I Z A Institute of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 14074

Gender and Educational Achievement: Stylized Facts and Causal Evidence

Judith M. Delaney
Paul J. Devereux

JANUARY 2021

DISCUSSION PAPER SERIES

IZA DP No. 14074

Gender and Educational Achievement: Stylized Facts and Causal Evidence

Judith M. Delaney
University of Bath, University College London and IZA

Paul J. Devereux
University College Dublin, NHH, CEPR and IZA

JANUARY 2021

ISSN: 2365-9793

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Gender and Educational Achievement: Stylized Facts and Causal Evidence*

There are two well-established gender gaps in education. First, females tend to have higher educational attainment and achievement than males and this is particularly the case for children from less advantaged backgrounds. Second, there are large differences in the fields of specialization chosen by males and females in college and even prior to college and females disproportionately enter less highly paid fields. This review article begins with these stylized facts and then moves on to describe evidence for the role of various factors in affecting educational achievement by gender. Gender differences in non-cognitive traits, behaviour, and interests have been shown to relate to differences in educational outcomes; however, this evidence cannot generally be given a causal interpretation. In contrast, the literature has been creative in estimating causal impacts of a wide range of factors using experimental and quasi-experimental variation. While the approaches are compelling, the findings vary widely across studies and are often contradictory. This may partly reflect methodological differences across studies but also may result from substantial true heterogeneity across educational systems and time periods. The review concludes by evaluating what factors are most responsible for the two central gender gaps, whether there is a role for policy to reduce these gender differences, and what the findings imply about the capacity for policy to tackle these gaps.

JEL Classification: I24, J16

Keywords: education, gender, schools, gender gaps, gender and educational achievement, gender and STEM

Corresponding author:
Judith M. Delaney
University of Bath
Claverton Down
Bath, BA2 7AY
United Kingdom

E-mail: judithmdelaney@gmail.com

* This is a working paper version of a review article prepared for the *Oxford Research Encyclopedia of Economics and Finance*. This work was partially supported by the Research Council of Norway through its Centres of Excellence Scheme, FAIR project No 262675.

1. Introduction

A large body of research has identified gender differences in educational achievement and there are two broadly accepted findings from this literature. First, females tend to have higher educational attainment and achievement than males – "the boy problem" – and this is particularly the case for children from less advantaged backgrounds. Second, there are large differences in the fields of specialization chosen by males and females in college and even before. These tend to imply that females disproportionately enter less highly paid fields – "the girl problem".

The "Boy Problem"

While there is a wide within-gender distribution of educational outcomes, on average, females have higher educational attainment and achievement. These differences are most pronounced among students who come from disadvantaged backgrounds.

The female advantage in educational achievement manifests in multiple dimensions and from early schooling through to college. Fortin et al. (2015) show that US high school GPAs are significantly lower for boys than for girls. Using NLSY data from the United States, Owens (2016) finds that high school boys are about 5 percentage points more likely than girls to report having repeated a grade and Jacob (2002) shows that 18 percent of boys repeated a grade in elementary school compared to 12 percent of girls.

Across OECD countries, women constituted 54% of new entrants to bachelor's degrees in 2017 (OECD, 2019).[1] In every OECD country with the relevant data, women have higher completion rates than men in bachelor's programs and the difference averages about 11 percentage points (OECD, 2019). Bertrand (2018) shows that, in the United States, almost

[1] In the United States, 57% of students enrolled in degree-granting postsecondary institutions in 2018 were female (https://nces.ed.gov/programs/digest/d19/tables/dt19_303.10.asp?current=yes).

40% of females from the 1985 birth cohort had a college degree by age 30; the analogous figure for males is 30%. Girls are also generally found to have higher academic achievement in college (in terms of GPA or class of degree), even conditional on their previous higher academic achievement (Conger and Long, 2010; Delaney and Devereux, 2020a).[2]

Much US research has shown that gender gaps favouring girls in school outcomes, such as in disciplinary problems, standardized test scores, and high school graduation rates, are larger amongst children from families with lower socio-economic status (SES) or absent fathers (Autor et al., 2020; Bertrand and Pan, 2013; Autor et al., 2019; Lei and Lundberg, 2020). Chetty et al. (2016) similarly find that college attendance rates of boys are more associated with parental income than are those of girls, with the gender gap in favour of girls being particularly high for persons raised in low-income families. However, Lei and Lundberg (2020) for the US and Brenoe and Lundberg (2018) for Denmark find family disadvantage has no systematic adverse effects on men compared to women when it comes to later outcomes such as college completion. So, while the relationship between disadvantage and the gender gap in school appears robust, the findings for longer-term educational outcomes are less certain.

The "Girl Problem"

There are systematic differences in choice of field of study between males and females. These are evident during secondary schooling and appear to strengthen at college level. In particular, boys are over-represented in Science, Technology, Engineering and Mathematics (STEM), economics, and many other technical fields and girls are over-represented in nursing, teaching, and many less technical areas. On average across OECD

[2] Conger and Long use data from the United States while Delaney and Devereux use data from Ireland. In contrast, Francesconi and Parey (2018) find lower college grades for girls using German data.

countries in 2017, only 30% of new entrants to bachelor's programs in STEM fields were women.[3] In contrast, women constituted 77% of new entrants to health and welfare at bachelor's level (OECD, 2019). Additionally, Astorne-Figari and Speer (2019) find that female STEM enrolees are more likely than males to switch out of these fields and the dropout rate from college STEM programs is often found to be higher for women than for men (Kugler et al., 2017; Isphording and Qendrai, 2019).[4]

These gaps in field choices have important effects in the labour market. Bertrand (2018) shows that, in the United States, women from the 1985 birth cohort choose college fields that, on average, pay about 6% less than fields chosen by men (this fell somewhat from the 10% gap for the 1960 birth cohort). Consistent with this, Campbell et al. (2020) find that, at UK college admission, women undermatch relative to men in terms of expected earnings, largely driven by choice of field of study. Card and Payne (2021) suggest that, in the U.S. and Canada, the gender gap in the likelihood of graduating with a STEM-related degree explains about 20% of the wage gap between younger college-educated men and women.

This review proceeds as follows. In Section 2, we discuss the role of non-cognitive skills, broadly defined, in determining gender educational gaps. In Section 3, we outline several of the factors that have been hypothesised to affect gender gaps in education and critically evaluate efforts to provide causal evidence about their effects. Section 4 considers what factors are most responsible for the two central gender gaps, whether there is a role for policy to reduce gender differences, and what the findings imply about the capacity for policy to tackle these gaps. Finally, Section 5 concludes.

---

[3] Additionally, even within STEM, large gender gaps typically exist only in mathematically intensive fields such as engineering, technology, computing, and mathematics rather than in sciences (see Kahn and Ginther (2018) for the U.S. and Delaney and Devereux (2019) for Ireland).

[4] However, Delaney and Devereux (2020a) find the opposite in Ireland, with females more likely to graduate and achieving higher quality degrees than males in STEM programs.

Given the vast literature on gender gaps in education, this review is necessarily selective and incomplete. We focus mainly on findings from developed countries and on research by economists. We also concentrate on school and college rather than pre-school education (see Del Boca et al. (2019) for a summary of gender differences in early education) and place particular emphasis on studies that have attempted to estimate causal effects.[5]

2. Role of Non-Cognitive Traits, Attitudes, and Behaviours

Researchers have found differences between males and females in average non-cognitive skills and related these to educational achievement. However, there is no clear interpretation of the relationship between non-cognitive skills and educational achievement. Much evidence suggests that these skills are malleable and are to some extent environmentally determined. Also, there is no real sense in which one can estimate a causal effect of these skills as they probably cannot be experimentally manipulated in a way that does not change other individual characteristics. The research we consider here relies on decompositions or mediation analysis and so can be considered as an accounting exercise relating skills to achievement and is subject to potential issues from omitted variables that correlate with non-cognitive skills and educational achievement.

A. Risk Aversion, Confidence, and Willingness to Compete

Following the seminal work of Niederle and Vesterlund (2007), several papers have experimentally measured "willingness to compete" by giving participants in a game an opportunity to choose between an incentive scheme that rewards absolute individual output

[5] There are several recent review articles by economists. Bertocchi and Bozzano (2020) are particularly strong on the historical evolution of gender gaps, Cavaglia et al. (2020) focus on developments in the UK, and Kahn and Ginther (2018) and McNally (2020) provide detailed analyses of the literature on gender gaps in STEM. Cheryan et al. (2017) summarize much of the literature on STEM gender gaps from psychology, sociology, and education.

versus one that has more of a winner-take-all payment scheme (Buser, Niederle, and Oosterbeek, 2014; Buser, Peter, and Wolter, 2017). These studies find that male students are, on average, more willing to compete and that this metric correlates with educational choices.

Using Swiss data, Buser, Peter, and Wolter (2017) find that competitiveness predicts choosing math-heavy courses in high school and this can explain between 9% and 17% of the gender gap in course choices. The method used is to examine how the female coefficient in a regression changes when measures of willingness to compete are added as covariates. Similarly, Buser, Niederle, and Oosterbeek (2014) find that willingness to compete explains about 20% of the greater tendency of boys in Dutch schools to choose more math-intensive and prestigious high school tracks. The authors also create measures of confidence (based on students' guess of their rank in a game) and risk attitudes (using both willingness to take an actual gamble and a questionnaire item about willingness to take risks). When they add these measures of confidence and risk attitudes, the reduction of the gender gap in track choice is 26%.

Reuben, Wiswall and Zafar (2015) use a similar strategy to create experimental measures of risk aversion, confidence, and willingness to compete for a sample of high ability students attending an elite university in the United States. While they find that these variables are highly predictive of earnings expectations, they have little predictive power for college major choice, as defined by four aggregated major categories. They acknowledge, however, that the channels through which these non-cognitive factors operate may be at the level of more specific majors such as choice of medical specialty.

