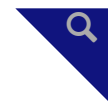




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▶ Gender gaps in math performance, perceiv

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Volume 30, 2022 - Issue 2

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Gender gaps in math performance, perceived mathematical ability and college STEM education: the role of parental occupation

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Pages 113-128 | Received 03 Jul 2020, Accepted 19 Aug 2021, Published online: 13 Sep 2021

 Download citation <https://doi.org/10.1080/09645292.2021.1974344>

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ABSTRACT

Despite the promising future of employment opportunities in occupations related to Science, Technology, Engineering, and Mathematics (STEM), women remain underrepresented in some STEM occupational fields. We use data from the Panel Study of Income Dynamics to study the role of gender differences in achievement and self-perceived ability in math during childhood, along with parental occupation

In this article

otherwise qualified young women and highlight the potential importance of parental occupation in STEM in encouraging women's participation in certain STEM fields.

Q KEYWORDS: STEM gender gaps self-perceived ability self-efficacy college major parental occupations

QJEL: Codes: J16 I20 J62

[◀ Previous article](#)

[View issue table of contents](#)

[Next article ▶](#)

Introduction

Employment opportunities in occupations related to Science, Technology, Engineering, and Mathematics, the so-called STEM fields, are projected to continue growing through time. According to the U.S. Bureau of Labor Statistics (2014), employment in STEM occupations is expected to grow by about one million jobs between 2012 and 2022. In addition, wages in STEM occupations, although they vary considerably, are estimated to be on average nearly double the national average wage for non-STEM jobs.

Despite these prospects and the growth of female labor participation, women remain under-represented in certain STEM occupations. Using data from the Census Bureau's 2009 American Community Survey, Beede et al. (2011) show that women hold less than 25 percent of STEM jobs, despite holding about 48 percent of all jobs. This trend is especially problematic in the math-intensive STEM professions, such as engineering, information technology, computer science, and mathematical occupations, and less so for the broader definition of STEM sciences, including for example the Life, Physical, and Social Sciences. In these science occupations, the share of women has risen, and higher wages in these jobs have helped women improve their occupational wage ranking (Li & Stafford, 2017).

step for this goal is to gain a better understanding of the drivers behind the gender gap in STEM participation. Until then, we would not be able to recommend effective policy proposals that could help reduce it.

Research suggests that factors such as differences in academic achievement and self-perceived mathematical ability, can help explain women's underrepresentation in some STEM fields (Nix et al., 2015; Perez-Felkner et al., 2017). However, less attention has been paid to the potential role that parental occupation type could have on mitigating these factors. In this paper, we use data from the Child Development Supplement (CDS) and Transition to Adulthood (TA) projects in the Panel Study of Income Dynamics (PSID).

The PSID is a longitudinal household survey that allows us to study the presence of gender differences in self-perceived ability and achievement in math during childhood and to follow children as they become young adults. By linking the children's data to parents' occupation type, it is possible to analyze whether children's measures of math test performance and self-perceived math ability differ when their parents work in STEM as compared to non-STEM occupations. We then contribute to the literature by jointly studying the role that academic performance, self-perceived ability, and parental occupation type have on the children's subsequent decision of majoring in a STEM field in college.

Our results corroborate significant gender differences in math test scores and self-perceived math ability during childhood. Having a parent working in a science-related field is associated with better performance in math but not necessarily higher levels of self-perceived math ability, after controlling for math performance. Importantly, girls' lack of self-perceived ability seems to be something specific to math, as these patterns do not replicate when looking at performance and self-perceived ability in reading.

science in college. However, boys appear to benefit more than girls from higher levels of math achievement, at least when considering a broad definition of STEM, and self-perceived math ability, when considering math-intensive STEM fields. The estimated effects of high levels of math achievement are about double for boys than they are for girls. Similarly, estimates of self-perceived math ability are also slightly higher for boys. These results suggest a loss in STEM enrollment by otherwise qualified young women.

Regarding parental occupation, most of the observed positive effects of having a parent in a science-related occupation seem to concentrate among females and when considering a broad definition of STEM fields. This finding suggests that, although limited, there is intergenerational feedback accumulating through time that boosts women's share in certain STEM fields. Our findings highlight the potential importance that parental role modeling effects or specific human capital investments, captured by parental occupation in a science-related field, can have to encourage women to major in STEM.

