

The Minority Trap: Minority Status Drives Women Out of Male-Dominated Fields

Xiaoyue Shan*

Abstract

This paper examines whether being in the minority causes women to leave male-dominated fields. I conduct a field experiment in an introductory economics course where I randomly assign students to small study groups with different gender compositions. Results show that women assigned to female-minority groups are 11 percentage points more likely to drop out of the course than women in other groups. This dropout effect is especially strong for women with higher math achievement and academic potential; when randomly assigned to a female-minority group, these women are also more likely to leave the original study program in the long run. I highlight three potential mechanisms of the effect: raised salience of women's minority status, decreased academic self-confidence, and reduced social integration. The findings of the paper suggest that minority status can perpetuate itself and create a vicious cycle of underrepresentation.

Keywords: minority status, gender, dropout, field experiment

JEL Codes: J16, J24, I23

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1 Introduction

Despite making up nearly half of the workforce, women remain underrepresented in high-paying occupations and positions. In the United States, women represent only 27% of the science, technology, engineering, and mathematics (STEM) workforce and hold only 20% of corporate board seats (Census Bureau 2019; Bertrand 2018). The lack of women in high-earning jobs is consistent with gender gaps in educational choices. Female students are less likely to enter and stay in competitive and prestigious fields of study like STEM (National Science Board 2018). The objective of this paper is to investigate whether minority status itself creates a barrier for women pursuing degrees in traditionally male-dominated fields. Specifically, I study whether being in the minority among peers causes women to drop out of economics, a field currently dominated by men (Lundberg 2018).

To test the impact of minority status on dropout, I conduct a field experiment in which I randomize the composition of study groups for an introductory economics course at a Swiss university. Three features make this course a good setting to study the question. First, as is typical in economics, only about 35% of the students are women, so it represents a male-dominated setting. Second, most students take the course in their first semester at college, a period when they meet new people and form new social networks. Third, the course is compulsory for students enrolled in business and economics study programs.

In my experiment, I randomly assign 620 students into four-person study groups. Students in the same group can study together for the economics course or other courses and meet for extracurricular activities. As a result of the random assignment, the groups vary exogenously in gender composition. This allows me to examine the impact of minority status in the study group on women and men. More specifically, I compare women in female-minority groups (with one woman and three men) to women in other groups, such as gender-balanced groups (with two women and two men) and male-minority groups

(with three women and one man). Similarly, I compare men in male-minority groups to other men. Because of the small group size, being in the minority means being the only woman or man in a group. This is a typical situation that women experience in male-dominated professions. Small groups such as collaborative projects, work teams, committees, and corporate boards often consist of only one woman.

The results show that minority status in the study group significantly raises the female dropout rate. Comparing women in female-minority groups to women in other groups, I find that women randomly assigned to be in the minority are 11 percentage points more likely to drop out of the course. Since the course is mandatory for successful completion of business and economics programs, dropping the course is a meaningful outcome. This means that minority status itself negatively affects women's persistence in male-dominated fields. For men, I find no evidence that assignment to male-minority groups impacts their dropout. These results are robust to controlling for a large set of individual-level and peer-level characteristics such as previous performance, parents' socioeconomic background, personality traits, and educational expectations.

Subgroup analysis shows that the dropout effect of minority status is almost entirely driven by women with above-median math achievement—a strong predictor of performance in the economics course and other courses. For these high-potential women, minority status in the group raises their dropout rate for the economics course by about 20 percentage points and all courses in the semester by 9.4 percentage points. Being in the minority also makes them more likely to permanently leave the economics course and their original study programs by more than 12 percentage points. These results mean that the women most equipped to succeed in economics and related fields are those being driven out by minority status. This further suggests that, as a male-dominated field, economics is facing a loss of talent and efficiency due to its unbalanced gender ratio.

To explain why minority status raises women's dropout rate, I explore three potential

mechanisms: (1) the perceived salience of women’s minority status in the field; (2) expectations about future achievement in the field, as a proxy for academic self-confidence; and (3) peer-to-peer interactions and evaluations, as a proxy for social integration. Below, I show supportive evidence on each mechanism.¹

Regarding the first mechanism, salience of minority status, I test how being underrepresented in the group affects the perceived gender ratio of students in the course. The idea is that women are more likely to leave a field that they believe to be male-typed and to which women do not belong. I find that, at baseline, women’s belief about the overall gender ratio does not vary by group gender composition. However, at the end of the semester, women assigned to female-minority groups believe that the course has a significantly lower percentage of women. The finding suggests that underrepresentation in small subgroups of the student population can raise the salience of women’s minority status in a male-dominated field and make them more likely to drop out.

Regarding the second mechanism, academic self-confidence, I examine the impact of minority status on students’ expectations about future achievement in the field. The intuition is that students who are less confident about future achievement may perceive lower returns to staying in the field and consequently drop out. Using students’ self-reported expectations about the final course grade, the probability of passing the first year in the program, and the highest academic degree, I find that being in the minority lowers women’s overall expectations by around 0.4 standard deviations (SD). This mechanism echoes recent laboratory evidence showing that women in male-typed areas or male-dominated groups are less confident, less willing to contribute ideas, and have lower leadership aspirations (Coffman 2014; Chen and Houser 2019; Born, Ranehill, and

¹The second and third mechanisms correspond to academic integration and social integration—key determinants of voluntary dropout behavior in college, according to the student integration model (Tinto 1975). The integration model is well known in the education literature. More specifically, the two determinants refer to expectations about future academic performance and perceptions of social integration. I will explain in Section 2 that the dropout outcome examined in this paper is a voluntary decision.

Sandberg 2020).

Turning to the third mechanism, social integration, I investigate how minority status in the group affects students' interactions and relationships with peers. The idea is that isolation among peers can undermine the sense of belonging and lower the consumption value of education, thus causing dropout (Oreopoulos and Salvanes 2011). I find that women assigned to female-minority groups interact 0.5 SD less with other group members. Moreover, women in the minority are evaluated as less smart, less helpful, less fun to work with, and less hardworking by their peers. By contrast, minority status does not significantly affect men's interaction frequency with peers or peers' evaluations of them. The results suggest that the marginalization of women in female-minority groups is driven by men's preference for male peers rather than women's same-gender preference. This finding is consistent with existing evidence on men's homophily preference in networking and its contribution to gender gaps in the workplace (Ibarra 1992; Gamba and Kleiner 2001; Cullen and Perez-Truglia 2019; Mengel 2020).

While many studies have explored why women are underrepresented in competitive or male-typed fields,² limited attention has been paid to the role of minority status itself. Only a few studies find suggestive evidence that a more pronounced minority status can increase women's dropping out of male-dominated settings (Huntington-Klein and Rose 2018; Griffith 2010; Bostwick and Weinberg 2021). In contrast to Griffith (2010) and Bostwick and Weinberg (2021), who use quasi-random variations across cohorts, I conduct a randomized experiment to alleviate endogeneity concerns and identify the causal effect of minority status itself on dropout. While all the previous studies rely on

²Previous studies show that individual factors such as competitiveness (Croson and Gneezy 2009; Niederle and Vesterlund 2011; Buser, Niederle, and Oosterbeek 2014), preferences for workplace attributes (Wiswall and Zafar 2018), and beliefs about earnings and ability (Stinebrickner and Stinebrickner 2012; Wiswall and Zafar 2015; Bian, Leslie, and Cimpian 2017), as well as contextual factors like teachers (Bettinger and Long 2005), family background (Dryler 1998; Cheng, Kopotic, and Zamarro 2017), and class/cohort peers (Anelli and Peri 2019; Brenøe and Zölitz 2020; Zölitz and Feld 2021) can discourage women from choosing male-dominated fields.

longitudinal administrative data and remain silent on the underlying mechanisms, this paper employs rich survey data to show evidence on potential channels through which minority status increases women’s dropout.³

The work closest to my study is Stoddard, Jessica, and Karpowitz (2020). The authors conduct a field experiment randomizing team composition in an undergraduate accounting program. Consistent with my findings, they show that women are perceived as less competent and influential when assigned to female-minority teams.⁴ In contrast to Stoddard, Jessica, and Karpowitz (2020), I show that minority status shapes women’s beliefs about the overall gender ratio and their own ability and causes them to drop out of economics and related fields.

This paper uses a field experiment in a policy-relevant male-dominated setting to establish a causal link between minority status and women’s dropout behavior. This finding implies the existence of a “minority trap,” in which underrepresented groups follow a vicious cycle of being in the minority. My results have implications for policy makers, school administrators, and firms seeking to increase the representation of women in male-dominated fields and industries. In addition to rethinking how small groups should be assigned, policy makers may need to consider whether “big pushes” are possible to alleviate women’s minority status and break the vicious cycle.⁵

³Another key difference between this paper and all the previous studies is that this paper focuses on minority status in small peer groups rather than the gender composition of large cohorts or classes. For example, the average cohort size is 17 in Bostwick and Weinberg (2021) and 32 in Huntington-Klein and Rose (2018). This difference is especially important from a policy perspective, because large cohorts and classes are difficult to manipulate, while small groups can serve as a light-touch and cost-effective policy tool. In another setting, Oosterbeek and Van Ewijk (2014) find no significant impact of gender composition in teaching sessions on women’s dropping out of business or economics.

⁴A related study by Sarsons et al. (2021) shows that women receive less credit for group work in economics and male-stereotyped tasks in the lab.

⁵This paper also relates to a growing literature studying how to increase women’s presence in male-dominated settings. Prior studies have examined policies focusing on role models, mentors, information, and gender bias (Blau et al. 2010; Carnes et al. 2015; Avilova and Goldin 2018; Porter and Serra 2020; Delfino 2020). Since small peer groups are ubiquitous in educational and workplace settings, they provide large scope for policy interventions. For example, given a male-dominated class or cohort, small subgroups where women are not in the minority may be introduced to counteract the effect of an unbalanced environment.

2 The Experiment and Data

2.1 Institutional Background

I conducted the experiment in an introductory economics course at a Swiss research university. The course is compulsory for all students with a major or minor in business or economics and is offered annually in the Fall semester. Students in the course are primarily in their first semester at college after obtaining a high school degree in Switzerland. The cohort size is around 1,000 and varies across years. The fraction of female students ranges from 30% to 40% depending on the cohort, so it is a male-dominated setting.

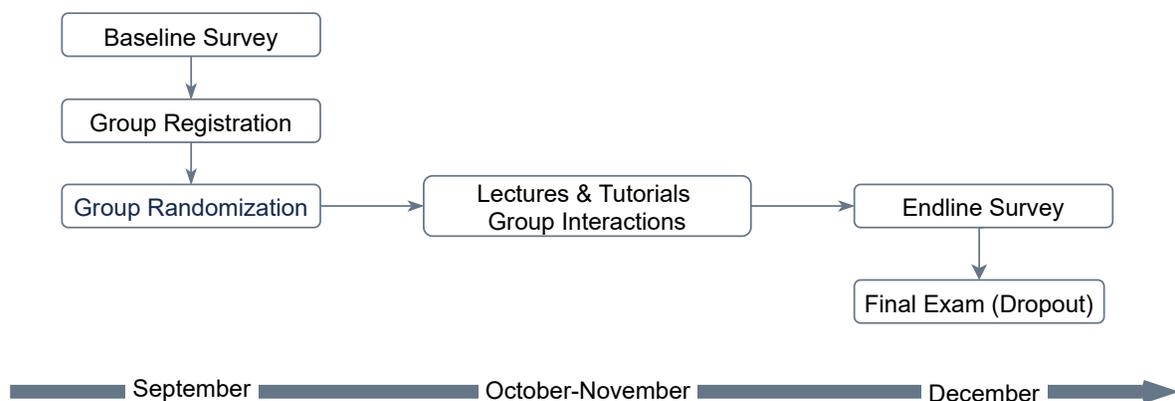
The course is instructed by one single professor who gives two lectures per week in one lecture hall. Students can sit in this lecture hall or watch live streams of the lecture in other rooms—the seating arrangement is decided by students themselves and not fixed over time. Students also attend weekly tutorial sessions where tutors mainly discuss questions on problem sets. The problem sets are designed to prepare students for the final exam, but they are not collected or graded. Students can freely choose among 15 to 20 tutorial sessions delivered by different tutors at different times. Lecture or tutorial attendance is not mandatory and not monitored. Based on self-reported data, the average student attends 85% of all lectures and 75% of tutorial sessions.

