How Early Adolescent Skills and Preferences Shape Economics Education Choices

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Women remain underrepresented in Science, Technology, Engineering and Math (STEM) and math-intensive fields such as economics, particularly in more advanced degrees (Hoover and Washington, 2021). Moreover, the gap is more pronounced in economics than many other STEM fields (Avilova and Goldin, 2018; Bayer and Rouse, 2016). What drives this gap is not well understood.

Leveraging administrative data from Sweden and field experimental data from Chicago, this paper studies the educational pipeline from adolescence through college for STEM and economics majors to better understand the potential determinants of the gender gap, and when these determinants first arise. We focus on three findings. First, we show that women are less likely to select into STEM courses in high school, despite equal or better prior preparation in terms of course choices and grades.[1]

Second, we provide descriptive evidence of important gender differences in preferences and beliefs in grade school, even conditional on ability. While there is no gender gap in 3rd-8th grade math test scores, we find that girls are less likely to report liking math, finding math easy, or being good at math than boys who have the same math scores. On the other hand, girls achieve higher language test scores by 3rd grade, and they are more likely to take advanced language courses by 7th grade.

Third, using Gelbach (2016) decompositions, we show that the early differences in preferences and beliefs explain more of the gaps in high school sorting than other candidate variables. In turn, high school sorting explains a large portion of the gender difference in attaining a college degree in STEM. For economics, high school sorting explains less of the gap, most likely because economics programs draw from both STEM and non-STEM tracks in high school.[2]

Our results suggest that early preferences and beliefs are key to understanding how gender differences in language and STEM first appear in grade school and high school, respectively. These initial gaps accumulate as preferences and beliefs drive further specialization in high school and college.

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[1] Hyde et al. (2008) and Lindberg et al. (2010) report similar findings.

[2] Our findings complement and expand Joensen and Nielsen (2016) who find that women who take more advanced STEM courses in high school become more likely to acquire a STEM college degree, Delaney and Devereux (2019) who find that course *choices* in secondary school rather than grades explain the gender gap in STEM in college, and Angelov et al. (2019) and Wiswall and Zafar (2015) who find that tastes and expectations of college students are important predictors of which fields students choose to study.

I. Data

To generate our insights, we use data from both Sweden and the United States. The Swedish data are from administrative records for the population of students who completed compulsory schooling (9th grade) in 1988-97. We merge the ninth grade, high school, and higher education registers to obtain longitudinal education histories. We supplement these data with the Evaluation Through Follow-up (ETF72) survey focusing on 3rd through 9th grade for the oldest cohort in our sample.[3] This enables us to explore early choices, early test scores, socio-emotional skills, preferences, beliefs, self-perceptions, investments, and socioeconomic background.

The U.S. data were collected as part of the U-Program (UProg) field experiment conducted in 7th-8th grade classrooms in the South Chicago suburbs during the 2016/2017 school year (Joensen et al., 2020). The majority of our sample consists of racial and ethnic minorities (75% Black, 20% Hispanic) and low-income households who are eligible for free or reduced-price lunches (69%-96% in the three schools studied). From this data set, we use information on student test scores, school administrative data on grades and course choices, as well as self-reported survey data eliciting socio-emotional skills, attitudes towards mathematics and other subjects, study habits and other investments, and the students' plans and beliefs about their future.

II. Results

In the Swedish data, conditional on college graduation, we find that men are 41% more likely to be economics majors.[4] Conditional on choosing an economics major, men are 39% more likely to pursue an economics PhD.

Earlier education choices drive some of the differential sorting into college major. In Sweden, students choose high school tracks after completing compulsory schooling (9th grade), which allows them to specialize in specific subject areas. Among students who enroll in "academic" tracks, men are almost 40 percentage points more likely to enroll in a STEM track than women (see Table 1). This sorting in high school may leave women less well prepared to study STEM or economics in college. For example, women with an economics degree are 13 percentage points less likely to have taken the STEM track in high school.

Gender differences in the sorting into high school STEM tracks do not appear to be driven by prior preparation. Girls are more likely to take advanced English in 7th-9th grade and score higher on language tests as early as 3rd grade. Moreover, girls are equally likely to take advanced math in 7th-9th grade, and have higher math grades and overall GPA. Girls and boys also have similar math test scores in 3rd through 8th grade in both the Swedish and U.S. data (see e.g. the distributions of math test scores in Figure 1).