The rest of the paper is organized as follows: Section 2 describes the literature related to the potential factors driving gender differences in STEM. In Section 3 we present an overview of the data from the PSID. Section 4 shows descriptive results on observed gender differences in achievement and self-perceived ability in math during childhood and to what extent parental occupation in STEM shapes these two factors. For comparison, we present similar results for reading performance and self-perceived reading ability. Section 5 presents our models of the relationships of math achievement, self-perceived math ability, and parental science occupation on the likelihood of majoring in a science field in college. Finally, section 6 summarizes the conclusions and policy implications.

Scholars argue that gaps in math performance are an essential factor affecting STEM outcomes and that these gaps begin early in elementary school. Robinson & Lubienski (2011) use data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999, and find that girls and boys enter kindergarten with similar levels of math ability. However, a gap in math performance, favoring boys, appears as early as first grade; this gap is wider among the top performers in math (see also Ellison & Swanson [2010] who find that girls are underrepresented at the top of the math achievement distribution). Although girls make up some ground over the middle school years, the authors report that the gender gap in math performance persists at the end of eighth grade.

Persistent gender gaps in math performance could limit girls' opportunities to access advanced placement (AP) math courses limiting access to upper-secondary education in science fields. However, the literature in this respect provides mixed results. At the high school level, research is not conclusive on the degree to which there are gender differences in the level of investment in math courses and how this difference may influence the gender gap in STEM college majors. Although there are overall observed gender differences in enrollment in specific science AP courses in high school (DOE, 2012), e.g. AP mathematics (calculus and statistics) or AP physics, girls appear to enroll in other AP science courses at a higher rate than boys.

Using administrative data from Canadian students, Card & Payne (2017) argue that gender differences in the type of courses high-achieving students take in high school have a modest effect on explaining gender gaps in the choice of STEM majors in college. The authors argue that the fact that many more non-STEM-oriented women enter university than men, as a result of different course choices early on at high school, helps explain a bigger share of the STEM gap in college. Along these lines, using administrative data from Irish students who apply to college, Delaney & Devereux

who have similar grades and course preparation during secondary school, a gender gap in STEM college education of 9 percentage points remains unexplained.

At the college level, gender differences in investments in math courses are more evident. For instance, Weinberger (2005) finds that, among students with the same level of math achievement, men are much more likely to select math-intensive college majors. In particular, women enroll in STEM majors at a rate of no more than half the rate of men with the same math scores. This result is consistent with that of Xie & Shauman (2003) who also find similar results in STEM college enrollment. Additionally, Xie & Shauman (2003) find that at the beginning of college, women experience larger attrition from science and engineering careers relative to men, whereas at the end of college, males and females have similar rates of attrition from these careers.

New research on economics highlights the potential role of psychological factors in explaining gender differences in labor market outcomes (Bertrand, 2011). Along these lines, Kamas & Preston (2012) find that women are less confident about their ability to compete relative to men and that this could translate into less representation of women in certain fields such as business. Researchers in educational psychology also stress that gender differences in self-perceived math ability may play a role in explaining the underrepresentation of women in STEM courses, college majors, and occupations. Nix et al. (2015) and Perez-Felkner et al. (2017) show that, among high school students, boys exhibit higher levels of self-perceived math ability than girls. The authors also find that higher levels of self-perceived math ability significantly predict the likelihood of enrolling in mathematically-intensive courses in high school and majoring in math-intensive fields during college, even after controlling for math achievement levels.

The extent to which women self-identify with the STEM field characteristics or stereotypes about math aptitudes could also affect the underrepresentation of women in STEM courses or college majors (Kiefer & Sekaquaptewa, 2007). Ehrlinger et al.

students. They also perceive themselves as less similar to the prototype relative to males. These gender differences in the perceptions of the engineer or scientific prototype help explain females' tendency to report less interest in pursuing college-classes or careers related to computer science and engineering. In contrast, Ganley et al. (2018) find that the perception that a college major is more male-dominated is what helps explain females' underrepresentation in STEM. Ceci et al. (2014) find that these stereotypes about perceptions of STEM careers or math ability begin in kindergarten and tend to increase with age, reducing females' tendency to major in math-intensive fields in college.

