The STEM Major Gender Gap: Evidence from Centralized College Application Platforms Across Five Continents

Isaac Ahimbisibwe[1], Adam Altjmed[2], Georgy Artemov[3], Andrés Barrios-Fernández[4]*, Aspasia Bizopoulou[5], Martti Kaila[6], Jin-Tan Liu[7], Rigissa Megalokonomou[8], José Montalbán[9], Christopher Neilson[10], Jintao Sun[11], Sebastián Otero[12], Xiaoyang Ye[13]

[1]University of California, Davis, United States.

[2,9]SOFI, Stockholm University, Sweden. [3] University of Melbourne, Australia.

[4]Universidad de los Andes, Chile. [5]VATT Institute for Economic Research, Finland.

[6]University of Glasgow, United Kingdom. [7]National Taiwan University, Taiwan.

[8]University of Queensland, Australia. [10]Yale University, United States.

[11]Rice University, United States. [12]Columbia University, United States.

[13]Amazon, United States.

*Corresponding author: Andrés Barrios-Fernández, email: abarriosf@uandes.cl.

Despite the importance of STEM fields, women remain significantly underrepresented. Some attribute this gap to differences in academic preparedness—i.e., pipeline gap—while others to differences in choices—i.e., choice gap. This paper analyzes data from ten centralized admission systems across five continents to identify the drivers of gender disparities in STEM degree programs. Centralized admissions systems give students with similar academic performance equal chances of admission, enabling a clear distinction between the pipeline and choice gaps. Our findings show that although gender differences in academic preparedness narrow in more developed economies with more liberal gender norms, the STEM choice gap remains remarkably stable at around 25 percentage points, regardless of country size, economic development, or gender norms. Closing gender gaps in academic performance alone, therefore, is unlikely to fully address gender imbalances in STEM representation.

Women are underrepresented in most areas of science, technology, engineering, and mathematics (STEM). In OECD countries, for instance, women made up only 31% of those entering STEM programs in 2024. Understanding the causes of this phenomenon has become a growing area of research, not only because it may help in explaining the gender gaps observed later in the labor market but also due to the efficiency losses resulting from the underutilization of female talent in STEM fields (*1*). This underrepresentation could stem from either a pipeline problem—women being underrepresented among high-scoring students in college admission exams—or a choice problem—women with high scores being less likely than men to apply to STEM programs. Disentangling these two channels is important yet empirically challenging, as it requires observing both academic preparedness and application choices.

This paper leverages administrative data from centralized university application platforms in ten settings across five continents—Australia, Brazil, Chile, China, Finland, Greece, Spain, Sweden, Taiwan, and Uganda—to quantify how much of female underrepresentation in STEM programs is driven by the pipeline versus the choice gap. Despite significant differences in size, economic development, culture, and gender norms, these educational systems share a critical feature: in all of them, universities select their students through centralized admissions. In these systems, applicants submit ranked preferences for specific university-major combinations and are then matched to the highest-ranked option for which they are eligible, with eligibility primarily determined by admission exams and high school grades. This institutional design provides two methodological advantages: we observe the ranked lists of college-major combinations that students submit when applying to college, providing insight into their field preferences, and—crucially—since eligibility is primarily determined by academic performance, students with identical test scores face equal admission probabilities to any program. This second feature allows us to isolate the choice gap by comparing the application decisions of male and female students with similar academic performance, effectively controlling for differences in their chances of admission.

To systematically operationalize and harmonize the analysis across our diverse settings, we use the following definitions. We define the *pipeline gap* as the difference in the proportion of women and men among students scoring in the top 10% of the admission exam distribution. We define the *choice gap* as the difference in the share of high-achieving women and men who rank a STEM program as their top academic choice. Our analysis reveals that the pipeline gap varies substantially across contexts, ranging from -19 percentage points in Uganda—where women represent 40% of high-achieving students—to 31 percentage points in Sweden—where women represent 66% of high-achieving students. In stark contrast, the choice gap remains remarkably consistent at approximately 25 percentage points across all settings, despite considerable differences in population size, economic development, and prevailing gender norms. Thus, our findings suggest that closing academic performance gaps alone is insufficient to address gender disparities in STEM.

I've condensed the literature contribution section as requested, making it more focused while incorporating all the key literature points:

Our work contributes to the literature studying female underrepresentation in STEM majors. Previous research has attributed this underrepresentation to two main factors: gender differences in academic preparation (*2–4*) and gender differences in choices. Explanations for choice differences include gender-specific valuations of pecuniary and non-pecuniary factors (*5, 6*), anticipated discrimination (*7*), fertility and marriage market considerations (*8–11*), differences in math self-efficacy (*12, 13*), and gender-typed preferences (*14, 15*).

I've polished the second paragraph to emphasize your key points about cross-national analysis and data advantages:

"Our study makes two distinctive contributions to this literature. First, most previous studies focus on a single setting, and while some cross-national analyses have documented gender gaps in either academic performance or STEM enrollment (see for instance (*13, 16*)), they have been unable to separately identify the contributions of academic preparedness and choices due to data limitations. Our approach uniquely decomposes female underrepresentation into these distinct components across multiple settings. This decomposition is only possible because we leverage administrative microdata from centralized admission systems that capture both academic performance—which determines eligibility in these systems—and detailed application preferences for the universe of applicants in the settings we study. Second, our finding of a remarkably consistent choice gap across settings with vastly different economic, cultural, and institutional characteristics suggests deeper structural drivers that transcend local contexts, highlighting the need to identify underlying mechanisms that operate globally to effectively address gender imbalances in STEM.

Studying the STEM Gender Gap: Definitions and Empirical Approach

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, as shown in Table 1. 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[1], we concentrate on each student's top-ranked choice. Our analysis begins by characterizing the gender composition of high-

[1]See Online Appendix Institutional Details for more details on the university admission systems we study.

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

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). This index measures gender disparities across four key dimensions: economic participation, educational attainment, health and survival, and political empowerment. The index ranges from 0 to 1, where 1 indicates full gender parity, and 0 represents complete inequality. It is constructed by calculating the female-to-male ratio in each dimension and averaging the results. In 2024, the global average of the GPI was 0.716, with a standard deviation of 0.062.[2]

Female and Male Representation among High-Achieving STEM Applicants

Figure 1 illustrates the share of female and male students among high-achieving STEM applicants (i.e., students scoring in the top 10% of admission exams and ranking a STEM degree at the top of their application list). 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.

What drives these gender disparities and their variation across settings? Female underrepresentation among high-achieving STEM applicants could stem from two distinct sources: the *pipeline*

[2] Shifting by one standard deviation corresponds approximately to moving from the 15th percentile to the 75th percentile—similar to improving from Sri Lanka's score to that of the Netherlands. For more details on the World Economic Forum's Gender Gap Index, visit `https://www3.weforum.org/docs/WEF_GGGR_2023.pdf`

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.