The final grade for this course depends solely on student performance in the final exam. The grade ranges from 1 to 6, with steps of 0.25 and 4 as the passing grade. Without attending the exam, the final grade is automatically the lowest, 1, which appears on the academic transcript. Students who fail the exam can retake the course in the next year, and they can only retake it one time. Without passing the course, they cannot complete their registered study programs—meaning that they have to change their programs or drop out of the university. Therefore, dropping out of the course is a high-stakes decision and has important consequences.

2.2 Experimental Design

Figure I shows a timeline of the experiment that took place in 2018 and 2019. Before the semester started, students enrolled in the course were invited to fill out the baseline survey that elicited information about demographics, high school background, parental background, educational expectations, and personality traits. The response rate for the baseline survey was about 90%. In the first lecture, students received information about study groups and decided whether to sign up. Students were fully aware that the study group registration decision was voluntary and did not directly affect the course grade. Overall, about one third of students in the course registered for study groups. The fact that group assignment is conditional on voluntary sign-up may affect the external validity of the results but not their internal validity. Appendix Table A.1 shows which baseline characteristics predict group registration. Although women on average are more likely to sign up, most baseline characteristics are balanced between women who do and do not sign up. See Section 5.2 for detailed discussions on the external validity of my results.⁶

Figure I. Timeline of The Experiment



Notes: The figure shows a timeline of the experiment, which was conducted in the Fall semester of 2018 and 2019 at a Swiss research university.

⁶In Appendix B, I discuss in full length the ethical considerations in this study.

Next, I conducted group randomization by randomly assigning students into groups of four. The assignment was stratified by three strata of study programs: (1) business or economics majors, (2) informatics majors, and (3) business or economics minors. Students in the same stratum have similar curricula. About two thirds of the experimental sample are from stratum 1, including three majors: business administration, economics, and finance. A similar fraction of the students are from strata 2 and 3. Due to the random assignment, study groups varied exogenously in gender composition. The total sample includes 620 students in 155 groups, among which 20 groups are male-only (0F/4), 53 groups are female-minority (1F/4), 47 are gender-balanced (2F/4), 28 are male-minority (3F/4), and 7 are female-only (4F/4).

Following the assignment, students received emails containing information about their group members and encouraging them to study together. To foster social interactions, each group was also given a voucher worth 20 Swiss francs (CHF \approx USD) for drinks at a university bar. The study group members could freely decide how and when they interacted with each other. They could study together for common courses and meet for social events.

The teaching period lasted from September to December. In this period, students attended lectures and tutorials and worked on problem sets by themselves or jointly. In early December, students were invited to fill out the endline survey measuring educational expectations and interactions among group members. In mid-December, the final exam took place. Around 10% of students did not attend the exam and received the lowest final grade, implying that they dropped out of the course during the semester.

2.3 Measurement and Data

In this paper, I focus my analysis on 547 students who completed the baseline survey.⁷ The survey was conducted before group randomization, and I find no evidence that group gender composition predicts the survey take-up. The estimation sample includes 231 women (42%) and 316 men; 213 students (40%) are from the cohort of 2018, and 334 students are from the cohort of 2019. Most students are aged between 19 and 22. Approximately a quarter of students are from each of the following age groups: ≤ 19 , 20, 21, ≥ 22 .

Baseline characteristics Table I summarizes the baseline characteristics of women and men by assigned minority status in the study group. As course records show, about 8.5% of students in the sample are taking the course for the second time. In the baseline survey, students reported their high school final grades for mathematics and the first language, which range from 1 to 6, as well as what the first language is (85% German). Students also reported their parents' socioeconomic background: parents' income quintile (1 to 5) and the number of parents with college degrees (0 to 2). The baseline survey also elicited the Big Five personality traits using the 15-item inventory on a scale of 1 to 7 (John, Donahue, and Kentle 1991; Gerlitz and Schupp 2005; Hahn, Gottschling, and Spinath 2012): openness, conscientiousness, extraversion, agreeableness, and neuroticism.

I also measured students' expectations about future academic achievement: (1) the final grade for the economics course, (2) the probability of passing the first year in the study program on a scale of 0 to 100, and (3) the highest academic degree to be obtained (a high school degree, a bachelor's, master's, or doctoral degree). To reduce concerns of multiple hypotheses testing and increase measurement accuracy, I combine the three

⁷The main results using the full sample of 620 students are similar. Because most background characteristics of the sample were observed in the baseline survey, I focus on the baseline sample (547 students) throughout the paper to test for balancing and estimate the effects of minority status.

dimensions of expectations and create a normalized index—the *overall educational expectation*—with higher values indicating greater optimism or self-confidence about future achievement. The results are consistent when looking at the distinct aspects of expectations.

Outcomes The primary outcome for this paper is dropping out of the economics course. I measure dropout with administrative data—students who did not attend the final exam are defined as dropout observations. The average dropout rate is 11% for women and 8% for men in the sample. Note that students not taking the exam receive the lowest course grade, 1, as reflected by official course records.

I also acquired administrative data on students’ registration and performance for all courses at the school of business and economics in the university, as secondary educational outcomes. Because students in a study group also took other courses together, the experiment may affect dropout in other courses. The data also allow me to study whether the dropout effect of minority status is long-lasting or more short-lived. I use the data to construct two long-term dropout outcomes: permanent course dropout (dropping out of the economics course and not retaking it) and leaving the original study program (no longer registered in the program).⁸

I focus on three other outcomes as potential mediators of the dropout effect of minority status: gender ratio beliefs, educational expectations, and interactions with peers. Educational expectations were measured in the endline survey with the same questions mentioned above. Gender ratio beliefs and interactions with peers were elicited in the endline survey only for the cohort of 2019. The overall response rate for the endline survey is about 75%. As Appendix Table A.3 shows, minority status does not significantly

⁸Note that I only have access to administrative data in the school of business and economics. I do not observe the courses that students take in other schools for other majors or minors. When a student disappears from the records, I cannot distinguish whether she/he leaves the program in the school or leaves the university.

affect the endline survey take-up for both women and men in 2018 and 2019.

The gender ratio belief is about the gender composition of students taking the course. The question was asked in the baseline and endline surveys: “Around 1,000 students took the course in 2018. Among these 1,000 students, how many do you think are women?” I did not directly ask about the situation in 2019 to avoid any potential priming effects on students’ interaction with others. I use this question as a proxy for the perceived minority status of women in business and economics.

Regarding interactions with peers, the endline survey asked students to report how frequently they interacted with each assigned peer. I measured two types of interactions: (1) academic interaction—joint study events such as attending tutorials, working on problem sets, and going through lecture slides; and (2) social interaction—joint social events such as playing sports, watching movies, and having dinner and drinks. Students reported the frequency of academic/social interaction on the following scale: never, less than once per month, once per month, two or three times a month, once per week, or more than once a week. Similarly, I create a normalized index, the *overall interaction with peers*, to capture the average frequency of interaction with other group members. The results are consistent when I construct alternative measures of interaction intensity, such as the number of peers with monthly/weekly meetings.

Appendix Table A.2 shows the descriptive statistics of baseline characteristics and main outcomes by gender and tests the gender differences. Women and men in the sample are significantly different in several aspects at baseline. Women have higher language grades, higher conscientiousness, and lower expectations, but their high school math grades are very similar to men’s. At endline, women also have lower educational expectations and believe that the course has fewer female students. However, I find no significant gender differences in the overall dropout rate and interaction frequency with peers.

Table I. Balancing of Baseline Characteristics by Gender and Minority Status

	(1)	(2)	(3)	(4)	(5)
Panel A: Women	Minority		Non-Minority		Difference
	(N=47)		(N=184)		(<i>p</i> -value)
Retaking the Course	0.06	(0.25)	0.11	(0.31)	0.361
High School Math Grade	4.52	(0.71)	4.56	(0.80)	0.747
High School Language Grade	4.86	(0.53)	4.93	(0.54)	0.464
Parents' Income Quintile	3.34	(0.76)	3.28	(0.94)	0.669
Number of Parents with College Degrees	0.77	(0.81)	0.79	(0.84)	0.840
Openness	5.03	(1.09)	4.96	(1.13)	0.703
Conscientiousness	5.09	(0.82)	4.94	(1.03)	0.331
Extraversion	4.51	(1.22)	4.88	(1.29)	0.081
Agreeableness	5.58	(0.69)	5.54	(0.95)	0.760
Neuroticism	4.59	(1.26)	4.48	(1.28)	0.591
Expected Final Grade	4.56	(0.45)	4.62	(0.50)	0.486
Expected Probability of Passing First Year	77.0	(14.20)	74.8	(17.13)	0.429
Expected Highest Degree: MA	0.92	(0.28)	0.81	(0.39)	0.087
Expected Highest Degree: PhD	0.04	(0.20)	0.10	(0.30)	0.231

	Minority		Non-Minority		Difference
Panel B: Men	(N=24)		(N=292)		(<i>p</i> -value)
Retaking the Course	0.13	(0.34)	0.07	(0.26)	0.347
High School Math Grade	4.48	(0.79)	4.53	(0.87)	0.779
High School Language Grade	4.65	(0.50)	4.66	(0.58)	0.923
Parents' Income Quintile	3.50	(1.06)	3.28	(0.98)	0.305
Number of Parents with College Degrees	0.75	(0.85)	0.74	(0.81)	0.937
Openness	5.04	(1.33)	4.89	(1.01)	0.498
Conscientiousness	4.63	(0.94)	4.63	(0.96)	0.971
Extraversion	4.81	(1.20)	4.70	(1.24)	0.696
Agreeableness	5.32	(0.92)	5.43	(0.89)	0.575
Neuroticism	3.74	(1.52)	3.75	(1.19)	0.957
Expected Final Grade	4.63	(0.48)	4.75	(0.52)	0.241
Expected Probability of Passing First Year	76.3	(15.51)	76.6	(19.56)	0.948
Expected Highest Degree: MA	0.92	(0.28)	0.75	(0.43)	0.065
Expected Highest Degree: PhD	0.08	(0.28)	0.12	(0.33)	0.564

Notes: The table shows the mean and standard deviation (in brackets) of each variable by gender and minority status. Column 5 tests the difference by minority status (*p*-values). High school grades and the expected final grade for the economics course are on a scale of 1 to 6; the Big Five personality traits are measured with the average values of three sub-items on a scale of 1 to 7; the expected probability of passing the first year ranges from 0 to 100. All age group indicators (≤ 19 , 20, 21, ≥ 22) are also balanced by minority status for both women and men.

3 Empirical Strategy

I use the following regression model to estimate the causal impact of minority status on student outcomes:

$$Y_{ig} = \beta \text{Minority}_{ig} + \gamma \text{Minority}_{ig} \times \text{Male}_{ig} + \delta \text{Male}_{ig} + \boldsymbol{\theta} \mathbf{X}_{ig} + \varepsilon_{ig}. \quad (1)$$

Y_{ig} is the outcome of student i in group g . I focus on four outcomes: course dropout, the gender ratio belief, educational expectations, and interactions with peers. Minority_{ig} is a dummy variable indicating whether student i is the minority gender in group g . Male_{ig} is an indicator for student gender. \mathbf{X}_{ig} is a battery of individual characteristics such as cohort fixed effects, study program fixed effects, course-retaking status, high school grades, parents' socioeconomic background, and personality traits. ε_{ig} is the residual term. As the default inference method, I cluster standard errors at the study group level.

