PIPELINE VS. CHOICE: THE GLOBAL GENDER GAP IN STEM APPLICATIONS

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Abstract
Women account for only 35% of global STEM graduates, a share unchanged for a decade. We use administrative microdata from centralized university admissions in ten systems to deliver the first cross-national decomposition of the STEM gender gap into a pipeline gap (academic preparedness) and a choice gap (first-choice field conditional on eligibility). In deferred-acceptance platforms where eligibility is score-based, we isolate preferences from access. The pipeline gap varies widely, from -19 to +31 percentage points across education systems. By contrast, the choice gap is remarkably stable: high-scoring women are 25 percentage points less likely than men to rank STEM first.

Keywords: gender inequality, STEM gender gap, centralized application platforms
JEL codes: I23, I24, N30

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1 Introduction

Despite decades of progress in educational attainment, women remain substantially underrepresented in science, technology, engineering, and mathematics (STEM). In 2024, they accounted for only 35% of STEM graduates worldwide—a share that has barely moved in a decade (UNESCO, 2024). Explanations for this persistence are typically grouped into two channels: a *pipeline* channel—gender differences in academic preparation and access to selective STEM programs (Card and Payne, 2021; Aucejo and James, 2021; Humphries et al., 2023)—and a *choice* channel—gender differences in preferences for program characteristics and the labor-market trajectories they imply (Zafar, 2013). Distinguishing pipeline from choice is empirically difficult, since it requires observing both program-specific eligibility and students' ranked application decisions.

This paper meets that challenge by leveraging administrative microdata from centralized admissions systems in ten settings across five continents—Australia, Brazil, Chile, China, Finland, Greece, Spain, Sweden, Taiwan, and Uganda. Despite vast differences in population size, economic development, and gender norms, these systems share a critical institutional feature: universities allocate seats through coordinated platforms in which students submit ranked preferences over college–major combinations and are assigned to the highest-ranked option for which they are eligible. Eligibility is determined almost exclusively by standardized exams and high school grades, while the deferred-acceptance-style assignment mechanisms ensure that preferences are reported truthfully. This institutional design provides two key advantages: (i) we directly observe students' ordered lists of applications, revealing their field preferences; and (ii) because eligibility is score-based, students with identical academic performance face equal admission probabilities, allowing us to isolate choice behavior holding access constant.

We first document a STEM gender gap across all settings. Among students in the top 10% of the admission exam distribution, women account for an average of only 34% of STEM applicants, mirroring global statistics (UNESCO, 2024). The gap ranges from 19% in Taiwan to 47% in Sweden.

We then ask whether these disparities reflect differences in the pipeline or in choices. We define the *pipeline gap* as the difference in female vs. male representation among top-decile students, and the *choice gap* as the difference in the share of high-achieving women and men who rank a STEM program first. The pipeline gap varies widely: in Uganda, women make up only 40% of top scorers (–20 percentage points), while in Sweden they account for 65% (+30 points).

By contrast, the choice gap is large and negative in every context: high-scoring women are systematically about 25 percentage points less likely than men to apply to STEM. Remarkably, this consistency holds despite large differences in population size, economic development, and gender norms. This stability across contexts is our central empirical finding.

The stability of the choice gap across diverse institutional and cultural settings points to deeper structural forces rather than local conditions. This pattern is consistent with a growing body of research showing that preferences play a central role in major choice: students—and especially women—systematically weigh pecuniary and non-pecuniary attributes differently (Zafar, 2013; Wiswall and Zafar, 2018; Patnaik et al., 2021). Yet the fact that high-achieving women are equally less likely to apply to STEM in Sweden and

Spain as in Uganda presents a puzzle: if the choice gap were primarily driven by mechanisms we expect to vary sharply across contexts (such as anticipated discrimination, family formation penalties, or gender norms), then the gap should be wider in Uganda than in Sweden. Its stability therefore highlights the need to identify persistent, globally operating mechanisms shaping women's educational choices.