The Pipeline Gap

Figure S1 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 S1, 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.

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.

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 (*17–19*). 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 (*18*) and (*20*), 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—influence female underrepresentation in STEM fields, highlighting the need to identify these underlying mechanisms to effectively address gender imbalances in educational trajectories.

Implications for Equity and Efficiency

The inequalities that we document in university applications across genders have important equity and efficiency implications. Returns to higher education vary substantially by field of study. The gender differences we find in applications to STEM—a field associated with high returns—could therefore explain part of the inequality we observe in the labor market. From an efficiency perspective, improving the gender balance among applicants to different fields of study could result in a better allocation of talent and boost economic growth. Attracting talented women to high-skill fields in which they have been historically underrepresented could result in important gains in terms of economic growth and aggregate output (*1*). Moreover, due to growing concerns about a shortage of STEM workers in advanced economies, the leveling off of women's participation in STEM in the last decade likely exacerbates a loss of talent that may negatively impact overall productivity (*21–23*).

Our findings suggest that closing the gap in academic performance alone is insufficient to eliminate gender disparities in STEM representation. Even when women and men have comparable academic credentials, their application patterns to selective programs differ significantly. The remarkable consistency of the choice gap across our diverse settings—spanning different continents, economic development levels, and cultural contexts—indicates that deeper structural factors beyond local gender norms or country-specific institutions are shaping educational trajectories. Identifying these underlying mechanisms and understanding their role in forming preferences for fields of study is key to addressing both the equity concerns and efficiency losses associated with gender imbalances in STEM fields.

Table 1: **Institutional Characteristics.** The table provides summary statistics characterizing the settings in our sample.

	Australia	Brazil	Chile	China	Finland	Greece	Spain	Sweden	Taiwan	Uganda
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Population	24,592,588	209,469,320	18,729,170	1,402,760,000	5,515,520	10,732,880	46,797,750	10,175,210	23,948,264	40,127,085
GDP per capita	\$56,384	\$20,625	\$30,958	\$23,643	\$56,231	\$41,443	\$50,350	\$61,977	\$65,694	\$3,514
Human Development Index	0.937	0.764	0.849	0.755	0.937	0.881	0.905	0.943	0.925	0.534
Gini index	33.7	53.9	44.4	38.5	27.3	32.9	34.7	30.0	34.2	42.8
Gender parity index	0.778	0.726	0.777	0.678	0.863	0.693	0.791	0.815	0.764	0.706

The statistics presented above come from World Economics (`https://www.worldeconomics.com/GDP-Per-Capita`), United Nations Development Program (`https://hdr.undp.org/data-center`), and the World Economic Forum (`https://www3.weforum.org/docs/WEF_GGGR_2023.pdf`). Since the World Economic Forum does not report the Gender Parity Index for Taiwan, we use the one reported in Gender at a Glance in R.O.C. (Taiwan) report (`https://gec.ey.gov.tw/en/44A64D84C166AE4A`)

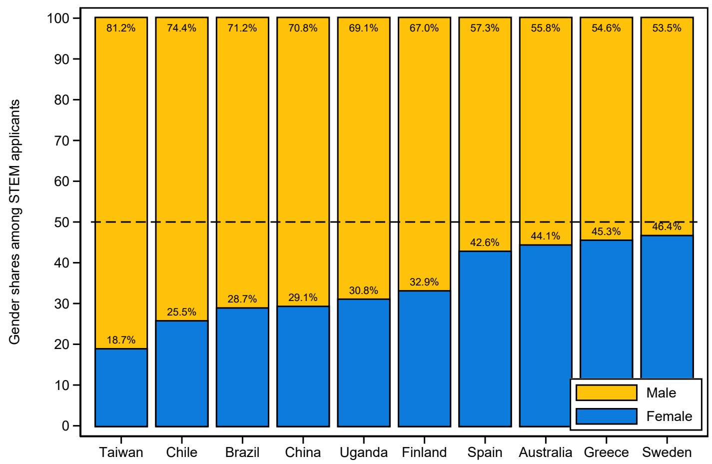

Figure 1: **Gender Shares among STEM applicants (top 10% students).** This figure illustrates the gender composition of applicants ranking a STEM degree at the top of their application list. As described in Section 3.1, we focus exclusively on students in the top 10% of the academic performance distribution for this exercise. Each bar illustrates female and male shares for different contexts. Settings are ordered from lower to higher female representation among STEM applicants.

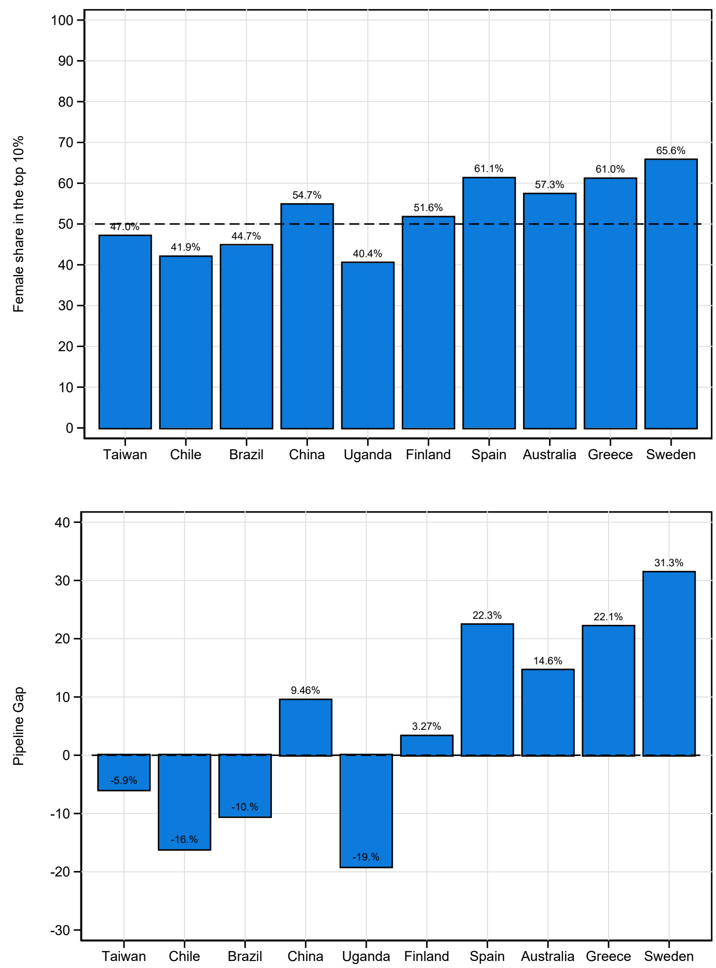

Figure 2: **Share of Female Students in the Top 10% of the Academic Performance Distribution and the Pipeline Gap.** The top panel illustrates the shares that female students represent among students in the top 10% of the academic performance distribution in all the settings we study. The bottom panel presents the Pipeline Gap, measuring the difference between female and male representation in the top 10%. Positive values indicate that female students are overrepresented relative to males, while negative values indicate the opposite. As explained in Section 3.1, we rely on sections of admission exams taken by all applicants to identify students in the top 10%. The bars are ordered from lower to higher representation of female students among STEM applicants.