An important factor, less studied in the STEM gender gap literature, is the potential role of parental occupation type. Parents' occupations can affect children's STEM choices in multiple ways. Higher wages in STEM-related occupations can lead to higher financial investments in children's human capital development. Parents in STEM fields can also differ in the type of educational activities they promote in their children, which possibly helps shape their preferences and potentially reduces gender stereotypes towards STEM fields.

Parents working in STEM occupations can also serve as role models for their children and can help promote social networks or specific job knowledge, increasing the potential returns of attaining a STEM credential. While there is some regression to the mean observed across generations in terms of both earnings and occupational type, with the highest parental occupations leading to lower occupational achievement of children, there is a substantial carryover still observed across generations (Li & Stafford, 2017) and a rising observed impact of work content shifting toward quantitative skills (Black & Spitz-Oener, 2010). Similarly, Cheng et al. (2017) use data from the Education Longitudinal Study of 2002 and find that parental occupation type could be relevant for women's long-term STEM outcomes, i.e. graduating from a STEM

Parental views on gender social norms, as well as the degree of gender equality in society, can also influence children's academic motivation, and therefore, affect student performance on math and science assessments (Fryer & Levitt, 2010; Pope & Sydnor, 2010; Rodríguez-Planas & Nollenberger, 2018; Stoet & Geary, 2018). Children whose parents believe that math and science are essential for subsequent education and future employment are more likely to have higher math test scores and enroll in more math and science courses in high school (Giannelli & Rapallini, 2017; Harackiewicz et al., 2012). Similarly, Eble & Hu (2018) find that parents' beliefs that boys are better than girls at learning mathematics are associated with a wider gender gap in math achievement. These beliefs are probably very different for parents in science-related and non-science related occupations.

This paper builds on the previous work of Cheng et al. (2017), Nix et al. (2015), and Perez-Felkner et al. (2017). We contribute to the literature by analyzing together the role of math test performance, self-efficacy, and parental occupation on explaining both boys' and girls' college decisions of whether or not to major in a STEM field. We document gender gaps in math achievement and perceived math ability during childhood and how both may differ by parental occupation type. We also study the role of these two factors along with parental occupation and analyze potential differential effects by gender on influencing the probability of majoring in science in college.

Data and descriptive statistics

For our analysis, we use data from the PSID. The PSID is a longitudinal household survey, which began in 1968 with 18,000 individuals living in 5,000 households in the United States. The PSID sample increases over time as the descendants from the

longitudinal survey includes information on family composition changes, housing and food expenditures, marriage and fertility histories, employment, income, health, and household consumption, among other topics.

Additionally, the PSID collects data over time on specific population groups to gather supplementary information. In particular, in this paper, we use the data collected through the Child Development Supplements (CDS) of the PSID. In 1997, the PSID collected supplemental information on up to two 0-to-12-year-old children from PSID families to obtain a nationally representative and longitudinal dataset of children to study the human capital formation process. By 1997, the CDS had 2,398 families who had 3,563 participant children. Two follow-up surveys in 2002–2003 and 2007–2008 collected information about the children from the participant families on the 1997 CDS who remained active in the PSID panel as of 2001. Using these follow-up surveys, the PSID obtained information of children up to age 18. Finally, a new cohort of the CDS began in 2014.

Another important supplemental PSID dataset for our analysis comes from the Youth's Transition into Adulthood (TA) study. These data follow former CDS participants in the time between the age 18 and before they form their households, which on average occurs at age 24. Therefore, the PSID can track children targeted at each CDS through up to three CDS supplemental surveys and then biennially from ages 18–24 under the TA study. Finally, around the age of 24, or whenever participants form their household, former TA members become new core members of the PSID.

For this study, we exploit the family structure in the PSID and combine information of the following surveys: Information about children from PSID members through the Child Development Supplement 2002 (CDS-2002), information about these children's college education through the Transition into Adulthood Supplement 2013 (TA-2013) and Transition into Adulthood Supplement 2015 (TA-2015). Finally, we obtain the

Our main variables from the CDS-2002 include measures of math and reading performance, using the standardized Woodcock-Johnson Applied Problems test scores (W-J AP) and the Broad Reading standardized test scores² (W-J BR), and measures of self-reported perceived math and reading abilities. Concerning the latter self-perceived ability variables, six-year-old children and older were asked to report on a scale from 1 to 7, that goes from 'not at all good' to 'very good,' how good at math and reading, respectively, they consider themselves to be. Using this information, along with sampling weights, we build weighted percentiles of the W-J AP and W-J BR test scores.

