut, Department of Economics, *Email:* pm10@aub.edu.lb

‡Peking University, School of Economics *Email:* wangyaojing@pku.edu.cn

1 Introduction

The question of why there are fewer women in science, technology, engineering & math (STEM) has long been of interest to social scientists, educators and policy makers. Despite women holding 48 percent of all jobs and half of college-educated occupations, they make up only 24 percent of the STEM workforce in the U.S. This is of growing concern as STEM employment is a critical component of a country's competitiveness. Further, technical jobs, such as those in STEM fields, are less prone to gender discrimination (Kuhn and Shen, 2013) and the gender wage gap is relatively smaller in STEM jobs than that in non-STEM jobs (Beede et al., 2011). Importantly, differences in occupational choices are not easily explained by gender differences in math and science achievement.[1] Rather, much if not all of the gender gap can be traced back to non-performance based choices made in school. In a 2015 U.S. News report, it was estimated that only 3 and 2 percent of US high school girls reported an interest in engineering and technology fields respectively, compared to 31 and 15 percent for boys. Given that the disparities in the human capital investment decisions of men and women likely have lasting consequences on both efficiency and gender equity, it is critical to understand the factors that affect these choices.

In this paper, we study the extent to which affirmation effects matter in explaining the STEM gender gap by looking at whether high-performing female peers in mathematics can influence the STEM choices of girls in high school. In addition, we show how these effects impact college outcomes. We do so in the context of the Chinese education system, a particularly relevant context, as negative gender stereotypes have contributed to a large STEM gender gap. Zhang and Zhen (2011) show that 10 and 23.1 percent of female and male students in China respectively agreed with the statement that "men are born to be better than women". Further, Guo, Tsang and Ding (2010) estimate that 73.9 percent of college graduates in science and engineering are male compared to only 26.1 percent female.

Additionally, unique features of the Chinese high school education system lend themselves favorably towards the estimation of our effects. One such feature is that students are subject to a common curriculum in their first year of high school and must choose between a science and arts track the following year. Importantly, this gives students one year of familiarity with a new set of formed peers before making track choices, allowing us to disentangle the effects of high school choice from track choice—which usually occur simultaneously in other

[1] Recent U.S. evidence shows that there is at most a 0.65 percent of a standard deviation difference in average math test scores across genders in grades 2 through 11. The difference is also small at the top of the distribution (Hyde, Lindberg, Linn, Ellis & Williams 2008). At the college level, Turner and Bowen (1999) estimate that differences in SAT scores can explain at most half of the total gender gap in college major choices.

educational settings. Further, peer effects may work in both directions, so that peer ability is endogenous to own ability if students have been together for a while; an issue referred to as the reflection problem (Manski, 1993). However, in our setting, transition from middle school to high school results in approximately 91 percent new peers being formed—allowing us to overcome concerns of reflection.

Utilizing student level administrative data from China, we look at how gender peer ability composition in the first year of high school affects females' decisions to choose a science or arts track the following year as well as college outcomes three years later. To account for observed and unobserved characteristics of schools and students that might be correlated with high-performing peer composition, we rely on idiosyncratic cross cohort within school variation in the proportion of high-performing female students, relative to all high-performing students. We demonstrate, using Monte Carlo simulations, that the observed within school variation in the proportion of high-performing female and male peers is consistent with variation generated from a random process.

Results indicate that a one standard deviation increase in the share of high-performing peers who are female significantly increases women's likelihood of choosing a science track by 1.8 to 2.1 percentage points, relative to men. This also indicates that being exposed to a larger number of high-performing men adversely affects women's chances of enrolling in a STEM track. In contrast, men are unaffected by the gender makeup of high ability peers, a result that is consistent with prior research documenting how men's academic choices may be less affected by peers and role models than women (See, for example, Bagès, Verniers and Martinot, 2016; Fischer, 2017; Lim and Meer, forthcoming). Additionally, we find that women exposed to a larger share of high-performing female peers also see an improvement in college outcomes, relative to men; they are more likely to attend a four-year university and a top-tier university. These results are robust to the inclusion of various cohort or time varying controls, district-by-cohort fixed effects and school specific linear time trends as well as to alternative definitions of high-performing students.

We further show that the interpretation most consistent with our findings is one in which an increased share of high achieving female peers in quantitative fields may provide a role model or affirmation effect for female students, mitigating the adverse effects of negative gender stereotypes and altering females' beliefs. Indeed, socio-psychological factors have shown to be major determinants of women's likelihood of entering the STEM pipeline. Zafar (2013) estimates that most of the gender gap in science can be attributed to gender differences in beliefs about enjoying coursework and workplace preferences. Blickenstaff (2005) highlights that gender stereotyping, lack of female role models in science and engineering as well as hostile environments for females in science majors are major determinants of the STEM gender gap.

Our paper is closest to an emerging body of literature that attempts to understand the persistent underrepresentation of women in STEM fields. Carrell, Page and West (2010) find that professor gender is a significant predictor of women's likelihood of graduating with a STEM degree in college. Ost (2010) provides evidence that female college students majoring in the physical sciences are more affected by grades than men. He shows that women are more likely to drop out of a physical science major in response to poor academic performance; a finding also documented in Kugler, Tinsley and Ukhaneva (2017). Zafar (2013) finds that the gender gap in science is mostly due to differences in beliefs about coursework as well as gender preferences. Card and Payne (2017) conclude that most of the STEM gender gap can be explained by the lower fraction of non-science oriented males who complete enough advanced level courses to qualify for university entry. In recent work, Fischer (2017) and Hill (2017) highlight the importance of student peer composition on female STEM choices and persistence in college.

Our paper makes several contributions to the existing literature. First, this is one of the very first papers to look at the determinants of female STEM enrollment in a high school setting.[2] This contrasts with the studies listed above which have focused on STEM enrollment or persistence at university. This is important as dynamic complementarities in the formation of human capital dictates that early educational choices may matter more and lead to a higher return to later STEM investments (Cunha and Heckman, 2007). Further, a recent large scale European study conducted by Microsoft (2017) identified the ages of 15-16 as a critical period after which females' STEM interest drops heavily and is hard to recover. Additionally, in many settings in the world, students are tracked into science versus non-science routes in high school, yet there is little evidence on how these choices are made and to what extent they perpetuate the STEM gender gap.[3]

Second, our paper also adds to an active literature documenting the importance of gender peer effects in academic settings. A number of studies have shown that girls and boys benefit academically from an increase in the number of female peers in school (Hoxby, 2000; Lavy and Schlosser, 2011). More closely related to our paper is a set of studies focusing on the effects of gender peer quantity on major choice. Anelli and Peri (2016) find that male students exposed to over 80 percent male peers are more likely to choose a male dominated college

[2]Lim and Meer (2017) find that having a female math teacher in middle school increases the likelihood that girls take higher level math courses and attend a STEM-focused high school.

[3]This form of tracking is very common in Europe and Asia. In the U.S., students are not explicitly placed into science tracks but they do have some degree of control over the courses they select in high school. Indeed, Xie and Shaumann (2003) show that female students in the U.S. are less likely to choose science and engineering electives in high school.

major in Italy. Schneeweis and Zweimüller (2012) show that girls with more female peers are less likely to choose female dominated school types in Austria. Conversely, Zölitz and Feld (2017) and Hill (2017) show that women exposed to a higher share of female college peers are more likely to choose female dominated majors; a finding we also document in our paper. We contribute to this literature by showing that gender peer quality—not just quantity—is of considerable interest and may mask contextual heterogeneity, which may explain the seemingly contradictory findings in the aforementioned papers.[4] This is in line with recent work by Fischer (2017) who documents that being in a class with higher ability peers negatively affects women's likelihood of graduating with a STEM degree. We add to the understanding of how peer ability composition affects education choice by showing that women can benefit from high-performing peers, conditional on them being of the same gender. This suggests that the direction and magnitude to which peer ability may affect female STEM choices is also highly dependent on the gender of those peers. Importantly, this also indicates that any potential gains from exposure to a higher number of female peers may be amplified by the quality of those peers.

Finally, in assessing the impact of peers on college enrollment, we join an emerging literature that has looked at how school teenage peers—a group perceived as being particularly susceptible to peer influence—affect longer run outcomes. Bifulco, Fletcher and Ross (2011) show that exposure to a higher percentage of high school classmates with college educated mothers increases university attendance. Anelli and Peri (2016) find that high school gender composition has no effect on college graduation or labor market outcomes. Finally, Black, Devereux and Salvanes (2013) show that additional female peers in ninth grade increase women's earnings and lower the incidence of teenage births. They also find that exposure to peers from wealthier backgrounds leads to better outcomes. We complement this literature by showing that high ability female peers increase teenage girls' likelihood of enrolling in a four-year university and an elite university, while the proportion of female peers in school has no effect on college outcomes for girls or boys.

The rest of the paper is organized as follows. Section II presents information on the educational system in China. Section III describes the data used in this paper. Section IV reviews the identification strategy. Section V presents the main empirical results as well as robustness checks. We discuss our results in section VI and section VII concludes.

[4] Put differently, two students in separate classrooms with the same number of female peers may have different outcomes depending on the ability composition of those females.

2 Institutional Background

Children in China generally start elementary school (1st grade) at around 6-7 years of age. After 6 years of elementary school, children then move on to the first part of middle school, a 3-year junior middle school (7th to 9th grade) to complete the 9-year national compulsory education. Graduates of 9th grade can then choose to continue education in the vocational or academic high school sector (10th to 12th grade). This is then followed by vocational (3-year or 4-year) or traditional college education (2-year or 4-year). Non-vocational high schools prepare students for four year colleges/universities and are rather competitive to get into as there are only enough seats for about 60% of junior middle school graduates in our sample.[5] In order to gain entrance into high school, 9th graders must sit for a national high school entrance exam (HET). In this exam, students are tested on seven subjects including Chinese language, Mathematics, English language, Physics, Chemistry, Political Science and Physical Education.[6] The total score achieved on these seven subjects is the one and only criterion for high school admission for most students.[7] In this paper, we focus only on students in the traditional educational track and so we limit our discussion to traditional high schools and universities.

Unlike elementary and junior middle school, high school is neither compulsory nor free in China. However, the majority of high schools are public and they charge relatively low tuition. For example, in our province, public high school tuition is around $200/year, and is subsidized if family income is below a certain threshold. Admission into high school is centrally operated by each district's education administrators. In early June, students fill out application forms indicating their ordered preference of high schools prior to taking the high school entrance exam (HET), which is generally administered in the middle of June. High schools preselect the number of students they want to admit for that year and grant admission based on students' preferences and test scores using an admissions procedure similar to the Boston Mechanism. This procedure involves multiple rounds of admissions whereby each high school only considers students who list them as their first choice in the first round. Students are then admitted into their first choice school conditional on exceeding that school's threshold high school entrance exam score. Students who are rejected from their

[5]Students attending vocational high schools are not strictly prohibited from taking the college entrance exam. However, the curriculum in vocational high schools differs substantially from the material on the college entrance exam.

[6]Chinese language, Mathematics and English language exams are worth 150 points each; Physics, Chemistry and Political Science are worth 100 points each; P.E. is worth 40 points but is not tested in all years in our sample.

