

Why do women so rarely become STEM professionals?

On the significance of the difference between mathematics skills and self-concept

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Introduction

- Since decades, Switzerland has a shortage of professionals in STEM occupations (Science, Technology, Engineering, Mathematics).
- Furthermore, there is huge gender gap in STEM.
- Consequently, existing educational policy tries to make STEM training more attractive for females.
- These efforts have only been mildly successful so far. Occupational gender segregation remains very pronounced in the Swiss labor market.
- Why is occupational segregation so persistent? In particular, why do women so rarely decide to become a STEM professional?

Hypotheses

- Generally, occupational gender segregation may have various causes (e.g. interplay between labor market and family policy, stereotypes, gendered education, ...).
- With respect to STEM, however, gender-specific skills in math and analytic thinking will be relevant.
- It is very obvious:
 - ▶ Women are not fit for math and this is why they do not want to become STEM professionals.
 - ▶ Probably something about the brain; let's ask the evolutionary biologists.
- Well, as social scientists we don't like this explanation.

Hypotheses

- Self-fulfilling prophecy:
 - ▶ Even if we do observe a gender difference in math skills, this does not mean that there is a (biological) difference in talent.
 - ▶ It seems obvious that gender stereotypes affect socialization and math learning.
 - ▶ For example, there is evidence that the behavior of teachers matters (e.g. gender bias grading).
 - ▶ Also, stereotypes will affect the effort that children put into their math learning.
 - ▶ As a consequence, the stereotype becomes true.

Hypotheses

- The role of the mathematical self-concept:
 - ▶ We further argue that gender stereotypes affect how women and men evaluate their own skills (“It can not be what may not be”).
 - ▶ In particular, we argue that women underestimate their math skills compared to men. That is, on average, among women and men with identical math skills, women are less confident in their skills than men.
 - ▶ Because women “think” that they are not good at math, they are opposed against STEM, even if they would have the necessary skills.
- This is the hypothesis that we want to test in this paper.
 - ▶ Can we find evidence for such a gendered evaluation of one’s own skills?
 - ▶ Do educational decisions depend on such a gender-bias?

1 Motivation

2 Data and Methods

3 Results

4 Conclusions

Data

- AES 2016 (Assessment of the Attainment of Educational Standards; ÜGK): Baseline measurement of math skills, mathematical self-concept, and occupational aspirations among a sample of over 20'000 school leavers (at about age 15).
- Wave 1 of the second cohort of TREE (Transitions from Education to Employment): Information on the actual educational situation one year after leaving school for a subsample of these school leavers.
- The analysis only includes respondents who provided a valid answer to the question on their likely job when they will be 30 years old (75% of respondents). No evidence that this introduces a gender bias into the results.

Measures

- Measure of math skills: WLE score from the extensive AES math assessments covering the Swiss curriculum.
- Two measures for the mathematical self-evaluation
 - ▶ general “self-concept” (agreement with questions such as “I am good at math” etc.)
 - ▶ specific “self-efficacy” (“How likely can you solve the following tasks?”); for simplicity, we use the arithmetic mean from four subscales (calculation, algebra, geometry, probabilities)
- Two measures for STEM aspiration
 - ▶ AES 2016: classification of the “job at the age of 30” into STEM professionals (at tertiary education level) and other occupations
 - ▶ TREE: classification of current educational track into tracks that likely lead to a STEM profession and other tracks

Methods

- We quantify under- and overestimation of one's own skills by comparing respondents' ranks in the distribution of skills and the distribution of self-evaluations.
 - ▶ A positive rank difference points to a relative overestimation, a negative difference points to a relative underestimation.
 - ▶ If there is no gender bias in self-evaluation, the average rank difference will be zero for both men and women.
- To quantify the effect on STEM aspirations, we conduct Oaxaca-Blinder decompositions (for binary dependent variables) accounting for skills as well as the rank differences between skills and self-evaluation.