In order to present the empirical relationships observed in our sample, we classify children's performance into three levels: Level 1 for those scoring between the 0 and 50 percentiles, Level 2 for those scoring between the 51 and 80 percentiles, and Level 3 for those performing between the 81 and 100 percentiles. Similarly, we create levels of self-perceived math and reading ability and classified children in our sample in three groups: Level 1 for those reporting levels of perceived ability between 1 ('not at all good') and 3, Level 2 for those reporting levels between 4 ('ok') and 5, and Level 3 for those reporting levels of self-perceived ability of 6 and 7 ('very good'). These classification categories maximize sampling power across different levels of performance and self-perceived ability. However, as a robustness check, we also disaggregated achievement into ventiles of the distribution and self-perceived ability into the following categories: 1 and 2, 3, 4, 5, and, 6 and 7. Overall, our results were robust to this more expanded classification.

From the TA-2013 and TA-2015, we capture information about college attendance and the main major of study in college. With this information, we create a dummy variable for college majors in math-intensive STEM. To define this variable, we adopt the definition of math-intensive fields from Ceci et al. (2014) who include geoscience, engineering, economics, mathematics, computer science, and physical sciences³ as math-intensive STEM fields.

include life sciences (e.g. biological sciences, conservation sciences, food, agricultural sciences, etc.), veterinary, medicine, dentistry, among others [see Ceci et al (2014) and Delaney & Devereux (2019)]. In contrast, the U.S. Census Bureau considers social sciences (e.g. psychology, sociology, etc.) as STEM fields. As a result, we also create a broader definition of STEM science majors with a dummy that includes all the above math-intensive majors plus architecture, life sciences, medical sciences, dentistry, veterinary medicine, physical therapy, pharmacy, sports management, and business majors.

Finally, parental occupation information comes from the PSID-2003. Occupation type is coded following the 3-digit code index of industries and occupations, from the 2000 census of population and housing, issued by the U.S Department of Commerce and the Census Bureau. With this information, we create a dummy variable indicating whether the head of the household or the spouse, at least one of them, reports working or having worked in a math-intensive STEM occupation.⁴ We also add a dummy variable for whether the head of the household or the spouse work or has worked in a science occupation using a broader definition of STEM sciences.⁵ These types of occupational classifications are based on the STEM definitions explained in the previous paragraph and approximately align with our definition of college STEM majors described above.

Table 1 presents descriptive statistics for our analytical sample. About half of the sample represents males and the other half females. The CDS 2002 collected information on math/reading performance and self-perceived math/reading ability when the children on average were about 11 years old. The TA 2013 and TA 2015 modules show college major enrollment information when the children in the sample were on average between 23 and 25 years old.

Table 1. Analytical sample summary statistics.



We find small but statistically significant differences in age for boys and girls in our sample with girls being slightly older. In addition, girls in our sample present statistically significant lower average performance on the W-J AP test, when measured during childhood, and report significantly lower average levels of self-perceived ability in math at this time. In contrast, girls on average present statistically significant higher levels of performance on reading through the W-J BR test and report higher levels of self-perceived ability in this subject. In the next section, we further study these patterns of math and reading achievement and self-perceived math and reading ability, paying particular attention to the role of parental occupation type.

Overall, we do not find statistically significant differences in the type of parental occupation by gender. Seven percent of both boys and girls in our sample have at least one parent or guardian who report working in a science-related occupation. Among these parents, five percent report working in an occupation related to a math-intensive STEM field.

Finally, when we look at the type of college major, declared by the young adults in our sample, we observe significant gender differences. Although both boys and girls seem to be majoring at the same rates in any STEM field, when we consider a wide definition of science, girls are much less likely to major in the math-intensive STEM fields than boys. On average, about 30 percent of both boys and girls declare a major in science, but only about 3 percent of girls do it in a math-intensive STEM field, while almost 10 percent of boys do so. On average, girls tend to major in non-science fields at a higher rate. Girls are about 8 percentage points more likely than boys to major in non-STEM careers. Finally, we observe that, on average, girls attend college at a higher rate than boys do in our sample; almost 53 percent of boys do not attend college as compared to 43 percent of the girls. Observing higher rates of college enrollment for young women is not a surprising result. Prior literature has reported increasing patterns of college attendance and graduation rates for women (Goldin et al., [2006](#)).