While differences in preparation before high school are small, boys and girls report notably different preferences and beliefs about math in 6th-8th grade. Figure 1 shows that nearly everywhere in the distribution of math test scores, girls are less likely to report liking math, less likely to report finding math easy, and less likely to report being good at math.[5]

Finally, we conduct a decomposition exercise to evaluate the relative explanatory power of various groups of variables in explaining the gender gap at various stages in the educational pipeline. Using Gelbach (2016) decompositions, Table 1 reports the overall and regression-adjusted gaps starting at the point where the gaps first appear: (i) taking advanced English in 7th grade, (ii) taking advanced English in 9th grade, (iii) 9th grade standardized math tests, (iv) taking a STEM track in high school (conditional on taking an academic track), (v)

[3]See Härnqvist (1998) for details on the survey.

[4]We focus on 4-5 year college degrees in Sweden.

[5]See the Online Appendix for evidence that a similar gap does not exist in spelling, reading, and the external point of view, where students are asked if their teacher thinks they are good at math.

majoring in a STEM field (conditional on college graduation), and (vi) majoring in economics (conditional on college graduation).

We use the ETF72 sub-sample to investigate grade school and high school gaps using rich information on several measures: (a) 7th grade choices; (b) 9th grade choices and performance; (c) high school choices and performance; (d) preference and belief measures; (e) earlier test scores; (f) earlier investments; (g) socio-emotional measures; and (h) other background and location characteristics.[6] We use the full Swedish data to investigate how early gaps account for later gender gaps in college. While girls and boys are equally likely to take advanced math in 7th-9th grade, girls are 11% more likely to take advanced English in 7th grade, and 14% more likely to take advanced English in 9th grade. The decomposition shows that preferences and beliefs explain a large part of the gap in 7th grade and 9th grade advanced English choices. The 9th grade choice also depends strongly on the choices made in 7th grade.

We begin to see a gap in math in 9th grade, with women scoring 0.18 standard deviations lower on standardized math tests. The decomposition reveals two counteracting mechanisms. On the one hand, accounting for prior academic choices and investments leads to an even larger gap. Alternatively, accounting for preferences and beliefs reduces the gap so that the two almost exactly cancel each other out.

The gap in 9th grade math test scores contributes to the gap in future high school and college choices. In each case, the gaps in preferences and choices accumulate. Conditional on attending academic high school, men are 40 percentage points more likely to take a STEM track. Our measures can account for about a quarter of this gap. As before, preferences and beliefs account for an important part of this gap, but now the 9th grade choices, test scores, and GPA also contribute to the large gap in high school choices. The last two columns of Table 1 show the decomposition for college degrees. Choices and grades in 9th grade and high school account for almost half of the gender gap in STEM majors. While performance in 9th grade and high school contribute to the college STEM gender gap, the majority of the explained gap (85%) is due to earlier choices. For economics, while 9th grade choices explain part of the gap, high school track choices *add* to the gap.

III. Discussion

In this study, we take a step towards better understanding how and why individuals sort into economics and STEM fields by focusing on early preferences and beliefs. Prior to high school, girls have higher GPAs and score equally well on math tests, but are less likely to report liking math, finding math easy, or believing they are good at math. These early beliefs and preferences predict specialization in high school, which is then an important determinant of the gaps in eventually studying STEM in college.

Our results highlight the important role that early preferences and beliefs play in human capital accumulation, and how this affects sorting into STEM and economics education for men and women. We leave several important questions for future research, such as the role of expected future earnings, or what drives gender differences in preferences and beliefs in the first place.[7]

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[6]See the Online Appendix for more details on variable definitions and descriptive statistics.

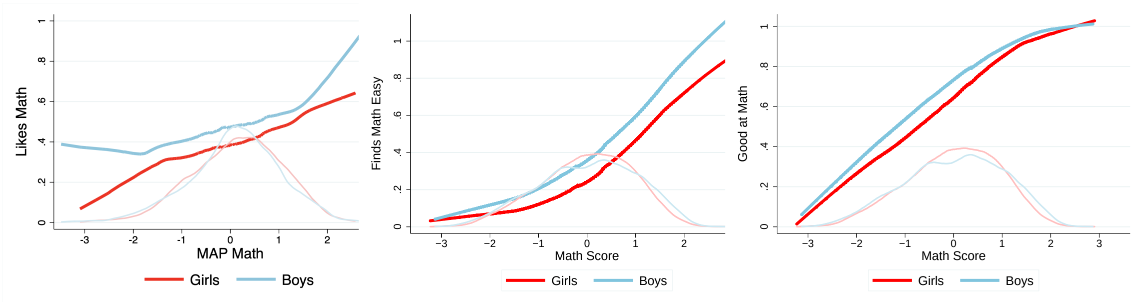
[7]Other studies in this symposium take on some of these questions, such as Chuan et al. (2022).