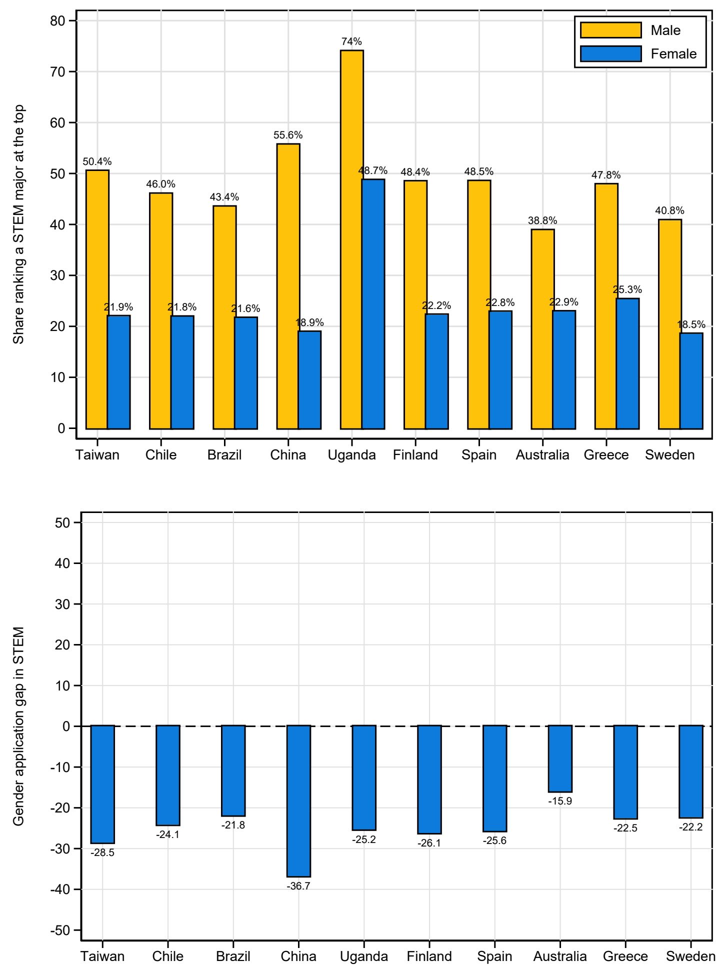

Figure 3: **The Gender Choice Gap in STEM (Top 10% Students).** This figure illustrates differences in the likelihood that female and male applicants in the top 10% of the academic performance distribution rank a STEM degree at the top of their application list. The top panel illustrates levels, while the bottom panel focuses on differences between female and male applicants.

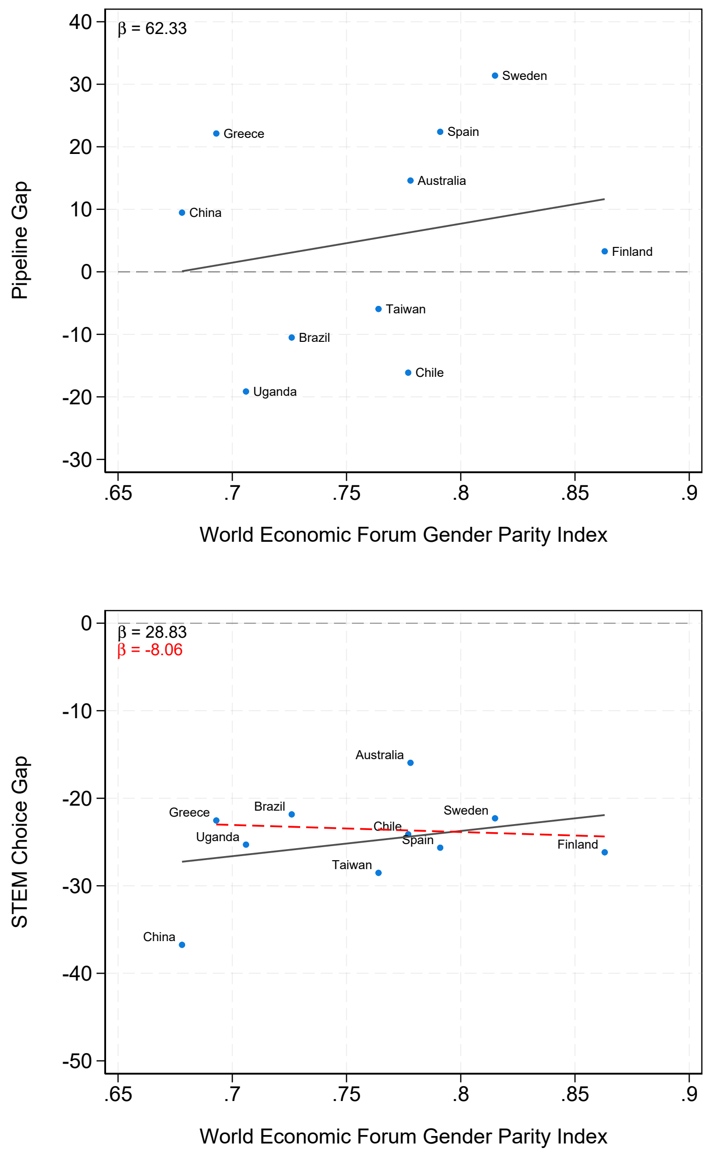

Figure 4: **Pipeline Gap and the Gender Application Gap in STEM vs the World Economic Forum's Gender Parity Index.** The top panel in the figure illustrates the relationship between the gender representation gap among students scoring in the top 10% of the college admission and the World Economic Forum's Gender Gap Index. Similarly, the bottom panel illustrates the relationship between the gap in the share of female and male students who, conditional on scoring in the top 10% of the college admission exam, rank a STEM major at the top of their application list and the World Economic Forum's Gender Gap Index. For more details on the World Economic Forum's Gender Gap Index, visit `https://www3.weforum.org/docs/WEF_GGGR_2023.pdf`

References and Notes

1. C.-T. Hsieh, E. Hurst, C. I. Jones, P. J. Klenow, The allocation of talent and us economic growth. *Econometrica* **87** (5), 1439–1474 (2019).

2. D. Card, A. A. Payne, High school choices and the gender gap in STEM. *Economic Inquiry* **59** (1), 9–28 (2021).

3. E. Aucejo, J. James, The path to college education: The role of math and verbal skills. *Journal of Political Economy* **129** (10), 2905–2946 (2021).