Our contribution is to bridge two strands of research. A first strand disentangles pipeline and choice within single settings (e.g., Ontario; Card and Payne 2021), but their narrow scope limits external validity. A second strand, typically in the form of international reports (OECD, 2017; Encinas-Martin and Cherian, 2023; UNESCO, 2024), documents STEM gender gaps across education systems but cannot separate pipeline from choice due to data limitations. By harmonizing centralized admissions data from ten contexts, we provide the first systematic cross-national decomposition of the STEM gender gap into pipeline and choice components. We show that while pipeline gaps vary considerably, the choice gap is strikingly stable, pointing to structural drivers that transcend local institutions and norms. These findings suggest that closing academic performance gaps, though important, will not by itself eliminate gender disparities in STEM.

2 Data and Empirical Strategy

This paper examines gender differences in representation among STEM applicants across ten settings that considerably differ in population size, economic development, inequality, and gender norms. A key feature that all these settings share is the use of centralized university admission systems, where admissions depend on the ranked list of preferences that students submit and on their academic performance. This institutional structure means that students with similar scores in admission exams face similar admission probabilities.

Leveraging these features, we focus on high-achieving students, defined as those scoring in the top 10% of their cohort on the mandatory sections of college admission exams. These students are most likely to gain admission to and succeed in selective STEM programs, which are associated with large economic and social returns.

We define programs as STEM based on the 2013 two-digit ISCED code, grouping programs in Engineering and Manufacturing, Information and Communication Technologies, and Natural Sciences and Mathematics under this category. Since the maximum number of programs that applicants can include in their preference lists varies across settings, we concentrate on each student's top-ranked choice.

Our analysis begins by characterizing the gender composition of high-achieving STEM applicants across our ten settings. We then decompose these gender differences by examining two gaps:

1. The pipeline gap: difference between women's and men's representation among students scoring in the top 10% of the admission exam distribution.

2. The choice gap: difference in the share of high-achieving women and men who rank a STEM program as their top choice.

We conclude by examining whether these gaps correlate with gender norms as measured by the World Economic Forum Gender Parity Index (GPI).

3 Results

3.1 Female and Male Representation among High-Achieving STEM Applicants

Figure 1 illustrates the share of female and male students among high-achieving STEM applicants. In all settings, the female share is lower than the male share. However, there are large differences across the educational systems we study. In five out of the ten settings in our sample, female students represent 30% or less of high-achieving STEM applicants. Taiwan, with a female share of 18.7%, has the lowest female representation among high-achieving STEM applicants. In contrast, Spain, Australia, Greece, and Sweden—with STEM female shares ranging between 42.6% and 46.4%—are the settings with the highest female representation among high-achieving STEM applicants.

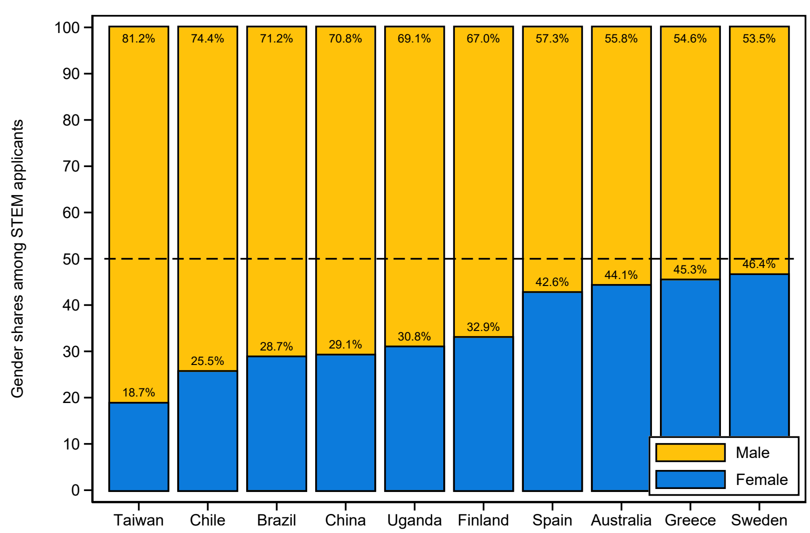

Figure 1. *Gender Shares among STEM applicants (top 10% students)*

What drives these gender disparities and their variation across settings? Female under-representation among high-achieving STEM applicants could stem from two distinct sources: the *pipeline gap*—women being underrepresented among the high-scoring students who qualify for selective programs—or the *choice gap*—high-achieving women being less likely than their male counterparts to select STEM fields when applying to university. To disentangle these mechanisms, we next analyze each gap separately across our diverse settings.