Boring and Brown (2016) show that, in a French university, female students apply for less prestigious international exchange placements than do men. They posit that this results from greater risk-aversion and a lower willingness to compete for highly demanded opportunities. Saygin (2016) shows that, in Turkey, girls applying to college through the centralized application system are less likely to apply for high-ranking universities than equally qualified boys. In contrast, in the Irish application system, Delaney and Devereux (2021), find no gender gap in selectivity of programs applied to amongst high achieving students and that, among low achievers, females are more likely to apply to selective programs than males. Both studies find evidence consistent with greater female risk aversion with girls being more likely to list "safety" choices.[6]

B. Perseverance and Grit

Buser and Yuan (2019) show that girls who narrowly miss out on reaching the second stage of the Dutch Math Olympiad are less likely than equivalent boys to re-enter the following year. This suggests that girls may have less perseverance in competitive situations. However, their outcome variable is somewhat tenuously related to educational achievement. Landaud and Maurin (2020) find that the underrepresentation of females in elite Science graduate programs in France can be partly explained by the reluctance of females to retake the entrance exam. In contrast, Goodman, Gurantz, and Smith (2020) find that female students are about 3-4 percentage points more likely to retake the SAT exam, conditional on their prior score. This is likely to increase their probability of college enrolment.

C. Willingness to Negotiate

Women have been found to be less likely than men to negotiate in the labour market (Babcock and Laschever, 2003).[7] Intriguingly, Li and Zafar (2020) provide evidence that this

[6] A report (OECD, 2020) conducted by the OECD using 2018 PISA scores found evidence that, on average, across OECD countries, females were more likely to state that they disliked competition and reported lower perceived reading ability than boys with similar reading scores. In addition, females were far more likely to answer that they fear failure and that this made them doubt their plans for the future. Given that STEM majors may be perceived as being harder to succeed in, these factors may contribute to the gender gap in STEM.
[7] Exley et al. (2020) provide evidence that females may act optimally in their negotiating strategy, avoiding negotiation in situations where it is unlikely to be beneficial.

applies to requesting regrades in college. Using both administrative and survey data from Colorado State University, they find that women are less likely than men to ask for regrades and that "gender differences in confidence, uncertainty in beliefs and personality traits can explain 43 percent of the gender difference in the propensity to ask". They also find evidence that greater female risk aversion plays a small role.

3. Causal Factors

Much literature has focused on estimating causal effects of factors that may impact gender differences in education. These have involved experimental or, more usually, quasi-experimental manipulation of environmental variables. We classify these factors into four broad groups: (A) assessment methods, (B) teachers and role models, (C) peers, and (D) curriculum.

A. Assessment Methods

The nature of assessments can have differential effects by gender. Girls tend to do better in school assessments and tend to finish school with higher Grade Point Averages (GPAs). However, boys and girls typically have similar IQ scores and girls do not systematically score better in standardized tests such as SAT, ACT, and AP exams (Duckworth & Seligman, 2006; Fortin et al., 2015; Goldin et al., 2006). This may reflect the varying requirements for success in different types of assessment.[8]

In trying to see what particular factors matter, researchers have studied the differential effects on boys and girls of multiple choice questions versus written answers, negative

[8] Duckworth and Seligman (2006) explain that school grades "typically reflect the ability to study for exams, complete homework assignments and long-term projects on time, and prepare for class discussions. Thus, grades depend heavily on the ability to sustain effort and concentration despite boredom, fatigue, and innumerable distractions over the course of an academic year. In contrast, achievement tests require sustained effort for only a few hours in a testing situation specifically designed to minimize distractions".

marking on multiple choice (MCQ) tests, the importance and level of competitiveness of the assessment, whether the assessment is graded anonymously, and the extent and type of feedback provided after the assessment.

Written Answers versus MCQ

Students doing the PISA mathematics tests in 2015 were randomly assigned different proportions of multiple choice and questions requiring written answers. Griselda (2020) finds that females do relatively worse than males if there is a higher proportion of multiple choice questions, suggesting that the types of questions used in standardized tests can have important implications for measured gender gaps. In this example, there was no penalty for answering multiple choice questions incorrectly rather than skipping a question. As seen in the next section, that can also affect the gender gap.

Negative Marking on MCQ Tests

Standardised tests usually have multiple choice questions and, often, use negative marking (zero points for leaving a blank and negative points for an incorrect answer). Researchers have used a variety of approaches to study the effects of negative marking on gender differences in question skipping (leaving a blank). The ideal experiment to address this would utilize random variation in the marking structure across otherwise identical questions or tests and several papers have achieved this type of research design.

Baldiga (2014) experimentally manipulates the penalties for wrong answers across students taking the same SAT-type exam. She finds that, when there are penalties for incorrect answers, females are more likely to skip questions than males. In the absence of penalties, there is no gender difference as nobody skips questions. Iriberri and Rey-Biel (forthcoming) vary the penalty structure across questions within the same math test and examine how gender differences in propensity to skip vary across individual questions. They find that females are more likely than males to skip questions if choosing a wrong answer is punished relative to leaving a blank. Importantly, it is generally the case that women are more likely to leave blanks rather than guess even when guessing is a superior strategy (Baldiga, 2014; Pekkarinen, 2015; Iriberri and Rey-Biel, forthcoming). Consistent with this, Coffman and Klinowski (2020) show that the elimination of negative marking in a college entry exam in Chile removed the greater initial tendency of girls to skip questions and reduced the male performance advantage. Taken together, these and other studies provide compelling evidence that moves towards eliminating negative marking in MCQs (such as in the US SAT from 2016) will tend to lead to better relative performance of girls on these standardized tests.

Baldiga (2014) investigates whether differential risk preferences can explain the greater tendency for female SAT takers to skip multiple choice questions when there is a penalty for wrong answers. She finds that an experimentally-based measure of risk aversion can explain some of the gender effect but, even allowing for measured risk aversion, females are still about one third more likely to skip a question than males. Iriberri and Rey-Biel (forthcoming) also find a major role for risk aversion (measured using a survey question rather than experimentally) in explaining the lower likelihood that girls answer multiple choice questions in a mathematics contest.

High Stakes versus Low Stakes Assessments and Competitive Pressure

Much research has focused on whether the importance of an assessment or the degree of competitive pressure affects gender differences in test performance. Iriberri and Rey-Biel (2019) show that, for a balanced panel, the gender gap in favour of males increases from stage 1 to stage 2 in a Spanish math competition, presumably due to the increase in the level of competitive pressure. Consistent findings are found from a study that compares gender gaps on the real GRE examination to those on a voluntary experimental section of the GRE, taken immediately after the real GRE exam (Attali et al., 2011).

Cai et al. (2019) compare gender gaps in the highly competitive Chinese college entrance exam (Gaokao) to those in the “mock” practice exams taken two months earlier. They find much higher gender gaps (in favour of boys) in the real exam and estimate that they lead to a 15% decline in the likelihood that females are eligible for admission into a top university, compared to performance in the mock exam. A potential issue with this design is that boys may be more likely to “cram” in the last two months before the exam. Ors et al. (2013) find that, while women do better than men in low-stakes national exams and first year college exams, they are outscored by males in high-pressure entrance exams to a selective French business school. Azmat et al. (2016) show, using data from a Spanish high school, that girls do relatively better in low stakes early term assessments than in higher stakes assessments later in the term. Studying a variant of competitive pressure, Morin (2015) shows that the relative performance of males improved slightly in the University of Toronto when the presence of a “double cohort” led to a more competitive environment.

In some of this research, it is difficult to distinguish the effects of the importance or competitiveness of the test from other differences between assessments -- the ideal experiment would randomize the stakes or degree of competitive pressure while maintaining all other features of tests the same. Also, an important caveat with this research is that it is very difficult to distinguish between girls “choking” under greater competitive pressure versus boys working harder because the stakes are higher. If the former is the case, welfare may be increased by reducing competition or lowering stakes; if the latter is the case, higher stakes assessments may be welfare-enhancing. More research would be useful here.[9]

[9] In related research, De Paola and Gioia (2016) show using a randomized field experiment with students from an Italian university that girls do relatively worse than boys in exams with time pressure. Oxford University has started to provide students with extra time in math and science exams in an effort to improve female performance.

Bias in Assessment Grading

Boys tend to do relatively better in standardized exams than when graded by teachers (Cornwell et al., 2013; Angelo and Reis, 2018).[10] However, it is difficult to know whether this results from the fact that the assessments are measuring different sets of skills or due to teacher bias. One approach in the literature is to compare the gender gap on assessments where teachers know child gender to that on assessments in which gender is unknown. Lavy (2008), Lindahl (2007), and Terrier (2020) amongst others have compared scores on blinded written exams to scores for the same students on non-blind teacher-graded exams. These papers find evidence for teacher discrimination against boys. Breda and Ly (2015) compare (blind) written test results to (non-blind) oral tests in the entrance exam of a French higher education institution. They find bias in favour of females that is particularly large in male-dominated fields. However, with these approaches there is the issue that the blind tests are different in structure to the non-blind tests and gender differences may occur due to differential performance by gender across different types of tests rather than due to grading differences.

A couple of studies that are robust to these issues have not found evidence for systematic gender discrimination in grading. Using assessments graded by both the teacher and also anonymously by another person, Hinnerich et al. (2011) find no evidence for gender-bias in teacher grading in Swedish high schools. Avitzour et al. (2020) carry out an experiment in which Israeli primary school teachers grade math exams and unique characteristics of Hebrew grammar are exploited to make exams appear to have been

[10] Due to COVID19, in 2020 the terminal high school examinations in Ireland, the Leaving Certificate exams, were replaced by an algorithm where the most important input was predicted grades as determined by teachers. A comparison of the gender distribution of the predicted teacher grades to the actual Leaving Certificate exam results in previous years is illuminating about the gender effects of exams versus teacher evaluations. Analysis shows that the teacher grades implied an increase in grades of girls relative to boys in most subjects, with a particularly large increase in the proportion of girls being awarded top grades in math (Department of Education and Skills: Report from the National Standardisation Group to the Independent Steering Committee and the Programme Board).

completed by a male or female student. Thus, every exam paper has a “female” and a “male” version, and they can see whether this affects how it is graded. They find that, while some teachers favour boys and others favour girls, there is no gender discrimination on average.[11] Overall, more research is required to further evaluate whether findings of teacher bias towards females in assessment is due to discrimination or due to subtle differences between other characteristics of blind and non-blind assessments.