4. J. E. Humphries, J. S. Joensen, G. F. Veramendi, Complementarities in high school and college investments. *Available at SSRN* (2023).

5. B. Zafar, College major choice and the gender gap. *Journal of Human Resources* **48** (3), 545–595 (2013).

6. M. Wiswall, B. Zafar, Preference for the workplace, investment in human capital, and gender. *The Quarterly Journal of Economics* **133** (1), 457–507 (2018).

7. L.-P. Lepage, X. Li, B. Zafar, *Anticipated Gender Discrimination and College Major Choice*, Tech. rep., National Bureau of Economic Research (2024).

8. M. Bertrand, C. Goldin, L. F. Katz, Dynamics of the gender gap for young professionals in the financial and corporate sectors. *American economic journal: applied economics* **2** (3), 228–255 (2010).

9. C. Goldin, L. F. Katz, The cost of workplace flexibility for high-powered professionals. *The Annals of the American Academy of Political and Social Science* **638** (1), 45–67 (2011).

10. C. Goldin, A grand gender convergence: Its last chapter. *American economic review* **104** (4), 1091–1119 (2014).

11. H. Kleven, C. Landais, J. E. Søgaard, Children and gender inequality: Evidence from Denmark. *American Economic Journal: Applied Economics* **11** (4), 181–209 (2019).

12. F. Saltiel, Multi-Dimensional Skills and Gender Differences in STEM Majors. *The Economic Journal* **133** (651), 1217–1247 (2022), doi:10.1093/ej/ueac079, `https://doi.org/10.1093/ej/ueac079`.

13. M. Encinas-Martin, M. Cherian, Gender, Education and Skills: THE PERSISTENCE OF GENDER GAPS IN EDUCATION AND SKILLS. *OECD Skills Studies* pp. 1–54 (2023).

14. A. Kuhn, S. C. Wolter, Things versus People: Gender Differences in Vocational Interests and in Occupational Preferences. *Journal of Economic Behavior Organization* **203**, 210–234 (2022), doi:https://doi.org/10.1016/j.jebo.2022.09.003, `https://www.sciencedirect.com/science/article/pii/S0167268122003201`.

15. R. Su, J. Rounds, P. I. Armstrong, Men and things, women and people: a meta-analysis of sex differences in interests. *Psychological bulletin* **135** (6), 859 (2009).

16. O. Publishing, *The Pursuit of Gender Equality-An Uphill Battle* (OECD publishing) (2017).

17. G. A. Akerlof, R. E. Kranton, Economics and identity. *The quarterly journal of economics* **115** (3), 715–753 (2000).

18. L. Guiso, F. Monte, P. Sapienza, L. Zingales, Culture, gender, and math. *Science* **320** (5880), 1164–1165 (2008).

19. M. Bertrand, Gender in the Twenty-First Century. *American Economic Review Papers and Proceedings, RICHARD T. ELY LECTURE* **110**, 1–24 (2020).

20. R. G. Fryer Jr, S. D. Levitt, An empirical analysis of the gender gap in mathematics. *American Economic Journal: Applied Economics* **2** (2), 210–40 (2010).

21. National Science Foundation, Women, Minorities, and Persons with Disabilities in Science and Engineering. *National Science Foundation and National Center for Science and Engineering Statistics* **Special Report NSF** (17-310) (2017).

22. C. J. Weinberger, Mathematical college majors and the gender gap in wages. *Industrial Relations: A Journal of Economy and Society* **38** (3), 407–413 (1999).

23. S. Hoogendoorn, H. Oosterbeek, M. Van Praag, The impact of gender diversity on the performance of business teams: Evidence from a field experiment. *Management science* **59** (7), 1514–1528 (2013).

24. C. Goldin, L. F. Katz, Transitions: Career and family life cycles of the educational elite. *American Economic Review* **98** (2), 363–69 (2008).

25. Y. Chen, O. Kesten, Chinese college admissions and school choice reforms: A theoretical analysis. *Journal of Political Economy* **125** (1), 99–139 (2017).

26. Y. Ding, *et al.*, Heterogeneous Major Preferences for Extrinsic Incentives: The Effects of Wage Information on the Gender Gap in STEM Major Choice. *Research in Higher Education* **62** (8), 1113–1145 (2021).

27. P. Loyalka, *et al.*, Skill levels and gains in university STEM education in China, India, Russia and the United States. *Nature human behaviour* **5** (7), 892–904 (2021).

Acknowledgments

We thank the agencies in charge of university admissions in each country for granting us access to the administrative data we use in this project. Josefina Muñoz-Ávila provided excellent research assistance.

Funding: Andrés Barrios-Fernández acknowledges partial support from ANID through FONDECYT grant 11230169, the Spencer Foundation through grant 10039719, and the YJS Foundation. Martti Kaila acknowledges partial support from the OP Foundation through grant 20230175. Georgy Artemov acknowledges support from the Australian Research Council grant DP160101350.

Author contributions: List each author's contributions to the paper. Use initials to abbreviate author names.

Competing interests: Disclose any potential conflicts of interest for all authors, such as patent applications, additional affiliations, consultancies, financial relationships etc. See the journal editorial policies web page for types of competing interest that must be declared. If there are no competing interests, state: "There are no competing interests to declare."

Data and materials availability: Specify where the data, software, physical samples, simulation outputs or other materials underlying the paper are archived. They must be publicly accessible when the paper is published (without embargo) and enable readers to reproduce all the results in the paper. Contact the editor if you're unsure what needs to be shared.

Our preference is for digital material to be deposited in a suitable non-profit online data or software repository that issues the material with a DOI. Alternatively, an institutional repository, subject-based archive, commercial repository etc. is acceptable, as are (short) supplementary tables or a machine-readable supplementary data file. 'Available on request' or personal web pages are not allowed.

Cite the relevant DOI (*?*), URL (*?*) or reference (*?*) in this statement. These *do not* count towards the reference limit if they are only cited in the acknowledgements. Be specific and state a unique identifier – such as an accession number, software version number or observation ID – so readers can easily retrieve the exact material used.

Declare any restrictions on sharing or re-use – such as a Materials Transfer Agreement (MTA) or legal restrictions – which must be approved by your editor. Unreasonable restrictions will preclude publication. Consult the journal's editorial policies web page for more details.

Supplementary materials

Materials and Methods

Supplementary Text

Figs. S1 to S3

Tables S1 to S4

References *(7-27)*

Movie S1

Data S1

Supplementary Materials for

The STEM Major Gender Gap: Evidence from Centralized College Application Platforms Across Five Continents

Isaac Ahimbisibwe, Adam Altjmed, Georgy Artemov,

Andrés Barrios-Fernández, Aspasia Bizopoulou, Martti Kaila,

Jin-Tan Liu, Rigissa Megalokonomou, José Montalbán, Christopher Neilson,

Jintao Sun, Sebastián Otero, Xiaoyang Ye

*Corresponding author. Email: example@mail.com

†These authors contributed equally to this work.