Gender differences in test performance and perceived ability

Math performance and perceived ability

Table 2 describes patterns in math performance on the W-J AP test as well as self-reported perceived math ability, by gender. Both math performance and self-perceived math ability are classified into three groups representing low, medium, and high levels, as described in the data section above. The diagonals of this table represent the percentage of children that could be considered reporting a self-perceived ability approximately on target with their math performance. In other words, those reporting low levels of math ability while performing on the lower percentiles of the W-J AP test, reporting medium levels of ability and performing on the middle of the math test distribution, or reporting high levels of ability and performing on the highest percentiles of the W-J AP test.

Table 2. Math performance and self-perceived math ability (% of the sample).



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We observe interesting patterns of math performance and self-reported ability by gender in this table. Boys present higher levels of performance on the W-J AP test than girls do because a higher proportion of boys in our sample performs in the middle and higher ends of the test distribution, while a higher proportion of girls performs on the lower percentiles. Similarly, girls tend to report lower levels of self-perceived math ability than boys do because girls tend to concentrate on the medium and lower levels of the self-perceived math ability scale. In general, boys tend to report levels of math

If we add the numbers above the diagonals in [Table 2](#), we obtain that about 60% of the girls are over-confident about their math ability, whereas about 56% of the boys are over-confident. However, girls' 'over-confidence' is of different intensity than boys' over-confidence. As we described above, girls' math ability self-ratings concentrate in the middle category of self-efficacy (4–5). For example, in the percentiles 0–50, about 40% of the girls rate their math ability as 4 or 5, while only 28% of boys do so. In contrast, the over-confidence of boys occurs because they tend to rate their math ability at the highest levels (6–7). If we add the numbers above the diagonal of the third column of the self-efficacy rating (6–7), we find that about 28% of boys rate their math ability as the highest, whereas only 20% of the girls do.

Even if, overall, girls appear to be more over-confident than boys, when we take a closer look at the distribution of math ability self-ratings above the diagonal, we observe that a higher proportion of boys consistently choose the highest rating, whereas girls choose lower ratings. In this case, the middle rating (4–5). Similarly, conditional on the highest W-J AP performance level, girls are less likely to rate themselves on the highest two levels of the math ability scale. Overall, girls are more likely to report a middle range for their self-perceived math ability than boys.

Next, we study how these observed patterns of math performance and perceived math ability may vary with parental occupation type. [Table 3](#) shows the same statistics that were presented in [Table 2](#) but by parental occupation in a science field or not, using a broad definition of STEM sciences. Observed gender differences in math performance and self-reported ability decrease when parents report working in a science-related occupation. The gender gap in performance at the highest level of the W-J AP test decreases from about 7 percentage points, when parents do not have a science occupation, to only 3 percentage points if at least one parent or guardian works in a science-related field.





Similarly, the difference between boys and girls reporting the highest levels of self-perceived math ability is about 17 percentage points, when parents do not work in a science-related job, and only 5 percentage points if we compare those with parents in science occupations. In addition, having a parent that works in a science-related job appears to increase the probability, for both boys and girls, to perform in the top percentiles of the W-J AP test distribution and the effect appears bigger for girls than for boys, an increase of about 30 percentage points for girls and 25 percentage points for boys. Girls with parents in science appear more optimistic about their abilities, reporting higher levels of perceived ability, than girls whose parents do not hold a science-related occupation. In contrast, boys with parents in a science-related occupation appear to adjust their perceived ability levels downward, especially for those performing in the lower levels of the W-J AP test distribution.

To get a better insight on gender differences in self-perceived math ability, we next compare in [Table 4](#) the self-perceived math ability levels of boys and girls performing on the same percentile groups of the W-J AP test. We observe meaningful differences in self-perceived math ability between boys and girls, especially at the tails of the W-J AP distribution. Focusing on the highest percentiles of math performance, we observe that a higher proportion of boys than girls report the highest levels of math ability, 64 percent of boys as compared to 50 percent of girls. Similarly, in the lower end of the math performance distribution, boys continue to be more optimistic about their math ability, with 29 percent of them still reporting the highest levels of ability as compared to 17 percent of the girls.