[7]The only exceptions are students with special talents; for example athletes. However, these students are a very small portion of the whole population.

first choice school are then placed with a new pool of candidates to be considered by the next high school on students' preference lists, conditional on that school having not reached capacity. This procedure continues until all high school slots are filled up. Importantly, once students are granted admission by any high school, the selection process ends for them and they are not to be considered by any other high school. In addition, public high schools are allowed to designate around 10% of their seats as "high-priced". Students enrolled through the high-priced channel receive the same education as other regular students, but require a lower cutoff score to enter their desired high school. Students entering through this channel must pay an extra one-time fee to the school upon registration. This one-time fee is set by the schools and revealed to students before they apply. College bound students are incentivized to attend the best quality high school they can as this substantially increases the chance of going to a better college or any college (Hoekstra, Mouganie and Wang, forthcoming).

Students opting into the traditional high school sector spend the first year studying a common curriculum. At the end of the first year of high school, students decide whether to pursue a science or arts track. If students choose to concentrate in the sciences, then their college entrance exam (CET), administered at the end of high school, will consist of Chinese language, English language, Mathematics for science students, Physics, Chemistry and Biology. Arts students, on the other hand, take a CET exam that contains Chinese language, English language, Mathematics for arts students, Political science, History and Geography.[8] Similar to the HET, the total score of the CET exam is the sole determinant of college admission for most students. Students in the science track still take classes in History, Political science and Geography after making their track choice and vice versa. All students need to pass an assessment exam comprised of all subjects at the end of the second year in high school regardless of track choice. Passing this exam is necessary for eligibility to take the CET exam and to go to college. The assessment test is generally very basic and nearly all students pass—99.66% as of 2012. On the other hand, the CET exam is meant to be more challenging so as to properly differentiate student ability. As a result, it is general practice that schools prepare students as much as possible on their chosen subjects, and just enough to pass the assessment exam on the subjects that are not going to be administered in the CET. This disparity in training makes it highly implausible that a student switch from science to arts or the other way around.

Similar to the high school admissions process, universities have a predetermined number

[8]The Chinese language and English language tests are identical for both arts and science students .The CET takes the form of 3+X+S/A where a student will take an exam on Chinese language, Mathematics (for science or arts), English language, one science or arts subject of her choice and a comprehensive science or arts test. A science student can choose any of the three science subjects (Physics, Chemistry or Biology) as their X subject and an arts student chooses their X subject from Political science, History and Geography.

of admission seats for each province. During admissions, colleges get to decide the proportion of science to arts students they would like to accept. This information is given to students before taking the CET exam and is fairly consistent over time. Students fill out a form indicating their university choices, then take the College Entrance Test (CET) which is province-specific. Generally, 60 percent of college seats available for students residing in our sample province are for science students and around 40 percent are left for arts students. As a result, a student may select into a science track for reasons besides interest in the subject itself; mainly due to the availability of more college seats for science students. Of course, students' mathematical ability or perception of their ability also plays a crucial role, seeing as it is common knowledge among students that the mathematics CET exam for arts is easier than the one administered to science students.

3 Data

3.1 Data Description

This paper uses student level administrative data for four separate high school cohorts in a large metropolitan area in southern China (students graduating high school from 2007 to 2010).[9] The city has a population of more than 10 million individuals and a per capita GDP of more than $20,000, compared to a national average of $16,000. Each observation contains an individual and school identifier, students' HET and CET scores by subject, students' high school track choice (Science or arts), and some demographic information: gender, minority status. The initial sample consists of 176,896 students attending 114 high schools across 12 separate school districts. We drop all schools that do not contain student records for all four cohorts, which occurs when a school is either new or an old school closes. We also exclude schools that have no high-performing students in a given year. The final sample used throughout our analysis consists of 133,845 students distributed over four cohorts and 100 high schools.

3.2 Summary Statistics

Summary statistics for the four cohorts of students used in our analysis are reported in Table 1. The percentage of females in our sample is 52%, whereas males constitute 48% of the sample. The treatment of interest in this paper is the share of high-performing female peers relative to all high-performing peers in a given cohort. We define a high-performing

[9]Our data come from the education bureau authorities of the city. As a condition of using the data, we are prohibited from directly revealing the name of the province and city.

student as one who scores within the top 20%, nationally, in the mathematics high school entrance exam. We focus on math performance as women's underrepresentation in STEM is generally concentrated in math-intensive science fields.[10] Further, it is generally believed that math ability and skills are necessary for STEM careers (Kahn and Ginther, 2017). Using this definition, Table 1 reveals that 16.4% of all female students in our sample are high-performing, compared to 25.5% of male students. Strikingly, Table 1 also reveals that the likelihood of female students choosing a science concentration in high school stands at 36%. This is in stark contrast to men who are approximately twice as likely to select a science track (71%).

The main outcome of interest in this paper is students' likelihood of enrolling in a science track. In addition, we also examine students' eligibility of attending a four year university and an elite university. We can do so because eligibility is centrally determined by whether students cross the lowest threshold score on the college entrance exam (CET) imposed by universities. This threshold is common to all students in a province regardless of which city they reside in within the province. As a result, while we do not observe the university students ultimately attend, we are able to determine whether they are eligible to enter any four year college or elite college using their final CET scores. Table 1 reveals that 11% of female and 10.6% of male students in our sample are eligible to attend an elite university. Further, girls are more eligible (48%) to attend a four year university compared to boys (43%).

The documented gender disparity in the likelihood of choosing a science track could be partially driven by differences in performance in quantitative versus non-quantitative subject material prior to track selection. Table 1 provides some support for this hypothesis as men score higher in quantitative portions of the high school entrance exam (Math, Physics, Chemistry), while females tend to perform better in non-quantitative subjects (Chinese, English, Political Science). However, these differences are quite small and unlikely to fully explain why men are twice as likely to choose a science track as compared to women. Total exam scores on the HET exam are similar as males achieve an average total score of 594, while females score 599 out of a possible 790 points. However, women perform significantly better than men in the college entrance exam (CET) taken three years after the HET—regardless of track choice (Science, Arts). Private school enrollment in China is quite low and averages around 1 to 2 percent for both genders. Finally, 12.1% of high-price students in high school are men compared to 8.6% female, suggesting that parents are more likely to pay a premium for education when they have a boy.

[10] In section 5.5, we show that the peer effects we document are robust to alternative definitions of high-performing students.

4 Identification Strategy

The effect of ability composition within a classroom or school is usually confounded by the effects of unobserved factors that can themselves affect students' outcomes. Indeed, students sorting across schools based on ability and other school characteristics would lead to bias in the estimation of peer effects on individual choices. To overcome this issue, we rely on within school variation in peer composition across four adjacent cohorts of Chinese high school students. The basic premise behind our identification strategy is to compare the outcomes of students from adjacent cohorts who face the same school environment, except for the fact that certain cohorts had a higher proportion of high ability students who are female in their first year of high school due to idiosyncratic variation.[11]

Additionally, unique features of the Chinese educational system allow us to overcome other identification challenges. First, students select into a science or non-science track after being exposed to one year of common peers in their first year of high school. This allows us to disentangle the effects of track choice from school choice which are usually made simultaneously in other educational contexts. Second, in our setting, students form, on average, 91 percent new peers in high school. This contrasts with most settings in the U.S. where a student's peers are more or less constant throughout various stages of schooling. Importantly, the significant re-shuffling of students in high school alleviates concerns over whether our results are driven by common unobserved shocks faced by students in middle school. Further, this re-mixing allows us to exploit variation in peer composition that is immune to the reflection problem, a common issue in peer studies (Manski, 1993). Indeed, if the peers a student was exposed to were constant over time, then it would be hard to identify the effect of peer ability composition on individual students from the effects of a student on his peers. Finally, high schools have no cap on the number or gender of students they can accept into a science or arts track.[12] Using four school cohorts, we estimate the following reduced-form equation:

$$\begin{aligned} Y_{isc} = \pi_1 TopF_{sc} + \pi_2 TopF_{sc} * Female_{isc} + \tau_1 PropF_{sc} + \tau_2 PropF_{sc} * Female_{isc} \\ + X'_{isc}\lambda_1 + S'_{sc}\lambda_2 + \alpha_s + \beta_c + \epsilon_{isc} \qquad (1), \end{aligned}$$

where i denotes individuals or students, s denotes high schools, and c denotes cohorts.

[11] Our data do not include classroom identifiers. Further, focusing on classroom level variation could lead to selection issues as classroom assignment within a school is not necessarily random (See for example, Lavy and Schlosser (2011)).

[12] This eliminates concerns over whether teachers or administrators may want to limit the number of accepted female or male science students in a given year.

Y_{isc} is the outcome of interest representing the likelihood of science track selection in the second year of high school and college outcomes at the end of high school. $Female_{isc}$ is a gender indicator variable which takes on values of 1 for females and 0 for males. $TopF_{sc}$ is the main treatment of interest and represents the proportion of high-performing female students relative to all high-performing students in the first year of high school s for each cohort c excluding student i. As mentioned earlier, high-performing students are defined as individuals who score in the top 20%, nationally, in the mathematics portion of the high school entrance exam. In section 5.5, we show our results are robust to alternative definitions of treatment. $PropF_{sc}$ is another peer effect of interest that represents the proportion of female peers in a cohort. α_s is a school fixed effect that controls for the most obvious potential confounding factor, the endogenous sorting of students across schools based on unobserved factors. β_c is a cohort fixed effect that controls for any unobserved cohort specific shocks common to all schools. X'_{isc} is a vector of student level covariates which includes gender, HET test scores, relative ranking of a student and high-price student status. S'_{sc} is a vector of school characteristics, including average peer HET test scores. Finally, ϵ_{isc} represents the error term, composed of school, cohort and individual specific random elements. Standard errors are clustered at the school level throughout.

In our analysis, $TopF_{sc}$ and $PropF_{sc}$ are standardized throughout. Further, we report the results of our parameters of interest separately for males and females. This allows us to see how variation in the quality and quantity of female peers differentially affects men and women. Accordingly, $\hat{\pi}_1$ measures the effect of a one standard deviation increase in the proportion of top performing female peers on men, while $\hat{\pi}_2$ estimates this effect for females, relative to males. Similarly, $\hat{\tau}_1$ summarizes the effect of a one standard deviation increase in the proportion of female peers on men and $\hat{\tau}_2$ reports the additional effect for women. Further, in some specifications, we add to equation (1) district-by-cohort fixed effects to account for any unobserved district specific time varying factors. In other specifications, we also add to equation (1) school specific linear time trends. This allows us to control for any linear unobserved time varying factors that are also correlated with peer composition changes within a school. In these specifications, identification is achieved from the deviation in peer composition from its school long term trend.

5 Results

5.1 Validity of Identification Strategy

The key identifying assumption in this paper is that within school changes in the share of top performing female students—relative to all top performers—are uncorrelated with observed and unobserved factors that could themselves affect academic outcomes. To test for this, we check whether student gender, high-price student status, and high school entrance exam test scores are related to our treatment of interest—the proportion of top performing female students in a cohort. We also check whether these covariates are related to the proportion of female peers in a cohort. Columns 1 through 3 of Table 2 report coefficients from separate regressions of the proportion of high-performing female peers on student characteristics using high school and cohort fixed effects. Results indicate that student gender, high school entry test scores and high-price student status are not statistically related to the proportion of high-performing female students within a school. Importantly, these effects are reasonably precise. For example, the upper 95% confidence interval in column 1 indicates that being female is associated with at most a 0.0015 percentage point increase in the proportion of high-performing female peers in school, i.e. 1.35 percent of a standard deviation.[13] In columns 4 through 6 of Table 2, we repeat this same exercise for the proportion of female peers. We also find no statistically or economically significant relationship between student characteristics and the quantity of female students within a school.