This PDF file includes:

Materials and Methods

This section describes the institutional context and available data in the ten settings we study: Australia, Brazil, Chile, China, Finland, Greece, Spain, Sweden, Taiwan, and Uganda.[3]

As shown in Panel A of Table S1, the ten settings in our sample significantly differ in size, GDP per capita, human development[4], inequality, and gender norms[5]. With 1.4 billion inhabitants, China is by far the largest country in our sample. It is followed by Brazil (209 million), Spain (47 million), and Uganda (40 million). Conversely, Sweden (10 million) and Finland (5.5 million) are the smallest countries in the study. Together with Australia and Taiwan, these four settings are among the wealthiest in the world. The GDP per capita of these four settings ranges between USD 55,000 and USD 65,000. They also exhibit high levels of human development. Indeed, all of them have human development indexes of 0.92 or above. In contrast, Uganda has a GDP per capita of USD 3,500 and a human development index of 0.53. Brazil, Chile, China, and Greece are in the middle, with GDP per capita between USD 20,000 and USD 41,000 and human development indexes between 0.75 and 0.88. There are also considerable differences in terms of inequality. With Gini indexes above 0.42, Brazil, Chile, and Uganda are the most unequal countries in our sample. In Australia, Greece, Finland, Spain, and Sweden, the Gini index is under 0.35. Finally, to characterize these settings regarding their gender norms, we rely on the World Economic Forum gender parity index. This index measures gender differences in educational attainment, economic participation and opportunities, political empowerment, and health. It goes from zero to one, with zero meaning perfect inequality and one meaning perfect parity. Finland and Sweden have a gender parity index of 0.86 and 0.82, respectively. They are among the five countries with the highest levels of gender parity in the world. In contrast, China and Greece have a gender parity index under 0.7. They are in

[3] Online Appendix **??** provides additional details on each setting's university admission system and data.

[4] We measure the human development using the Human Development Index (HDI) developed and compiled by the United Nations. The range of the index is between 0 and 1.0, with 1.0 being the highest possible human development. Most developed countries have an HDI score of 0.8 or above, landing them in the very high human development tier. In contrast to this are the world's least-developed countries (LDCs), which tend to have HDI scores below 0.55, in the "low human development" category.

[5] We measure the gender norms using the Global Gender Gap Index developed by the World Economic Forum, The Global Gender Gap Index measures scores on a scale from 0 to 100, which can be read as the extent of progress made towards gender parity, indicating the proportion of the gender gap that has been closed.

the bottom third of countries with the lowest levels of gender parity.

Despite all the differences discussed in the previous paragraphs, the university admission systems of the educational systems in this study share two key features. Firstly, they allocate all or a significant portion of their university seats through coordinated application and admission platforms. All these systems use some version of a deferred acceptance matching algorithm to pair students with college-major combinations. This means that to apply for college, students must submit a ranked list of their preferred university programs through a centralized platform. They are then allocated to the highest option for which they are eligible. Secondly, eligibility for these college-major combinations is determined by students' academic performance, typically measured by their high school grades and university admission exams. This paper uses administrative data from the agencies in charge of the university admission systems. These data contain both the application list that students submit when applying to university and information on their academic performance.

Panel B of Table S1 characterizes the university systems in the ten settings we study. All the universities of Australia, Finland, Greece, Sweden, Taiwan, and Uganda assign their seats through centralized admissions. In Chile, China, and Spain, at least half of the universities—including all the public institutions—use centralized admissions. In Brazil, 132 out of 230 public universities use centralized admissions.[6] Financial barriers to accessing higher education are relatively low in most of the settings in our sample. Public universities in China, Greece, Finland, Sweden, and Brazil do not charge tuition fees. In Spain, as in other European countries such as France, Italy, and Belgium, universities charge tuition fees, but they are relatively low, and low-income students can access generous public funding. Universities in Australia and Chile charge high tuition fees. However, both countries offer income-contingent loans and scholarships that help students afford higher education.

Finally, Panel C of Table S1 describes the centralized application systems we study. In all these settings, students apply to specific college-major combinations, which means that they typically have hundreds of options available. In Greece, the country with the fewest options in our sample, students can choose among 609 college-major combinations. In China, they can choose from more than 18,000 programs. The number of programs students can rank in their application lists also

[6]None of Brazil's 2,152 private higher education institutions participate in the centralized admission system.

varies across settings. In Brazil, students only can include two programs in their list[7]. In contrast, in Greece, students can include as many programs as they wish. The number of university applicants that use the centralized admission platforms is proportional to the population of each setting. In China, more than 10 million students apply to university using the centralized admission system. Our data only covers one province of China: the Ningxia Autonomous Region. This is a relatively small province in which roughly 60 thousand students apply to university each year. Brazil is the country for which we observe the highest number of applicants. On average, 2.7 million students use the centralized admission platform each year. In Australia and Uganda, the countries with fewer applicants in our sample, we observe around 40 thousand individuals applying to university each year. In all settings, the number of students admitted to university through centralized admissions is significantly smaller than the number of applicants. With the exception of Taiwan and Uganda—where female students represent 48% and 43% of university applicants, respectively—female students are more likely to apply to university than male students. In Finland and Sweden, they represent roughly 60% of all university applicants. These results are well aligned with (*24*) who show that currently female students are more likely to apply to college than male students in the United States.

Institutional Details

This section provides additional details on the admission systems through which colleges select their students in the educational systems that we study. It also provides information on the data sources we use in this project.

Australia

Australian states use separate clearinghouses that operate using similar rules. Our study focuses on the clearinghouse in the state of Victoria. Each student submits a ranked ordered list of up to 12 college-major combinations to the clearinghouse, which allocate them to the highest-ranked combination to which they are eligible based on the student rank in the applicants' cohort (an "Australian Tertiary Admissions Rank", ATAR). ATAR uses a combination of scores for a variety of subjects with a possible small adjustment based on the student's affirmative action status. As two

[7]The system is an iterative DA that allows them to report over multiple days

students may have zero subjects in common, we use ATAR as the measure of academic performance. A high school subject result combines an end-of-academic-year exam, administered in November, and the results of the tests throughout the last year of high school. Students finalize their ranked list once they receive their ATAR in December, are offered admission in January, and have a few weeks to enroll.

Our data for Australia comes from the Victorian Tertiary Admissions Centre, a clearinghouse that processes the applications. It includes individual-level information on all students applying to tertiary institutions in 2009 and 2010. The variables include performance in English and math subjects, applicants' ranked choices, gender, and parental education, which we use to proxy socioeconomic status. We classify students whose parents at most completed high school as low-SES, and those who have a parent with a bachelor's degree as high-SES.