For robustness, I also implement split-sample analyses to separately estimate the effects of minority status on the outcomes of women and men and derive p -values for the estimated effects using randomization inference (RI)—also known as permutation tests or randomization tests (Fisher 1935; Imbens and Wooldridge 2009; Young 2019). I calculate the RI p -values by reassigning students into study groups following the same stratification design. For each reassignment, I reestimate the coefficient of minority status for women and men. Under the null hypothesis of no treatment effect, the p -value equals the fraction of reestimated coefficients larger in absolute values than the actual coefficient. As Appendix Table A.7 shows, all the estimated coefficients and significance levels are similar when splitting the sample by gender and using randomization inference.

Because study groups are randomly assigned, β identifies the causal impact of minority status on women, and γ estimates the gender gap in the impact. To confirm that the randomization was successful, I test whether individual characteristics are balanced

by minority status at baseline. As Table I shows, most of the baseline characteristics (including all age group indicators not shown in the table) are not significantly different by minority status for both women and men. Only two variables display an imbalance at the 10% significance level. For women, those assigned to be in the minority are slightly less extroverted and more likely to expect that their highest academic degree is a master's degree. For men, those assigned to be in the minority are also more likely to expect a master's degree. However, as I show below, these characteristics do not significantly predict course dropout, and the results are robust to controlling for these characteristics.⁹

4 Results

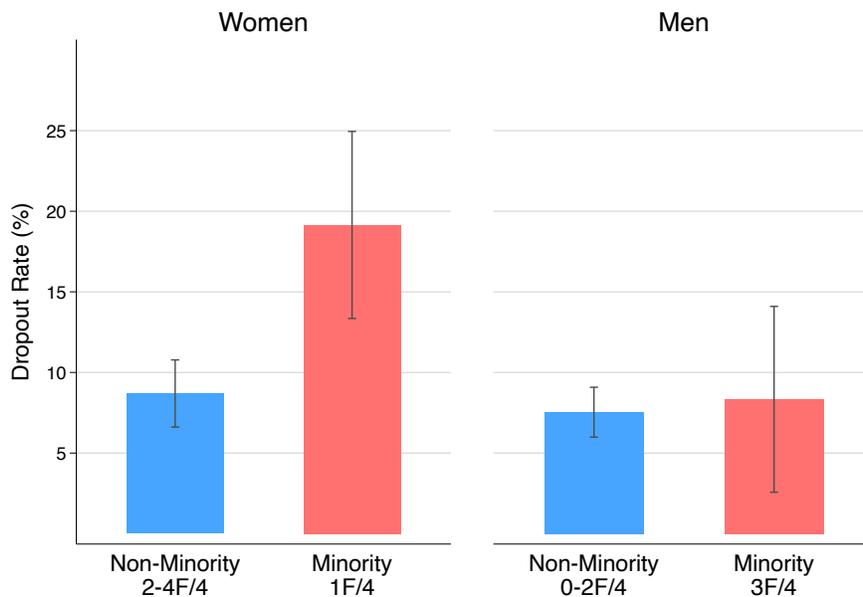
4.1 The Impact of Minority Status on Dropout

Figure II shows the dropout rate by gender and assigned minority status in study groups. For women, those assigned to female-minority (1F/4) groups have a much higher dropout rate than those assigned to other groups. The overall difference by minority status is about 10 percentage points (19% versus 9%). For men, the dropout rate is very similar between those in male-minority (3F/4) groups and others.

Table II presents the estimated impact of minority status on dropout using ordinary least squares (OLS) regressions. The dependent variable is the indicator for dropping out of the economics course. Regressions in all columns include the randomization controls: study program fixed effects and cohort fixed effects. The models in columns 2–5 gradually include the following sets of controls: age group fixed effects, course-retaking status, major fixed effects (for business and economics majors), high school controls, parental

⁹Appendix Table A.4 further summarizes baseline characteristics for women and men in gender-balanced groups and in majority status and separately tests the differences between minority status and the other two types of gender composition. The pattern is similar. In Appendix Table A.5, I also test whether group assignment itself is random using the Edwin Leuven test of randomization. Unsurprisingly, I find no evidence that group assignment is systematically related to background characteristics including gender, age, high school grades, parental background, and personality traits.

Figure II. Dropout by Gender and Minority Status



Notes: The figure shows the raw dropout rate by student gender and assigned minority status in the group. Note that women in the minority are in 1F/4 groups, while men in the minority are in 3F/4 groups. Error bars indicate standard errors of the mean.

background, personality traits, and baseline expectations.

The results show that being underrepresented in study groups significantly increases women’s dropout rate. The estimated coefficients and significance levels are robust to controlling for a rich set of individual characteristics. Using the fully controlled specification in column 5, I find that minority status makes women 11.9 percentage points more likely to drop out of the economics course (p -value=0.041). The effect size is substantial, considering that the dropout rate of women not in the minority is 9% (control group mean). The impact of minority status on men’s dropout is about 12 percentage points smaller, meaning that the impact is effectively zero. I find similar results when separately estimating the effect by gender and using randomization inference (RI). As Panel A of Appendix Table A.7 shows, when including the full set of controls, minority status is estimated to raise women’s dropout rate by 12.4 percentage points (p -value=0.028 based on clustered standard errors and RI p -value=0.022). Appendix Table A.6 further repli-

cates Table II using probit regressions. The effect size is smaller but the estimations are more precise: the estimated coefficient of minority status is around 0.08 and the p -values range from 0.026 to 0.034.

Table II also shows that the level of extraversion and expecting a master's degree as the highest degree—the baseline characteristics that are slightly imbalanced by minority status—do not significantly predict dropout behavior. Also, the estimated effects of minority status remain very similar after controlling for these characteristics in the regressions. The factors that significantly predict dropout includes high school math grade, parents' educational and income levels, and openness to new experience. Students with math achievement higher by one SD or with parental income higher by one quintile are about three percentage points less likely to drop out of the course. By contrast, students with one more parent who has a college degree are 3.5 percentage points more likely to drop out—perhaps because they are aware of more outside options (other study programs) in the university or other universities. Other variables not listed in Table II do not significantly predict dropout.

Impact on course grade In Panel A of Table III, I examine how minority status affects the final grade for the economics course. The grade ranges from 1 to 6, and students who did not attend the exam received the lowest grade 1. The model in column 1 includes the full estimation sample. In column 2, I focus on students who attended the exam. The results show that overall, women in the minority receive lower grades than women in other groups, although this gap is only marginally significant (p -value=0.084). However, conditional on taking the exam, women in the minority obtain grades that are not statistically different from the grades of women not in the minority. In Appendix Figure A.4, I further show that minority status does not significantly influence women's study hours, course attendance, or their course satisfaction. Taken together, the results

Table II. The Overall Impact of Minority Status on Dropout

Dependent Variable: Dropout	(1)	(2)	(3)	(4)	(5)
Minority Status	0.112* (0.060)	0.114** (0.057)	0.115** (0.056)	0.116** (0.057)	0.119** (0.058)
Minority Status \times Male	-0.136 (0.085)	-0.122 (0.085)	-0.117 (0.087)	-0.121 (0.088)	-0.122 (0.088)
Male	0.007 (0.026)	-0.000 (0.025)	0.001 (0.026)	-0.010 (0.027)	-0.010 (0.028)
Retaking the Course		-0.040 (0.047)	-0.033 (0.048)	-0.035 (0.049)	-0.039 (0.050)
Std. High School Math Grade			-0.033*** (0.013)	-0.031** (0.012)	-0.029** (0.013)
Number of Parents with College Degrees			0.035** (0.015)	0.033** (0.015)	0.034** (0.015)
Parents' Income Quintile			-0.029** (0.014)	-0.028** (0.014)	-0.028** (0.014)
Std. Openness				0.020* (0.011)	0.020* (0.012)
Std. Extraversion				0.004 (0.012)	0.005 (0.013)
Expecting MA Degrees					-0.018 (0.046)
Observations	547	547	547	547	547
R-squared	0.028	0.072	0.096	0.106	0.108
Study Program and Cohort FEs	Yes	Yes	Yes	Yes	Yes
Age Group and Major FEs	No	Yes	Yes	Yes	Yes
Course-Retaking Status	No	Yes	Yes	Yes	Yes
High School and Parental Background	No	No	Yes	Yes	Yes
Personality Traits	No	No	No	Yes	Yes
Baseline Expectations	No	No	No	No	Yes

Notes: The table estimates the impact of minority status on the dropout rate of women and men, using ordinary least squares (OLS) regressions. Column 1 only includes randomization controls (study program fixed effects and cohort fixed effects). Column 2 includes age group fixed effects, fixed effects for business and economics majors, and course-retaking status. Column 3 further includes high school controls (math and language grades and an indicator for German as the instruction language) and parental controls (income quintile and number of parents with college degrees). The regression in column 4 also controls for the Big Five personality traits and in column 5 baseline expectations. Standard errors are in parentheses and clustered at the study group level. * $p < .1$, ** $p < .05$, *** $p < .01$.

suggest that minority status does not hamper women’s learning motivation, investment, or the potential to pass the exam; the negative impact on final grade is driven by women voluntarily withdrawing from the course.

Table III. Impact on Grade and the Dropout Effect by Comparison Group and Math Achievement

	(1) Panel A: Course Grade		(3) Panel B: By Comparison Group		(5) Panel C: By Math Achievement	
	All	Attended Exam	Balanced	Majority	High-Math	Low-Math
Minority	-0.354* (0.203)	-0.013 (0.144)	0.133** (0.065)	0.143** (0.063)	0.207*** (0.075)	-0.014 (0.094)
Minority × Male	0.180 (0.344)	-0.125 (0.197)	-0.096 (0.094)	-0.152 (0.096)	-0.138 (0.115)	-0.158 (0.125)
Male	0.300** (0.118)	0.299*** (0.082)	-0.002 (0.041)	0.010 (0.041)	0.030 (0.028)	-0.083 (0.065)
Observations	547	498	239	286	355	192
R-squared	0.213	0.240	0.180	0.164	0.126	0.195

Notes: Panel A of the table estimates the impact of minority status on the final course grade for all students and students who attended the exam. Panels B and C show the impact on course dropout for different subsamples. Panel B separately compares students in the minority to those in gender-balanced groups and those in the majority. Panel C separately examines the impact of minority status on students with above-median high school math grades (*high-math*) and students with below-median math grades (*low-math*). All regressions use the fully controlled specification in column 5 of Table II. Standard errors are in parentheses and clustered at the group level. * $p < .1$, ** $p < .05$, *** $p < .01$.

Comparison group As the main estimation model, students in the minority are compared to all others not in the minority. To better understand how dropout depends on group gender composition, in Panel B of Table III, I separately use students in gender-balanced groups and students in majority status as the comparison group. I find that the estimated effects of minority status on women’s dropout are very similar when using these two gender compositions as the benchmark (13.3 and 14.3 percentage points respectively). This is consistent with the raw pattern shown in Figure A.1. The finding suggests a non-linear relationship between women’s dropout and the number of female peers in a group. One implication is that achieving gender balance in groups is crucial in

preventing women from leaving male-dominated fields; after gender balance is achieved, the marginal benefit of increasing female representation is smaller.¹⁰

Heterogeneity by math achievement From a policy perspective, it is important to know which women are most affected by minority status, because losing different types of women has different implications. For example, if the highly skilled women drop out, this implies a loss of talent in male-dominated fields. Panel C of Table III examines the impact of minority status by high school math grade, as a proxy for academic ability. Math grade strongly and significantly predicts achievement in the economics course and other courses required for business and economics programs.¹¹ I divide students into two groups: those with below-median math grades (<4.5 ; called *low-math*) and the rest whose math grades are at or above the median (≥ 4.5 ; called *high-math*). Women with higher math achievement are overall less likely to drop out than low-math women (8% versus 16%), but being in the minority has a much stronger effect on high-math women. The results show that minority status raises the dropout rate of high-math women by about 20 percentage points (p -value=0.007). In contrast, for low-math women, being in the minority does not significantly impact their dropout behavior.