Table 1—: Gelbach Decomposition of Gender Differences in Selected Outcomes

	7th Adv English	9th Adv English	9th Math Test	HS STEM	STEM Major	Econ Major
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Gender diff. $(\overline{Y}_M - \overline{Y}_W)$						
Base	-10.76	-14.21	18.15	39.59	28.18	0.69
	(0.95)	(1.01)	(2.39)	(2.05)	(0.23)	(0.06)
Full	-7.09	-5.24	18.07	30.55	14.73	0.92
	(0.91)	(0.85)	(2.08)	(2.48)	(0.22)	(0.06)
Avg. outcome, Women $(\overline{Y}_W)$	78.52	74.65	-9.55	25.55	22.94	0.99
	(0.95)	(0.72)	(1.71)	(1.41)	(0.15)	(0.04)
Gelbach Decomposition						
7th grade choices		-4.79	-1.39	-0.01		
		(0.48)	(0.32)	(0.23)		
9th grade choices				1.60	1.08	0.04
				(0.50)	(0.04)	(0.01)
9th grade TS & GPA				2.46	1.91	-0.00
				(1.28)	(0.05)	(0.01)
HS choice					10.40	-0.25
					(0.12)	(0.02)
HS GPA					0.05	-0.01
					(0.01)	(0.003)
Preferences and beliefs	-3.16	-2.33	1.69	3.14		
	(0.43)	(0.31)	(0.75)	(0.92)		
Early TS	-1.23	-0.98	0.43	0.85		
	(0.31)	(0.26)	(1.32)	(0.39)		
Investments	0.37	-0.08	-1.13	-0.14		
	(0.39)	(0.37)	(0.89)	(1.05)		
Socio-emotional	-0.07	-0.71	0.47	0.89		
	(0.38)	(0.35)	(0.87)	(0.95)		
SES/Race/Ethnic	0.07	0.05	0.11	0.22		
	(0.07)	(0.08)	(0.11)	(0.15)		
Location/School	0.35	-0.13	-0.10	0.01		
	(0.24)	(0.13)	(0.40)	(0.38)		
ETF72	✓	✓	✓	✓		
ALL					✓	✓

Notes: The top part of this table shows the gender difference in selected outcomes in a linear regression model with no controls ("Base") and the full set of explanatory variables ("Full"). The bottom part of the table shows the Gelbach (2016) decomposition for groups of pre-determined variables. The Gelbach decomposition uses the omitted variables bias formula to perform a conditional decomposition for the role of different groups of controls on a parameter of interest. The columns refer to the following outcomes: (i) "7th Adv. English" refers to the probability of taking advanced English in 7th grade. (ii) "9th Adv. English" refers to the probability of taking advanced English in 9th grade. (iii) "9th Math Test" is the standardized national math test score in 9th grade. (iv) "HS STEM" refers to the probability of taking the STEM academic track in high school conditional on enrolling in an academic high school. (v) "STEM Major" and (vi) "Econ Major" refer to the probability of having a college major in Engineering, Math, or Science or in Economics, respectively, conditional on attaining a college degree. All numbers are multiplied by 100 to be percentages. See the Online Appendix for an extended version of this table which includes "7th Adv Math", "9th Adv Math", and "9th English Test", and for figures visualizing the results.

Figure 1. : Math Preferences over the Math Test Scores Distribution



(a) UProg: Like math (b) ETF72: Math easy (c) ETF72: Good at math

Notes: This figure shows the fraction of students responding that math is their favorite subject ("Like math"), that they find math easy ("Math easy"), and that they are good at math ("Good at math") over the distribution of early math ability. Math ability is measured by the standardized MAP Math test score in the UProg data in panel (a) and in the ETF72 data in panels (b) and (c) early math test scores are the standardized average of the total points on the two math aptitude tests in 3rd grade (spatial and mathematical ability) and the three math aptitude tests in 6th grade (inductive, spatial, and mathematical ability tasks 1-19). The blue line refers to boys and the red line refers to girls.

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