3.2 The Pipeline Gap

Figure 2 illustrates the *pipeline gap*. The bars in the top panel represent the share of female students in the top 10% of the academic performance distribution. As women represent roughly 50% of the population, bars under 50% indicate that women are under-represented among high-achieving students. The bars in the bottom panel represent the pipeline gap—i.e., the difference between female and male shares in the top 10%.

In four out of the ten settings we study—Brazil, Chile, Taiwan, and Uganda—female students are under-represented in the top 10% of the academic performance distribution. Uganda—with a female share of 40.4%—has the largest negative pipeline gap (19 percentage points). In the other six settings—Australia, China, Finland, Greece, Spain, and Sweden—the pipeline gap is positive. This means that there are more female than male students in the top 10% of the academic performance distribution. Sweden—with a female share of almost 66%—is the setting with the highest proportion of women among high-achieving students and the largest positive pipeline gap (31 percentage points).

When comparing Figures 1 and 2, it becomes clear that the *pipeline gap* cannot fully explain differences in gender representation among STEM applicants. Even in settings where women outnumber men among high-achieving students, female representation among STEM applicants remains lower than male representation. This indicates that factors beyond academic performance are influencing gender disparities in STEM applications.

3.3 The Choice Gap

Figure 3 illustrates the *choice gap*. The bars in the top panel illustrate the share of high-achieving female and male students who rank a STEM program at the top of their application list. The bars in the bottom panel illustrate the *choice gap*—i.e., the difference between female and male shares.

In contrast to the significant cross-setting differences observed when studying the *pipeline gap*, the *choice gap* is remarkably similar across the settings in our sample. In all of them, high-achieving female students are considerably less likely to rank a STEM program at the top of their list than high-achieving male students. In seven of the ten educational systems that we study, female students in the top 10% of the academic performance distribution are between 22 and 26 percentage points less likely than their male counterparts to rank a STEM degree at the top of their list. On the extremes, we find that Australia has the smallest (16 percentage points) and China has the largest (36.7 percentage points) *choice gap*.

The striking consistency of the *choice gap* across settings that differ substantially in size, economic development, and cultural context raises an important question: to what extent do broader societal factors, such as gender norms, explain the variations we observe in both the pipeline and choice gaps? We explore this question next by examining the relationship between these gaps and a standardized measure of gender parity.