All course dropout Because students in the same group also took other common courses, the experiment in the economics course may generate spillover effects on other courses. In Panel A of Table IV, I examine the effects of minority status on the dropout rate for all business and economics courses that students took in the semester. I use student-course level observations for the analysis. (Most students took 5 courses in the

¹⁰I omit the comparison between students in the minority and students in purely female/male groups because the estimation sample has only 7 female-only groups.

¹¹On average, students whose math grades are one SD higher achieve grades that are 0.3 SD higher for the economics course and 0.27 SD higher for all courses (p -values are smaller than 0.01 for both). This is not surprising, because most mandatory courses (e.g., mathematics, banking and finance, financial accounting, and business administration) require mathematical and quantitative skills.

semester—including the economics course.) Besides all the student-level controls specified above, the analysis also includes course-by-year fixed effects.¹² For the full sample of women, I find that minority status increases their dropout rate by 3.5 percentage points, but the effect does not reach conventional significance levels. When splitting the sample by math achievement, I find large and consistent heterogeneity in the effect. Being in the minority raises the dropout rate of high-math women by 9.4 percentage points (p -value=0.047) but does not significantly influence low-math women’s dropout behavior.

Table IV. Impact on All Course Dropout and Long-Term Outcomes

	(1)		(2)		(3)		(4)		(5)		(6)	
	Panel A:						Panel B:				Panel C:	
	Dropout for All Courses						Permanent Econ Dropout				Leave Original Program	
	All	High-Math	All	High-Math	All	High-Math	All	High-Math	All	High-Math	All	High-Math
Minority	0.035 (0.031)	0.094** (0.047)	0.042 (0.048)	0.129** (0.064)	0.026 (0.081)	0.156* (0.089)						
Minority × Male	-0.077* (0.042)	-0.111* (0.059)	-0.039 (0.071)	-0.085 (0.089)	-0.091 (0.132)	-0.243* (0.129)						
Male	0.015 (0.015)	0.023 (0.015)	-0.044* (0.024)	-0.008 (0.017)	-0.077 (0.056)	0.011 (0.065)						
Observations	2,775	1,807	547	355	518	335						
R-squared	0.072	0.083	0.089	0.102	0.191	0.222						

Notes: The table examines the impact of minority status on dropout for all courses in the experiment semester and two long-term outcomes: permanently dropping out the of economics course and leaving the original study program by Spring 2020. Panels B and C use the same specification as column 5 of Table II. Panel A uses student-by-course observations and also controls for course-by-year fixed effects. The estimations in Panel C exclude students who could have graduated by Spring 2020, so the sample size is slightly smaller. Standard errors are in parentheses and clustered at the group level. For each outcome, the table shows the overall impact and the impact on high-math students. When using the low-math sample, the estimated coefficients of minority status are close to zero and insignificant. Based on Wald test results, the differences in the effects of minority status on women by math achievement are statistically significant in all three panels: the p -values are 0.029, 0.023, and 0.053. * $p < .1$, ** $p < .05$, *** $p < .01$.

Long-term outcomes Finally, I ask whether the dropout effect observed in the semester leads to long-term dropouts, or if instead, students counteract this effect by retaking the course and remain in their study programs. I answer the question by checking course

¹²I focus on courses with more than five attendants to increase estimation precision, but the results are very similar if I drop this condition or adjust the threshold.

enrollment and program registration records in 2019–2021. Panels B and C of Table IV estimate the impact of minority status on two long-term outcomes: permanently dropping out of the economics course (not retaking it) and leaving the original study program. The results show that overall, being in the minority has directionally positive but insignificant impact on women’s long-term dropout. When focusing on high-math women, again, I find large and significant influences of minority status: being assigned to female-minority groups in the economics course makes them 13 percentage points more likely to permanently drop the course (p -value=0.045) and 15.6 percentage points more likely to leave their original programs up to two years after the experiment (p -value=0.081). For low-math women, minority status does not impact their long-term dropout.

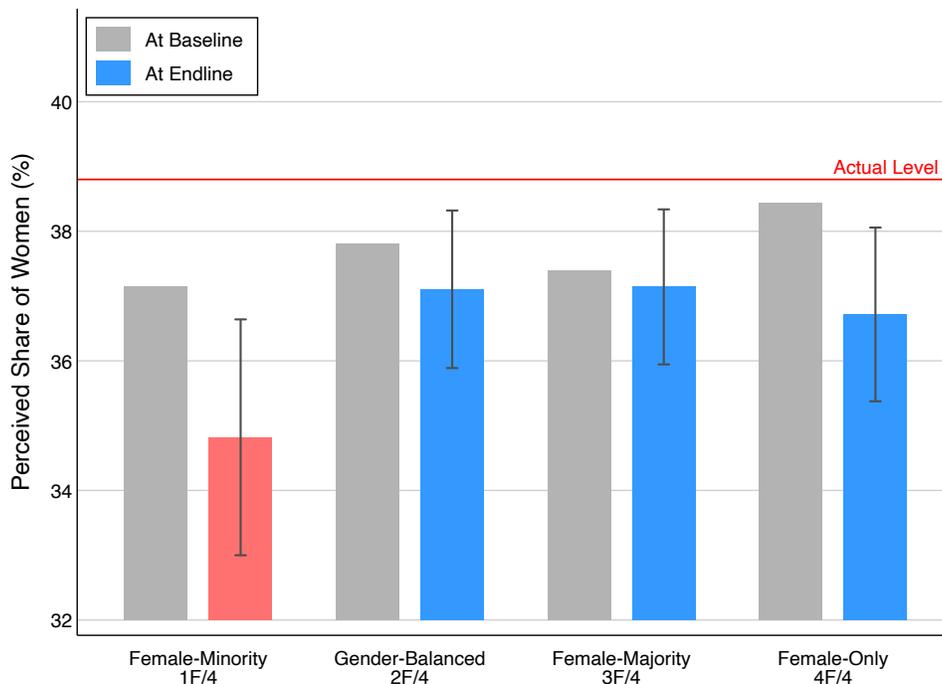
Taken together, the results show that the dropout effect of minority status is driven by women with higher math achievement and higher potential to succeed in economics. For these women, the dropout effect is also long-lasting and irreversible. By contrast, being in the minority does not significantly affect the educational persistence or dropout behavior of low-math women. The finding suggests that economics, as a male-dominated field, is losing the potentially talented women. There are three possible explanations for this striking pattern of heterogeneity. First, high-ability women may have better outside options. They can switch to another field of study and perform well. Second, higher math achievement is correlated with higher expectations and aspirations at baseline, which potentially lead to stronger disappointment and higher dropout. Third, high-ability women can be more marginalized and disliked in male-dominated groups, while women with lower ability may socialize better with other men. I show supportive evidence on the second and third explanations below in Section 4.2.4.

4.2 Mechanisms

4.2.1 Perceived Minority Status of Women

Having shown that being underrepresented in the study group makes women more likely to drop out of the economics course, I explore the underlying mechanisms. The first mechanism that I focus on is the perception of women’s minority status in the setting. The idea is that our immediate social network or local environment can affect how we perceive our status in the broad social environment. For women in a stereotypically male field, being underrepresented in peer groups can raise the salience of their minority status in the field and undermine their sense of belonging.

Figure III. Women’s Gender Ratio Beliefs by Group Gender Composition



Notes: The figure plots women’s perceived gender ratio of students in the course at baseline and endline by group gender composition. The actual share of women is 38.8%, as indicated by the red horizontal line. Error bars indicate standard errors of the mean.

To test for this mechanism, I examine how group gender composition affects students’ beliefs about the overall gender ratio in the course. Figure III plots women’s perceived

percentage of female students at baseline and endline by group gender composition. While women’s baseline perception is similar across groups, their perception at endline differs significantly by minority status. After being exposed to minority status in the group, women believe that there are fewer female students in the course.

Table V. Impact of Minority Status on Gender Ratio Beliefs

	(1)	(2) All	(3)	(4) Women	(5) Men
Dependent Variable: Perceived Share of Women at Endline					
Minority Status	-0.036* (0.019)	-0.035* (0.018)	-0.045* (0.023)	-0.060** (0.026)	0.044** (0.020)
Minority Status \times Male	0.092*** (0.032)	0.085*** (0.029)	0.083*** (0.030)		
Male	0.016 (0.011)	0.011 (0.012)	0.016 (0.013)		
Observations	253	253	253	106	147
R-squared	0.091	0.164	0.246	0.253	0.311
Randomization controls	Yes	Yes	Yes	Yes	Yes
Baseline belief	No	Yes	Yes	Yes	Yes
Full controls	No	No	Yes	Yes	Yes

Notes: The dependent variable is the perceived share of women measured at endline ranging from zero to one. The estimation in column 1 only includes the randomization controls (study program and cohort fixed effects). Column 2 also controls for the baseline level of the dependent variable. Regressions in columns 3–5 include all controls in column 4 of Table II. Standard errors are in parentheses and clustered at the group level. * $p < .1$, ** $p < .05$, *** $p < .01$.

Regression results in Table V corroborate the story. Minority status in the group significantly lowers women’s perceived share of female students in the course by 4 to 6 percentage points, depending on the specification. For men, minority status in the group makes them think that there are more women in the course by a similar magnitude. The results suggest that the gender composition in small groups or networks can indeed change students’ perception about their overall representation in the broader environment. This effect helps to explain why minority status in small groups can change women’s decision about staying in a field or not. This effect also explains why men are not affected by minority status in the group. As the dominant gender, even when underrepresented in

a group, they will not question their fitness in the field and consequently choose to drop out.

4.2.2 Mechanism: Academic Self-Confidence

This section examines the impact of minority status on educational expectations as a proxy for academic self-confidence. Appendix Figure A.1 shows how the overall educational expectation at endline varies with group gender composition. Similar to dropout, a large gap exists between women in female-minority groups and women in other groups. For men, the differences are small and insignificant.

Table VI presents the estimated impact of minority status on educational expectations at endline. Columns 1–3 estimates the overall impact using a standardized index that captures all aspects of expectations. I find that being in the minority lowers women’s expectations about future academic achievement by around 0.4 SD (p -value=0.02 for the fully controlled specification). The magnitude and significance levels are robust to the inclusion of individual controls such as high school background, personality traits, and baseline expectations. For men, the effect is much smaller in magnitude, but the gender gap is not statistically significant. As Panel C of Appendix Table A.7 shows, the results are effectively the same when splitting the sample by gender: minority status significantly lowers women’s expectations but has no significant impact on men’s expectations.

In columns 4–7, I show the impact of minority status on different aspects of expectations: the expected grade for the course, the expected probability of passing the first year in the study program, the highest academic degree expected to be obtained, and the likelihood of expecting a doctoral degree. I find that being in the minority lowers women’s expectations along all dimensions and most of the effects are statistically significant. For instance, minority status lowers women’s expected course grade by more than 0.5 SD and the likelihood of expecting a doctoral degree by 10 percentage points.