To further alleviate concerns over selection, we show that within school cohort-to-cohort deviations in the share of high-performing female and male students—relative to all students in school—are idiosyncratic. To do so, we conduct Monte Carlo simulations to check whether the observed within school deviations in high ability female and male students are consistent with variation stemming from a random process.[14] For each school, we randomly designate a female (male) student as high ability in each cohort using a binomial distribution function with p equal to the average proportion of high ability females (males) in the school across all four cohorts. We then proceed to calculate the within school standard deviation of high-performing female (male) students relative to all students. We repeat this process 1,000 times to obtain a 95% empirical confidence interval of within school standard deviations. Figure 1 summarizes the results of this simulation for high-performing women; we find that the observed standard deviation in high-performing female students is within the 95% empirical confidence interval for 93% of schools, consistent with a random process. Further, Figure 2 reveals that the observed standard deviation in high-performing male students is within the

[13] One standard deviation in the proportion of high-performing peers is equal to 0.11

[14] This procedure is similar to the randomization test conducted in Lavy and Schlosser (2011)

95% empirical confidence interval for 94% of schools. As a final check, we also re-estimate all main regressions after dropping all schools that are not within the simulated confidence intervals in Figures 1 and 2. We obtain results virtually similar to those from the main sample. These results are summarized in Appendix Table A1.

Combined, these tests suggest that cohort-to-cohort variation in the share of top performing female students is uncorrelated with observable and unobservable changes within schools. A final potential threat to our identification strategy is if students strategically transferred to another school after their first year of high school. Specifically, a concern would be if students interested in pursuing a science track decided to transfer to schools with a larger proportion of high ability females. While we cannot directly test for this with our data, we find this to be highly unlikely in the context of the Chinese high school education system, where students cannot generally transfer from one public high school to another unless they relocate to another city or province.

5.2 Likelihood of Science Track Selection in High School

Table 3 presents results on how men and women's track choices in high school are affected by the quality and quantity of female peers. Column 1 of Table 3 shows estimates from our most basic specification that only includes the main treatment of interest, a gender indicator and high school and cohort fixed effects. The estimates from this parsimonious regression indicate that exposure to a higher proportion of high-performing female peers has no effect on men but increases women's likelihood of enrolling in a science track in high school. The estimate of 0.018 in the second row of column 1 indicates that a one standard deviation increase (0.11) in the share of high performers who are female leads to a 1.8 percentage point increase in the likelihood of women enrolling in science, relative to men. The estimate is statistically significant at the 5% level and represents a 5 percent increase to the baseline likelihood of 35% reported in Table 1. Since a larger share of high-performing students who are female would mean a smaller share of high-performing males, then our results also indicate that being exposed to more high-performing men adversely affects women's likelihood of selecting into a science track, a result we return to in section 5.5.

One might be concerned based on the results in column 1 that it is not high-performing women that matter, but women overall. Indeed, previous literature has shown that having more female peers in a classroom can raise academic outcomes for both sexes through lower levels of classroom disruption and violence (Lavy and Schlosser, 2011). In column 2 of Table 3, we report treatment estimates controlling for the share of female students in a school cohort. This does not meaningfully affect the main results found in column 1; a one standard deviation increase in the proportion of high-performing females still has no effect on boys and increases girls' odds of selecting a science track by 2.1 percentage points, relative to boys.[15] Strikingly, results from column 2 indicate that exposure to a higher proportion of female peers has the opposite effect of increased exposure to higher quality female peers. Estimates from rows 3 and 4 of column 2 indicate that a one standard deviation increase (0.04) in the proportion of female peers increases men's likelihood of enrolling in a science track by 1.7 percentage points and decreases women's chances by 1 percentage point, relative to men.[16] However, the overall impact on girls is statistically insignificant.[17]

In columns 3 and 4 of Table 3, we add controls for cohort varying school and student level variables that could potentially affect the choice of high school track. Specifically, we control for the number of students in a high school as well as overall peer mean HET exam scores, essentially holding overall classroom performance constant. At the student level, we control for the high-price status of a student, which serves as a proxy for socioeconomic background. We also control for students' relative ranking within a school, which has shown to affect academic achievement and subject choice (Murphy and Weinhardt, 2014). We also add controls for individual HET scores which could be a primary determinant of student ability. Finally, we control for district-by-cohort fixed effects to account for any unobserved time varying district-specific shocks. The results remain largely unchanged and in line with those found in column 2, lending support to our identifying assumption that cross cohort within school variation in female peer ability composition is as good as random. Finally, one may be concerned that there still remain cohort-varying unobserved factors that are also correlated with the proportion of top performing female students within a school. To account for this, we report results with the addition of school specific linear time trends in column 5.[18] Using this specification, the results are again mostly unchanged; women are 1.9 percentage points more likely than men to pursue a science track when exposed to better quality female peers and men are 2.9 percentage points more likely to choose a science track when exposed to a higher proportion of female peers.

In conclusion, our results indicate that a 1 standard deviation increase in the proportion of high-performing females in school increases the likelihood of women majoring in science by 1.8 to 2.1 percentage points, relative to men. In addition, a 1 standard deviation increase

[15]The total impact of a one standard deviation increase in high-performing female students is 0.003 + 0.018 = 0.021 (column 1) for girls. The overall effect is -0.005 + 0.021 = 0.016 , after controlling for the proportion of female peers (column 2).

[16]This results is consistent with Zölitz and Feld (2017) and Hill (2017) who show that women exposed to a higher share of female college peers are more likely to choose female dominated majors.

[17]From column 2, the joint overall effect of a one standard deviation increase in the proportion of female peers on girls is 0.017-0.01 = 0.007, a statistically insignificant estimate.

[18]We must note that one caveat with these results is the short time series trend (4 cohorts).

in the proportion of female peers increases the overall likelihood of men majoring in science by 1.7 to 2.9 percentage points, but has no significant overall impact on girls. To further ease interpretation of results, we perform back of the envelope calculations to understand the impact of adding one additional top performing female student to a classroom. Results from this exercise indicate that adding one more high-performing female peer to an average classroom would result in a 1 percentage point (2.85 percent) increase in the likelihood of other female students in the classroom choosing a science concentration.[19] We must note that this exercise is merely illustrative as Carrell, Sacerdote and West (2013) show how policies based on "optimally" designed peer groups can be confounded by the endogenous sorting of students into differential peer groups, thus avoiding the peers they were intended to interact with.

5.3 College outcomes

Next, we look at how gender peer effects impact college outcomes. Our first outcome of interest is four-year university enrollment. University admissions in China is centralized and determined by a province level college entrance exam score cutoff which varies from year to year.[20] Using these cutoffs, we are able to distinguish between students eligible to attend four year universities and those ineligible. Table 4 summarizes the results of this exercise.

Column 1 of Table 4 indicates that a one standard deviation increase in high-performing female peers has a statistically insignificant effect (-0.007) on boys' eligibility to pursue a four-year degree. Conversely, it increases girls' university enrollment likelihood, relative to boys, by 2.1 percentage points. Results from column 2 suggest that these effects persist even after controlling for the quantity of female peers in a classroom. However, results from more saturated regression models indicate that the proportion of high-performing female peers

[19] The average classroom size for schools in our city stands at approximately 50 students per class and, on average, 20.7 percent of all students are high-performing, i.e. 10 students per classroom. Further, the mean proportion of high-performing female peers stands at 35% (i.e. 3.5 girls per classroom). Increasing this proportion by 11 percentage points (1 standard deviation) would result in the proportion of high-performing females becoming 46% (i.e approximately half of the 10 high-performing students per classroom). This is equivalent to adding around 2 additional high-performing female students to a classroom of 50. This means that adding 1 high-performing student to a classroom would result in a (1.8/2) to (2.1/2) increase in high school STEM enrollment for girls relative to boys. We must note that these calculations ignore the second order effects of an increase in the proportion of high-performing female peers (i.e. we hold quantity of female peers constant). This simplification is innocuous since the proportion of female peers has no statistically significant overall impact on girls' science decisions. Finally, we caution that this exercise also assumes that all classrooms within a school look similar. While most students are randomly sorted into classrooms, some schools in China—including some of those within our province—track students into different classrooms based on ability.

[20] There are 2 separate cutoffs within the same year. One cutoff is for students taking the CET arts exam and the other is for those taking the CET science exam.

has a negative and significant impact on boys. Indeed, estimates in columns 3 through 5 indicate that a one standard deviation increase in high-performing females decreases boys' chances of attending a four year university by 1.3 to 1.8 percentage points. It also increases girls' likelihood of eligibility by 1.8 to 2.1 percentage points, relative to boys. Additionally, results from columns 2 through 5 reveal that peer gender has no effect on four year college eligibility for boys or girls.

Finally, we look at how these documented peer effects impact enrollment in top-tier universities. Similar to four year college attendance, enrollment at top-tier colleges in China is based on a province level cutoff that varies from year to year. Students who wish to enroll in elite and prestigious colleges, must score above these thresholds. Results reported in columns 1 through 5 of Table 5 indicate that higher quality female peers have no effect on elite college eligibility for men, but increase women's chances by 0.7 to 0.9 percentage points—a 6 to 8 percent increase. We also find that the proportion of female or male peers in school has no effect on the likelihood of attending a top-tier university for boys or girls.[21]

5.4 Heterogeneous Effects

While the above results indicate that women's STEM choices and college outcomes are, on average, positively affected by the quality of female peers in school, there are reasons to believe that some women may be more affected than others. For example, if lower ability female students were more affected by higher quality peer exposure, then this would suggest that ability spillovers could be a potential channel driving the main results. Thus, in order to complement the initial results, we next look at heterogeneous treatment effects by students' absolute mathematical ability. To do so, we classify students into two subgroups based on whether they score above or below the median score in the national mathematics HET exam. We also check whether these effects differ with respect to overall student ability by looking at subgroups based on students' overall score in the HET exam.

Results presented in columns 1 through 4 of Table 6 indicate that an increased share of high-performing peers who are female has no effect on track choice for boys regardless of mathematical or overall ability, nor does it affect lower ability female students. However, we do find significant effects on high school track choice for girls with high math ability; a one

[21]We also examine effects on CET scores other than just the admissions cutoffs. Specifically, in Table A2 of the Online Appendix, we show how the proportion of high-performing females in school affects the likelihood of students scoring in the top five deciles of the CET distribution. We find statistically significant effects on the likelihood female students score in the top 3 deciles of the CET distribution, relative to men. For example, estimates from column 1 suggest that a one standard deviation increase in high-performing female peers increases girls' likelihood of scoring in the top 10 percent of the CET exam, relative to men. We find no statistically significant impact on scoring in the top 40 or top 50 percent of the CET distribution.

standard deviation increase in high-performing female peers leads to a 2 percentage point increase in the likelihood of girls selecting a science track, compared to boys. These relative effects are more pronounced (0.051) for female students in the top half of the overall ability distribution. We also find that women who score below the median in the math HET exam are the only subgroup affected in terms of likelihood of enrolling in college (1.9 percentage point increase). This relative effect seems to be mostly driven by a 1.5 percentage point reduction for men. In terms of elite university eligibility, we find that the largest effects are on high ability women. A one standard deviation increase in high-performing female peers leads to a 1.3 and 3.5 percentage point relative increase in the likelihood of attending an elite university for women in the top half of the mathematical and overall ability distribution respectively.