Table 4. Self-perceived math ability by gender, given math scores (% of the sample).



Finally, in [Table 5](#) we study if observed gender patterns in reporting math ability levels are different depending on the type of parental occupation, science versus non-science jobs. Having at least one parent or guardian working in a science-related field does not seem to reduce gender differences in reported math ability once we condition on a given level of W-J AP performance. If anything, it seems that children with parents working in a science field appear to be more pessimistic about their self-perceived math ability than those with parents working in other types of occupations. It is possible that children who have parents working in STEM have more parental involvement with math at home and could transmit higher standards of what being good at math means. Prior studies document that parental math-anxiety, parental involvement, or beliefs about math appear to affect students' self-efficacy and achievement in math (Casad et al., [2015](#); Eble & Hu, [2018](#); Giannelli & Rapallini, [2017](#); Harackiewicz et al., [2012](#); Ing, [2013](#)).

Table 5. Self-perceived math ability by gender, given math scores (% of the sample).



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Reading performance and self-perceived ability

Given girls' lack of self-perceived ability in math described above, one could wonder whether this is a pattern specific to math or if this is the result of girls generally being more pessimistic about their levels of ability. As we described in the data section, the PSID also includes results of the W-J Broad Reading (W-J BR) test and asked children to report their self-perceived ability in reading. In [Tables 6](#) and [7](#), we use this information to replicate [Tables 2](#) and [4](#) above but for the case of reading.

of the sample).



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Table 7. Self-perceived reading ability by gender, given reading scores (% of the sample).



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As we can see in [Table 6](#), overall girls score higher in reading than boys and report higher levels of self-perceived ability in this subject. Around 20 percent of the girls score in the highest level of reading performance compared to 16 percent of the boys. Similarly, 51 percent of girls report the highest level of self-perceived ability in reading while only about 40 percent of boys do so.

Descriptive statistics presented in [Table 7](#) suggest that the problem of girls reporting lower levels of self-perceived ability, given performance, is only concentrated in math and not in reading. In contrast, we now observe that girls are more likely to report high levels of self-perceived reading ability despite performing in the lowest level of the W-J BR test. In the lowest level of reading performance, approximately 41 percent of the girls report the highest level of reading ability compared to 29 percent of the boys. For higher levels of reading performance, a higher proportion of boys continue to report the highest levels of self-perceived ability, but the difference concerning the proportion of girls who do so is much smaller than in the case of math.⁶

Math test performance, self-perceived ability, parental occupation type and gender differences in college major choices

studying science majors in college. We also explore whether there is a direct relationship between parental occupation and the probability of majoring in science. This relationship could arise from differential parental human capital investments or role modeling effects, derived from having at least a parent or guardian working in a STEM field. We estimate linear probability models for the probability of currently studying or having studied a science major in college (math-intensive STEM majors or wide definition of STEM majors) as a function of gender, W-J AP and W-J BR performances, self-reported math and reading abilities, and whether or not one of the parents or guardians works in a science-related occupation. By including interaction terms with a dummy for being female, we study the potential of differential effects of these variables by gender.

We also include household socio-demographic controls such as the natural logarithm of total household income, dummies of mother and father highest educational attainment (i.e. high school and college or higher degrees), and the number of siblings living in the household. We drop the observations who report income data as zero or negative (there are only 12 observations in our sample that meet these criteria).⁷ We perform this analysis for both math-intensive STEM majors and parental occupations as well as for a broader definition of STEM majors and occupations, as described in the data section above.

[Table 8](#) presents the results when considering the probability of majoring in math-intensive STEM fields. Columns 1, 2, and 3 present estimates for the entire sample of CDS 2002 children, independently of college enrollment status. In contrast, columns 4, 5, and 6 present results when we condition the sample to only those children who at least enroll in college (i.e. those who are currently in college, graduated from college, or attended college but did not graduate). We observe the expected gender differences in the probability of majoring in math-intensive STEM fields with females presenting on average a lower probability to do so, about 5 percentage points lower

college (column 4). In this case, girls have a 14 percentage points lower probability of majoring in math-intensive fields than boys.

Table 8. Determinants of the probability of majoring in a math-intensive STEM field in college.