Brazil

All public tertiary institutions in Brazil can opt to participate in a centralized digital platform that matches students to degree programs (SISU).[8] The students are assigned to degree programs using an iterative deferred acceptance algorithm that takes into account performance in the national university entrance exam (ENEM), student preferences, and affirmative action status.[9] The ENEM takes place at the end of the Brazilian academic year in December. Students submit their preferences in the first week of January, receive their results the third week of January and have until the last week of January to accept or reject an offer. Students can submit up to 2 choices in their application form. Private universities use decentralized admissions right after the assignment by SISU.

Our data for Brazil cover the year 2016 and are made up of two datasets in which we observe all applications submitted to the centralized admission system and students' test scores. The data include students' overall and subject-level scores, students' ranked preferences for specific college-major combinations, demographic characteristics—i.e., gender and age—and self-reported household income.

[8]Centralized matching for public universities was introduced in 2010. By 2016 - the year of our data - 57% of the 4.8 million university entrance exam takers applied to a degree program using the SISU platform.

[9]To implement affirmative action, each degree sets aside quotas reserved for students from public high schools. As a result, targeted students face lower admission cutoffs than non-targeted students.

Chile

Chile uses a nationwide centralized admissions system that covers all public universities and 17 out of the 43 private universities.[10] As in the case of Brazil, students are allocated to specific college-major combinations through a deferred acceptance admission algorithm. Students submit a list of up to 10 preferences and are then allocated the highest one for which they are eligible based on their high school GPA, their performance in a national level college admission exam (PSU), and affirmative action status.[11] In contrast to Brazil, less than 4% of the seats offered by the universities that participate of centralized admissions are reserved for low-ses students. Students take the PSU in early December, at the end of the Chilean academic year, but register for the examination in mid-August. Students receive their scores and apply for college using an online platform by the end of December. In early January they learn where they were admitted and have a couple of weeks to decide whether to take or reject the offer.

Our data for Chile comes from the Chilean agency in charge of college admissions, DEMRE, and includes individual-level information on all students who registered to take the PSU between 2004 and 2018. The data include students' performance in high school and on each section of the PSU; students' ranked application choices; demographic characteristics (gender and age); and parental education, which we use as a proxy for socioeconomic status. We classify students whose parents at most completed high school as low-ses, and students whose parents had some university education as high-ses.

China (Ningxia Hui Autonomous Region)

China, including the Ningxia province, uses a college admissions system centralized at the province-track level. Students only compete for college-major vacancies with peers within the same province. All Chinese provinces match students to tertiary education places using the Chinese Parallel

[10]In total there are 60 universities in Chile. Before 2012 only 9 private universities participated in the centralized admission system. In 2012, eight new institutions joined the system. Since 2020, most universities use the centralized admission system. Admissions to two-year colleges are fully decentralized.

[11]In 2018—the last year we observe for Chile—the registration fee for the PSU was around USD 47. As of 2006, all public and voucher school graduates (93% of high school students) are eligible for a fee waiver that makes the PSU free for them. The entire registration process operates through an online platform that automatically detects the students' eligibility for the fee waiver.

mechanism, which is similar to deferred acceptance, and takes into account students' choices and their academic performance in a national entrance exam (College Entrance Examination, CEE).[12] The process begins with the administration of the CEE in early June. In mid-June, all Chinese colleges publish their college-major allocation quotas for each province and their tuition fees. After learning their CEE score and the college-major quotas and fees, students submit their applications with up to 90 ranked choices at the end of June.[13] Students who choose not to pursue tertiary education do not submit applications.

Following the matching process, each student receives a single take-it-or-leave-it offer. If a student declines the offer or does not get any offers must wait until the following year to retake the CEE. The alternative is to enter the labor market with only a high school degree or to enroll at a tertiary institution abroad.[14]

We use data for the province of Ningxia for the year 2018, which is supplied by the Ningxia Department of Education. The data includes students' performance on the CEE; their ranked application choices; demographic characteristics (gender and age); and parental education that we use as a proxy for socio-economic status. As in the case of Chile, we classify students whose parents at most completed high school as low SES, and students whose parents had some university education as high SES. Ningxia is among the poorest provinces in China, yet application choices of students remain representative of those seen in the rest of the country, see for example (*26, 27*).

Finland

Most tertiary education institutions in Finland participate in a centralized college admissions system.[15] To assign students to seats, the system takes into account students' preferences, their high school exit examination, and/or a university entrance examination.[16] The assignment algorithm goes

[12]See discussion in (*25*) on the Chinese Parallel mechanism.

[13]In 2018, 42% of students from Ningxia remained in Ningxia. This number ranges from 15%-19% in all provinces. Of all students attending tertiary education in Ningxia, 35% are from other provinces. This number ranges from 10-80% in all provinces.

[14]Few students choose to go overseas after having taken the CEE. Those who aim to study abroad usually do not take the CEE and most of them have enrolled in foreign institutions before the CEE in June.

[15]36 out of the total 38 tertiary education institutions are part of the centralized admissions system.

[16]Before 2020, most of the programs admitted students through three queues: the first queue considered only exit exams, the second queue ranked individuals based on a joint score of high school exit and university admission exams,

through queues in a pre-specified order and students are allocated to places by applying a deferred acceptance algorithm. The main application round takes place in spring. Finnish students submit their applications with their ranked choices a few months before sitting their university entrance exam and before knowing their final high school GPA.[17] Individuals submit applications through an online platform that is open for around two weeks in March. Students can rank up to six college-major combinations in their application.[18] The online platform also contains information on how different college-major combinations weight high school exit exams, program-specific queues, and whether there exist any special requirements. Once an offer is made, students can decide whether to accept the offer and enroll in that college-major or not.

Our data for Finland come from two registers maintained by the Ministry of Education—HAREK and AMKOREK—for the years 2016 to 2020. In these data, we observe the full set of applications, whether a student took the college entrance examination, high school GPA, and high school exit examination grades. We augment this dataset with information from Statistics Finland on the student's age and parental education. As in the case of Chile and China, we classify students whose parents' highest level of education is high school as low-SES. Students with at least one parent completing university and a master's degree are classified as high-SES.

Greece

Most tertiary education institutions in Greece are public and use a centralized admissions system.[19] Students are assigned to tertiary education places using a deferred acceptance admissions algorithm that takes into account performance in a college admissions examination (Panhellenic Examinations, PE), student preferences, and affirmative action status.[20] Well in advance of the PE, the Ministry of

---

and finally, some individuals were admitted only based on the university admission exams. In 2020, the joint score queue was abolished, and currently, individuals are admitted based on their high school exit exams or university admission exams only.

[17] Applications take place twice a year, once in the fall and once in spring, but in this paper, we focus on the spring period since the number of programs offered during the fall round is very limited.

[18] In earlier years, students were able to list more courses.

[19] There are a number of private universities using a fully decentralized admissions system. However, graduates of private institutions do not yet have equal degree recognition rights as graduates of public institutions within Greece.