Table VI. Impact of Minority Status on Educational Expectations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Overall Expectations			Aspects of Expectations			
				Grade	Pass	Degree	PhD
Minority Status	-0.494*** (0.185)	-0.427** (0.179)	-0.395** (0.170)	-0.519** (0.205)	-0.149 (0.164)	-0.238* (0.135)	-0.098*** (0.033)
Minority Status × Male	0.366 (0.286)	0.275 (0.272)	0.173 (0.263)	0.212 (0.250)	-0.007 (0.288)	0.195 (0.292)	0.085 (0.083)
Male	0.135 (0.113)	0.081 (0.101)	0.111 (0.115)	0.072 (0.110)	0.205 (0.126)	-0.015 (0.109)	0.007 (0.035)
Observations	403	403	403	403	403	403	403
R-squared	0.058	0.254	0.305	0.288	0.226	0.230	0.214
Randomization controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Baseline expectation	No	Yes	Yes	Yes	Yes	Yes	Yes
Full controls	No	Yes	Yes	Yes	Yes	Yes	Yes

Notes: All models are estimated using OLS regressions. The dependent variable in columns 1–3 is the standardized index for the overall educational expectations at endline. In columns 4–7, the dependent variables are the expected final grade for the course (standardized), the expected probability of passing the first year in the study program (standardized), the highest academic degree expected to be obtained (standardized), and whether a PhD degree is expected. *Baseline expectation* refers to the baseline level of the dependent variable in each column. Full controls refer to all the baseline characteristics in column 4 of Table II. Standard errors are in parentheses and clustered at the group level. * $p < .1$, ** $p < .05$, *** $p < .01$.

In Appendix Figure A.2, I further investigate why being underrepresented lowers women’s expectations. I focus on potential driving forces of the effect including estimation of their own ability (overconfidence or underconfidence), aspirations, and estimation of others’ ability. Results suggest that minority status decreases women’s expectations because it lowers their estimation of their own ability and their educational aspirations. On average, women and men are both overconfident about their final grade at baseline. However, at endline, women in the minority are significantly less overconfident. Their aspired minimum grade for the course is also significantly lower. Minority status does not affect men’s estimation of their own ability but raises their estimation of others’ ability.

4.2.3 Mechanism: Social Integration

This section examines how minority status affects peer-to-peer interactions and evaluations within a study group. The idea is that the minority gender in a group may get excluded or marginalized, and the lack of social inclusion can lead to dropout. As Appendix Figure A.1 shows, women in the minority report a lower intensity of interaction with peers than other women. The gap is especially large between women in the minority and women in gender-balanced groups.

Panel A of Table VII shows how minority status affects students' interaction with study group peers. The dependent variable in columns 1–2 is a standardized index for the overall frequency of interaction with peers, including both academic and social interactions. Using the specification with full controls, I find that women assigned to female-minority groups interact 0.54 SD (p -value=0.03) less frequently with peers than women assigned to other groups. Columns 3–4 show that this effect is similar when separately looking at academic and social interactions with peers. The results are not driven by women's under-reporting of activities. For a pair of peers, their reported interactions with each other are highly correlated—the correlation coefficient is 0.8 for academic activities and 0.7 for social activities. The results are also similar when using alternative measures of interaction intensity such as the number of peers with weekly or monthly meetings.

To better understand why women are socially marginalized or excluded in female-minority groups, I examine how minority status affects peers' perceptions of students. I use peers' evaluations of a student in terms of how smart, helpful, and hardworking the student is and how much fun it is to work with the student. As Panel B of Table VII shows, compared to women in other groups, women in the minority are perceived as about 0.5 SD less smart, less fun to work with, less helpful, and less hardworking. By contrast, men in the minority are not evaluated differently from men in other groups.

Table VII. Impact of Minority Status on Interaction with Peers and Evaluations by Peers

	(1)	(2)	(3)	(4)
Panel A: Average Interaction with All Peers (Self-Reported)				
	Overall Interaction		Academic Interaction	Social Interaction
Minority Status	-0.517** (0.219)	-0.538** (0.248)	-0.502** (0.247)	-0.455* (0.241)
Minority Status × Male	0.464 (0.328)	0.400 (0.354)	0.611 (0.412)	0.104 (0.333)
Male	-0.119 (0.148)	-0.103 (0.147)	-0.192 (0.150)	0.007 (0.151)
Full controls	No	Yes	Yes	Yes
Observations	314	314	314	314
R-squared	0.073	0.114	0.086	0.126
Panel B: Characteristics Evaluated by Peers (Other-Reported)				
	Smart	Fun to Work with	Helpful	Hardworking
Minority Status	-0.464** (0.219)	-0.581** (0.242)	-0.480* (0.274)	-0.556** (0.217)
Minority Status × Male	0.417 (0.283)	0.650 (0.422)	0.564 (0.509)	0.728** (0.332)
Male	-0.050 (0.157)	-0.136 (0.123)	-0.175 (0.141)	-0.483*** (0.137)
Full controls	Yes	Yes	Yes	Yes
Observations	383	383	383	383
R-squared	0.084	0.115	0.086	0.163

Notes: Panel A examines the effect of minority status on the average frequency of academic, social, and combined interactions with three peers in the group. All dependent variables are standardized indexes. Panel B estimates how minority status affects peers' evaluations of students' following characteristics on a scale of 1 to 7: being smart, fun to work with, helpful, and hardworking. The dependent variables are standardized ratings of these four characteristics. Estimations in Panel A use student observations. In Panel B, the estimations use student-peer pairwise observations and focus on students who receive at least two ratings from peers to increase estimation precision. Standard errors in parentheses are clustered at the group level. * $p < .1$, ** $p < .05$, *** $p < .01$.

Taken together, the findings suggest that women's isolation in female-minority groups is driven by men's same-gender or homophily preferences rather than women's dislike of male peers. The lack of social integration and potential discrimination from peers can make women in the minority feel like they do not belong in the course and program, thus

leading them to drop out.¹³

4.2.4 Heterogeneous Effects on the Mediators

To summarize, the results presented so far show that minority status in the study group raises women’s dropout rate, and three factors potentially mediate this impact: raised salience of women’s underrepresentation in the setting, lower expectations about future academic achievement, and reduced peer-to-peer interaction and recognition in the group.¹⁴ As the effects of minority status on short-term and long-term dropout are consistently driven by women with higher math achievement, I test whether the effects on the mediators are also concentrated on high-math women.

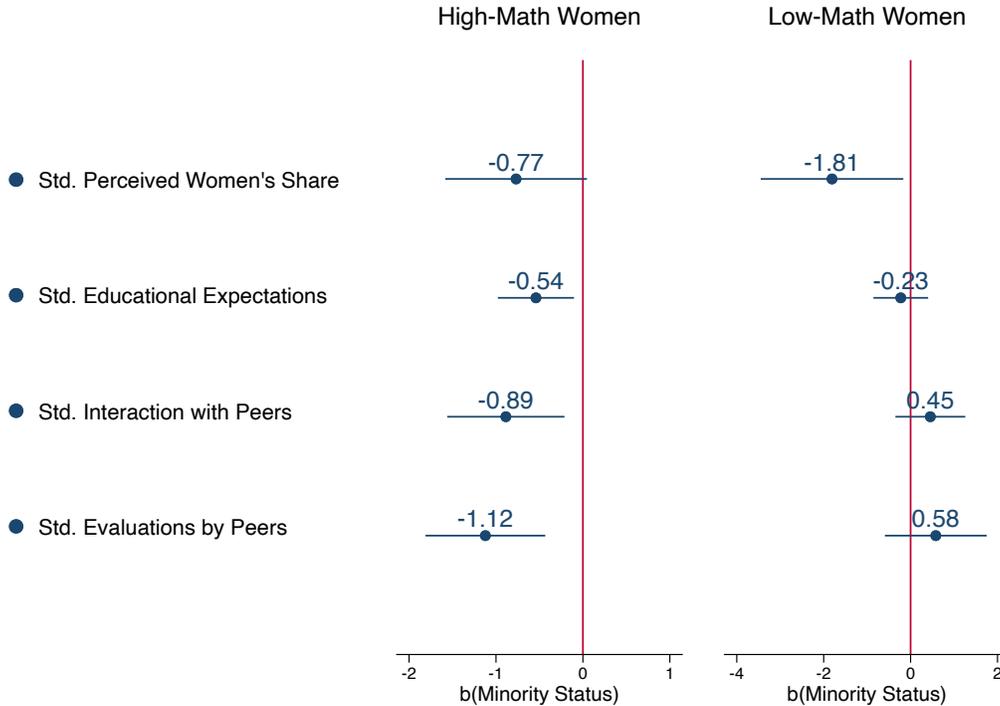
Figure IV shows that the negative effects of minority status on women’s educational expectations, interactions with study group peers, and received evaluations from peers are all driven by high-math women. The undermined academic self-confidence, social integration, and peer recognition possibly explain why minority status strongly and permanently drives these women out of the course and their programs. For women with lower math achievement, the estimated effects of minority status on these mediators are statistically insignificant and even directionally positive for interactions and relationships with peers. In terms of gender ratio beliefs, high-math and low-math women are similarly affected by minority status. The results suggest that being in the minority is particularly detrimental for the underrepresented gender with higher ability and higher expectations. Therefore, achieving gender balance in small groups and networks can be especially help-

¹³I also find that minority status does not affect the likelihood of having any meaningful interactions (studying together or having joint social events), but significantly lowers the number of such interactions for women in the minority. This finding suggests that the marginalization or exclusion of women in male-dominated groups is not due to the lack of initial interactions, but rather due to students’ preferences or tastes for close peers.

¹⁴Appendix Figure A.3 shows that these three factors negatively correlate with women’s dropout rate. Women are less likely to drop out if they believe the course has more female students, if they expect higher academic achievement, and if they have more frequent interaction with peers. However, I cannot provide causal evidence that these three factors affect dropout, and I cannot separate the effects of these three mechanisms.

ful in retaining the high-potential women in male-dominated fields and professions.

Figure IV. Impact of Minority Status on Mediators by Math Achievement



Notes: The figure shows the estimated effects of minority status on the following outcomes of women by math achievement: perceived share of women in the course at endline, educational expectations at endline, the overall interaction frequency with peers, and the average evaluations by peers (the mean of the four outcomes in Panel B of Table VII). Each point estimate is derived from one regression using the sample of women and including the full set of controls. *High-Math Women* refer to women whose high school math grades are at or above the median. Error bars indicate 95% confidence intervals.

5 Robustness and Discussions

5.1 Robustness

Other peer characteristics As documented in the literature, various student characteristics such as ability, behaviors, and personality traits can affect peers' educational outcomes—see Sacerdote (2014) for an extensive review. Also, as Appendix Table A.2 shows, men and women in the sample display different characteristics. Therefore, it is a

valid concern that the dropout effect of minority status can be confounded by other peer characteristics related to gender. To mitigate this concern, I further include peer-level controls when estimating the impact of minority status on dropout. Results in Appendix Table A.8 show that the estimated impact of minority status on women’s dropout remains strong and statistically significant even after controlling for a large set of peer characteristics, such as high school grades, personality traits, and parental background. The results suggest that the unbalanced gender ratio, rather than other peer characteristics, generates the dropout effect of minority status on women.

Survey selection Although the results on dropout use administrative data without missing values, the mechanism analyses rely on the endline survey, for which the response rate was 70%. To address concerns about nonrandom attrition, I show the following. First, as presented in Appendix Table A.3, the survey response is balanced by minority status for both women and men in both cohorts. Put differently, I do not find evidence that minority status affects the likelihood of answering the endline survey. Second, I show results on the three potential mechanisms using Lee bounds (Lee 2009) with and without employing inverse probability weighted (IPW) regressions in Appendix Table A.9. I find that the lower and upper bounds are within the 95% confidence intervals of the OLS estimations, suggesting that endogenous attrition is not driving the results.