The Role of Assessment Feedback

Beuchert et al. (2020) explore the role of feedback from a standardized math test in third grade in Danish schools. Parents receive information on whether performance was “Considerably below average,” “Below average,” “Average”, “Above average”, or “Considerably above average”. The authors deal with the issue that negative feedback results from bad performance by using a regression discontinuity design that exploits grade cutoffs. Interestingly, they find bigger positive effects of negative feedback on future math performance for boys than for girls, possibly because boys are relatively over-confident about their math-ability and are shocked into working harder by negative feedback. Fischer and Wagner (2018) come to a similar conclusion when studying feedback in an experimental setting. On the other hand, the evidence generally suggests that females are more influenced by subject grades when deciding whether to persist with that subject. For example, using a regression discontinuity design, Owen (2010) finds that female (but not male) undergraduates are more likely to major in economics if they get an A in the first economics class.

[11] Diamond and Persson (2016) study the tendency of teachers to “bump up” marginal students to higher grades in high states exams in Sweden. They find no differences by student gender in this type of teacher behaviour.

Takeaway: Does Assessment Method Matter?

Overall, the evidence suggests that many aspects of assessment have implications for gender differences in performance. While the research is creative and compelling, two overarching questions are difficult to answer. First, when performance differs by gender, is this due to one gender underperforming or the other overperforming or, perhaps, both? Second, while the research provides insight about which assessments are relatively favourable to girls versus boys, it does not directly speak to which assessment methods provide the optimal measure. This will depend on what we are trying to predict with the assessments, and this may be an important issue for future study.

B. Teachers and Role Models

While there is much work on how teacher characteristics affect gender disparities, we will focus on two that have played a large role in the literature. First, the effect of having a gender-biased teacher, and second, whether having a teacher of the same gender influences the educational outcomes of students. We will also discuss how role models other than teachers affect gender gaps.

Effect of having a Biased Teacher

While the literature on teacher bias discussed earlier studies whether, on average, teachers have biases that affect gender gaps, a related literature examines the causal effect on students of being exposed to teachers with gender biases. Biased teachers may affect students by interacting differently with boys than with girls or by grading in a biased way. One set of papers (Lavy and Megalokonomou, 2019; Lavy and Sand, 2018; Terrier, 2020) measures bias of each individual teacher by comparing the gender difference in scores on his/her teacher-graded assessments to that from blinded assessments of the same students. Carlana (2019) instead measures teacher gender stereotypes using the Gender-Science Implicit Association Test. All these papers find long-term effects – teachers with more pro-girl (or less pro-boy) biases or stereotypes cause girls to do relatively better than boys in future tests and to be more successful in terms of other educational outcomes. Additionally, Lavy and Megalokonomou (2019) find effects of teacher bias in high school on the probability that girls enter science fields in university. All these studies have plausibly random or quasi-random assignment of students to teachers (explicit randomisation in the case of Lavy and Megalokonomou, 2019). However, a possible confounding factor is that teacher biases may be correlated with other unobserved teacher characteristics that affect student outcomes. Alan et al. (2018) deal with this issue by collecting information on a large number of teacher characteristics such as teaching style, classroom practices, and effort levels. They use data on Turkish schools where students are randomly assigned to teachers and find that girls who are taught by teachers who have "traditional views about gender roles" perform less well in objective mathematics and verbal tests and the effect size increases with longer exposure to the teacher. However, there is no effect on boys.

Effect of having a Teacher of the Same Gender

A large literature has studied the effect of having a teacher of the same gender using creative approaches to deal with possible non-random sorting of students to teachers – for example, more able or less-troublesome boys being allocated to female teachers. Some studies have used random assignment. These include Antecol et al.'s (2015) study of disadvantaged US primary schools, Carrell et al.'s (2010) study of students at the U.S. Air Force Academy, Eble and Hu (2020) and Gong et al.'s (2018) studies of middle-school students in China, and Lim and Meer's (2017, 2020) studies of Korean middle schools.

Other researchers have used data on environments where students have different teachers for different subjects to analyse whether students do relatively better in subjects where the teacher is of the same gender (using student and subject fixed effects). This design allows for non-random sorting of students to teachers so long as it is not subject-specific. This work includes Dee's (2007) study on US middle school students, Hoffmann and Oreopoulos' (2009) study of first year undergraduates in the University of Toronto, Holmlund and Sund's (2008) study of upper secondary school students in Sweden, Paredes's (2014) study of 8th graders in Chile, and Puhani's (2018) study of primary school children in Germany.

Overall, findings from this literature are mixed. Some studies find positive effects of same-gender teachers, particularly for girls in math (Eble and Hu, 2020) and for their likelihood of persisting with STEM subjects (Carrell et al., 2010; Lim and Meer, 2020).[12] Others find that effects are small or non-existent and there are rare findings that same-sex teachers are bad for students (Antecol et al. (2015) find that female teachers lead to lower test scores for girls). Teachers in primary schools and, to a lesser extent middle and secondary schools, tend to be disproportionately female. Thus, the lack of strong evidence for an adverse effect of female teachers on boys at these levels is perhaps reassuring. On the other hand, the somewhat stronger evidence that female teachers in STEM subjects have positive effects on girls in high school and college suggests that policy could aim to increase the relative share of female teachers/professors in these subjects.

[12] The effects found are sometimes large. Lim and Meer (2020) find that being taught by a female versus a male math teacher in seventh grade leads females to be 15 percentage points more likely to choose the math-science track in high school. Carrell, Page, and West (2010) find that being assigned exclusively female professors (compared to having exclusively male professors) in introductory math and science courses led to a 26 percentage points increase in the probability that top female students subsequently major in STEM.

Gender of Role Models other than Teachers

While most work on role models in education has focused on teacher-student interactions, other relationships may have important influences on students. As with teachers, non-random matching of students to role models is a potential issue so we focus on studies that have random assignment. Canaan and Mouganie (forthcoming) use data from a private 4-year US college in which undergraduates are randomly assigned to advisors. They find that being randomly matched with a female science advisor leads to greater female STEM enrolment and graduation. Kato and Song (2018) use a similar design in a US liberal arts university to show that having a same-gender advisor benefits undergraduates in terms of retention and GPA.

While the student-advisor relationship involves repeated one-on-one interactions and students may be influenced through factors other than role model effects, two field experiments randomly assign students to external female role models for a single short period of time to see whether this affects decisions of females. Note that, in these studies, what is randomised is not the gender of the role model but whether or not the student is exposed to a female role model. A caveat with these studies is that students may be responding to features of the role model other than gender, such as their enthusiasm or substantive message.

Breda et al. (2020) expose students in French high schools to a female scientist (for one hour) and find a 30% increase in the share of Grade 12 girls enrolling in selective (male-dominated) STEM programs in higher education. Porter and Serra (2019) find that having "*successful and charismatic women who majored in economics at the same university*" talk for 15 minutes in a Principles of Economics class led to an increased probability of girls enrolling in future economics classes and/or majoring in economics.[13] While somewhat

[13] The authors explain that "Each visit consisted of a 15-minute discussion about the role model's experiences as an economics major, a description of their career paths and achievements, and an explanation of how their specific major (economics) contributed to their success on the job."

imprecisely estimated, the effect is large -- an 8 percentage points increase in the probability females major in economics, relative to a baseline probability of 9%. These studies are compelling due to their experimental design and suggest that brief encounters with female role models can have large and long-term effects on female educational choices, particularly in terms of encouraging them to enter male-dominated fields. However, further research with larger samples is needed to verify the robustness and generality of the findings.[14]

C. Peers and Other School Characteristics

Much research has shown that student outcomes are influenced by the characteristics and behaviours of their classroom peers. In this section, we concentrate on work that has studied the differential effects of peers on girls and boys. It is notoriously difficult to estimate the causal effect of peers as people tend to share environments with others who are similar, thus making it hard to distinguish between similar people choosing a common environment versus people being affected by their peers. Additionally, children in the same classroom will tend to have correlated outcomes due to common influences, such as having the same teacher. For these reasons, causal analysis in this area has relied on peer groups being manipulated either experimentally or quasi-experimentally. We start by discussing findings about the gender mix of the school or class.

Same-sex versus Mixed-sex schools

Much focus has been placed on whether schools are same-sex or mixed-sex. Why would this matter for student outcomes? Possible reasons include instruction being tailored to gender-specific needs in same-sex schools, gender stereotypes (such as the idea that girls are

[14] Other experimental studies have found mixed results when testing whether email interventions to provide information and encouragement lead to greater female uptake of economics at undergraduate level (Li, 2018; Bayer, Bhanot, and Lozano, 2019; Pugatch and Schroeder, 2020).

less good at science or math) being less salient in same-sex schools, or the presence of the opposite sex in mixed-sex schools being distracting to students, maybe especially for girls as boys tend to be more disruptive. There are two main identification challenges in this area. First, the allocation of students between single-sex and mixed-sex schools may be non-random and, second, other school characteristics may differ systematically between single-sex and mixed-sex schools. For example, single-sex schools may be more likely to have teachers that share the gender of the students.