Next, we look at how students from top versus lower tier high schools are impacted.[22] Results reported in columns 5 and 6 of Table 6 indicate that an increased concentration of high-performing female peers has no effect on track choice for boys enrolled in elite and non-elite high schools, nor does it affect girls attending non-elite schools. However, we do find large effects for girls enrolled in elite schools; a one standard deviation increase in high-performing female peers leads to a 5.1 percentage point increase in the likelihood of girls selecting a science track, relative to boys. These results extend to four year university eligibility where we find that exposure to better quality female peers only affects girls enrolled in elite schools. In terms of elite university eligibility, our estimates suggest that the effects are driven by women from elite high schools. The estimate reported in Column 5 of Panel C is statistically insignificant—most likely due to reduced sample size—however, the magnitude of the point estimate is similar to the overall effects we find in Table 5. Finally, we investigate how students attending high schools in rural versus urban areas are differentially affected. Results in columns 7 and 8 indicate that girls attending schools in rural and urban areas are both affected by female peer quality. However, estimated effects are larger for girls attending high school in rural areas. Indeed, females exposed to a one standard deviation higher concentration of high-performing women are 2.8 and 3.1 percentage points more likely than men to choose a science track and attend a four-year college respectively. This contrasts with women residing in urban areas who are 1.9 and 1.6 percentage points more likely to do so. In terms of elite college eligibility, both subgroups are impacted with effects being more pronounced for women residing in urban areas.

[22]To ensure smoother and more transparent school-student matching, high schools are divided into four groups by the city education department. The best schools are classified as Tier I schools, the second-best are Tier II, and so on. We define top tier schools as those in Tier 1 (elite schools) and lower tier schools as those in Tiers II trough IV.

5.5 Additional Results and Robustness Checks

5.5.1 Alternate Definitions of High-Performing Students

To alleviate any concerns attributed to the way we define high-performing peers, we check the robustness of our results to alternative definitions of treatment. We begin by first redefining top performing peers to also include the top 15%, top 25%, top 30%, top 35% and top 40% national performers in the math high school entrance exam.[23] Table 7 summarizes the results of this exercise where we report regression estimates using varying definitions of high-performing female peers in mathematics.[24] Results from Panel A of Column 1 indicate that a one standard deviation increase in exposure to high-performing women—defined as those in the top 15% in mathematics—decreases men's likelihood of enrolling in a science track by 1.2 percentage points. However, when we define high performers as students in the top 25%, top 30%, top 35% and top 40%, as in columns 2 through 5, we find no statistical relationship between high-performing female peers and the likelihood of boys pursuing a STEM degree, similar to our original findings. The results for women are more robust and estimates from columns 1 through 5 indicate that a one standard deviation increase in the proportion of high-performing women, regardless of treatment definition, increases women's relative chances of pursuing a science degree by 1.2 to 1.4 percentage points.

Results presented in Panel B of Table 7 are also in line with our main findings on college outcomes. There is suggestive—but inconclusive and non-robust—evidence that an increase in the proportion of high-performing female peers decreases the likelihood of men being eligible to pursue a four year degree. On the other hand, there is strong evidence that a one standard deviation increase in high-performing peers leads to a 1 to 2.5 percentage point increase in four-year college eligibility for women. This result holds regardless of how narrow or wide we define a top performing female peer. Finally, results from Panel C are also in line with our main findings. There is no relationship between top performing female peers and elite university attendance for men, but women are 0.5 to 0.6 percentage points more likely to attend an elite university when exposed to higher quality female peers.

Our main definition of treatment is the share of top national performing students in mathematics who are female. Variation in treatment could be due to differences in the number of top performing female or male students in a given school cohort. To examine the full extent to which variation in top performing female and male peers affects outcomes, we

[23] We do not use the proportion of top 5% and top 10% national scoring students when redefining treatment, as there are many schools that do not have such students resulting in a significantly reduced sample.

[24] All coefficients in Table 7 represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends.

present estimates from a modified version of equation (1) that controls for the proportion of top performing female and male peers separately. Formally, we estimate the following equation:

$$\begin{aligned} Y_{isc} &= \pi_1 TopF_{sc} + \pi_2 TopF_{sc} * Female_{isc} + \tau_1 TopM_{sc} + \tau_2 TopM_{sc} * Female_{isc} \\ &+ \quad \theta PropF_{sc} + \gamma PropF_{sc} * Female_{isc} + X'_{isc}\lambda_1 + S'_{sc}\lambda_2 + \alpha_s + \beta_c + \epsilon_{isc} \qquad (2) \end{aligned}$$

Here, $TopF_{sc}$ and $TopM_{sc}$ are defined as the proportion of top female and male national performers in mathematics relative to all students in a given school cohort. In the first two rows of Panel A of Table 8, we present estimates outlining the effects of high performing female and male peers for male students. These correspond to π_1 and τ_1 in equation (2). In the next two rows, we report estimates for female students, relative to males (π_2 and τ_2). These estimates are in line with our main findings and indicate that men are unaffected by the mathematical peer ability of men and women in school. We also find—in line with previous findings— that female students are more likely to enroll in a science track when exposed to a higher proportion of high-performing female students and are less likely to do so when exposed to more high-performing men. Specifically, a one standard deviation increase in the proportion of top performing female students (0.108) increases women's chances of enrolling in a science track by 4.2 percentage points, relative to men. Conversely, increased exposure to high-performing men decreases this likelihood by 2.9 percentage points. We further find that women are more likely to attend any college or an elite college when exposed to higher ability female peers in mathematics and high-performing male peers seem to negatively affect females' college outcomes, though these estimates are not statistically significant. We further assess the robustness of this definition to comparisons within gender groups. Specifically, we present estimates whereby we redefine top performing female and male students relative to students of the same gender. These results are summarized in Panel B of Table 8 and are in line with those from Panel A. Men are overall unaffected by the proportion of female and male peers who are high-performing. Women's high school and college outcomes are positively affected by the proportion of females who are high-performing and negatively affected by the proportion of top performing males, though the effects on college outcomes are not all statistically significant.

5.5.2 Linear-in-Means Model and the Effect of Student Rank

Next, we look at how students are affected by the average academic peer composition within a school. Specifically, we estimate how boys and girls are influenced by the mean female and male peer ability in mathematics within a school. The first two rows of Appendix Table A3 summarize the overall impact for boys. Estimates from column 1 of Table A3 suggest that men's track choices are negatively affected by an increase in the average mathematical ability of female peers, although this effect is not statistically significant. This contrasts with a positive and significant effect from increased exposure to higher average performing males in mathematics. Additionally, columns 2 and 3 indicate that men's college outcomes are unaffected by the average peer ability of males and females in the classroom. In the last two rows of Table A3, we report average peer estimates for girls, relative to boys. The estimate of 0.157 in Column 1 indicates that women are 15.7 percentage points more likely to choose a science track when exposed to a one standard deviation increase in average performing female peers in mathematics.[25] This effect is offset by exposure to higher performing male peers; women are 14.6 percentage points less likely to pursue a STEM track when exposed to higher average performing male peers. These results are in line with our main findings. Finally, estimates from columns 2 and 3 of Table A3 show that women are more likely to attend a four-year and an elite university when exposed to higher average female peers, but their college outcomes are unaffected by the average ability composition of male peers.

Mean school-cohort ability is mechanically related to students' relative rank within a given classroom or school. Indeed, potential gains from exposure to higher ability peers could be partially offset by being ranked lower within that peer group. Recent papers document that ordinal rank within a school or classroom can have significant effects on academic and labor market outcomes (Murphy and Weinhardt, 2014; Elsner and Isphording, 2017; Denning, Murphy, and Weinhardt, 2018). We have shown that the gender peer effects we document persist even after controlling for a student's relative rank within school. However, to the extent that ordinal rank has been shown to affect student outcomes in other settings, it would be interesting to assess the magnitude of its effect in our particular context. To do so, we build on a slightly modified variant of our main identification strategy. This strategy is similar to that used in Elsner and Isphording (2017). Formally, we estimate the following regression:

$$Y_{isc} = \alpha + \beta Rank_{isc} + \beta_2 Rank_{isc} * Female_{isc} + g(a_{isc}) + X'_{isc}\lambda + \delta_{sc} + \epsilon_{isc} \qquad (3)$$

,

The dependent variable Y_{isc} measures academic outcome. The treatment of interest $Rank_{isc} \in [0,1]$ is a student's ordinal rank in mathematics within his/her respective gender

[25] A one standard deviation increase in average female peer quality is equivalent to being in a classroom with students who average 15 points higher in the mathematics HET exam.

group.[26] Further, we interact $Rank_{isc}$ with a $Female_{isc}$ dummy variable to look at effects on the male and female population separately. Similar to Murphy and Weinhardt (2014) and Elsner and Isphording (2017), we use a fourth order polynomial $g(a_{isc})$ of the mathematics HET exam to control for mathematical ability. X'_{isc} is a vector of student level covariates such as gender and high price status. Equation (3) is run using two specifications. In our simpler specification, we define $\delta_{sc} = \delta_s + \delta_c$ and estimate equation (3) using separate fixed effects for school and cohort. In these regressions, we identify rank effects through comparing students in the same school with similar levels of absolute ability, but who ultimately differ in their ordinal school-cohort rank because they face a different ability distribution in their cohort. To consistently identify rank effects using this specification, we must also condition on average school-cohort peer mathematics ability since students with a given absolute ability are mechanically ranked lower in a school environment with higher average ability. In a second and more restrictive specification, we estimate our model with school-by-cohort fixed effects δ_{sc}. This enables us to control for mean peer ability as well as any other school-by-cohort confounders. In this model, we compare students across all school cohorts after removing all observable and unobservable mean differences between school cohorts. As illustrated in Elsner and Isphording (2017), as long as school cohorts differ in higher moments of the ability distribution, students with similar absolute ability may have different ordinal ranks in their respective school cohorts.

Results from this exercise are summarized in Table A4. The first three columns of Panel A summarize results using our simpler two-way fixed effect specification, controlling for individual math ability and peer mean math ability. We find that a student's ordinal ranking in mathematics has no statistically significant effect on men's track choices in high school or elite college eligibility. We do however find that a one standard deviation (10 percentage point) increase in rank leads to a 0.78 percentage point higher likelihood of college attendance for men. Conversely, we find that women are more likely to enroll in a science track, compared to men, though the overall effect is statistically insignificant. We also find that a decile increase in rank decreases women's likelihood of enrolling in any university and an elite university by 0.25 and 0.2 percentage points, relative to men. However, the overall impact of rank for women is statistically insignificant for elite university attendance. In Columns 4 through 6 of Panel A, we report estimates from our more restrictive model using school-by-cohort fixed effects. Results remain largely unchanged and in line with those

[26] We define the rank variable with respect to female and male peer groups separately since our ability peer measure of interest was also defined separately. Formally, rank is defined as $\frac{a_f - 1}{N_f - 1}$ for females and $\frac{a_m - 1}{N_m - 1}$ for males; where a_f and a_m measure the absolute rank of female and male students within their respective gender group in mathematics. N_f and N_m represent the number of female and male students within a school-cohort respectively.

from the two-way fixed effect specification. Finally, in Panel B, we report estimates using an alternative definition of rank; overall rank within gender group. Results are consistent with those reported in Panel A for track choice and four year college eligibility. We also find stronger evidence of positive (0.045) rank effects on men's chances of attending an elite university. Overall, we find that ordinal rank mostly impacts men and women's chances of attending a four year and elite university.