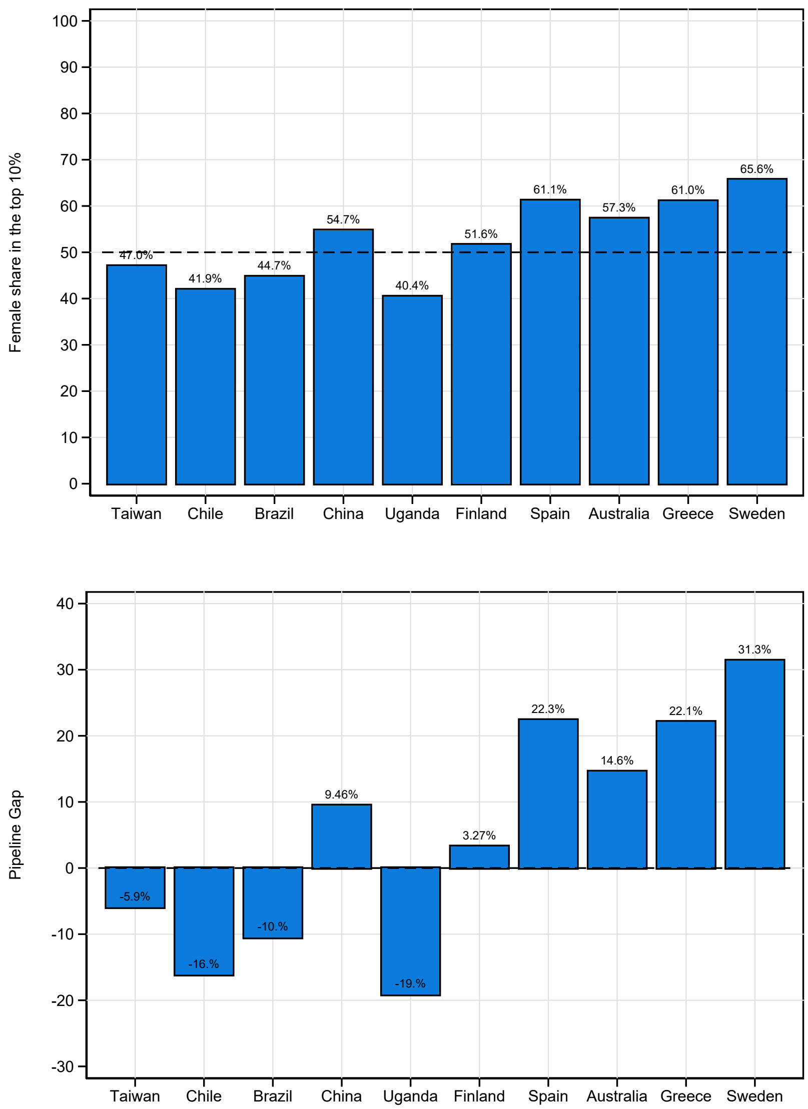

Figure 2. *Share of Female Students in Top 10% and the Pipeline Gap*

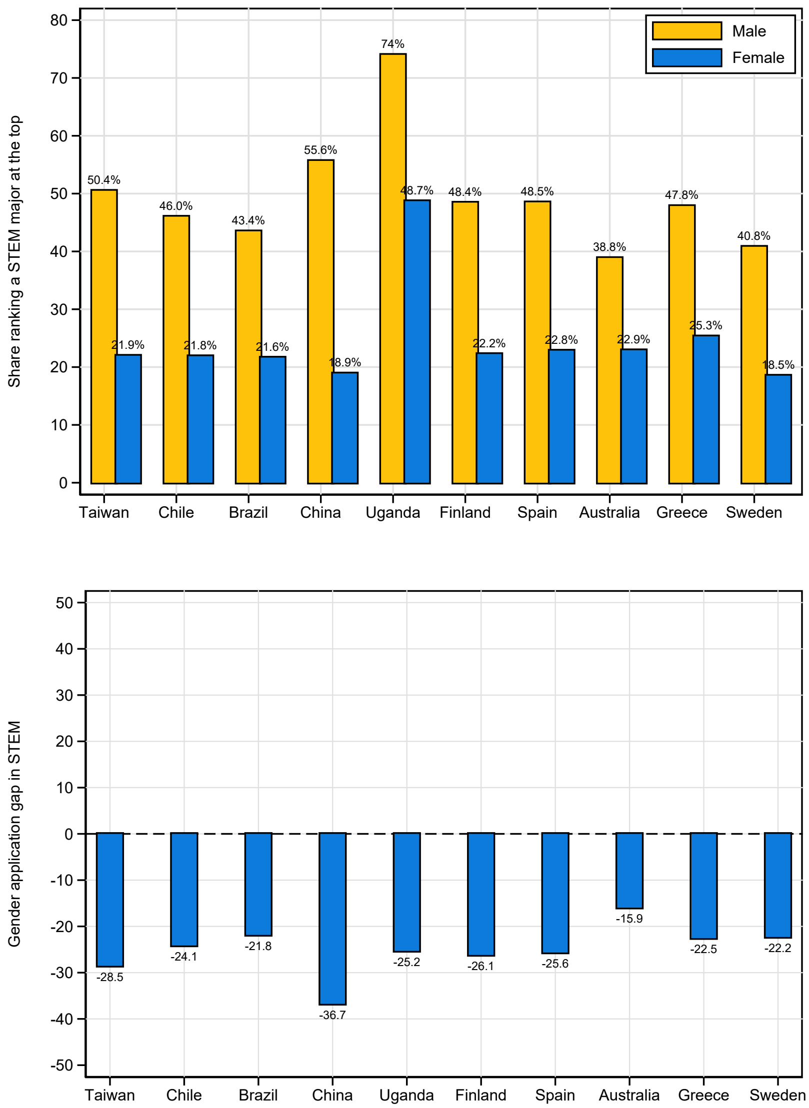

Figure 3. *The Gender Choice Gap in STEM (Top 10% Students)*

3.4 The Pipeline Gap, The Choice Gap, and Gender Norms

Gender norms are often cited as a potential driver of differences in educational outcomes of female and male students (Akerlof and Kranton, 2000; Guiso et al., 2008; Bertrand, 2020). To explore whether this hypothesis has some support in our data, we study correlations between the *pipeline* and *choice gaps* and gender norms measured by the Gender Parity Index (GPI) computed by the World Economic Forum. Figure 4 plots these relationships.

Consistent with Guiso et al. (2008) and Fryer Jr and Levitt (2010), we find that in contexts with more gender parity, female representation among high-achieving students is higher. In fact, an increase of one standard deviation in the GPI distribution (0.062) increases the *pipeline gap*—female minus male shares in the top 10%—by 3.9 percentage points. In settings with higher gender parity such as Sweden, Finland, Spain, and Australia, women significantly outnumber men among top-performing students. This positive association between the pipeline gap and gender parity suggests that more equitable gender norms may help narrow academic performance differences. However, substantial unexplained variation indicates that other factors are also at play.

The correlation between the *choice gap* and gender parity is much weaker. An increase of one standard deviation in the GPI distribution (0.062) reduces the difference between the share of female and male students ranking a STEM degree at the top of their list by only 1.8 percentage points. Moreover, this modest association is strongly driven by one data point—China. Indeed, if we remove China from the analysis, the association becomes much weaker—less than a third of the original size.