Multiple hypotheses testing This paper has eight main estimations: the effects of minority status on women’s dropout and three mediators and the gender differences in these effects. I use the step-down approach of Romano and Wolf (2005, 2016) to calculate the p -values for multiple hypotheses testing. Appendix Table A.12 shows the original p -values based on clustered standard errors, bootstrapping p -values with 1,000 replications, and the Romano-Wolf p -values. As the results show, the estimated effects of minority status on women’s outcomes remain statistically significant at the same levels

after applying bootstrapping and Romano-Wolf corrections.

Results for the 2019 cohort As the results on gender ratio belief and peer-to-peer interactions only use data from 2019, I test if the results on dropout and educational expectations display similar patterns when focusing on the cohort of 2019. As columns 1 and 3 of Appendix Table A.10 show, the results have similar magnitude, but unsurprisingly, the estimations are less precise than the full-sample results. Columns 2 and 4 also show that the results are similar when focusing on students taking the course for the first time (non-repeaters).

5.2 Discussions

Are study groups overall beneficial? To this point, all results apply to students in randomly assigned study groups. One question that remains unanswered is whether study groups themselves are beneficial. I cannot provide causal evidence on this because students voluntarily select into study groups. As I discuss fully in Appendix Section B, my study group experiment does not appear to affect the overall dropout rate at the cohort level (see Figure B.2). I also test how group participation correlates with dropout within a cohort. As Figure B.3 shows, the dropout rate of women without study groups is 16%, which is higher than the dropout rate among women with study groups (11%). For men, the dropout rate is very similar between those with groups and those without groups. The results suggest that having a study group is overall harmless and even correlates with better outcomes for women.

Counterfactual group assignment Given the results of this paper, the final question that I ask is what the optimal group assignment should be in order to lower women's dropout rate. I conduct a simple counterfactual analysis in my experimental setting. By fixing the sample size and the observed dropout rate by gender composition, I abol-

ish female-minority groups and assign students into other types of groups. For each counterfactual assignment, I calculate the average female and male dropout rate. As Appendix Figure A.5 shows, in all counterfactual scenarios without female-minority groups, women’s dropout rate is lower than the actual level. In the best scenario, we can decrease women’s dropout rate by 2 percentage points while keeping men’s dropout rate the same. This exercise shows that in a male-dominated setting with small groups such as shared offices, work groups, and joint projects, we may retain more women by replacing female-minority groups with groups where women are not in the minority.

External validity A final concern about this paper relates to the external validity of the results. This study has two limitations regarding its generalizability. First, with groups of four, I observe only one scenario of minority status (1/4). Therefore, I cannot distinguish minority status from one-woman (or one-man) status. Groups of five make it possible to compare the effects of being 1/5 and 2/5. Assuming that the impact of minority status increases with its intensity, the estimated effect of minority status in this paper should lie between the 1/5 and 2/5 scenarios. Future work could explore this question.

The second limitation is that students decide whether to register for study groups. It raises the concern that the average treatment effects (ATE) of minority status estimated by the experimental sample may not be externally valid for the whole population of students. It is less of a concern because (1) baseline characteristics are mostly balanced between women having study groups and women without study groups (see Appendix Table A.1), and (2) students who want to interact with others and register for study groups are arguably of higher policy interest—they are the relevant population. Nevertheless, I check how the ATE estimations change after correcting for potential participation bias, using the approach of Andrews and Oster (2019). As Appendix Table A.11 shows, the

effect of minority status on women’s dropout is robust to the correction. Even after considering a wide range of observable characteristics such as high school grades, parental background, and personality traits, the unobservables would have to be more important than the observables ($\Phi > 2$) to deliver an ATE of zero in the population.

6 Conclusion

This paper provides experimental evidence that minority status can drive women out of male-dominated fields. I find that compared to women in other groups, those assigned to female-minority groups are more likely to drop out of a compulsory economics course. The impact of minority status on course dropout is concentrated on women with higher math achievement and higher potential to succeed in economics. For these women, the dropout impact is also long-lasting and irreversible. This suggests that male-dominated fields are losing the potentially talented women due to the unbalanced gender ratio.

Given the current efforts to promote gender equality and close gender gaps in male-dominated fields and industries, this paper has important implications. My findings suggest that minority status can perpetuate itself and trap underrepresented groups in a vicious cycle of underrepresentation. This minority trap likely contributes to the “leaky pipeline” phenomenon, which describes women’s gradual disappearance from male-dominated professions. I also find suggestive evidence on three mechanisms of the minority trap: more salient minority status, lower expectations about future achievement, and undermined social integration. These mechanisms are fairly generalizable, suggesting that other underrepresented groups may face similar minority traps.

To break the minority trap—similar to poverty traps—we may need to introduce “big push” policies at the profession level. For example, much effort is required to change dominant cultures, correct biases against women, and attract more female students into male-dominated fields at an early stage.

My results also have implications about group assignment policies in education and the workplace. Working and decision-making in groups is becoming increasingly prevalent in firms, organizations, and academia (Devine et al. 1999; Lazear and Shaw 2007; Rath and Wohlrabe 2016). To improve gender diversity in male-dominated professions, a common practice is to allocate one woman or a few women to groups predominantly consisting of men. This paper shows that instead of helping women “lean in,” such female-minority groups can make women less confident, more isolated, and cause them to “leak out.” Therefore, institutions can increase women’s retention rate by avoiding female-minority groups whenever assigning students or workers to collaborative projects, shared offices, lab groups, interview panels, or board committees.

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A Appendix Tables and Figures

Table A.1. How Student Characteristics Predict Group Registration

	(1) All	(2) Women	(3) Men
Dependent Variable: Sign-up for Study Groups			
Female	0.047** (0.024)		
Std. High school math grade	-0.012 (0.011)	-0.015 (0.017)	-0.012 (0.015)
Std. High school language grade	0.002 (0.012)	0.017 (0.017)	-0.016 (0.016)
Parents' income quintile	-0.018 (0.013)	-0.012 (0.020)	-0.022 (0.018)
Number of parents with college degrees	0.025* (0.014)	0.036* (0.020)	0.015 (0.019)
Std. Openness	0.032*** (0.011)	0.019 (0.017)	0.042*** (0.015)
Std. Conscientiousness	-0.017 (0.011)	-0.019 (0.017)	-0.023 (0.016)
Std. Extraversion	0.009 (0.011)	0.008 (0.017)	0.011 (0.016)
Std. Agreeableness	0.002 (0.011)	0.000 (0.016)	0.002 (0.016)
Std. Neuroticism	-0.001 (0.011)	-0.005 (0.017)	-0.010 (0.016)
Observations	1,660	737	923

Notes: The tables shows which students are more likely to sign up for study groups. Each point estimate is derived from one OLS regression, where the dependent variable is the indicator for group registration and the control variables include major fixed effects and cohort fixed effects. Column 1 uses the full sample of students who have completed the baseline survey, column 2 focuses on the sample of women, and column 3 focuses on men. The raw registration rate is 33% overall, 34% for the sample of women, and 31% for men. Robust standard errors are in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table A.2. Descriptive Statistics by Gender

	(1)	(2)	(3)	(4)	(5)
	Women (N=231)		Men (N=316)		Gender Diff.
	mean	sd	mean	sd	<i>p</i> -value
Panel A: Baseline Characteristics					
Retaking the Course	0.10	(0.30)	0.08	(0.27)	0.331
High School Math Grade	4.55	(0.78)	4.53	(0.86)	0.705
High School Language Grade	4.91	(0.54)	4.66	(0.57)	0.000
Parents' Income Quintile	3.29	(0.90)	3.30	(0.99)	0.898
Number of Parents with College Degrees	0.79	(0.83)	0.74	(0.81)	0.476
Openness	4.97	(1.12)	4.90	(1.03)	0.460
Conscientiousness	4.97	(0.99)	4.63	(0.95)	0.000
Extraversion	4.80	(1.28)	4.71	(1.23)	0.407
Agreeableness	5.55	(0.91)	5.42	(0.89)	0.101
Neuroticism	4.50	(1.27)	3.75	(1.21)	0.000
Expected Final Grade	4.61	(0.49)	4.74	(0.52)	0.002
Expected Prob. Pass First Year	75.27	(16.57)	76.54	(19.26)	0.420
Expected Highest Degree: MA	0.83	(0.38)	0.76	(0.43)	0.051
Expected Highest Degree: PhD	0.09	(0.28)	0.12	(0.33)	0.207
Panel B: Outcomes					
Course Dropout	0.11	(0.31)	0.08	(0.27)	0.192
Std. Educational Expectation at Endline	-0.11	(0.96)	0.13	(1.03)	0.019
Std. Perceived Share of Women at Endline	0.37	(0.07)	0.40	(0.09)	0.000
Std. Interaction with Peers	0.03	(1.01)	0.04	(1.03)	0.918

Notes: The table shows the means and standard deviations (sd) of baseline characteristics and main outcomes for women and men separately and tests the gender differences for all characteristics. For self-reported outcomes at endline, the sample size is smaller.

Table A.3. Minority Status Does Not Affect Endline Survey Take-Up

	(1)	(2)	(3)	(4)	(5)	(6)
		Women			Men	
	All	2018	2019	All	2018	2019
Minority Status	-0.015 (0.075)	0.069 (0.097)	-0.088 (0.113)	0.105 (0.100)	0.116 (0.165)	0.082 (0.126)
Observations	231	95	136	316	118	198
R-squared	0.003	0.014	0.018	0.014	0.020	0.013

Notes: The tables tests whether minority status affects the take-up rate of the endline survey. The dependent variable is the take-up indicator. All models control for study program fixed effects (and cohort fixed effects). Standard errors are in parentheses and clustered at the group level.

Table A.4. Descriptive Statistics of Baseline Characteristics by Group Gender Composition

	(1)	(2)	(3)	(4)	(5)
Panel A: Women	Minority (N=47)	Balanced (N=84)	Majority (N=78)	Minority v.s. Balanced Majority	
Retaking the Course	0.06	0.12	0.12	0.314	0.347
High School Math Grade	4.52	4.63	4.44	0.434	0.531
High School Language Grade	4.86	5.00	4.83	0.155	0.720
Parents' Income Quintile	3.34	3.23	3.27	0.485	0.666
N. Parents w/ College Degrees	0.77	0.81	0.69	0.779	0.615
Openness	5.03	4.90	5.06	0.555	0.871
Conscientiousness	5.09	5.04	4.84	0.772	0.149
Extraversion	4.51	4.83	4.93	0.177	0.070
Agreeableness	5.58	5.44	5.55	0.400	0.845
Neuroticism	4.59	4.47	4.41	0.616	0.448
Expected Final Grade	4.56	4.72	4.48	0.096	0.263
Expected Probability Passing	77.0	78.4	71.4	0.637	0.048
Expected Highest Degree: MA	0.92	0.82	0.80	0.147	0.077
Expected Highest Degree: PhD	0.04	0.08	0.10	0.380	0.234

	Minority (N=24)	Balanced (N=84)	Majority (N=137)	Minority v.s. Balanced Majority	
Retaking the Course	0.13	0.12	0.04	0.938	0.066
High School Math Grade	4.48	4.44	4.60	0.852	0.525
High School Language Grade	4.65	4.69	4.64	0.725	0.951
Parents' Income Quintile	3.50	3.31	3.20	0.403	0.166
N. Parents w/ College Degrees	0.75	0.79	0.78	0.858	0.864
Openness	5.04	4.73	4.96	0.244	0.736
Conscientiousness	4.63	4.68	4.70	0.816	0.734
Extraversion	4.81	4.85	4.62	0.891	0.503
Agreeableness	5.32	5.44	5.39	0.565	0.723
Neuroticism	3.74	3.87	3.63	0.667	0.679
Expected Final Grade	4.63	4.77	4.76	0.185	0.237
Expected Probability Passing	76.3	74.9	77.5	0.759	0.781
Expected Highest Degree: MA	0.92	0.76	0.74	0.099	0.057
Expected Highest Degree: PhD	0.08	0.16	0.11	0.377	0.703

Notes: The table shows the means of baseline characteristics for women and men in the minority, in gender-balanced groups, and in the majority. The table also reports the p -values for the differences between women/men in the minority and women/men in gender-balanced groups or in the majority. Female-only and male-only groups are omitted in the table, because the sample includes very few 4F/4 groups. The variable scales are the same as in Table I.