5.5.3 The Full Extent of Non-Linearities in Treatment

The treatment of interest in this paper is the share of high-performing students who are female, where we define high performers as students scoring in the top 20% of the national mathematics high school entrance exam. In an attempt to shed light on the heterogeneous nature of our effects with respect to peer achievement, we next look at the full extent of non-linearities in treatment at different quantiles of the ability distribution. Specifically, we assign peers into five categories depending on their mathematical ability and then look at how the share of women in the five quintiles of the mathematics ability distribution jointly affects men and women's academic outcomes.

Table A5 summarizes findings from this exercise. We find that the proportion of women in the top 20% of national math scorers, controlling for the share of women in the bottom 4 quintiles of mathematical ability, has no effect on men's educational outcomes but positively affects women's outcomes—in line with our main findings. Additionally, we find no statistically significant effects on high school track choice for men and women exposed to a higher fraction of female peers in the second, third and fourth quintile of the mathematics ability distribution. For college outcomes, the results are a bit mixed as women exposed to more female peers in the middle 3 quintiles of the ability distribution appear to also enroll at university at higher rates than men. However, elite college attendance is improved for women exposed to a higher share of female peers in the 2nd quintile (top 20-40%) of ability and not the 3rd and 4th quintile. Finally, we find that women exposed to a higher fraction of female peers at the bottom of the distribution are worse off than men with respect to all academic outcomes. For example, a one standard deviation increase in the proportion of women in the bottom quintile of the ability distribution decreases women's chances of enrolling in a science track by 0.9 percentage points, relative to men; driven by a 1.1 percentage point increase in men's likelihood.

While it is beyond the scope of this paper to identify a single structure of peer effects that can explain our findings, estimates from this section help shed light on which of the existing peer effects models are consistent with the patterns we observe in our data (See Hoxby and Weingarth, 2005 for a comprehensive review of the different structures of peer effects models). Our results indicate that top female peers have a disproportionately positive effect on all other female students in the classroom, compared to other peers. This would seem to favor a peer effects model of shining light over a bad apples structure. A model of shining light formally states that a student with sterling outcomes has a disproportionately large positive impact on his/her classroom peers. However, given the lack of classroom level data in our setting and the large number of top performing students in our narrowest definition of high-performing peers, it is hard to draw any definitive conclusions on the structure of peer effects from this exercise.[27]

5.5.4 Peers in Quantitative versus Non-Quantitative Subjects

The focus in this paper is on how peers' math performance affects women's high school track choices. Our emphasis on mathematics is because women's underrepresentation in STEM is generally concentrated in math-intensive science fields and since it is also believed that math ability and skills are necessary for STEM careers (Kahn and Ginther, 2017). Further, there is a widespread stereotype in China that men are better able to learn mathematics than women (Eccles and Wang, 2016; Eble and Hu, 2017). However, to the extent that women respond to positive peers in mathematics, then we would expect to observe some beneficial effects from exposure to top performing females in slightly less quantitative subjects such as Physics and Chemistry. Results presented in columns 1 and 2 of Appendix Table A6 are in line with expectations; girls exposed to a larger proportion of female high performers in Physics and Chemistry are more likely to choose a science track, enroll in a four year degree and attend a top tier university. The magnitude of these effects are slightly lower than those in our main findings. For example, a one standard deviation increase in female high performers in Physics leads to a 1.1 percentage point increase in science tracking for girls, compared to boys.[28]

Conversely, when women are exposed to an increased share of high-performing female peers in non-quantitative subjects such as Chinese, Political Science and English, results differ substantially. Column 3 indicates that men and women's track choices are unaffected

[27] With the caveat of reduced sample size and changes in school sample composition, we also look at the effects of top and bottom performing female peers on academic outcomes by redefining our peer groups to a much narrower set of students—those in the top and bottom 10% of the mathematics national high school entrance exam respectively. Since the number of students in these peer groups will be quite small, this would allow us to better speak to the structure of peer effects. These results, available upon request, suggest that top peers have a disproportionately positive effect on students. Specifically, for our key outcome, we find that an increase in the share of top 10% performing female peers increases women's likelihood of enrolling in a science track by 4.7 percentage points, relative to men. Conversely, a larger fraction of bottom 10% performing female peers decreases this likelihood by 1.9 percentage points.

[28] Using the same specification, we found that a one standard deviation increase in female high performers in Mathematics led to a 1.9 percentage point increase in science tracking for girls, relative to boys.

by peer quality composition in Political Science. However, women are 0.8 percentage points less likely than men to enroll in a four-year university when exposed to a higher proportion of top performing females in Political Science. Results from Column 4 indicate that women are 1.8 percentage points less likely to pursue a science degree and 0.4 percentage points less likely to attend an elite university when exposed to a one standard deviation increase in the proportion of high-performing female peers in Chinese, whereas men are unaffected. Finally, results presented in column 5 indicate that boys and girls do not respond to the gender ability composition of peers in English language, most likely because English is given at a similar level in both high school tracks.

6 Discussion and Interpretation

Our main treatment of interest is the share of high-performing peers in high school who are female; a higher proportion indicates more top performing women and fewer top performing men in school. Accordingly, we interpret our findings as evidence of women being positively affected by higher quality female peers and negatively affected by higher quality male peers in high school. Results from Table 8 are in line with such an interpretation as we show that an increase in the proportion of top performing female peers encourages girls to pursue a science track and also improves their college outcomes. Conversely, an increase in the proportion of top performing male peers has the exact opposite effect on girls.

The main purpose of this paper is to show how women's STEM choices are affected by peer environment. However, before turning to a detailed discussion on the potential mechanisms driving the results on female STEM choices, we first interpret findings on college outcomes. In section 5.3, we show that men and women's university outcomes are unaffected by the number of female and male peers in high school. However, we do find that exposure to a higher share of top performing female peers increases women's chances of attending a four year university and an elite university. Track choices are made one year after exposure to a new set of peers in high school and college outcomes are decided two years after track selection. A natural question thus arises: is the improvement in women's college outcomes driven by better peers in the first year of high school or a result of track choice the following year?

While we are unable to conclusively disentangle the effect of higher quality peers and the endogenous choice of track selection on college outcomes, we nonetheless provide suggestive evidence on what may be driving these persistent effects. The heterogeneous analysis summarized in Table 6 highlights an interesting finding; elite college eligibility is only improved for the subpopulation of students who are induced into science tracks (columns 1, 3, 5, 7 and

8). This pattern does not hold when looking at four-year college enrollment rates. Additionally, in our setting, universities provide more admission slots for students from a science track, with elite universities providing an even higher share of STEM seats. This suggests that track choice could be an important mediating factor affecting college outcomes, though evidence of this is not conclusive. Accordingly, we interpret our results as evidence that gender peer ability composition improves females' college outcomes, relative to men, with track choice being a potential mediating channel.

We now turn to the question of why an increase in the proportion of top performing female peers in mathematics increases the likelihood that women choose a science track the following year. We focus on two potential interpretations. The first is one in which female students benefit from higher quality female peers in the classroom through ability spillovers. While we cannot completely rule out such an interpretation, we believe our findings are inconsistent with such a channel. Indeed, a learning or ability spillover mechanism would have likely meant that male students exposed to higher ability male or female peers would be affected on some dimension. Also, this mechanism does not fully explain why the number of girls or boys in school influence track choice. Further, we have also shown that our effects are driven by students at the top of the ability distribution, who are arguably less likely to benefit from ability spillovers.

Instead, we argue that our findings are more consistent with a socio-psychological interpretation of educational investments whereby gender stereotypes, ability beliefs and preferences are influenced by the presence of high-performing female role models. This is particularly important in a context like China whereby negative gender stereotypes and the rampant perception that men are better than women in science and engineering has led to a large STEM gender gap. Indeed, in a recent survey, it was estimated that 83% of workers in China believe that men have a genetic advantage in math and science (Hewlett, 2014). These beliefs are particularly damaging to minority groups in the sciences such as women. Crocker and Major (1989) show that individuals in a minority position have a tendency to be influenced by stereotypes pertaining to their own social category. Further, recent studies have shown the importance of role model effects in eliminating stereotype bias and altering ability beliefs. Two recent papers study this in a context where there is initial widespread belief that men are better able to learn mathematics—the Chinese middle school system. Eble and Hu (2017) find that student-teacher gender match is able to reduce this belief and increase women's performance and investment in math-related human capital. They provide evidence that the main mechanism behind this change is the presence of positive role models. Similarly, Gong, Lu and Song (forthcoming) find that having a female teacher improves girls' mental status and acclimation relative to boys. They also find evidence that female teachers contribute to altering girls' beliefs about commonly held gender stereotypes which in turn increases girls' motivation to learn.[29]

While previous literature has demonstrated the importance of teachers in influencing educational choices, we provide evidence suggesting that peers may also serve as important role models in educational investments. In our context, exposure to high-performing peers of the same gender may update girls' beliefs about their own mathematical ability, mitigating the effects of negative gender stereotypes. Indeed, in section 5.4, we show that women exposed to high ability females in quantitative subjects are more likely to enter the STEM pipeline. Conversely, exposure to top performing women in non-quantitative fields—where gender stereotypes are not as prevalent—does not or negatively affects female track choices.[30] Additionally, we show that the peer effects we document are stronger for women attending school in rural areas. Insofar as high-performing female peers act as positive role models, this should matter more in rural areas where gender bias and stereotypes are more prevalent.

Finally, if top performing female peers provide an affirmation to other girls in school, then we would expect our effects to be most pronounced for high ability women, particularly those with a comparative advantage in mathematics. In other words, we would expect female role models to correct for a mis-optimization of high school track choice for high ability female students who have a comparative advantage in mathematics over non-quantitative subjects—the group of women most likely to benefit from entering the STEM pipeline from a policy standpoint. We investigate these patterns in Table 9. Results reported in column 1 of Panel A indicate that a one standard deviation increase in top performing female peers increases female students' relative chances of entering a STEM track by 2.4 percentage points when they have a comparative advantage in mathematics over Chinese language. Results presented in Panels B and C of Table 9 indicate that these results are driven by high ability women. Conversely, we find no peer effects for boys or girls who have a comparative advantage in Chinese over mathematics regardless of overall ability. These results are in line with a socio-psychological interpretation of peer effects whereby high ability women update female students' beliefs about their own ability. In summary, the interpretation most consistent with our main findings is that high-performing female peers in mathematics are a positive reinforcement to girls wanting to enter the STEM pipeline.

[29]Experimental evidence has also shown that women respond to positive role models more than men, consistent with our main findings. Bagès, Verniers and Martinot (2016) find that 6th grade girls' math test scores dramatically improved when exposed to a role model explaining to them that "students' success is due to effort exerted", while no effect was found for boys.

[30]This is consistent with Eccles and Wang (2016) who show that updating females' beliefs about their mathematical ability—controlling for actual math and writing ability—increases their likelihood of being in a STEM career.

7 Conclusion

In this paper, we estimate the impact of high-performing female peers on female students' track choices in high school as well as college outcomes. Our unique data and Chinese setting allow us to track the choice of STEM fields as early as high school. The evidence provided in this paper suggests that boys are mostly unaffected by the quality of their high school peers. For girls, however, having a larger portion of high-performing female peers in mathematics increases their likelihood of choosing a science track while having more high-performing male peers harms their chances. We also show that increased exposure to high ability female peers improves college outcomes for women. Finally, we show that our effects are driven by high ability women with a comparative advantage in mathematics. One explanation for our findings is that girls may perceive top performing female classmates as role models who provide them with an ability affirmation.