The most compelling findings have come from studies where students are randomly assigned to same-gender or mixed-gender classes or schools.[15] Giardili (2019) studies admissions lotteries to primary schools in Malta and finds that being in a same-sex school leads to better test scores for both boys and girls and also leads them to subsequently choose less-gendered subjects. She argues that the schools are very similar in characteristics other than sex-mix. At high school level, Eisenkopf et al. (2015) study a Swiss school where female students are randomly assigned to either single-sex or mixed-sex classes, with all other characteristics of the schooling experience remaining similar. They find that females in the single-sex classes do better in mathematics. A set of papers have studied the Korean high school system as students are randomly assigned to either mixed-sex or same-sex schools (Park et al. 2013, 2018; Dustmann et al. 2018; Sohn 2016). The findings imply higher test scores in English and Korean for both girls and boys in single-sex schools. Boys, but not girls, are also found to have higher math scores and a higher probability of subsequently doing STEM. This is found to be partly due to the higher prevalence of male math and science teachers in all-boys schools, emphasizing the difficulty in separating the effects of the gender-mix of the school from that of other school characteristics. At university level, Booth

[15] There are also many studies that use quasi-experimental variation. For example, Calkins et al. (2020) exploit the timing of transitions of US women's colleges to coeducation from the 1960s-2000s. They find that after 10 years, the share of females majoring in STEM in the newly created coeducational colleges decreased by 2 percentage points (or 24 percent).

et al. (2018) randomly assign students to all-female, all-male, and mixed-sex classes that take place for one hour per week. They find large beneficial effects of single-sex classes on academic performance of females (57% less likely to drop out of university and 61% more likely to get a top ranked degree) but not males.

Overall, the evidence from studies that use random assignment is generally supportive of positive effects of single-sex schooling for boys and for girls. However, the findings are mixed as to whether there are meaningful effects on gender gaps in academic outcomes and on the types of courses/fields chosen.

Effect of Peer Gender in Mixed-sex Environments

Most educational environments are mixed-sex, so it is important to know whether the gender mix matters in this situation. A common source of identification is idiosyncratic variation in the proportion of students in a grade that is female, implemented by relating outcomes of adjacent cohorts in a school to their gender mix. Additionally, some research studies situations where students are randomly assigned to classes and there are resulting differences in the female-male ratio across classes.

A common finding is that a higher proportion of females in a school grade or class increases test scores of females; effects on boys are mixed with some studies finding a positive effect (Hoxby, 2000; Lavy and Schlosser, 2011), others finding a negative effect (Black et al, 2013; Schone et al., 2020; Lu and Anderson, 2015), and others finding the effect is unclear (Whitmore, 2005; Eren, 2017). In terms of later field choices, the findings for high school students are once again mixed with some studies finding a negative effect of the female-male ratio on the probability girls choose STEM (Brenoe and Zolitz, 2020) and others finding a positive effect (Schone et al., 2020).

At university undergraduate level, a higher proportion of females has been associated with better outcomes for men (Hill, 2017) and better outcomes overall for a pooled sample of men and women (Braakmann and McDonald, 2018). Zolitz and Feld (forthcoming) find that, in a Dutch business school, students randomly assigned to more female-intensive TA sessions in first year economics and business are more (less) likely to later choose to major in male-dominated majors, such as Finance, if male (female). At PhD level, Bostwick and Weinberg (2018) show that, if a program has a higher proportion of females, women are more likely to graduate on-time. This is found to be especially true in male-dominated programs. Overall, while researchers have been creative in overcoming challenges to credibly identify gender peer effects in education, there are few systematic findings, and more research is needed.

Effect of Other Peer Characteristics

In contrast to the mixed findings for peer gender, a range of well-identified studies from several countries have found that females are made worse off by having high ability male peers and are less likely to choose or succeed in STEM if they are exposed to male peers who have high math/science ability (Fischer, 2017; Landaud et al., 2020; Cools et al., 2019; Mouganie and Wang, 2020). On the other hand, some studies find that exposure to high ability girls is beneficial to females (Balestra et al., 2020; Cools et al., 2019; Mouganie and Wang, 2020). Most of these studies find that boys are largely unaffected by the presence of high ability peers, an exception being Balestra et al. (2020) who find that they benefit from high ability peers.

Other work has found that the beliefs of parents of peers can matter. Eble and Hu (2019) show that, in a situation where classmates are randomly assigned in China, a greater proportion of classmates with parents who believe that boys are innately better than girls at learning mathematics is associated with lower math performance of girls relative to boys.

Effect of Class Size

Given the presence of peer effects, it is plausible that the beneficial effect of being in a smaller class differs by gender. However, well-identified studies differ in terms of whether class size is important, many studies do not report differences in effects by gender, and studies that test for gender differences often disagree (for example, Ho and Kelman (2014) find smaller class sizes disproportionately benefit females while De Giorgi et al. (2012) find the opposite). Jepsen (2015) provides an overview of the class size literature.

D. School Curriculum

Given the importance of math at high school level for field choices in college, can changes in the curriculum to increase math training have real effects? Several papers have studied a German reform that made advanced mathematics compulsory in the last two years of high school when previously only about 20% of students chose it (Biewen and Schwerter, 2019; Gorlitz and Gravert, 2016, 2018). They find that it led to higher dropout rates for women and a positive effect on subsequent enrolment in college STEM programs for men but not for women. De Philippis (2017) finds similar effects on college STEM enrolment of a UK reform that provided more science instruction to high ability students in high school. In contrast, Joensen and Nielsen (2016) find that a pilot scheme in Danish high schools that made it easier to study advanced mathematics led more girls (but not boys) to subsequently complete college STEM programs. So, findings are mixed as to whether more mathematics or science training in schools can narrow gender gaps in STEM.

4. Reasons for Gender Gaps and the Role of Policy

As discussed in the first section, the two main stylized facts are that females average higher educational achievement than males (particularly amongst students from lower SES backgrounds) and that there are large gender differences in college field of study. We conclude by discussing likely explanations for these stylized facts and the possible role for policy to address them.

A. Lower Educational Achievement of Boys

In principle, the “boy problem” can be explained by a higher return to education for females but there is limited evidence for this. Becker et al. (2010) suggest that, while the gap has fallen over time, the return to education is still probably higher for males due to their higher labour market participation rate.[16] They suggest the reason for the gender gap in educational attainment is probably on the cost side and emphasize superior non-cognitive skills of girls that imply lower psychic costs of schooling and also enable them to perform better, thus lowering financial costs (through scholarships etc.).

A lot of research has studied differences across gender in capacity to learn in school with a focus on self-discipline, engagement with learning, externalising behaviour, and related issues. From early ages, boys are more likely to have behavioural problems in school. They are less likely to fully engage with the school learning experience and more likely to receive sanctions such as expulsion. Jacob (2002) shows that boys have more behavioural problems in school and spend less time on homework than girls. Aucejo and James (2019a) show that there are large differences in behaviour between males and females and these can explain much of the gender gap in schooling outcomes at all levels. Autor et al. (2020) report a relatively modest 0.45 percentage point gender gap in school absences in Florida public

[16] However, the increase in female educational attainment over time relative to males is plausibly explained by increases in the return to education for females as their labour market participation has risen due to less discrimination, better access to contraception/fertility control, and technological progress that has reduced domestic workload (Goldin et al., 2006).

schools; both genders attend about 95% of school days. However, the gender gap is much larger in the bottom tail which they argue is most relevant to school dropout.[17]

Some work argues that low aspirations may lead to male educational underperformance. Fortin et al. (2015) show that, in US high schools, greater educational expectations (such as plans to acquire a graduate degree in law or medicine) have important explanatory power for the higher GPAs achieved by girls. Using survey data from the U.S., Lundberg (2020) finds that boys are much less likely to report a desire to pursue higher education and that aspirations are much better predictors of educational achievement than behaviours. She concludes that "gender identity concerns may influence (and damage) the educational prospects of boys as well as girls through norms of masculinity that discourage academic achievement."

There are other possible reasons for male underachievement. Girls tend to mature at earlier ages (Lim et al., 2015), possibly providing educational benefits in systems where important gateway assessments take place at about age 16.[18] Additionally, females tend to have much stronger verbal skills and evidence suggests that these types of skills are particularly valuable for educational attainment and can largely explain greater female enrolment in college (Aucejo and James, 2019b). Also, as discussed earlier, for any given level of ability, boys tend to obtain lower teacher assessments than girls, likely due to worse classroom behaviour, and this can lower their opportunity to progress successfully in the educational system.

[17] It is not clear to what extent behavioural differences between boys and girls are biological versus culturally determined. Sociologists have emphasized the role of cultural conceptions of masculinity that dissuade boys from engaging fully with schooling (DiPrete and Buchmann, 2013).

[18] In Finland, a policy change that delayed tracking to age 16 led to increases in the educational attainment of girls relative to boys (Pekkarinen, 2008). This may reflect the fact that girls are past puberty by age 16 but boys are still at a difficult phase of their development.

The Role of Policy

Does the gender gap in educational attainment (favouring girls) matter? The main issue is whether it is efficient or not. Given large returns to education and generally poor outcomes for school dropouts, it seems likely that many boys are inefficiently underinvesting in human capital, particularly in school. There also appear to be sizeable negative externalities to society from low male educational attainment such as through greater crime and delinquency. So, there appears to be a role for policy to attempt to improve the educational achievement of low-performing boys.

However, it is unclear what policy interventions are likely to be effective in reducing gender gaps. The review of the causal literature found few policy changes that have been robustly found to improve school performance of boys. One exception is that school outcomes of boys would likely be improved by moving away from continuous assessment and teacher-assigned grades towards greater use of standardized tests. They also might benefit from greater emphasis on mathematics and less on verbal skills in assessment and from greater efforts to prevent boys falling behind in verbal skills at early ages (Machin and McNally, 2008).[19] Cavaglia et al. (2020) suggest that, given there is a gender gap (favouring girls) in university entry in many countries, increased availability of vocational educational opportunities may be beneficial to males.