Table A.5. Edwin Leuven Test of Group Randomization

	(1) <i>F</i> -statistic	(2) <i>p</i> -value
Female	0.912	0.744
Retaking the Course	4.414	0.000
High School Math Grade	0.932	0.691
High School Language Grade	0.952	0.636
Parents' Income Quintile	1.021	0.431
Number of Parents with College Degrees	0.985	0.536
Openness	1.082	0.271
Conscientiousness	0.824	0.919
Extraversion	1.061	0.321
Agreeableness	0.943	0.660
Neuroticism	1.144	0.152
Expected Final Grade	1.025	0.419
Expected Probability Passing First Year	0.962	0.606
Expected Highest Degree: MA	0.880	0.823
Expected Highest Degree: PhD	0.843	0.891
Age \leq 19	0.873	0.836
Age = 20	0.885	0.809
Age = 21	0.977	0.561
Age \geq 22	1.045	0.364

Notes: I first regress each characteristic on randomization strata dummies (study program and cohort fixed effects) and derive the residuals. Then, I regress the residuals on study group dummies and test the joint significance of group dummies—the *F*-statistics and *p*-values are reported.

Table A.6. Impact of Minority Status on Dropout Using Probit Regressions

Dependent Variable: Dropout	(1)	(2)	(3)	(4)	(5)
Minority Status	0.084** (0.039)	0.082** (0.037)	0.077** (0.035)	0.075** (0.036)	0.077** (0.036)
Minority Status × Male	-0.104 (0.075)	-0.068 (0.071)	-0.058 (0.071)	-0.059 (0.073)	-0.062 (0.074)
Male	0.006 (0.028)	-0.003 (0.026)	-0.007 (0.026)	-0.017 (0.028)	-0.016 (0.029)
Observations	547	547	547	547	547
Study Program and Cohort FEs	Yes	Yes	Yes	Yes	Yes
Age Group and Major FEs	No	Yes	Yes	Yes	Yes
Course-Retaking Status	No	Yes	Yes	Yes	Yes
High School and Parental Background	No	No	Yes	Yes	Yes
Personality Traits	No	No	No	Yes	Yes
Baseline Expectations	No	No	No	No	Yes

Notes: The table reports the average marginal effects of minority status on the dropout of women and men using probit regressions—the control variable. Column 1 only includes randomization controls. Column 2 includes age group fixed effects, fixed effects for business-economics majors, and course-retaking status. Column 3 further includes high school controls and parental controls. The regression in column 4 also controls for the Big Five personality traits and in column 5 baseline expectations. Standard errors are in parentheses and clustered at the group level. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table A.7. Estimated Effects on Main Outcomes by Gender with RI p -Values

	(1)	(2)	(3)	(4)
	Women		Men	
	Strata FEs	Full controls	Strata FEs	Full controls
Panel A: Course Dropout				
Minority Status	0.112*	0.124**	-0.013	0.005
	(0.059)	(0.056)	(0.064)	(0.067)
[RI p -value]	[0.034]	[0.022]	[0.852]	[0.941]
Observations	231	231	316	316
R-squared	0.042	0.167	0.019	0.117
Panel B: Perceived Share of Women				
Minority Status	-0.042**	-0.060**	0.059**	0.044**
	(0.020)	(0.026)	(0.024)	(0.020)
[RI p -value]	[0.033]	[0.009]	[0.050]	[0.109]
Observations	106	106	147	147
R-squared	0.096	0.253	0.036	0.311
Panel C: Std. Educational Expectations				
Minority Status	-0.481**	-0.399**	-0.014	-0.117
	(0.185)	(0.175)	(0.202)	(0.203)
[RI p -value]	[0.021]	[0.047]	[0.957]	[0.621]
Observations	177	177	226	226
R-squared	0.062	0.263	0.041	0.362
Panel D: Std. Interaction with Peers				
Minority Status	-0.572**	-0.580**	-0.153	-0.291
	(0.237)	(0.262)	(0.187)	(0.212)
[RI p -value]	[0.040]	[0.028]	[0.580]	[0.312]
Observations	130	130	184	184
R-squared	0.101	0.290	0.057	0.141

Notes: The table reports the estimated impact of minority status on the main outcomes by student gender, with only randomization strata (cohort and program) fixed effects or with the full set of controls. Significance stars are based on clustered standard errors in parentheses. $*p < .1$, $**p < .05$, $***p < .01$. Randomization inference p -values in brackets are derived from 1,000 reassignments of study groups.

Table A.8. Impact on Dropout Controlling for Peer-Level Characteristics

Dependent Variable: Dropout	(1)	(2)	(3)	(4)	(5)
Minority Status	0.153** (0.072)	0.148** (0.071)	0.151** (0.072)	0.164** (0.070)	0.162** (0.069)
Minority Status \times Male	-0.114 (0.103)	-0.107 (0.101)	-0.110 (0.100)	-0.130 (0.101)	-0.136 (0.101)
Male	0.005 (0.033)	0.001 (0.032)	0.001 (0.032)	0.008 (0.031)	0.011 (0.032)
Peer-level controls:					
Retaking status & high school grades	No	Yes	Yes	Yes	Yes
Parental background	No	No	Yes	Yes	Yes
Personality traits	No	No	No	Yes	Yes
Baseline expectations	No	No	No	No	Yes
Observations	380	380	380	380	380
R-squared	0.131	0.146	0.149	0.159	0.167

Notes: The table shows the estimated effect of minority status on course dropout with different sets of peer-level controls. The model in column 1 uses the same specification as column 5 of Table II but only includes students whose three peers have all completed the baseline survey. Column 2 further controls for peers' average high school grades for math and language and average course-retaking status. Column 3 also controls for peers' parental background (average income and educational levels). Columns 4 and 5 also include the average levels of peers' Big Five personality traits and baseline expectations. Clustered standard errors are in parentheses. $*p < .1$, $**p < .05$, $***p < .01$.

Table A.9. Estimated Effects of Minority Status Using Lee Bounds

	(1)	(2)	(3)
Dependent Variable: Std. Perceived Women's Share			
OLS Estimation	-0.68	-0.67	-0.82
95% Confidence Interval	[-1.30, -0.05]	[-1.31, -0.02]	[-1.54, -0.11]
Lower Bound	-0.92	-0.93	-1.08
Upper Bound	-0.41	-0.39	-0.56
Dependent Variable: Std. Educational Expectations			
OLS Estimation	-0.38	-0.37	-0.35
95% Confidence Interval	[-0.77, 0.01]	[-0.77, 0.04]	[-0.73, 0.03]
Lower Bound	-0.46	-0.46	-0.42
Upper Bound	-0.30	-0.26	-0.28
Dependent Variable: Std. Interaction with Peers			
OLS Estimation	-0.52	-0.50	-0.75
95% Confidence Interval	[-0.92, -0.12]	[-0.10, -0.01]	[-1.31, -0.20]
Lower Bound	-0.54	-0.70	-1.01
Upper Bound	-0.45	-0.18	-0.33
Inverse Probability Weighting	No	Yes	Yes

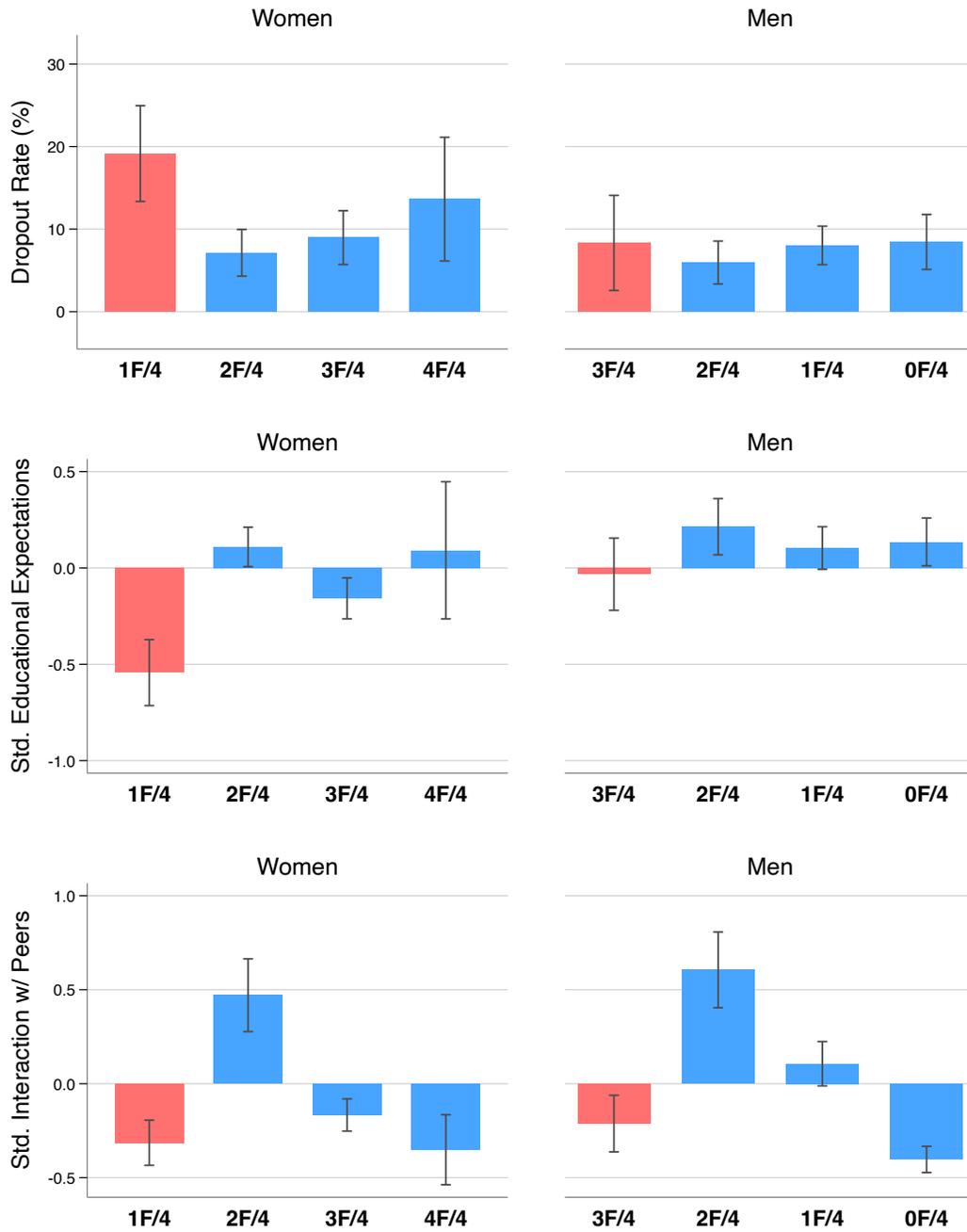
Notes: The table shows the original OLS estimations with 95% confidence intervals and the Lee upper/lower bounds. Columns 2–3 conduct inverse probability weighted analyses, where the probability is the predicted likelihood of having non-missing values for the dependent variable. The prediction of the likelihood in column 2 is based on randomization controls, age group fixed effects, and course-retaking status. The prediction in column 3 also includes parental and high school background and personality traits as specified in column 4 of Table II.