We show how peer environment early on in high school may play a vital role in narrowing the STEM gender gap in college and the labor market. However, it is important to note that driving more women into science fields in high school is not a sufficient remedy on its own. In a recent survey, it was revealed that more than 44% of female STEM students in China reported "gender discrimination" in the job market. Further, with the benefit of hindsight, 53.8% of females surveyed stated that they would have rather chosen a major with less of a science component (Zhang and Zhen, 2011). Our results provide some suggestions on how to encourage girls into science tracks early on, but without proper institutional support in college and the labor market, these investments may be suboptimal.

References

Anelli, M., and Peri, G., Forthcoming. The Effects of High School Peers' Gender on College Major, College Performance and Income. *The Economic Journal*.

Bagès, C., Verniers, C., and Martinot, D., 2016. Virtues of a Hardworking Role Model to Improve Girls' Mathematics Performance. *Psychology of Women Quarterly* 40 (1), 55-64.

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., and Doms, M. E., 2011. Women in STEM: A Gender Gap to Innovation. *Economics and Statistics Administration Issue Brief* (04-11).

Bifulco, R., Fletcher, J. M., and Ross, S., 2011. The Effect of Classmate Characteristics on Post-Secondary Outcomes: Evidence from the Add Health. *American Economic Journal: Economics Policy* 3 (1), 25-53.

Black, E. S., Devreux J. P., Salvanes, G. K., 2013. Under Pressure? The Effect of Peers on Outcomes of Young adults. *Journal of Labor Economics.* 31(1), 119-153.

Blickenstaff, Clark J., 2005. Women and Science Careers: Leaky Pipeline or Gender Filter? *Gender and education* 17 (4), 369-386.

Card, D., and Payne, A. A., 2017. High School Choices and the Gender Gap in STEM. *NBER Working Paper No. 23769*.

Carrell, S.E., Page, M. E., West, J. E., 2010. Sex and Science: How Professor Gender Perpetuates the Gender Gap. *Quarterly Journal of Economics*, 125(3), 1101-1144.

Carrell, S.E., Sacerdote, B. I., West, J. E., 2013. From Natural Variation to Optimal Policy? The Importance of Endogenous Peer Group Formation. *Econometrica*, 81(3), 855-882.

Crocker, J., and Major. B., 1989. Social Stigma and Self-esteem: The Self Protective Properties of Stigma. *Psychological Review*, 96(4), 608-630.

Cunha, F. and Heckman, J., 2007. The Technology of Skill Formation. *American Economic Review*, 97(2), 31-47.

Denning, J. T., Murphy, R., and Weinhardt, F. 2018. Class Rank and Long-Run Outcomes. *IZA DP No. 11808*.

Eble, A., and Hu, F., 2017. Role Models, the Formation of Beliefs, and Girls' Math Ability: Evidence from Random Assignment of Students in Chinese Middle Schools. *Working Paper*.

Eccles, J. S., and Wang M. 2016. What Motivates Females and Males to pursue Careers in Mathematics and Science. *International Journal of Behavioral Development*, 40 (2), 100-106.

Elsner, B., and Isphording I. E. 2017. A Big Fish in a Small Pond: Ability Rank and Human Capital Investment. *Journal of Labor Economics*, 35 (3), 787-823.

Fischer, S., 2017. The Downside of Good Peers: How Classroom Composition Differently Affects Men's and Women's STEM persistence. *Labour Economics*, 44, 151-160.

Gong, J., Lu, Y. M., and Song, H., Forthcoming. The Effect of Teacher Gender on Students' Academic and Noncognitive Outcomes. *Journal of Labor Economics.*

Guo, C., Tsang, C. M., and Dink, X., 2010. Gender Disparities in Science and Engineering in Chinese Universities. *Economics of Education Review*, 29, 225-235.

Hewlett, S.A., 2014. What's Holding Women Back in Science and Technology Industries. Harvard Business Review.

Hoekstra, M., Mouganie, P., and Wang, Y., Forthcoming. Peer Quality and the Academic Benefits to Attending Better Schools. *Journal of Labor Economics.*

Hoxby, C., 2000. Peer Effects in the Classroom: Learning from Gender and Race Variation. *NBER Working Paper No. w7867.*

Hoxby, C.,and Weingarth, G., 2005. Taking Race Out of The Equation: School Reassignment and The Structure of Peer Effects. *Unpublished manuscript, Harvard University.*

Hill, A. J., 2017. The Positive Influence of Female College Students on Their Male Peers. Labour Economics, 44, 151-160.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., and Williams, C. C., 2008. Gender Similarities Characterize Math Performance. *Science*, 321(5888), 494-495.

Kuhn, P., and Shen, K., 2013. Gender Discrimination in Job Ads: Evidence from China. *The Quarterly Journal of Economics*, 321(5888), 128 (1), 287-336.

Kugler, A. D., Tinsley, C. H., and Ukhaneva, O., 2017. Choice of Majors: Are Women Really Different from Men? *IZA working paper No. 10947.*

Lavy, V., and Schlosser, A., 2011. Mechanisms and Impacts of Gender Peer Effects at School. *American Economic Journal: Applied Economics.* 3, 1-33.

Lim, J., and Meer, J., Forthcoming. The Impact of Teacher-Student Gender Matches: Random Assignment Evidence from South Korea. *Journal of Human Resources.*

Lim, J., and Meer, J., 2017. Persistent effects of Teacher-Student Gender Matches. *NBER Working Paper No. 24128.*

Manski, C., 1993. Identification of Endogenous Social Effects: The Reflection Problem. *The Review of Economic Studies*, 60 (3), 531-542.

Microsoft, 2017. Why Europe's girls aren't studying STEM. *Technical Report.*

Murphy, R., and Weinhardt, F., 2014. Top of the class: The importance of ordinal rank. *CESIFO Working Paper No. 4815*

Ost, B., 2010. The role of peers and grades in determining major persistence in the Sciences. Economics of Education Review, 29(6), 923-934.

Paredes, V., 2014. A Teacher like Me or a Student Like Me? Role Model versus Teacher Bias Effect". *Economics of Education Review*, 39, 38-49.

Schneeweis, N. and Zweimüller, M., 2012. Girls, Girls, Girls: Gender Composition and Female School Choice. *Economics of Education Review*. 31(4): 482-500.

Turner, S. E., and Bowen, W. G., 1999. Choice of major: The changing (unchanging) gender gap. *Industrial & Labor Relations Review*, 52(2), 289-313.

The U.S. News/Raytheon STEM Index Shows Gender and Racial Gaps Widening in STEM Fields. (2015). U.S. News.

Xie, Y., and Shauman, K. A., 2003. Women in science: Career processes and outcomes. Vol. 26. No. 73.4. Cambridge, MA: *Harvard University Press.*

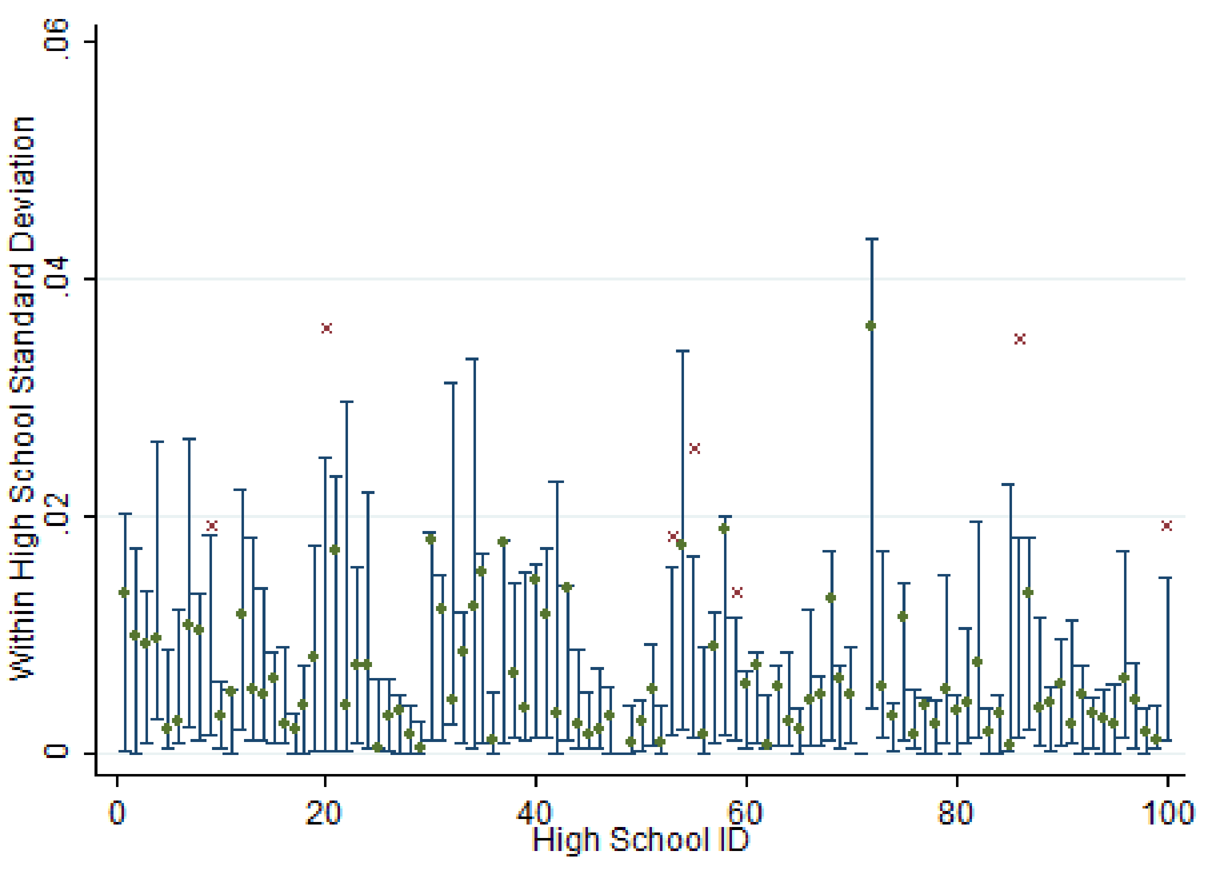
Zafar, B., 2013. College major choice and the gender gap. *Journal of Human Resources*, 48(3), 545-595.

Zhang L., and H.Zhen., 2011. A Study on the Dilemma The Female University Students in Science and Technology Encountered during Their Learning. *Tsinghua Journal of Education*, 32(5).