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Both W-J AP performance and self-perceived math ability are significant predictors of the likelihood of majoring in a math-intensive STEM field. Looking at column 2, we observe that both boys and girls performing on the highest percentiles of the W-J AP distribution, as compared to performing in the lowest percentiles, have a higher probability of majoring in a math-intensive STEM field of about 17 percentage points for boys and of about 9 percentage points for girls, allowing for the negative interaction term (-0.088). However, the interaction term with female is not statistically significant, suggesting that there might not be gender differences on the effect of higher levels of math performance on the probability of enrolling in a math-intensive STEM fields.

Concerning self-perceived math ability, reporting the highest levels of self-perceived math ability, as compared to the lowest levels, increases the probability of majoring in a math-intensive STEM fields by about 9 percentage points for males, while allowing for the point estimate on the female interaction term (-0.073), by only 2 percentage points for females. In this case, we observe an statistically significantly increase in the probability of enrolling in math-intensive STEM fields in college for girls who have high levels of self-perceived math ability. However, this increase for girls is lower than the increase for boys at the same level of self-perceived math ability. We observe similar results if we condition the sample to those who at least enroll in college (columns 5

with the likelihood of majoring in math-intensive STEM fields in college for girls, this effect is not statistically significant.

Table 9 presents results using a broader definition of STEM sciences. In accordance with the descriptive statistics presented above, we observe that, in this case, there is no disadvantage for females majoring in science. In fact, women are as likely as men to major in any of these STEM fields, when we use a broader definition of STEM and look at the whole sample (see columns 1, 2, and 3). Also, we mostly observe no statistically significant gender differences when studying only those who enroll in college (see columns 4, 5, and 6).

Table 9. Determinants of the probability of majoring in any STEM science in college.



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The W-J AP performance and self-perceived math ability continue to be statistically significant determinants of the probability of majoring in a science field. In this case, boys clearly benefit more than girls from the highest level of W-J AP achievement. Something to notice are the negative and statistically significant interaction coefficients in columns 2, 3, 5, and 6 between female and highest W-J AP level. These findings suggest a loss of STEM enrollment by otherwise capable women between 21 and 24 percentage points decrease in the probability of majoring in STEM.⁸ In this case, however, we do not find an statistically significant relationship between high self-perceived math ability and female.

Finally, having at least a parent or guardian working in a STEM-related occupation continues to have a positive, and in this case statistically significant, effect on the probability of majoring in any science field; this effect concentrates among females.⁹

whole sample, girls are between 34 and 36 percentage points more likely to major in any science field relative to boys (see columns 3 and 4) if they have a parent working in a STEM field. This parental effect is even higher when we focus on those who at least enrolled in college (see columns 5 and 6).

Discussion and conclusion

Despite predicted increasing labor opportunities and returns to the study in the STEM fields, i.e. Science, Technology, Engineering, and Mathematics, women remain underrepresented in certain STEM fields, at least when we focus on a narrow definition of STEM and consider only the math-intensive STEM fields (i.e. engineering, mathematics, and computer sciences). Research suggests that gender differences in math performance and self-perceived levels of math ability during childhood could be essential factors explaining this underrepresentation. Parental occupation type, a factor that seems less studied in the STEM gender gap literature, could also be an important factor in reducing women's underrepresentation in sciences. Differential parental investments in human capital development or direct role-modeling effects could be very different depending on having a parent working in a STEM-related field or not. In this paper, we use longitudinal data from the PSID to study the potential effect of these three factors on the decision of majoring in a STEM field in college.

Our results corroborate significant gender differences in math test scores and self-perceived math ability during childhood. Even after comparing boys and girls at the same level of math test performance, girls significantly report lower levels of self-perceived math ability than boys do. This finding is especially problematic among those in the tails of the math achievement distribution. Having at least a parent or guardian working on a STEM-related occupation is associated with a higher probability of performing on the highest percentiles of the math test score distribution, but not

math, as these patterns do not replicate when looking at performance and self-efficacy in reading.

Finally, all three factors, math achievement, self-perceived math ability, and parental occupation in STEM fields, are significant predictors of the probability of majoring in a STEM field in college. However, the estimated effects of high levels of math achievement and self-perceived math ability are bigger for boys than for girls. In the case of high math performance, this variable matters for the probability of enrolling in a broad definition of STEM fields in college, whereas in the case of high self-perceived math ability, this variable matters for the probability of enrolling in math-intensive STEM fields. The former finding suggests a loss in enrollment in STEM fields by otherwise qualified young women.