1 Motivation

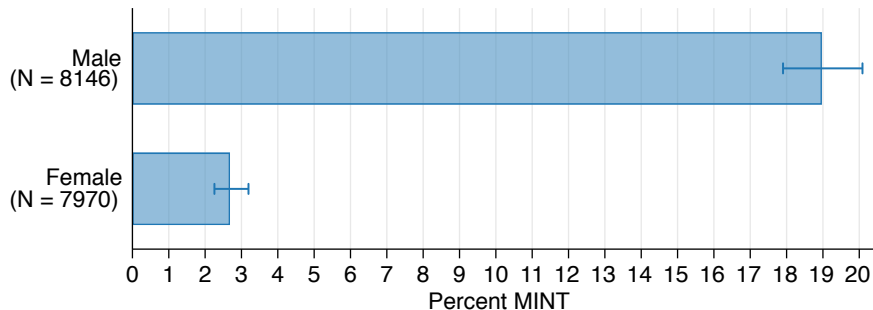
2 Data and Methods

3 Results

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Raw gender difference in STEM aspirations

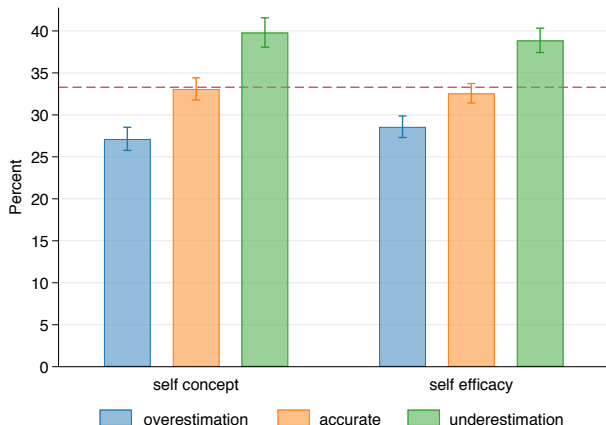
- Gender gap in STEM aspirations (job at 30)



- The gender difference is about 16 percentage points.

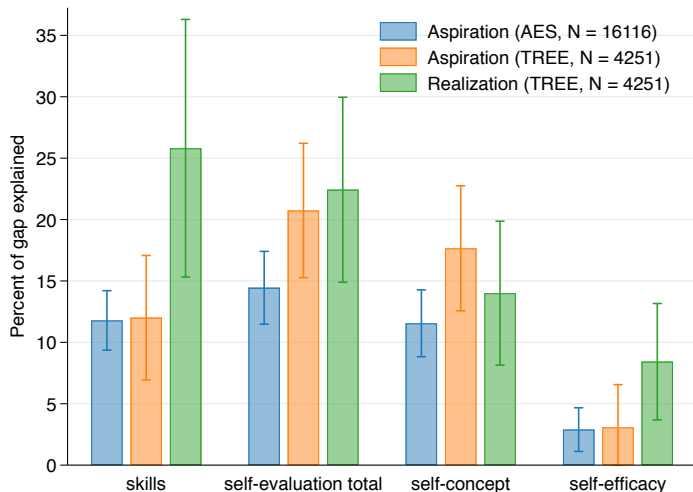
Gender bias in mathematical self-evaluation

- Distribution of females across terciles of rank differences between skills and self-evaluation



[The gender gap in average rank differences is 11 and 7 points, respectively. Correlation between self-evaluation and skills is 0.35 and 0.60, respectively.]

Explanation of STEM gender gap (OB decomposition)



[using rank differences between skills and self-evaluation; results show contribution of gender gap in self-evaluation over and above skills gap]

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Conclusions

- Skill differences between women and men explain some of the gender gap in STEM aspirations/choice (although, of course, these skill differences may already be a result of stereotypes affecting learning).
- Also the self-evaluation of these skills plays an important role: females are less likely to choose STEM because they underestimate their skills compared to men.
 - ▶ That is, women's lower preference for STEM fields is related to their lower confidence in their mathematical skills, independently from their true skills.
 - ▶ The general self-concept seems more important for aspirations; for the realized educational choice, the specific self-efficacy becomes more important.
- The difference in the self-concept is most likely due to gender stereotypes; hence, at least part of the gender STEM gap is due to gender stereotypes that affect women's confidence in their own skills.

More information

- Jann, Ben, Sandra Hupka-Brunner (2020). Falsche Selbsteinschätzung hält Frauen von technischen Berufen fern. *Die Volkswirtschaft* 93(3): 41–44.
[link to online publication]
- Jann, Ben, Sandra Hupka-Brunner (2020). Warum werden Frauen so selten MINT-Fachkräfte? Zur Bedeutung der Differenz zwischen mathematischen Kompetenzen und Selbstkonzept. *Swiss Journal of Educational Research* 42(2): 391–413.
[link to working paper; DOI:10.7892/boris.134223]