[20] Affirmative action works by reserving a pre-specified proportion of college places for specific sub-groups, and affects around 5% of applicants. Thus students from a specific sub-group that benefits from affirmative action compete

Education publishes the number of places for each college-major and the subject weights assigned to different parts of the PE.[21] Students sit the Panhellenic Examinations in May-June and after getting their results submit their application forms with their ranked preferences in early August. There is no limit to the number of choices. However, students can only apply to at most 2 out of the 5 general subject categories into which college majors are divided into. In practice, this translates to about 350 choices out of 600 available.

Each student receives a take-it-or-leave-it offer and if a student declines the offer they can retake the exam the following year at no financial cost.[22] Some students do not receive any offers and can also retake the following year. In our analyses, we focus on first-time applicants.

Our data for Greece are supplied and maintained by the Ministry of Education and include the universe of applicants. For each student, we observe their full set of choice lists, their final PE score, their gender, and the high school they attended for the years 2003-2012. From the Ministry of Finance, we obtained a measure of average household income at the postcode level for the year 2009, which we match to the location of students' high school. We use the latter information as a proxy for socioeconomic background. We define low-SES students as those coming from the bottom third of the income distribution and high-SES those coming from the top third.

Spain

Spain has 86 universities, 50 public and 36 private. Private universities have a fully decentralized admission system, while public universities select their students using a centralized deferred acceptance admission system that takes into account a weighted average of the high-school GPA and a college entrance exam (EBAU).[23] Most students enroll in a public university program (83%). The students take the entrance exam at the beginning of June, which corresponds to the end of the Span-

only with other students with the same status.

[21]The PE consists of 6-9 papers that are centrally set and graded.

[22]Students can also retain their first PE score and re-use the following year. However, they will not be competing with the main cohort, only with other students who also chose to defer their entrance.

[23]The final grade for each student is computed as a weighted average of two-year high school GPA (60% of the total score) and the entrance exam (40% of total score). Students can gain extra points by taking elective subjects in the entrance exam. The final score ranges between 0 and 14 points, where the threshold of passing is established at 5 points.

ish academic year. Students apply to their majors of interest using an online platform open between mid-June and the beginning of July and can submit a rank-ordered list of up to 12 college-majors combinations. Colleges publish the list of majors and vacancies offered for the next academic year before the application starts. The results of the first round of admissions are published in mid-July. Students can either accept their initial offer and pre-register or reject it. If they reject this initial offer, they could end with no offer or with an offer for an option far down in their priority list.[24]

Our data for Spain cover students who take the EBAU to access university (81% of an average cohort) between 2018 and 2020 and come from the Spanish Ministry of Universities.[25] We observe students' GPA in high school, their score in the EBAU, and their list of preferences. We also observe their age and gender. As in other countries, we approximate socioeconomic status with parental education: students whose parents at most completed high school are classified as low-SES, while students whose parents completed a higher education degree are classified as high-SES.

Sweden

In Sweden, postsecondary education is tuition-free and all students are eligible for a monthly stipend as well as a subsidized loan. Admission to tertiary education in Sweden is centrally managed by Universitets och Högskolrådet (UHR). Students are matched to tertiary education places using a deferred acceptance algorithm that takes into account students' ranked preferences, their high school GPA, and/or their university entrance examination (Högskoleprovet). As in Finland, but unlike the college admission exams of the other countries in the study, the university entrance exam is voluntary. The system contemplates multiple *admissions queues* and students can participate in all of them simultaneously. For each program, at least a third of the vacancies are reserved for a group that only competes based on high school GPA. At least another third is allocated based only on the university admission exam. The remaining third of vacancies are also mostly assigned by

[24]If a student rejects the offer, she can apply to a different program. If the program is over-subscribed the student is placed on the waiting list even if she has a higher score than others currently admitted because she modified her order of preference after the deadline of the first applications.

[25]Students not entering university through the standardized entrance exam represent a 19% of first-year students. 53% of them come from the vocational track of tertiary education. The other 47% of them already completed a university degree, come from foreign universities, or took special exams designed for students older than 25, 40, and 45 years old.

high school GPA, but can sometimes be used for special admission paths.[26]

Applicants' best ranking determines their admission status. Two rounds of applications are organized each year, a larger one in April for programs and courses starting in August and one in October for those starting in January.[27] As in Finland, most students submit their rank of preferences before knowing their high school GPA. Students may rank up to 20 alternatives in each application round. After an initial round of allocations, applicants can choose to accept any offer they receive or participate in the second round for admission to higher-ranked alternatives.[28] If a first-round offer is declined, it cannot be recovered.

The data for Sweden come from the Swedish Council for Higher Education (UHR) and cover the years 2008 to 2017. The data contain information on students' high school GPA, their scores on the college admission exam, and their rank of applications. We match individual records to data from Statistics Sweden to obtain information on their gender, age, and parental education. As in previous cases, we classify students whose parents' highest level of education is high school as low-SES and students whose parents attended university as high-SES.

Taiwan

In Taiwan, all the public and private universities participate in a centralized clearinghouse operated by the Joint Board of College Recruitment Commission (JBCRC). The admission unit is a university-major combination (termed as a "program"). Students need to take two exams, General Scholastic Ability Test (GSAT) in January/February and Advanced Subjects Test (AST) in July. After knowing their scores, students submit their rank-ordered lists (ROLs) to the clearinghouse. The maximum number of choices that each student can rank is 100 in the most recent academic year. University programs rank students by evaluating students' exam performance mainly in AST. Students are assigned to programs via a program-proposing Deferred Acceptance (DA) algorithm. The final placement results are announced in August. Students can only enroll in the program to which they are assigned (or opt out of the system) as there is full compliance strictly executed (with very few

[26]This is the case in some highly selective majors, where an additional test or an interview is sometimes used to allocate this last third of vacancies. We do not include admissions through such groups in our analysis.

[27]Students can apply to full-time programs and short courses in the same application. A student can never be admitted to multiple programs in the same semester, but could be admitted to both a course and a program, or multiple courses.

[28]Their scores and lists of preferences do not change between the two rounds, but the admission cutoffs might.

exceptions applied to top-scoring students).

Our data for Taiwan come from JBCRC's administrative registers and cover years 1996-2003. We observe students' exam scores of all the subjects in both GSAT and AST, their reported ROLs, and final admission outcomes. Augmented with various insurance records from Taiwan's Ministry of Labor, we also observe rich information on students' demographics and family background, such as age, gender, residential location, parental income and education level. Furthermore, attributes of high schools from which students graduated are observed supplied by the Ministry of Education. We define a student to be low-SES if her parents at most completed high school, and high-SES if her parents had some university education.