Although, we do not find statistically significant differences in the probability of majoring in math-intensive fields between high math ability girls and boys, girls who report high self-perceived math ability are less likely to major in math-intensive fields in college than boys who report high self-perceived ability. It could be possible that as girls grow up, they update their self-perceived ability better than boys do, and therefore, they think their math ability is not good enough to major in math-intensive fields. For example, a study from Goldin ([2013](#)), suggest that undergraduate female students react more strongly than boys to the grades they receive in an introductory to economics course reducing their probability of majoring in economics. Unfortunately, we cannot answer this question in our paper with the current data but it would be worth exploring it in future research.

In contrast, most of the observed positive effects of having at least a parent or guardian in a STEM occupation seem to concentrate among females, when considering a broad definition of STEM, which suggests that, although limited, there is intergenerational feedback accumulating through time that boosts the share of women in certain STEM fields.

science fields. Having a parent who works in a science-related occupation could help reduce some of these barriers by potential role-modeling effects or specific parental investments in STEM, which could help reduce gender stereotypes. Our results suggest that interventions designed to help parents promote the utility value of STEM in their children (see e.g. Harackiewicz et al., 2012; Rozek et al., 2017) could be promising in helping closing observed gender gaps in certain STEM fields but not those in the math-intensive with traditionally bigger gender gaps. Similarly to parents, teachers could also potentially have similar effects on STEM outcomes. Unfortunately, our data do not allow us to study this possibility. It would be good, however, for future research, to study the extent to which and under which circumstances teachers could have similar effects to parents in improving STEM outcomes for girls and how to better close remaining gender gaps in math-intensive fields.

Supplemental material

Supplemental Material

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Disclosure statement

No potential conflict of interest was reported by the author(s).

1 Technically, our occupational information refers to the head of the household and spouse who could be different from the parents of the child. However, in the 88% of the cases, the child is son or daughter of the head of the household or spouse. Therefore, we refer to this variable as parental occupation. The remaining percentage of cases represent situations in which the child is a stepson or stepdaughter of the head of the household, the head or spouse is a grandparent, or the child lives with other relatives.

2 The W-J AP test is a nationally-normed standardized assessment of mathematical thinking developed for ages 2–90. Thus, W-J AP and W-J BR scores are adjusted for age. For more information on the W-J AP test and other tests administered in the CDS module of the PSID see: https://psidonline.isr.umich.edu/publications/Papers/tsp/2014-02_Achievement.pdf

3 We also estimate our models using the STEM definition from the U.S. Census Bureau (USCB). The USCB counts as STEM computer and mathematical occupations, architecture and engineering occupations as well as life, physical and social sciences. However, we excluded social sciences, but include economics, in this definition. The results we obtain are similar to the ones we obtain using the definition from Ceci et al. (2014). Results are available from the authors upon request.

4 In the 2000 classification, these were occupations within the codes of 11, 30, 100–156, 170–172, 174, 176, 180, 192–194, and 493.

5 In the 2000 classification, these were occupations within the codes 160–180.

6 In addition to this classification, we replicate tables from 2 to 7 by disaggregating math and reading achievement into ventiles and self-perceived ability into the following categories: 1 and 2, 3, 4, 5, and, 6 and 7. Overall, we find that our general descriptive results do not depend on the classification we use. If we expand the

7 The omission of these observations does not change the results.

8 We replicate estimations in tables 8 and 9 interacting math ability with reading ability to assess whether or not there is an advantage of being high ability in these two subjects on the probability of majoring in STEM. We include these results in appendixes A2 and A3. Although prior studies find that there is an advantage (Riegle-Crumb et al., 2012; Wang et al., 2013), we do not find any evidence in our sample that suggests that being high ability in both subjects has an advantage overall and by gender.

9 We also estimate the models presented in Tables 8 and 9 but allowing for differential effects depending on the gender of the parent working in a STEM occupation. We find that both mother and father working in any STEM field have a positive and statistically significant effect, of similar magnitudes, on increasing girls' probability of majoring in any STEM field. The results are similar for majoring in math-intensive fields but they are not statistically significant. Overall, we do not find a differential effect depending on the gender of the parent working in a STEM field. These results are available from the authors upon request.

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