As discussed earlier, the gender gap in educational attainment partly results from greater sensitivity of boys to home difficulties and childhood disadvantage. It may be particularly important to change the aspirations and attitudes of disadvantaged boys so that high achievers are less likely to be considered “uncool” or nerdy. One way to achieve this might be to showcase to this group the many exciting and interesting pathways and

[19] Stoet and Geary (2020) using PISA data for 18 countries find evidence of smaller enrolment gaps in countries in which boys performed well in reading, suggesting that policies that improve male reading ability may be particularly important.

opportunities that higher academic achievement can lead to, including, of course greater earnings. Also, any policy that could successfully reduce the amount of time boys spend playing video games and increase the time they spend on homework would be likely to reduce gender gaps in educational achievement.

Even if not specifically focused on boys, the greater sensitivity of boys to disadvantage implies that programs targeted at disadvantaged students may reduce gender gaps. However, the evidence for this contention is weak at best. Rizzica (2020) found that a policy aimed at raising the aspirations of disadvantaged students in the UK had negligible effects on college enrolment. A Canadian program that used mentoring, tutoring, group activities, and financial incentives was found to be particularly effective at increasing academic attainment of disadvantaged high schoolers (Oreopoulos et al. 2017). However, girls responded more than boys, so the program increased rather than reduced gender gaps favouring girls. Overall, finding policy solutions to the "boy problem" appears challenging.

B. Underrepresentation of Females in STEM

Researchers have been fastidious in trying to explain differential field selection by gender and, in particular, the college gender gap in STEM and other technical fields such as economics. One finding in the literature is that there are significant differences in subject choices in high school that lead to lower levels of "STEM-readiness" amongst females at the end of high school. This has been found to be an important predictor of doing STEM in college (Delaney and Devereux, 2019; Speer, 2020; Card and Payne, 2021).

There is also evidence for an important role for comparative advantage in explaining the gender gap in college STEM major choice. Standardized international tests tend to find a gender difference in mathematics favouring boys (often small, and non-existent in some countries), while boys tend to score significantly worse than girls in reading (Borgonovi et al., 2018; OECD, 2015).[20] There are many possible reasons for these findings, including biological and cultural, and we will not focus on them here.[21] Instead, we emphasize efforts that have been made to link differences in math and language/verbal scores by gender to field choices in college.

Aucejo and James (2019b) find that comparative advantage in mathematics and verbal skills can explain about 5.4 percentage points of the 17-percentage points gender gap in STEM in England. Using a broader set of skills that includes mechanical skills, Speer (2017) finds that it can explain about 6 percentage points of the 17-percentage points gender gap in the probability of doing a STEM major in the US. Delaney and Devereux (2019) find that, in Ireland, comparative advantage at the end of high school explains only about 3 percentage points of the 22 percentage points gender gap in STEM college choices. Moving beyond grades, some studies have examined the effects of student beliefs about their abilities in mathematics (Saltiel, 2019; Di Tommaso et al., forthcoming) and found that girl's lack of confidence in their mathematical abilities can also explain some of the gender gap in STEM.

Using PISA data on 15-year-olds from many countries, Breda and Napp (2019) find that comparative advantage in reading relative to mathematics can explain about 75% of the gender gap in students' intentions to pursue math-intensive studies. This finding implies a larger role for comparative advantage than is generally found in the literature, possibly because the authors are studying intentions rather than actual decisions.

Another set of papers has examined whether a student's comparative advantage in mathematics within their school or class affects decisions of whether to enrol in STEM in

[20] Anaya and Zamarro (2020) argue that gender differences in standardized test scores are heavily influenced by less effort being made by boys and that the true gender gaps may be larger than measured gaps in math and smaller in reading.

[21] Other than biological differences, explanations include gender stereotypes that imply lower evaluation of math ability of girls by parents, teachers, and students themselves -- Guiso et al. (2008) find that the male advantage in math disappears in cultures where gender stereotypes are weaker. Stoet and Geary (2018) find that gender differences in pursuit of STEM degrees increase with national gender equality. They attribute this to life quality pressures in less gender-equal countries that encourage females to pursue STEM. However, Breda et al. (2020) find that gender stereotypes may explain this "gender-equality paradox".

college. The idea is that students may infer their comparative advantage across subjects from their rank across subjects in school. These studies generally find that being relatively better at math than English (or the relevant language of instruction), relative to classmates or members of the same school cohort, leads students to be more likely to choose a STEM course in high school and in college and that this can explain a small proportion of the gender gap in STEM choice (Denning et al., 2018; Goulas et al., 2020; Delaney and Devereux, 2020b).

Overall, while the quantitative findings vary, differences in STEM-readiness and comparative advantage in verbal rather than mathematical skills at the end of high school can explain some but not all of the gender gap in STEM in college.[22] So, what other factors can account for gender differences in college field choices?

A primary explanation is differences in preferences by gender over fundamental characteristics of fields – women either prefer certain types of studies or prefer the types of work that ultimately results from the field of study. Kuhn and Wolter (2020) show that, in Switzerland, female apprentices tend to choose occupations that are oriented towards working with people, while male apprentices tend towards occupations that involve working with things. Additionally, women may have a comparative advantage in tasks requiring social and interpersonal skills (Cortes et al., 2020). Male-dominated occupations tend to pay better and Osikominu and Pfeifer (2018) find that female students have lower wage expectations than men. However they also find that "gender differences in the wage expectations for average graduates across different fields do not contribute to explaining the gender gap in the choice of STEM majors." Indeed, research suggests that women may be particularly influenced by non-pecuniary characteristics of occupations such as job flexibility (Zafar, 2013; Wiswall and Zafar, 2018; Angelov et al., 2019).

[22] Indeed, even with detailed controls for every subject taken in high school and the associated subject grades, Delaney and Devereux (2019) find that females in Ireland are 9 percentage points less likely to apply for a STEM major in college than observationally equivalent males.

However, it is difficult to separate the relevance of fundamental characteristics of occupations from cultural factors arising from their gender mix. For example, it may be that women are unlikely to study computer science because it is male-dominated and is considered to have a male-ethos and be unfriendly (and possibly discriminatory) towards women, or because of gender norms and stereotypes that women should not study it, or because they anticipate that it would lower their future marriageability.[23] Indeed, evidence suggests that women are reluctant to enter male-dominated fields. Astorne-Figari and Speer (2019) show that women who transfer from college STEM majors often stay in science-related majors but enter majors that are less male-dominated, suggesting that the decision is less about leaving science and more about finding a more female-friendly environment. Additionally, female role models may be scarce in male-dominated fields such as computer science and engineering and, as discussed earlier, there is emerging evidence that female role models can be important in encouraging women into male-dominated fields.

The Role of Policy

Should policy target the gender gap in choice of college field? The gender gap in field choices may be efficient if students are well informed and optimally choose fields based on costs and benefits and gender differences are due to different preferences or skills. However, if gender gaps result in part from imperfect information (about own capabilities as well as field characteristics), gender stereotypes, discrimination, and study or work environments that are unfriendly to females, it may be that many women are making suboptimal choices and policy interventions are justifiable.[24] Certainly, given the higher salaries that often

[23] Interestingly, Cherrier (2017) reports that females represented 40 percent of computer science undergraduates in the US in 1985 but that this proportion decreased to just 17 percent in the 2010s. She discusses how the image of a computer programmer increasingly became "systematic, logical, task-oriented, "detached," chess player, solver of mathematical puzzles, and masculine".
[24] As argued by Bertrand (2020), preferences themselves may be shaped by societal stereotypes about appropriate gender-specific roles.

accompany male-dominated college majors, females appear to be leaving money on the table with their field choices.

It is unclear what policy interventions are likely to be effective in reducing this gender gap. Female lack of confidence in mathematics and STEM might be targeted by providing them with more information about their place in the distribution of skills in these fields.[25] The literature on role models suggests that the gender gap in field choices can be reduced by providing female students with greater exposure to women working in male-dominated fields. Additionally, further information that shows the full range of activities in fields and occupations rather than what may be narrow female-unfriendly stereotypes (such as the idea that STEM graduates mostly work alone in laboratories) may encourage greater female participation.[26]

College gender gaps are larger in areas such as computer science and engineering, subjects that are not widely studied in school. Cheryan et al. (2017) suggest that greater exposure to these subjects in school, possibly by making STEM subjects in school compulsory for all (or in afterschool or club programs or through work experience), would make girls more likely to study them in college. However, if many girls avoid certain fields mostly because of their gender mix, this provides a difficult challenge for policy to overcome.

Another type of policy response is to change the nature of the educational system itself. For example, STEM or economics programs could reduce the amount of abstract math in the curriculum to become more female-friendly. Reducing the reliance on standardized entry tests for STEM programs would also tend to benefit females – over the 2015-2020

---

[25] Owen (2020) uses a randomised controlled trial to evaluate the effect of providing information to undergraduate STEM majors about their performance in STEM relative to their classmates and other STEM majors. The paper finds that the intervention reduces the gender gap in subsequent STEM course taking, mainly driven by over-confident males updating their beliefs and taking fewer STEM courses rather than under-confident females choosing more STEM courses.

[26] An important ethical issue is that females should not be given the impression that more female-friendly aspects of the field or occupation are more prevalent than they actually are, always a concern when trying to encourage female participation by showing the richness and variety of activity within an area.

period some astronomy and physics PhD programs have removed the physics GRE as a requirement. Colleges can also provide preferential admissions policies for females into STEM college programs. This is explicitly done with “gender points” for some college programs in Norway and may be implemented unofficially in other contexts -- Bhattacharya and Rabovic (2020) find that amongst Cambridge University applicants in STEM fields and economics, male applicants faced higher admissions standards. However, given the generally lower educational achievement of males, it may be increasingly difficult to justify policies that give preferential treatment to females in the educational system.