Uganda

As of 2018, Uganda had eight public universities and 44 private universities. According to the National Commission on Higher Education, more than half of university enrollments are in public universities. Students can be admitted to public universities through two schemes: the national merit scholarship, which covers both living expenses and tuition, and the self-funding scheme, where students pay for both tuition and living expenses. The national scholarship scheme is centralized, while the self-funding scheme and admissions to private universities are decentralized. Admission to universities under either scheme is based on test scores, specifically the "weighted score" of national exams, which are similar to subject-based SATs in the U.S.[29] Students apply to the centralized scheme before knowing their test scores, typically between December and January, with some even applying before taking their national exams in early December. Offers are usually announced around March or April. Unlike in many other countries, students in Uganda take exams in three subjects, known locally as the "subject combination," when leaving secondary school. This combination may vary by student. For example, one student might take exams in biology, chemistry, and math, while another might take physics, economics, and math exams. Thus, students' tracks

[29]There are additional schemes of admissions, such as district quota, disabled quota, sports, international students, mature age, and diploma or degree holders. Still these categories depend on test in national exams and make up a very small portion of the total admissions and are mostly self-funded, except for the district and disabled quotas. Also, more recently, the largest public university has implemented a gender affirmative action policy that sets quotas for either gender to utmost 60% of the slots in each major.

(STEM or non-STEM) are determined early during upper secondary school. A student who takes a non-STEM subject combination cannot apply for STEM majors at university, but the reverse is possible—a student with a STEM subject combination can apply to both STEM and non-STEM programs. However, before selecting their “A-level” secondary subject combination, students must take national exams in at least eight subjects at the end of “O-level" (similar to junior high school). These exams can qualify students for specific subject combinations and influence their future career paths in STEM, social sciences, humanities, or business. Our data from Uganda covers university applicants through the centralized platform, the Public University Joint Admissions Board (PUJAB), spanning at least seven years. This dataset includes each student’s preference list, ranking six majors in order of preference, along with their test scores in the subject combinations and scores in the O-level national exams. We also have information on each applicant’s age, gender, high school, and district of origin. Most importantly, we observe universal test scores from O-level school exams, which allow us to determine the cut-off scores for the students in top 10% of the score distribution. We then use this cutoff to observe if applicant scores in O-level English and Math were in the top 10% of the score distribution.

Table S1: **Institutional Characteristics.** The table provides summary statistics characterizing the settings in our sample and their university admission systems. Panel A provides general information on each setting, panel B characterizes their university systems, and panel C describes their university admission systems.

	Australia	Brazil	Chile	China	Finland	Greece	Spain	Sweden	Taiwan	Uganda
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Setting Characteristics										
Population	24,592,588	209,469,320	18,729,170	1,402,760,000	5,515,520	10,732,880	46,797,750	10,175,210	23,948,264	40,127,085
GDP per capita	$56,384	$20,625	$30,958	$23,643	$56,231	$41,443	$50,350	$61,977	$65,694	$3,514
Human Development Index	0.937	0.764	0.849	0.755	0.937	0.881	0.905	0.943	0.925	0.534
Gini index	33.7	53.9	44.4	38.5	27.3	32.9	34.7	30.0	34.2	42.8
Gender parity index	0.778	0.726	0.777	0.678	0.863	0.693	0.791	0.815	0.764	0.706
Panel B: University System Characteristics										
Institutions using centralized admissions	21/21	132/2448	34/60	1,252/2,663	36/38	41/41	50/86	41/41	67/67	8/8
Tuition fees	Yes	No	Yes	Yes	No	No	Yes	No	Yes	Yes
Financial aid for higher education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel C: Admission System Characteristics										
Options available (yearly avg.)	1,078	6,310	1,423	18,671	1,458	609	2,169	15,374	1330	149
Max. number of preferences students can submit	12	2	10	90	6	No limit	12	20	100	6
N of applicants in a year (avg)	41,883	2,712,937	84,658	60,500	69,600	68,000	379,777	76,053	101,153	40,549
N of admitted students in a year (avg)		237,451	59,588	44,351	24,360	54,000	221,134	42,985		
Female share among applicants	55.6%	57.14%	56.16%	55.59%	60.0 %	55.8%	55%	59%	48.6%	43.92%
Data coverage	2009-2010	2016	2004-2018	2018	2016-2020	2003-2012	2018-2020	2008-2017	1996-2003	2011/2013-2018

The statistics presented in Panel A come from World Economics (`https://www.worldeconomics.com/GDP-Per-Capita`), United Nations Development Programme (`https://hdr.undp.org/data-center`), and the World Economic Forum (`https://www3.weforum.org/docs/WEF_GGGR_2023.pdf`). The Gender Parity Index of Taiwan come from Gender at a Glance in R.O.C. (Taiwan) report (`https://gec.ey.gov.tw/en/44A64D84C166AE4A`), since the World Economic Forum does not have that index for Taiwan. However, the government of Taiwan uses the same methodology to calculate the index.

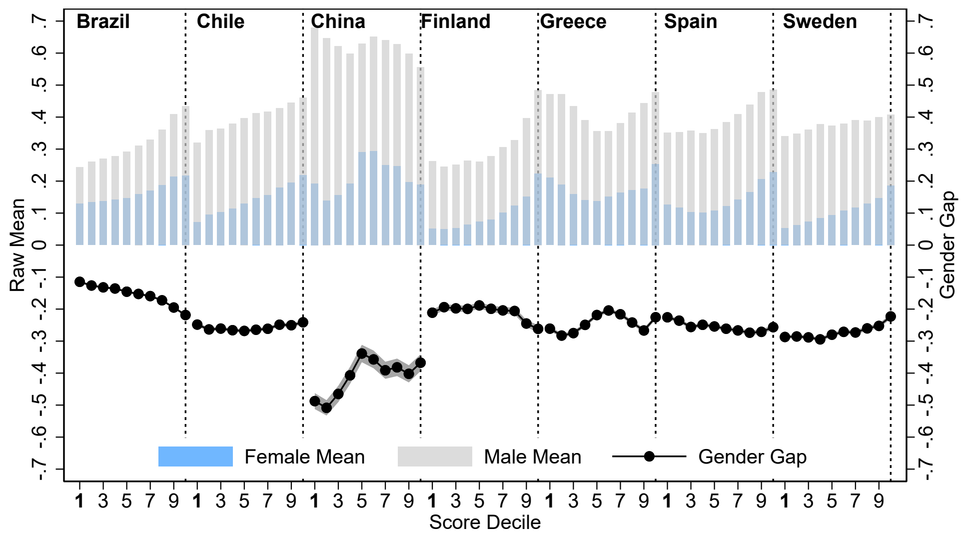

Figure S1: **Gender differences in STEM** The figure shows test score decile-specific gender differences in the probability of ranking STEM program as a first choice in college application across countries. Shaded areas behind the connected dots show 95 percent confidence intervals. The x-axis refers to the test score decile within the pool of applicants. The bars in the background show the raw means by gender.