This weak relationship is unsurprising, given that the gender choice gap remains remarkably consistent at approximately 25 percentage points across most settings, regardless of their gender parity levels. Our findings thus suggest the existence of persistent factors beyond gender norms—as captured by the GPI—that influence female underrepresentation in STEM fields, highlighting the need to identify these underlying mechanisms to effectively address gender imbalances in educational trajectories.

4 Conclusion

The gender inequalities we document in university applications have important implications for both equity and efficiency. Since returns to higher education vary substantially across fields, the underrepresentation of women in STEM—where returns are especially high—likely contributes to persistent gender gaps in the labor market. From an efficiency perspective, improving the gender balance in applications across fields could lead to a better allocation of talent and ultimately boost economic growth. Attracting more women into high-skill fields where they have been historically underrepresented could therefore yield substantial gains in productivity and aggregate output (Hsieh et al., 2019; National Science Foundation, 2017; Weinberger, 1999; Hoogendoorn et al., 2013).

A central contribution of this paper is to decompose women's underrepresentation in STEM into a *pipeline gap* and a *choice gap*. The pipeline gap varies widely across countries—from a 20 percentage-point deficit in Uganda to a 30-point advantage in Sweden. By contrast, the choice gap is remarkably stable: in every setting, high-achieving women are roughly 25 percentage points less likely than men to rank a STEM program first. This decomposition shows that narrowing academic performance gaps, while valuable, is insufficient on its own to close gender disparities in STEM representation.