5. Conclusion

We briefly conclude with a few general points on research on gender gaps in education. First, while the stylized facts are quite well established, there is still much work to be done to better understand the reasons for these gaps. Second, there is a very impressive set of studies that have estimated causal factors influencing gender gaps in education. However, there is a lack of consistent findings. This may partly reflect methodological differences across studies but also may result from substantial true heterogeneity across educational systems and time periods. Thus, there is scope for further work to better understand these heterogeneities and help determine which policies are likely to be effective and in which circumstances. Finally, many papers that estimate interesting causal effects do not report separate results by gender, leaving us unsure about the effect of the treatment studied on gender gaps. We encourage future research to rectify this omission.

References

Alan, S., Ertac, S., & Mumcu, I. (2018). "Gender Stereotypes in the Classroom and Effects on Achievement." *Review of Economics and Statistics, 100*(5), 876–890.

Anaya, L., & Zamarro, G. (2020). "The Role of Student Effort on Performance in PISA: Revisiting the Gender Gap in Achievement." (EdWorkingPaper: 20-295). Available at: Annenberg Institute at Brown University: https://doi.org/10.26300/f056-5t92.

Antecol, H., Ozkan, E., & Ozbeklik, S. (2015). "The Effect of Teacher Gender on Student Achievement in Primary School." *Journal of Labor Economics*, 33(1): 63-89.

Angelo, C., & Balcão Reis, A. (2018). "Gender Gaps in Different Grading Systems." SSRN Electronic Journal.

Angelov, N., Johansson, P., Lindahl, M., & Pihl, A. (2019). "Subjective Expectations and the Gender Gap in STEM Majors: Evidence from a Sample of Swedish Students." Working Paper.

Astorne-Figari, C., & Speer, J. D. (2019). "Are Changes of Major Major Changes? The Roles of Grades, Gender, and Preferences in College Major Switching." *Economics of Education Review*, 70, 75–93.

Attali Y., Neeman, Z., & Schlosser, A. (2011). "Rise to the Challenge or Not Give a Damn: Differential Performance in High vs. Low-Stakes Tests." IZA discussion paper 5693.

Aucejo, E. M., & James. J. (2019a). "Catching up to Girls: Understanding the Gender Imbalance in Educational Attainment Within Race," *Journal of Applied Econometrics*, 34 (4), 502–525.

Aucejo, E.M., & James, J. (2019b). "The Path to College Education: The Role of Math and Verbal Skills." Working Paper.

Autor, D., Figlio, D., Karbownik, K., Roth, J. & Wasserman, M. (2019). "Family Disadvantage and the Gender Gap in Behavioral and Educational Outcomes." *American Economic Journal: Applied Economics*, 11(3), 338–81.

Autor, D., D. Figlio, K. Karbownik, J. Roth, and M. Wasserman. (2020). "Males at the Tails: How Socioeconomic Status Shapes the Gender Gap." NBER Working Paper No. 27196, May.

Avitzour, E., Choen, A., Joel, D., & Lavy, V. (2020). "On the Origins of Gender Biased Behavior: The Role of Explicit and Implicit Stereotypes." NBER Working Paper No. 27818.

Azmat, G., Calsamiglia, C. & Iriberri, N. (2016). "Gender Differences in Response to Big Stakes," *Journal of the European Economic Association* 14:6, 1372–1400.

Babcock, L., & Laschever, S. (2003). *Women don't ask: Negotiation and the gender divide*. Princeton University Press.

Baldiga, K. (2014). "Gender Differences in Willingness to Guess." *Management Science* 60 (2): 434–48.

Balestra, S., Sallin, A., & Wolter, S.C. (2020). "High-Ability Influencers? The Heterogeneous Effects of Gifted Classmates." Working Paper.

Bayer, A., Bhanot, S.P., & Lozano, F. (2019). "Does Simple Information Provision Lead to More Diverse Classrooms? Evidence from a Field Experiment on Undergraduate Economics." *AEA Papers and Proceedings* 109 (May): 110–14.

Becker, G. S., Hubbard, W.H.J, & Murphy, K.M. (2010). "Explaining the Worldwide Boom in Higher Education of Women," *Journal of Human Capital* 4: 203–41.

Bertocchi, G., & Bozzano, M. (2019). "Gender Gaps in Education." In: Zimmermann K. (eds) *Handbook of Labor, Human Resources and Population Economics.* Springer, Cham. https://doi.org/10.1007/978-3-319-57365-6_26-1

Bertrand, M. (2018). "The Glass Ceiling." *Economica* 85, no. 338: 205–31.

Bertrand, M. (2020). "Gender in the Twenty-First Century." *American Economic Review: Papers and Proceedings* 110, 1–24.

Bertrand, M. & Pan, J. (2013). "The Trouble with Boys: Social Influences and the Gender Gap in Disruptive Behavior." *American Economic Journal: Applied Economics*, Jan, 5(1), 32–64.

Beuchert, L., Eriksen, T. L. M., &Krægpϕth, M.V. (2020). "The Impact of Standardized Test Feedback in Math: Exploiting a Natural Experiment in 3rd Grade." *Economics of Education Review*, 77, August 2020.

Bhattacharya, D. & Rabovic, R. (2020). "Do Elite Universities Practise Meritocratic Admissions? Evidence from Cambridge." Working Paper.

Biewen M. & Schwerter, J. (2019). "Does More Math in High School Increase the Share of Female STEM Workers? Evidence from a Curriculum Reform." IZA discussion papers 12236, March. Bonn: IZA Institute of Labor Economics.

Black, S., Devereux, P., & Salvanes, K. (2013). "Under Pressure? The Effect of Peers on Outcomes of Young Adults." *Journal of Labor Economics* 31 (1):119–153.

Booth, A., Cardona-Sosa, L., & Nolen, P. (2018). "Do Single-sex Classes affect Academic Achievement? An Experiment in a Coeducational University." *Journal of Public Economics* 168, pp. 109-126.

Borgonovi, F., Choi, Á., & Paccagnella, M. (2018). "The Evolution of Gender Gaps in Numeracy and Literacy Between Childhood and Adulthood." *OECD Education Working Papers*, No. 184, OECD Publishing, Paris.

Boring, A. & Brown, J. (2016). "Gender, Competition and Choices in Higher Education." Working Paper. Retrieved from http://www.anneboring.com/higher-education.html.

Bostwick, V. K. & Weinberg, B.A. (2018). “Nevertheless She Persisted? Gender Peer Effects in Doctoral STEM Programs.” NBER Working Paper 25028.

Braakmann, N. & McDonald, S. (2018). “Student Exposure to Socio-economic Diversity and Students’ University Outcomes–Evidence from English Administrative Data.” Working Paper.

Breda, T., Grenet, J., Monnet, M., & Van Effenterre, C. (2020). “Do Female Role Models Reduce the Gender Gap in Science? Evidence from French High Schools” IZA Discussion Paper No. 13163, April.

Breda, T. & Ly, S.T. (2015). ”Professors in Core Science Fields are Not Always Biased Against Women: Evidence from France.” *American Economic Journal: Applied Economics, 7*(4), 53–75.

Breda, T. & Napp, C. (2019). “Girls' Comparative Advantage in Reading can Largely Explain the Gender Gap in Math-related Fields.” *Proceedings of the National Academy of Sciences*, 201905779.

Breda, T., Jouini, E., Napp, C. & Thebault, G. (2020). Gender stereotypes can explain the gender-equality paradox. *Proceedings of the National Academy of Sciences*, Dec 2020, 117 (49) 31063-31069.

Brenøe, A., & Lundberg, S. (2018). “Gender gaps in the Effects of Childhood Family Environment: Do They Persist into Adulthood?” *European Economic Review,* 109*,* 42–62.

Brenøe, A. & Zolitz, U. (2020). “Exposure to more female peers widens the gender gap in STEM participation.” *Journal of Labor Economics*, 38 (4), 1009-1054.

Buser, T., Niederle, M., & Oosterbeek, H. (2014). “Gender, Competitiveness, and Career Choices.” *Quarterly Journal of Economics* 129 (3): 1409–47.

Buser, T., Peter, N., & Wolter, S.C. (2017). "Gender, Competitiveness, and Study Choices in High School: Evidence from Switzerland." *American Economic Review*, 107 (5): 125-30.

Buser, T. & Yuan, H. (2019). “Do Women Give Up Competing More Easily? Evidence from the Lab and the Dutch Math Olympiad.” *American Economic Journal: Applied Economics*, 11 (3), 225–252.

Cai, X., Lu, Y., Pan, J., & Zhong, S. (2019). “Gender Gap Under Pressure: Evidence from China’s National College Entrance Examination.” *Review of Economics and Statistics* 101, 249–263.

Calkins, A., Binder, A.J., Shaat, D., & Timpe, B. (2020). “When Sarah Meets Lawrence: The Effect of Coeducation on Women's Major Choices.” Working Paper.

Campbell, S., Macmillan, L., Murphy, R. & Wyness, G. (2020). “Matching in the Dark? Inequalities in student to degree match.” CEPEO Working Paper No. 20-01, January 2020.

Canaan, S., & Mougaine, P. (forthcoming). “The Impact of Advisor Gender on Female Students' STEM Enrollment and Persistence.” *Journal of Human Resources.*

Card, D., & Payne, A.A. (2021). “High School Choices and the Gender Gap in STEM.” *Economic Inquiry*, 59: 9-28.

Carlana, M. (2019). “Implicit Stereotypes: Evidence from Teachers’ Gender Bias.” *Quarterly Journal of Economics* 134(3): 1163–224.

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.

Cavaglia, C., Machin, S., McNally, S., & Ruiz-Valenzuela, J. (2020). “Gender, Achievement and Subject Choice in English Education, Paper” Prepared for *Oxford Review of Economic Policy* issue on Gender.

