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Gender streaming and prior achievement in high school science and mathematics☆

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ABSTRACT

Girls choose advanced matriculation electives in science and mathematics almost as frequently as boys, in Israel, but are very much under-represented in physics and computer science, and over-represented in biology and chemistry. We test the hypothesis that these patterns stem from differences in mathematical ability. Administrative data on two half-cohorts of Israeli eighth-grade students in Hebrew-language schools links standardized test scores in mathematics, science, Hebrew and English to their subsequent choice of matriculation electives. It shows that the gendered choices they make remain largely intact after conditioning on prior test scores, indicating that these choices are not driven by differences in perceived mathematical ability, or by boys' comparative advantage in mathematics. Moreover, girls who choose matriculation electives in physics and computer science score higher than boys, on average. Girls and boys react differently to early signals of mathematical and verbal ability; and girls are less adversely affected by socioeconomic disadvantage.

1. Introduction

Under-representation of women in high-paying jobs in engineering and information technology (IT) contributes substantially to the gender wage gap in advanced industrialized economies (OECD, 2007). Excluding women from high-paying professions has clear equity implications, and may also undermine efficiency, if it leads to less-able men displacing more-able women in key professions that drive economic growth, or if it contributes to a shortage of qualified graduates in these professions. Similar patterns are observed in higher education where women account for a minority of engineering and computer science degrees and a majority of degrees in life sciences and health professions (Fig. 1). In Israel, women constitute 46.5% of the labor force but account for only 24% of employment in high-technology occupations (Fichtelberg-Barmatz, 2009); and while comprising over half of all degree recipients, receive fewer than 30% of degrees in computer science and engineering. Women have made huge strides in tertiary education, overtaking men in overall participation and in many fields of study (Goldin, Katz, & Kuziemko, 2006), but

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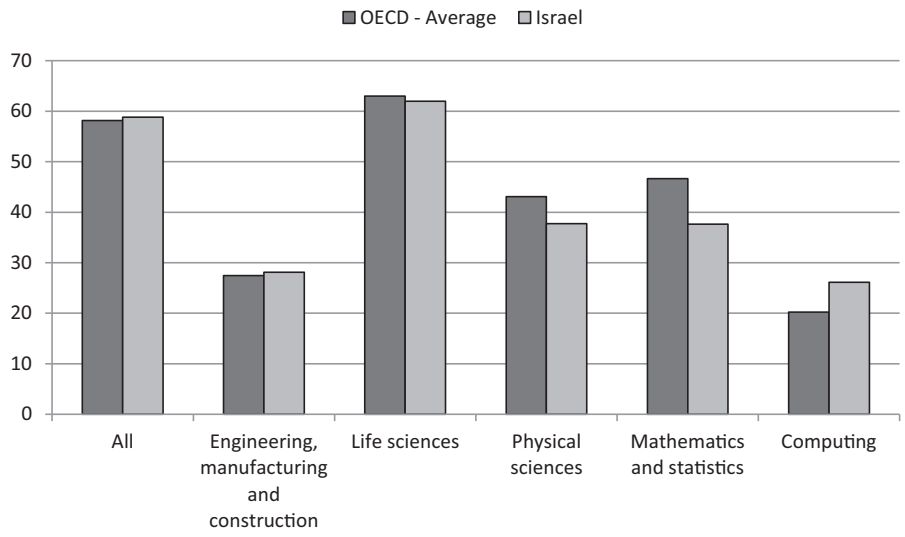

Fig. 1. Share of tertiary qualifications awarded to women in Israel and OECD countries within field of education, % Source: OECD (2011).

engineering, physical science and IT remain predominantly male preserves.

Career choices in general, and specifically the choice to specialize in Science, Technology, Engineering, and Mathematics (STEM) fields in secondary and tertiary education can be viewed as part of a dynamic process of successive decision making under uncertainty (Altonji, 1993; Altonji, Blom, & Meghir, 2012; Arcidiacono, 2004; Zafar, 2013). The mathematical intensity of fields in which women are under-represented has led many to assume that it is mathematics acting as a "critical filter", and males' absolute or comparative advantage in mathematics, that drives these patterns (Sells, 1973).[1] This has generated extensive research on whether and to what extent there is indeed a male advantage in mathematics. Findings indicate that males generally have a slight average advantage, which varies with age, cultural context, type of test and other factors, and in some cases disappears.[2] There is clearer evidence of a male advantage at the high end of the distribution of mathematics outcomes, as a result of the greater variability in male outcomes (Ellison & Swanson, 2010; Hedges & Nowell, 1995; Hyde et al., 2008; Pope & Sydnor, 2010; Xie & Shauman, 2003). Evidence of a male comparative advantage in mathematics is similarly robust and persistent, as the female advantage in language skills is everywhere greater than any male advantage in mathematics (Fryer & Levitt, 2010; Goldin et al., 2006; Wang, Eccles, & Kenny, 2013).

Several studies have tested the "critical filter" hypothesis directly with regard to the choice of college major in the United States, among them Turner and Bowen (1999), Xie and Shauman (2003), Riegle-Crumb and King (2010) and Riegle-Crumb, King, Grodsky, and Muller (2012) found that significant gender gaps in choice remain after controlling for high school and SAT achievement. In this paper, we use longitudinal data to test this hypothesis directly at an earlier stage of education: the choice of advanced science and mathematics electives by high-school students in Israel, a country with patterns of gender streaming in the choice of tertiary degree fields that closely follow the OECD averages (Fig. 1). To this end, we follow two half-cohorts of eighth-grade students in Israeli Hebrew language schools, for whom we have standardized eighth-grade test scores in mathematics, Hebrew, science and English, to the twelfth-grade, when they are tested in matriculation electives chosen during the three years of high school.[3]

[1] As Ceci, Ginther, Kahn, and Williams (2014, p. 75) summarize the extensive literature on women in academic science, "women are underrepresented ... in those fields that are the most mathematically intensive."

[2] On the United States, see, e.g., Fryer and Levitt (2010), on the emergence of a gap in the early years of elementary school; and Pope and Sydnor (2010) on middle and high school. Among international studies, TIMSS 2003 indicates a gap favoring boys in OECD countries (Bedard & Cho, 2010), which does not extend to all participating countries (Else-Quest, Hyde, & Linn, 2010; Kane & Mertz, 2012) while PISA shows a general advantage for boys (Else-Quest et al., 2010; Guiso, Monte, Sapienza, & Zingales, 2008). Meta-analyses covering a wide range of ages, test types and nationalities (Hyde, Fennema, & Lamon, 1990; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg, Hyde, Petersen, & Linn, 2010) find a large dispersion of findings with a small average advantage for boys. Over time, average gaps favoring boys have decreased (Ceci et al., 2014; Goldin et al., 2006; Neuschmidt, Barth, & Hastedt, 2008). In Israel, boys show a slight advantage in PISA and TIMSS 2003 mathematics while girls slightly outperform boys in TIMSS 2007 and on curriculum-based national eighth-grade mathematics tests.

[3] We follow two halves of full national cohorts of eighth-grade students in Hebrew-language schools in two successive years, excluding students in ultra-orthodox schools that do not participate in these tests. We focus on Hebrew-language schools because of the the large cultural difference between the Jewish and Arab populations, not least in repect to gender roles. We investigate these differences as they affect choice of science subjects in high school in a separate paper (Friedman-Sokuler & Justman, 2016). Matriculation electives are chosen in tenth grade, and most tests are administered at the end of grades eleven and twelve.