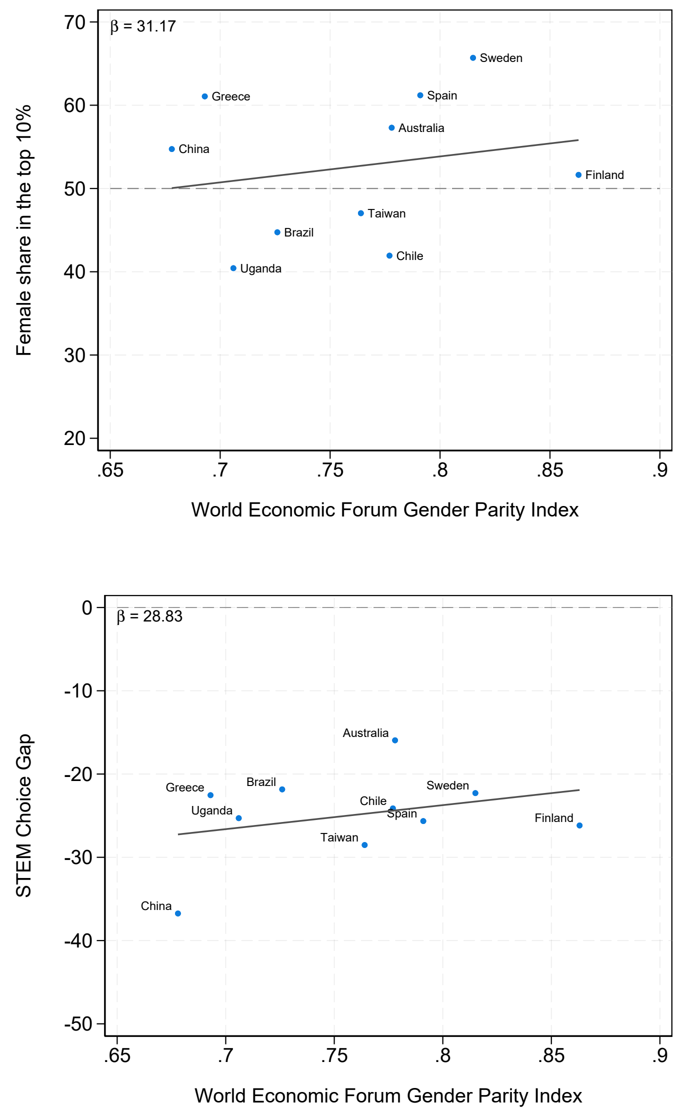

Figure 4. *Pipeline/Choice Gaps vs World Economic Forum Gender Parity Index*

The striking consistency of the choice gap across highly heterogeneous contexts—spanning continents, levels of development, and cultural norms—suggests that deeper structural forces are at play. This pattern emerges regardless of local institutions or gender norms. This finding complements a growing body of evidence highlighting the role of preferences in shaping major choice. Zafar (2013) shows that gender differences in tastes for program attributes, rather than beliefs about returns, account for much of the gap in field choice. Wiswall and Zafar (2018) find that women and men systematically differ in their willingness to trade wages for non-pecuniary job attributes. And Patnaik et al. (2021) emphasize that pipeline differences alone cannot explain women's persistent underrepresentation in STEM. Our results extend this literature by showing that the choice gap is not context-dependent but instead emerges consistently across societies as different as Sweden and Uganda. Any explanation of gendered application patterns must therefore address not only why preferences differ, but also why these differences persist even in societies with dramatically different gender norms, working conditions, and institutions.

A further contribution of this paper is to adopt a *market design perspective*, leveraging administrative microdata from centralized admissions systems that implement Deferred Acceptance. Because these systems elicit applicants' complete rank-ordered preference lists, and truthful reporting is a dominant strategy under DA, they provide a credible measure of genuine preferences rather than strategic behavior. Focusing on the top 10

Identifying the mechanisms underlying such a stable choice gap remains an important challenge. Preferences may reflect differences in how men and women value job attributes, expectations of discrimination, family-formation considerations, identity and belonging, or self-efficacy. Our findings imply that these forces operate globally rather than being context-specific. Designing interventions that directly target them is essential if gender parity in STEM is to be achieved. Doing so is not only an equity imperative but also a crucial step toward realizing the full efficiency gains from a more inclusive allocation of talent.

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