Cheryan, S., Ziegler, S.A., Montoya, A.K., & Jiang, L. (2017). “Why Are Some STEM Fields More Gender Balanced than Others?” *Psychological Bulletin*. 143(1):1-35.

Chetty, R., Hendren, N., Lin, F., Majerovitz, J., & Scuderi, B. (2016). “Childhood Environment and Gender Gaps in Adulthood,” *American Economic Review Papers and Proceedings*, 106(5): 282–288.

Cherrier, B. (2017). “’The American Economic Association Declares that Economics is not a Man’s Field’: The Missing Story,” The Undercover Historian (blog), March 31, 2017, https://goo.gl/D3QJxP.

Coffman, K.B., & Klinowski, D. (2020). “The Impact of Penalties for Wrong Answers on the Gender Gap in Test Scores.” *PNAS*, 117(16) 8794-8803.

Conger, D., & Long, M. (2010). “Why are Men Falling Behind? Gender Gaps in College Performance and Persistence.” *The Annals of the American Academy of Political and Social Science*, 627, 184–214.

Cools, A., Fernandez, R., & Patacchini, E. (2019). “Girls, Boys, and High Achievers.” NBER Working Paper No. 25763, National Bureau of Economic Research.

Cornwell, C. M., Mustard, D. B., & van Parys, J. (2013). “Noncognitive Skills and the Gender Disparities in Test Scores and Teacher Assessments: Evidence from Primary School.” *Journal of Human Resources*, 48(1), 236–264.

Cortes G.M., Jaimovich N., & Siu. E.H. (2020). “The Growing Importance of Social Tasks in High-Paying Occupations: Implications for Sorting.” Retrieved from https://www.dropbox.com/s/q4qj4xyx3mnjh3r/endofmen20201103.pdf?dl=0

Dee, T. S. (2007). “Teachers and the Gender Gaps in Student Achievement.” *Journal of Human Resources*, 42(3): 528-554.

De Giorgi, G., M. Pellizzari, & Woolston, W. G. (2012). “Class Size and Class Heterogeneity.” *Journal of the European Economic Association* 10 (4), 795–830.

De Paola, M. & Gioia, F. (2016). "Who Performs Better Under Time Pressure? Results from a Field Experiment." *Journal of Economic Psychology*, 53, 37-53.

De Philippis, M. (2017). "Stem Graduates and Secondary School Curriculum: Does Early Exposure to Science Matter?" Banca D'Italia Working Paper (1107), 1-51.

Del Boca D., Martino E.M., Meroni E.C., & D. Piazzalunga. (2019) "Early Education and Gender Differences." *Economia Italiana,* 2019/3: 11-36

Delaney J.M. and P.J. Devereux (2019). "Understanding Gender Differences in STEM: Evidence from College Applications." *Economics of Education Review*, Volume 72, October, Pages 219-238.

Delaney J.M. and P.J. Devereux (2020a). "How Gender and Prior Disadvantage predict performance in College." *Economic and Social Review*, Vol. 51, No. 2, Summer, 189-239.

Delaney J.M. and P.J. Devereux (2020b). "High School Rank in Math and English and the Gender Gap in STEM." Working Paper.

Delaney J.M. and P.J. Devereux (2021). "Gender Differences in College Applications: Aspiration and Risk Management." *Economics of Education Review*, 80, February, 102077.

Denning, J. T., Murphy, R., & Weinhardt, F. (2018). "Class Rank and Long-run Outcomes", No. 11808, IZA Discussion Paper.

DiPrete, T. A., and C. Buchmann (2013). "The Rise of Women: The Growing Gender Gap in Education and What it Means for American Schools." Russell Sage Foundation.

Di Tommaso, M.L., Maccagnan, A., and S. Mandolia. (forthcoming) "The Gender Gap in Attitudes and Test Scores: A New Construct of the Mathematical Capability." *Feminist Economics.*

Diamond, R. and P. Persson. (2016). "The Long-term Consequences of Teacher Discretion in Grading of High-stakes Tests." National Bureau of Economic Research Working Paper Series, No. 22207.

Duckworth, A. L. and M. E. P. Seligman (2006). "Self-Discipline Gives Girls the Edge: Gender in Self-Discipline, Grades, and Achievement Scores." *Journal of Educational Psychology* 98(1): 198-208.

Dustmann, C., H. Ku, and D. Won Kwak (2018). "Why Are Single-Sex Schools Successful?" *Labour Economics* 54, pp. 79-99.

Eble, A. and F. Hu (2019). "How Important are Beliefs about Gender Differences in Math Bbility? Transmission Across Generations and Impacts on Child Outcomes." CDEP-CGEG Working Paper, 53.

Eble, A. and F. Hu (2020). "Child Beliefs, Societal Beliefs, and Teacher-student Identity Match", *Economics of Education Review*, Volume 77, August.

Eisenkopf, G., Hessami, Z., Fischbacher, U., and H. Ursprung. (2015). "Academic Performance and Single-sex Schooling: Evidence from a Natural Experiment in Switzerland." *Journal of Economic Behavior and Organization.* 115, 123–143.

Eren, O. (2017). "Differential Peer Effects, Student Achievement, and Student Absenteeism: Evidence from a Large-scale Randomized Experiment." *Demography*, 54(2), 745-773.

Exley, C. L., Niederle, M. and L. Vesterlund. (2020). "Knowing When to Ask: The Cost of Leaning In." *Journal of Political Economy*, 128, issue 3, p. 816 - 854.

Fischer S. (2017). "The Downside of Good Peers: How Classroom Composition Differentially Affects Men's and Women's Stem Persistence." *Labour Economics* 46:211–226.

Fischer, M. and V. Wagner. (2018). "Effects of Timing and Reference Frame of Feedback: Evidence from a Field Experiment." *IZA Discussion paper 11970*.

Fortin, N. M., P. Oreopoulos, and S. Phipps (2015). "Leaving Boys Behind: Gender Disparities in High Academic Achievement." *Journal of Human Resources,* 50 (3): 549–79.

Francesconi, M., and M. Parey. (2018). "Early Gender Gaps Among University Graduates." *European Economic Review*, 109, 63–82.

Giardili, S. (2019). "Single-Sex Primary Schools and Student Achievement: Evidence from Admission Lotteries." Working Paper.

Goldin, C., Katz, L., and I. Kuziemko. (2006). "The Homecoming of American College Women: The Reversal of the College Gender Gap." *The Journal of Economic Perspectives*, *20*(4), 133–156.

Gong, J., Y. Lu, and H. Song. (2018). "The Effect of Teacher Gender on Students' Academic and Noncognitive Outcomes.", *Journal of Labor Economics* 36(3): 743–78.

Goodman, J., Gurantz, O., and J. Smith (2020). "Take Two! SAT Retaking and College Enrollment Gaps." *American Economic Journal: Economic Policy*, 12(2), 115-58.

Gorlitz, K. and C. Gravert (2016). "The Effects of Increasing the Standards of the High School Curriculum on School Dropout." *Applied Economics* 48, 5314-5328.

Gorlitz, K. and C. Gravert (2018). "The Effects of a High School Curriculum Reform on University Enrollment and the Choice of College Major." *Education Economics* 26, 321-336.

Goulas, S., Griselda, S. and R. Megalokonomou. (2020). "Comparative Advantage and Gender Gap in STEM." IZA DP No. 13313.

Griselda, S. (2020). "Different Questions, Different Gender Gap: Can the Format of Questions Explain the Gender Gap in Mathematics?" Working Paper.

Guiso, L., Monte, F. Sapienza, P. and L. Zingales. (2008). "Culture, Gender, and Math." *Science* 320 (5880): 1164–65.

Hill, A. J. (2017). "The Positive Influence of Female College Students on their Male Peers." *Labour Economics*, 44, 151-160.

Hinnerich, B. T., Höglin, E., and M. Johannesson. (2011). "Are Boys Discriminated in Swedish High Schools?" *Economics of Education review*, *30*(4), 682-690.

Ho D.E. and M.G. Kelman. (2014). "Does Class Size affect the Gender Gap? A Natural Experiment in Law." *Journal of Legal Studies* 43: 291–321.

Hoffmann, F. and P. Oreopoulos. (2009). "A Professor Like Me, The Influence of Instructor Gender on College Achievement." *Journal of Human Resources* 44, 479-494.

Holmlund, H., and K. Sund. (2008). "Is the Gender Gap in School Performance Affected by the Sex of the Teacher?" *Labour Economics*, 15(1): 37-53.

Hoxby, C. (2000). "Peer Effects in the Classroom: Learning from Gender and Race Variation." NBER Working Paper No. 7867, National Bureau of Economic Research.

Iriberri N. and P. Rey-Biel. (2019). "Competitive Pressure Widens the Gender Gap in Performance: Evidence from a Two-stage Competition in Mathematics." *Economic Journal*, 129(620): 1863–1893.

Iriberri, N. and P. Rey-Biel (forthcoming). "Brave Boys and Play-it-Safe Girls: Gender Differences in Willingness to Guess in a Large Scale Natural Field Experiment." *European Economic Review*.

Isphording, I., and P. Qendrai. (2019). "Gender Differences in Student Dropout in STEM." IZA Research Reports 87.

Jacob, B. A. (2002). "Where the Boys aren't: Non-cognitive Skills, Returns to School and the Gender Gap in Higher Education," *Economics of Education Review*, 21 (6), 589–598.

Jepsen C. (2015). "Class Size: Does it Matter for Student Achievement?" *IZA World of Labor* 2015:190. https ://doi.org/10.15185/izawol.190.

Joensen, J. and H. Nielsen (2016). "Mathematics and Gender: Heterogeneity in Causes and Consequences." *Economic Journal* 126, 1129-1163.