Zölitz, U., and Feld, J., 2017. The Effect of Peer Gender on Major Choice and Occupational Segregation. *Working Paper.*

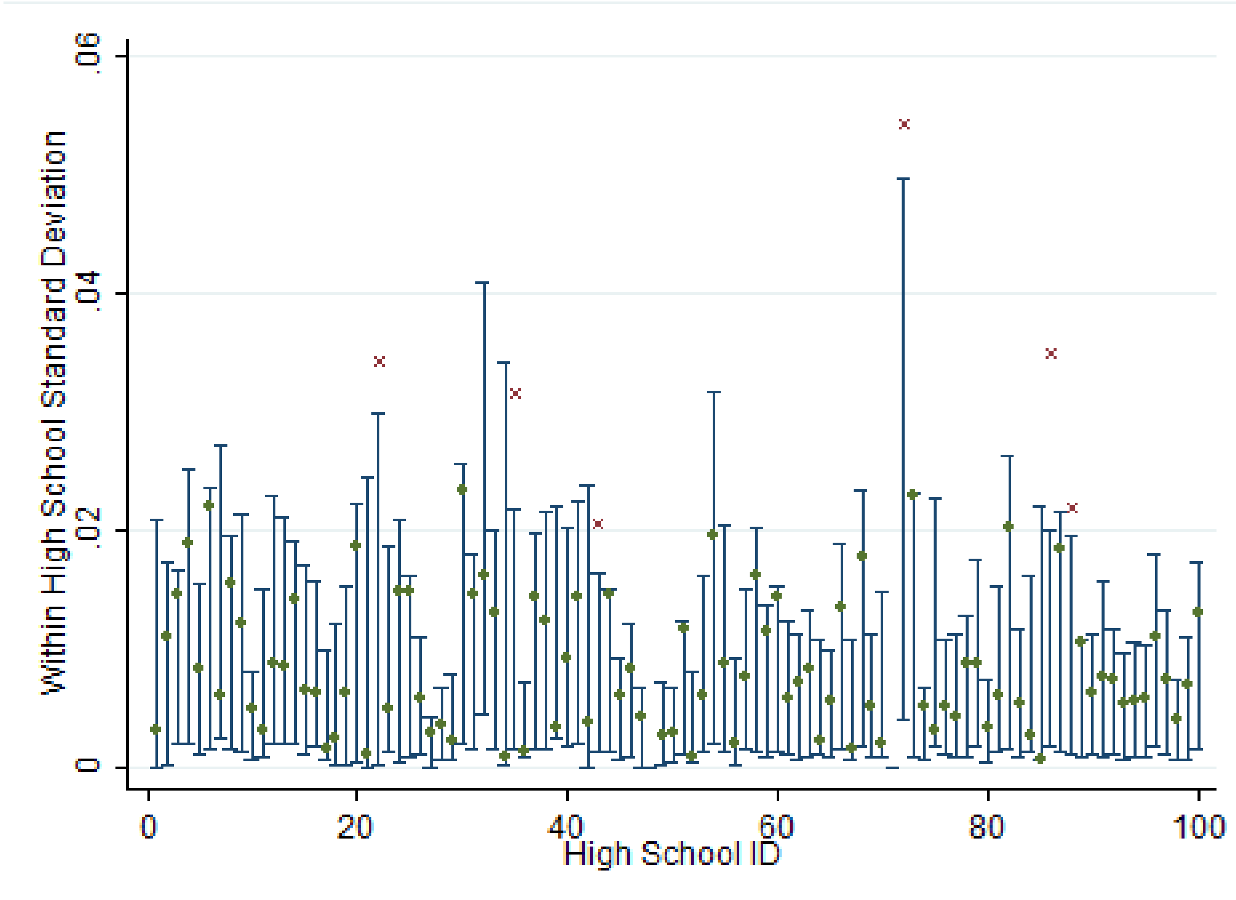
A Figures

Figure 1: Monte Carlo simulations for the within high school standard deviation in the proportion of high-performing female students, relative to all students



Notes: Vertical bars represent simulated 95% confidence intervals for within high school standard deviations in top performing female students. Scatter points represent actual within standard deviations for each school.
Filled circles indicate that the actual standard deviation is within the simulated 95% C.I., whereas X's indicate schools with standard deviations outside the simulated C.I.

Figure 2: Monte Carlo simulations for the within high school standard deviation in the proportion of high-performing male students, relative to all students



Notes: Vertical bars represent simulated 95% confidence intervals for within high school standard deviations in top performing male students. Scatter points represent actual within standard deviations for each school.
Filled circles indicate that the actual standard deviation is within the simulated 95% C.I., whereas X's indicate schools with standard deviations outside the simulated C.I.

B Tables

Table 1: Descriptive Statistics

	(1) Whole Sample	(2) Females	(3) Males
Proportion of students in cohort	1	0.52	0.48
Proportion of high performing students	0.207	0.164	0.255
Likelihood of selecting “Science” track	0.525	0.357	0.710
Proportion eligible to attend ‘elite university’	0.108	0.110	0.106
Proportion eligible to attend four-year university	0.458	0.482	0.432
Chinese language HET exam score	109	111	106
English language HET exam score	110	115	105
Political Science HET exam score	75.5	77	74
Mathematic HET exam score	111	109	114
Physics HET exam score	77	75	79
Chemistry HET exam score	77	75	79
Total HET exam score	597	599	594
Total CET exam score (Science students)	488	504	480
Total CET exam score (Arts Students)	469	481	442
Proportion attending Private School	0.0017	0.0015	0.002
Proportion of high price students	0.010	0.086	0.121
Number of schools	100	100	100
Number of Students	133,845	70,619	63,226

Note: Means of variables reported. Proportion of high-performing students refers to the proportion of students scoring in the top 20% nationally in the math high school entrance exam. HET refers to the High school Entrance Test. CET refers to the College Entrance Test.

Table 2: Tests for random assignment of top performing female students and proportion of female students

	Proportion high performing female	Proportion high performing female	Proportion high performing female	Proportion female	Proportion female	Proportion female
	(1)	(2)	(3)	(4)	(5)	(6)
Female	0.00061			-0.00004		
	(0.00053)			(0.00021)		
High School entry test scores		0.00003			0.00001	
		(0.00003)			(0.00002)	
High price students			-0.00041			-0.00055
			(0.00136)			(0.00045)
Observations	133,845	133,845	133,845	133,845	133,845	133,845

Note: Coefficients in columns (1) through (3) represent estimates from separate regressions of the proportion of top performing female peers on student level characteristics. Coefficients in columns (4) through (6) represent estimates from separate regressions of the proportion of female peers on student level characteristics. All regressions include high school and cohort fixed effects.
Standard errors clustered at the school level and reported in parentheses *** p <0.01 ** p <0.05 * p <0.1

Table 3: The effect of high-performing female peers on science high school track choice

	(1)	(2)	(3)	(4)	(5)
Proportion High Performing Female	0.003	-0.005	-0.009	-0.010	-0.006
	(0.007)	(0.007)	(0.007)	(0.007)	(0.009)
Female × Proportion High Performing Female	0.018**	0.021***	0.021***	0.019***	0.019***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
Proportion Female		0.017***	0.020***	0.021***	0.029***
		(0.006)	(0.005)	(0.006)	(0.009)
Female × Proportion Female		-0.010**	-0.010**	-0.011**	-0.011**
		(0.005)	(0.004)	(0.004)	(0.004)
Gender Dummy	Yes	Yes	Yes	Yes	Yes
High School Fixed Effects	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes	Yes
Proportion Female Peers		Yes	Yes	Yes	Yes
District-by-Cohort Fixed Effects			Yes	Yes	Yes
Overall Peer Mean HET Scores			Yes	Yes	Yes
Overall Individual HET Scores				Yes	Yes
School Enrollment				Yes	Yes
High Price Status				Yes	Yes
Relative Ranking Within School				Yes	Yes
School Specific Linear Time Trends					Yes
Observations	133,845	133,845	133,845	133,845	133,845
R^2	0.172	0.172	0.173	0.201	0.204

Note: The dependent variable is the likelihood of selecting a science track in high school. Each column represents estimates from separate regressions. The proportion of high-performing female peers and the proportion of female peers are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table 4: The effect of high-performing female peers on 4-year university eligibility

	(1)	(2)	(3)	(4)	(5)
Proportion High Performing Female	-0.007	-0.009	-0.013**	-0.014***	-0.018**
	(0.007)	(0.008)	(0.006)	(0.005)	(0.007)
Female × Proportion High Performing Female	0.021***	0.020***	0.021***	0.017***	0.018***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Proportion Female		0.002	-0.003	0.000	0.006
		(0.007)	(0.005)	(0.005)	(0.007)
Female × Proportion Female		0.002	0.002	-0.001	0.001
		(0.004)	(0.004)	(0.004)	(0.004)
Gender Dummy	Yes	Yes	Yes	Yes	Yes
High School Fixed Effects	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes	Yes
District-by-Cohort Fixed Effects			Yes	Yes	Yes
Overall Peer Mean HET Scores			Yes	Yes	Yes
Overall Individual HET Scores				Yes	Yes
School Enrollment				Yes	Yes
High Price Status				Yes	Yes
Relative Ranking Within School				Yes	Yes
School Specific Linear Time Trends					Yes
Observations	133,845	133,845	133,845	133,845	133,845
R^2	0.352	0.352	0.356	0.466	0.469

Note: The dependent variable is the likelihood of being eligible to attend a four-year university. Each column represents estimates from separate regressions. The proportion of high-performing female peers and the proportion of female peers are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1 *** p <0.01 ** p <0.05 * p <0.1

Table 5: The effect of high-performing female peers on elite university eligibility

	(1)	(2)	(3)	(4)	(5)
Proportion High Performing Female	-0.001	-0.001	-0.003	-0.003	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Female × Proportion High Performing	0.009**	0.009**	0.009**	0.007*	0.007**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Proportion Female		0.000	-0.000	0.001	-0.001
		(0.003)	(0.003)	(0.002)	(0.003)
Female × Proportion Female		0.000	0.000	-0.001	-0.001
		(0.002)	(0.002)	(0.002)	(0.003)
Gender Dummy	Yes	Yes	Yes	Yes	Yes
High School Fixed Effects	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes	Yes
District-by-Cohort Fixed Effects			Yes	Yes	Yes
Overall Peer Mean HET Scores			Yes	Yes	Yes
Overall Individual HET Scores				Yes	Yes
School Enrollment				Yes	Yes
High Price Status				Yes	Yes
Relative Ranking Within School				Yes	Yes
School Specific Linear Time Trends					Yes
Observations	133,845	133,845	133,845	133,845	133,845
R^2	0.266	0.266	0.268	0.330	0.332

Note: The dependent variable is the likelihood of being eligible to attend a top-tier university. Each column represents estimates from separate regressions. The proportion of high-performing female peers and the proportion of female peers are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1 *** p <0.01 ** p <0.05 * p <0.1

Table 6: Heterogeneous effects of high-performing female peers

	(1) Top Half Math	(2) Bottom Half Math	(3) Top Half Overall	(4) Bottom Half Overall	(5) Elite Schools	(6) Non-Elite Schools	(7) Rural Schools	(8) Urban Schools
Panel A: Science								
Proportion High Performing Female	0.008	0.008	-0.008	0.007	-0.008	0.008	-0.026	0.005
	(0.009)	(0.008)	(0.010)	(0.008)	(0.015)	(0.008)	(0.020)	(0.008)
Female × Proportion High Performing	0.020**	0.009	0.051***	0.012	0.051***	0.007	0.028***	0.019***
	(0.009)	(0.008)	(0.011)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)
Panel B: 4-year Univ.								
Proportion High Performing Female	-0.010	-0.015***	-0.001	0.005	-0.015	-0.001	-0.016	-0.008
	(0.012)	(0.006)	(0.012)	(0.006)	(0.012)	(0.008)	(0.010)	(0.008)
Female × Proportion High Performing	0.011	0.019***	-0.016	-0.008	0.022**	0.008	0.031**	0.016***
	(0.007)	(0.007)	(0.010)	(0.006)	(0.010)	(0.006)	(0.015)	(0.006)
Panel C: Top Univ.								
Proportion High Performing Female	-0.004	-0.003	-0.011	0.002**	-0.004	0.002	-0.006	-0.002
	(0.008)	(0.002)	(0.009)	(0.001)	(0.007)	(0.004)	(0.008)	(0.005)
Female × Proportion High Performing	0.013**	0.002	0.035***	-0.004***	0.010	0.001	0.005*	0.008**
	(0.006)	(0.001)	(0.010)	(0.001)	(0.007)	(0.002)	(0.003)	(0.004)
Observations	66,945	66,900	66,955	66,890	67,310	66,535	22,293	111,552

Note: All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. The proportion of high-performing female peers is standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table 7: Robustness to alternative definitions of high-performing female peers.

	(1) Top 15%	(2) Top 25%	(3) Top 30%	(4) Top 35%	(5) Top 40%
Panel A: Science					
Proportion High Performing Female	-0.012*	-0.004	-0.007	-0.008	-0.009
	(0.006)	(0.010)	(0.009)	(0.012)	(0.013)
Female × Proportion High Performing Female	0.014***	0.013**	0.012**	0.014**	0.014**
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)
Panel B: Four-Year University					
Proportion High Performing Female	-0.004	-0.021***	-0.018***	-0.012	-0.018*
	(0.004)	(0.007)	(0.006)	(0.008)	(0.009)
Female × Proportion High Performing Female	0.010***	0.016***	0.020***	0.022***	0.025***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Panel C: Elite University					
Proportion High Performing Female	0.001	-0.004	-0.004	-0.005	-0.006
	(0.002)	(0.004)	(0.004)	(0.004)	(0.005)
Female × Proportion High Performing Female	0.005**	0.006*	0.006**	0.006**	0.006**
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	133,845	133,845	133,845	133,845	133,845

Note: All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. The proportion of high-performing female peers and the proportion of female peers are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table 8: The effects of top-performing female and male peers on student outcomes using alternate definitions of treatment

	Science	Four-year college	Elite College
Panel A: Top female and male performers proportional to all students			
Proportion High Performing Female	0.004	-0.010	0.003
	(0.036)	(0.025)	(0.017)
Proportion High Performing Male	0.012	0.011	-0.016
	(0.025)	(0.028)	(0.016)
Female × Proportion High Performing Female	0.042***	0.020*	0.016*
	(0.013)	(0.011)	(0.009)
Female × Proportion High Performing Male	-0.028**	-0.016	-0.006
	(0.013)	(0.011)	(0.008)
Panel B: Top female and male performers proportional to students of same gender			
Proportion High Performing Female	0.023	0.010	-0.011
	(0.032)	(0.024)	(0.018)
Proportion High Performing Male	0.019	0.001	0.006
	(0.030)	(0.033)	(0.019)
Female × Proportion High Performing Female	0.058***	0.019	0.023**
	(0.016)	(0.016)	(0.011)
Female × Proportion High Performing Male	-0.044**	-0.012	-0.017*
	(0.017)	(0.016)	(0.009)
Observations	133,845	133,845	133,845

Note: All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. All coefficients are standardized. Standard errors clustered at the school level and reported in parentheses. *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 9: The effect of high performing students on high school track choice for students with a comparative advantage in Mathematics over Chinese.

	(1) Comparative Advantage in Math	(2) Comparative Advantage in Chinese
Panel A: All students		
Proportion High Performing Female	0.006	0.012
	(0.008)	(0.009)
Female × Proportion High Performing	0.024***	-0.001
	(0.008)	(0.008)
Panel B: Top half students		
Proportion High Performing Female	0.009	0.004
	(0.009)	(0.011)
Female × Proportion High Performing	0.031***	0.007
	(0.010)	(0.012)
Panel C: Bottom half students		
Proportion High Performing Female	0.007	0.014
	(0.025)	(0.010)
Female × Proportion High Performing	0.010	-0.001
	(0.015)	(0.009)
Observations (all students)	67,623	64,848

Note: Comparative advantage in Chinese is defined as students scoring higher on the Chinese HET exam relative to Mathematics. Comparative advantage in Mathematics is defined as students scoring higher on the Mathematics HET exam relative to Chinese. Top half students are defined as students scoring in the top half of the HET exam and bottom half students are those scoring in the bottom half. All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

C Online Appendix

Table A1: The effect of high-performing peers on track choice and college outcomes—excluding all outlier schools from the Monte Carlo simulation

	Science	Four-year college	Elite College
Proportion High Performing Female	0.004	-0.012	-0.006
	(0.010)	(0.009)	(0.004)
Female × Proportion High Performing	0.017**	0.016***	0.007**
	(0.007)	(0.005)	(0.004)
Proportion Female	0.016**	-0.005	-0.005
	(0.008)	(0.006)	(0.003)
Female × Proportion Female	-0.008	0.003	-0.001
	(0.006)	(0.004)	(0.002)
Observations	121,999	121,999	121,999

Note: Sample excludes students in schools where the within school standard deviation in top performing females or males is not within the 95% simulated confidence interval. All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. The average female and male peer quality are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table A2: The effect of high-performing female peers on the distribution of college entrance exam test scores

CET Percentile	(1) Top 10%	(2) Top 20%	(3) Top 30%	(4) Top 40%	(5) Top 50%
Proportion High Performing Female	-0.001	-0.015	-0.021**	-0.020**	-0.008
	(0.008)	(0.010)	(0.010)	(0.009)	(0.008)
Female × Proportion High Performing	0.032***	0.038***	0.024***	0.008	-0.007
	(0.005)	(0.006)	(0.006)	(0.008)	(0.008)
Proportion Female	0.013	0.017	0.008	-0.002	-0.007
	(0.012)	(0.011)	(0.009)	(0.008)	(0.009)
Female × Proportion Female	-0.004	-0.003	-0.001	0.005	0.010**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Observations	133,845	133,845	133,845	133,845	133,845

Note: The Chinese college entrance exam (CET) is different for students in science and arts tracks. As a result, we calculate deciles separately by track and then combine them into one outcome variable. All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. All coefficients are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table A3: Average (Linear in means) peer quality in mathematics and student academic outcomes

	Science	Four-year college	Elite College
Average Female Performance	-0.073	-0.008	-0.015
	(0.052)	(0.042)	(0.021)
Average Male Performance	0.061*	0.005	0.000
	(0.034)	(0.035)	(0.020)
Female × Average Female Performance	0.157***	0.052**	0.028***
	(0.025)	(0.021)	(0.010)
Female × Average Male Performance	-0.147***	-0.028	-0.022**
	(0.025)	(0.022)	(0.009)
Observations	133,845	133,845	133,845

Note: All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. The average female and male peer quality are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table A4: The effect of relative rank within gender group on student outcomes

	Science	Four-year college	Elite College	Science	Four-year college	Elite College
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Relative Mathematics Rank						
Rank within school-cohort	-0.015	0.078**	0.019	-0.023	0.078**	0.020
	(0.021)	(0.033)	(0.022)	(0.021)	(0.033)	(0.023)
Female × Rank within school-cohort	0.027*	-0.025**	-0.020***	0.027*	-0.025**	-0.020***
	(0.015)	(0.011)	(0.006)	(0.015)	(0.011)	(0.006)
Panel B: Relative Overall Rank						
Rank within school-cohort	-0.015	0.069**	0.045*	-0.022	0.055*	0.041*
	(0.014)	(0.033)	(0.025)	(0.014)	(0.033)	(0.022)
Female × Rank within school-cohort	0.014	-0.023*	-0.015**	0.014	-0.024*	-0.014**
	(0.014)	(0.013)	(0.006)	(0.014)	(0.013)	(0.006)
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual HET Scores (quartic)	Yes	Yes	Yes	Yes	Yes	Yes
Average Peer Mean HET Scores	Yes	Yes	Yes	No	No	No
High School Fixed Effects	Yes	Yes	Yes	No	No	No
Cohort Fixed Effects	Yes	Yes	Yes	No	No	No
District-by-Cohort Fixed Effects	Yes	Yes	Yes	No	No	No
School-by-Cohort Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	133,845	133,845	133,845	133,845	133,845	133,845

Note: We define rank within gender group since our peer measure of interest is also defined separately for each gender. Formally, rank is defined as $\frac{a_f-1}{N_f-1}$ for females and $\frac{a_m-1}{N_m-1}$ for males; where a_f and a_m measure the absolute rank of female and male students within their respective gender group in mathematics. N_f and N_m represent the number of female and male students within a school-cohort respectively. Individual controls include controls for gender and high price status. Standard errors clustered at the school level and reported in parentheses *** p <0.01 ** p <0.05 * p <0.1

Table A5: Nonlinear estimates of proportion of top performing females in mathematics

	Science	Four-year college	Elite College
Proportion Female in Top 20%	-0.002	-0.001	0.000
	(0.008)	(0.009)	(0.003)
Female × Proportion Female in Top 20%	0.016*	0.013*	0.006**
	(0.009)	(0.007)	(0.002)
Proportion Female in Top 20-40%	0.003	0.034***	0.005
	(0.009)	(0.010)	(0.005)
Female × Proportion Female in Top 20-40%	0.008	0.007	0.006*
	(0.007)	(0.005)	(0.003)
Proportion Female in Top 40-60%	-0.002	0.002	-0.005
	(0.009)	(0.007)	(0.004)
Female × Proportion Female in Top 40-60%	0.003	0.014**	-0.003
	(0.007)	(0.006)	(0.004)
Proportion Female in Top 60-80%	-0.003	0.005	0.000
	(0.004)	(0.004)	(0.002)
Female × Proportion Female in Top 60-80%	-0.008	0.005**	-0.003
	(0.005)	(0.002)	(0.004)
Proportion Female in Bottom 20%	0.011**	0.004	0.007**
	(0.005)	(0.006)	(0.003)
Female × Proportion Female in Bottom 20%	-0.009**	-0.010**	-0.009***
	(0.004)	(0.005)	(0.003)
Observations	133,845	133,845	133,845

Note: Each column represents estimates from separate regressions. All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. All coefficients are standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1

Table A6: Quantitative versus non-quantitative high-performing female peers

	(1) Physics	(2) Chemistry	(3) Pol. Science	(4) Chinese	(5) English
Panel A: Science					
Proportion High Performing Female	-0.000	0.002	0.006	0.004	-0.005
	(0.008)	(0.009)	(0.006)	(0.008)	(0.008)
Female × Proportion High Performing Female	0.011**	0.010**	-0.005	-0.018***	-0.006
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
Panel B: Four-Year University					
Proportion High Performing Female	-0.003	-0.005	0.003	0.007	0.002
	(0.005)	(0.003)	(0.002)	(0.005)	(0.004)
Female × Proportion High Performing Female	0.012***	0.013***	-0.008***	-0.005	0.001
	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
Panel C: Elite University					
Proportion High Performing Female	-0.002	0.001	-0.001	0.000	0.002
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Female × Proportion High Performing Female	0.005*	0.006**	-0.002	-0.004*	-0.002
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Observations	133,845	133,845	133,845	133,845	133,845

Note: All coefficients represent estimates from our most saturated regression specification where we include: a gender dummy, high school fixed effects, cohort fixed effects, proportion of female peers, district-by-cohort fixed effects, overall peer mean HET scores, individuals HET scores, school enrollment, high-price status, relative ranking within school and school specific linear timer trends. The proportion of high-performing female peers is standardized. Standard errors clustered at the school level and reported in parentheses. *** p <0.01 ** p <0.05 * p <0.1