Kahn, S. and D. Ginther. (2018). "Women and Science, Technology, Engineering, and Mathematics (STEM): Are Differences in Education and Careers Due to Stereotypes, Interests, or Family?" In (Eds) Susan L. Averett, Laura M. Argys, and Saul D. Hoffman. *The Oxford Handbook of Women and the Economy*. Oxford University Press.

Kato, T. and Y. Song. (2018). "An Advisor Like Me: Does Gender Matter?" IZA Discussion Paper No. 11575.

Kugler, A. and Tinsley, C. and Ukhaneva, O. (2017). “Choice of Majors: Are Women Really Different from Men?” National Bureau of Economic Research. No. w23735.

Kuhn, A. and S. C. Wolter (2020). “Things versus People: Gender Differences in Vocational Interests and in Occupational Preferences.” IZA DP No. 13380, June.

Landaud, F., and É. Maurin. (2020). “Aim High and Persevere! Competitive Pressure and Access Gaps in Top Science Graduate Programs.” PSE Working paper No 2020 - 79.

Landaud, F., S. Thierry Ly, and É. Maurin. (2020). “Competitive Schools and the Gender Gap in the Choice of Field of Study.” *Journal of Human Resources*, Volume 55, Number 1, Winter, 278-308.

Lavy, V. (2008). “Do Gender Stereotypes Reduce Girls’ Human Capital Outcomes? Evidence from a Natural Experiment.” *Journal of Public Economics*, 92(10–11), 2083–2105.

Lavy, V. and R. Megalokonomou (2019). “Persistency in Teachers’ Grading Bias and effects on Longer-term Outcomes: University Admissions Exams and Choice of Field of Study.” NBER Working Paper No. 26021.

Lavy, V. and E. Sand (2018). “On the Origins of the Gender Human Capital Gap: Short and Long Term Effect of Teachers' Stereotypes.” *Journal of Public Economics*. 167, 263-279.

Lavy, V. and A. Schlosser. (2011). “Mechanisms and impacts of gender peer effects at school.” *American Economic Journal: Applied Economics* 3 (2):1–33.

Lei, Z. and S. Lundberg. (2020). “Vulnerable Boys: Short-term and Long-term Gender Differences in the Impacts of Adolescent Disadvantage.” *Journal of Economic Behavior & Organization,* Volume 178, October 2020

Li, C. H. and B. Zafar. (2020). “Ask and You Shall Receive? Gender Differences in Regrades in College.” IZA DP No. 12983, February 2020.

Li, H. (2018). “Do Mentoring, Information, and Nudge Reduce the Gender Gap in Economics Majors?” *Economics of Education Review* 64 (June): 165–83.

Lim, J., & Meer, J. (2017). “The Impact of Teacher-Student Gender Matches: Random Assignment Evidence from South Korea.” *Journal of Human Resources*, 52(4): 979-997.

Lim, J., & Meer, J. (2020). “Persistent Effects of Teacher-Student Gender Matches.” *Journal of Human Resources*, 55(3), 809-835.

Lim, S., Han, C.E., Uhlhaas, P.J., & Kaiser, M. (2015). “Preferential Detachment during Human Brain Development: Age- and Sex-specific Structural Connectivity in Diffusion Tensor Imaging (DTI) Data.” *Cerebral Cortex*, 25, 1477–1489.

Lindahl, E. (2007). “Comparing Teachers’ Assessments and National Test Results: Evidence from Sweden.” IFAU Working Paper.

Lu, F., and Anderson, M. (2015). “Peer Effects in Microenvironments: The Benefits of Homogeneous Classroom Groups.” *Journal of Labor Economics* 33, 91–122.

Lundberg, S. (2020). “Educational Gender Gaps.” *Southern Economic Journal* 87: 416– 439.

Machin, S., and McNally, S. (2008). “The Literacy Hour.” *Journal of Public Economics* 92: 1441-1462.

McNally, S. (2020). “Gender Differences in Tertiary Education: What explains STEM Participation?” EENEE Analytical Report No.41 Prepared for the European Commission.

Morin, L. (2015). “Do Men and Women Respond Differently to Competition? Evidence from a Major Education Reform.” *Journal of Labor Economics* 33:2, 443–491.

Mouganie, P., and Wang, Y. (2020). “High Performing Peers and Female STEM Choices in School.” *Journal of Labor Economics,* 38(3): 805-841.

Niederle, M., and Vesterlund. L. (2007). “Do Women Shy Away from Competition? Do Men Compete Too Much?” *Quarterly Journal of Economics* 122 (3): 1067–1101.

OECD (2015). “The ABC of Gender Equality in Education: Aptitude, Behaviour, Confidence.” *OECD Publishing*, Paris.

OECD (2019). “Education at a Glance 2019: OECD Indicators.” *OECD Publishing*, Paris.

OECD (2020). “Do Boys and Girls Differ in their Attitudes towards School and Learning?”, in PISA 2018 Results (Volume II): Where All Students Can Succeed, *OECD Publishing*, Paris.

Oreopoulos, P., R. S. Brown, and Lavecchia, A. (2017) “Pathways to Education: An Integrated Approach to Helping At-Risk High School Students.” *Journal of Political Economy*, August 2017, No. 4, Vol. 125, pp 947-984

Ors, E., Palomino, F. and E. Peyrache (2013). “Performance Gender Gap: Does Competition Matter?” *Journal of Labor Economics,* 31:3, 443–499.

Osikominu, S., & Pfeifer. G. (2018). “Perceived Wages and the Gender Gap in STEM Fields.” IZA Discussion Paper No. 11321.

Owen, A. L. (2010). “Grades, Gender, and Encouragement: A Regression Discontinuity Analysis.” *The Journal of Economic Education*, 41:3, 217-234.

Owen, S. (2020). “College Field Specialization and Beliefs about Relative Performance. An Experimental Intervention to Understand Gender Gaps in STEM”. Working Paper.

Owens, J. (2016). “Early Childhood Behavior Problems and the Gender Gap in Educational Attainment in the United States.” *Sociology of Education*, 89(3), 236-258.

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.

Park, H., J. R. Behrman, and J. Choi (2013). “Causal Effects of Single-Sex Schools on College Entrance Exams and College Attendance: Random Assignment in Seoul High Schools.” *Demography* 50.2, 447-469.

Park, H., J. R. Behrman, and J. Choi (2018). “Do Single-sex Schools enhance Students' STEM (Science, Technology, Engineering, and Mathematics) Outcomes?” *Economics of Education Review* 62, pp. 35-47.

Pekkarinen, T. (2008). “Gender Differences in Educational Attainment: Evidence on the Role of Tracking from a Finnish Quasi-experiment.” *Scandinavian Journal of Economics*, 110 (4), 807–825.

Pekkarinen, T. (2015). “Gender Differences in Behaviour under Competitive Pressure: Evidence on Omission Patterns in University Entrance Examinations.” *Journal of Economic Behavior & Organization, 115* , 94–110.

Porter, C. and D. Serra (2020). “Gender Differences in the Choice of Major: The Importance of Female Role Models” *American Economic Journal: Applied Economics*, 12(3): 226–254.

Pugatch, T. and E. Schroeder (2020). “Promoting Female Interest in Economics: Limits to Nudges.” IZA DP No. 13489.

Puhani, P.A. (2018). “Do Boys Benefit from Male Teachers in Elementary School? Evidence from Administrative Panel Data.” *Labour Economics*, 51, April, 340-354.

Reuben, E., M. Wiswall, and B. Zafar. (2017). “Preferences and Biases in Educational Choices and Labour Market Expectations: Shrinking the Black Box of Gender.” *The Economic Journal*, 127(604): 2153–2186.

Rizzica, L. (2020). “Raising Aspirations and Higher Education: Evidence from the United Kingdom’s Widening Participation Policy.” *Journal of Labor Economics* 38:1, 183-214.

Saltiel, F. (2019). “What’s Math Got to Do With it? Multidimensional Ability and the Gender Gap in STEM.” Department of Economics, University of Maryland.

Saygin P. O. (2016). “Gender Differences in Preferences for Taking Risk in College Applications.” *Economics of Education Review*, 52:120–133.

Schøne, P., K. von Simson, and M. Strøm. (2020). “Peer Gender and Educational Choices.” *Empirical Economics*. 59**:** 1763–1797.

Sohn, H. (2016). “Mean and Distributional Impact of Single-sex High Schools on Students' Cognitive Achievement, Major choice, and Test-taking Behavior: Evidence from a Random Assignment Policy in Seoul, Korea.” *Economics of Education Review* 52, pp. 155-175.

Speer, J. D. (2017). “The Gender Gap in College Major: Revisiting the Role of Pre-college Factors.” *Labour Economics, 44*, 69–88.

Speer, J. D. (2020). “Bye Bye Ms. American Sci: Women and the Leaky STEM Pipeline.” Working Paper.

Stoet, G., & Geary, D. C. (2018). “The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education.” *Psychological Science*, 29(4), 581–593.

Stoet, G., & Geary, D. C. (2020). “Gender Differences in the Pathways to Higher Education.” *Proceedings of the National Academy of Sciences* Jun 2020, 117 (25) 14073-14076; DOI: 10.1073/pnas.2002861117

Terrier, C. (2020). “Boys Lag Behind: How Teachers’ Gender Biases affect Student Achievement.” *Economics of Education Review*, Volume 77, August.

Whitmore, D. (2005). “Resource and Peer Impacts on Girls’ Academic Achievement: Evidence from a Randomized Experiment.” *AEA Papers and Proceedings* 95 (2):199–203.

Wiswall, M., and B. Zafar. (2018). “Preference for the Workplace, Investment in Human Capital, and Gender.” *The Quarterly Journal of Economics* 133 (1): 457–507.

Zafar, B. (2013). “College Major Choice and the Gender Gap.” *Journal of Human Resources, 48*(3), 545–595.

Zolitz, U. and J. Feld. (forthcoming). “The Effect of Peer Gender on Major Choice in Business School.” *Management Science.*