Table A.10. Impact on Dropout and Expectations for the 2019 Cohort and Non-Repeaters

	(1) Dropout		(3) Std. Educational Expectations	
	2019 Cohort	Non-Repeaters	2019 Cohort	Non-Repeaters
Minority Status	0.152*	0.105*	-0.498	-0.481**
	(0.084)	(0.058)	(0.335)	(0.200)
[RI p -value]	[0.044]	[0.072]	[0.097]	[0.034]
Observations	136	208	106	157
R-squared	0.199	0.164	0.320	0.285

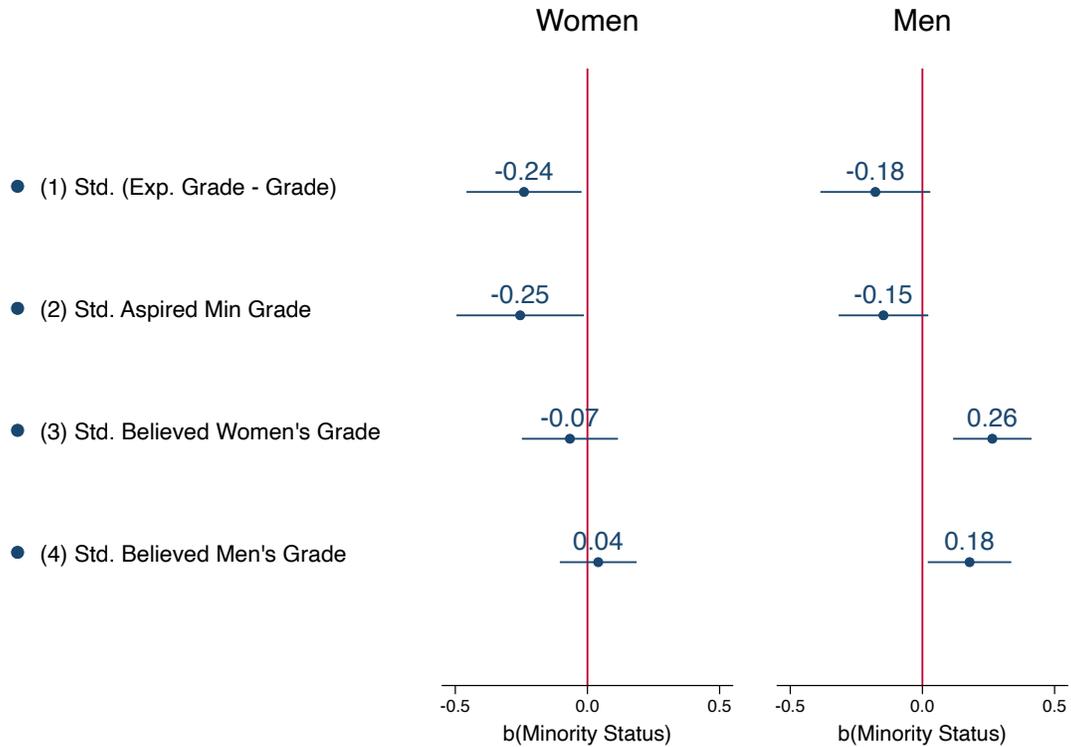
Notes: The table shows the estimated effects of minority status on dropout and endline educational expectations when focusing on women from the cohort of 2019 and women who are not retaking the course. All estimations only include the sample of women and control for all individual characteristics listed in column 4 of Table II. Clustered standard errors are in parentheses and randomization inference p -values are in brackets. Significance stars are based on the standard errors. * $p < .1$, ** $p < .05$, *** $p < .01$.

Figure A.1. Dropout, Expectations and Interaction with Peers by Gender Composition



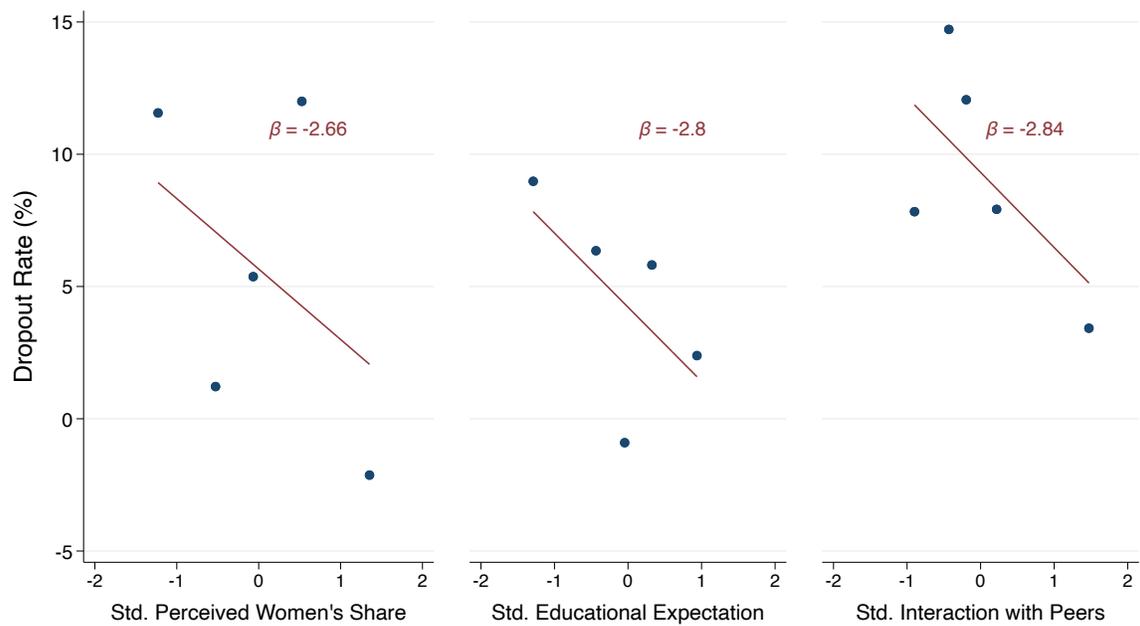
Notes: The figure plots the distribution of the overall dropout rate, educational expectations at endline, and overall interaction frequency with peers by group gender composition and own gender. Error bars indicate standard errors of the mean.

Figure A.2. Unpacking the Impact of Minority Status on Expectations



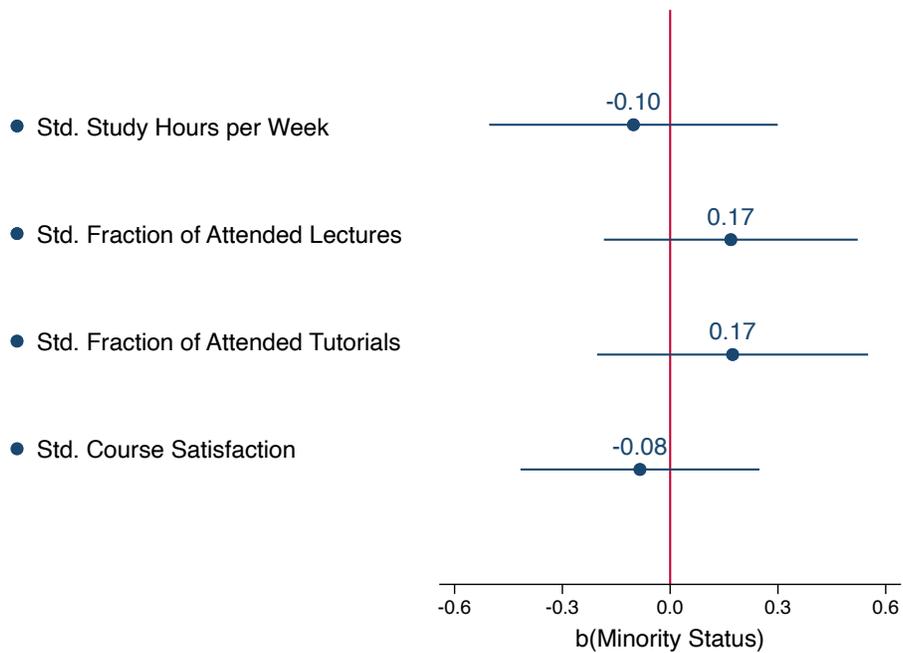
Notes: The graph plots the estimated effects of minority status on the following outcomes of women and men: (1) the gap between the expected grade and the actual grade, used as a proxy for overconfidence or underconfidence in one’s ability; (2) the aspired minimal grade for the course, used as a proxy for educational aspiration; and (3)–(4) the believed grade of the average woman or man in the previous cohort. Each point estimate is derived from one OLS regression. All outcomes are based on answers in the endline survey and use standardized values. Outcomes 2–4 are only available in 2019. For outcome 1, results including and excluding students who drop the course are very similar. All regressions include the full set of controls and the baseline level of the dependent variable. Error bars indicate 95% confidence intervals.

Figure A.3. Correlations Between Dropout and Mediators



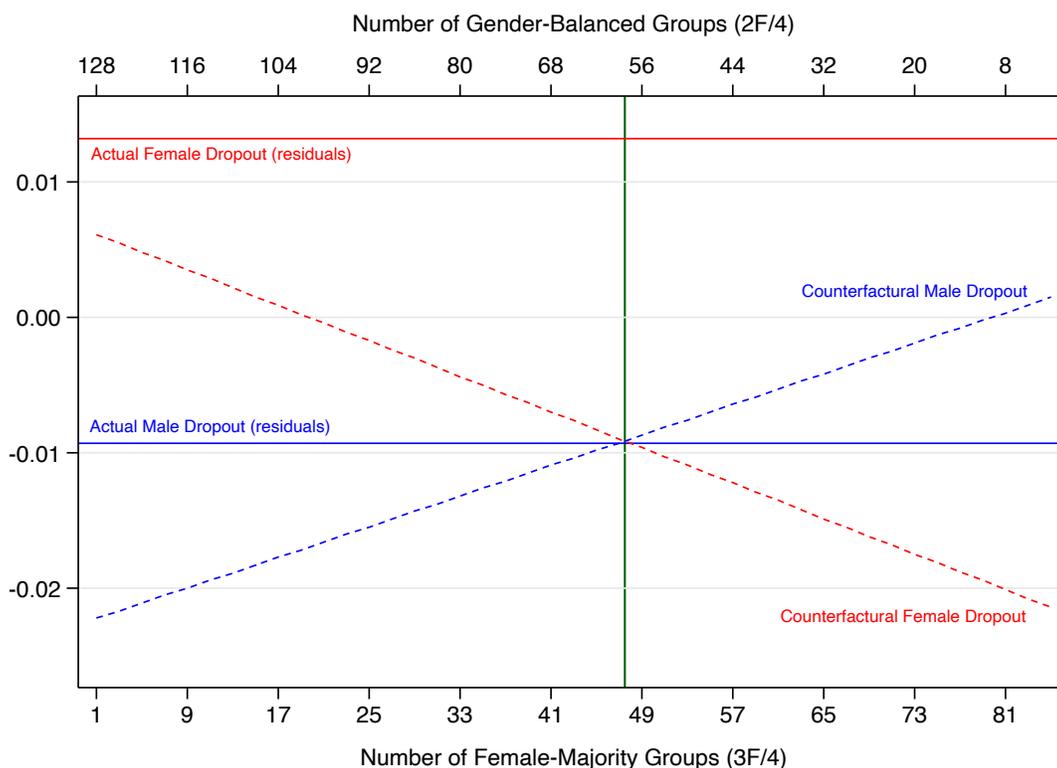
Notes: The binned scatter plots show how female dropout correlates with three potential mediators: the perceived share of women in the course, the overall educational expectation, and the overall interaction intensity with peers. All figures control for program, cohort, and age group fixed effects, course-retaking status, and the baseline level of the outcome if applicable. β is the slope of the fitted line, corresponding to a linear regression of dropout on the mediator and covariates.

Figure A.4. No Significant Impact on Course Learning and Satisfaction



Notes: The figure shows the impact of minority status on the following outcomes: study hours per week for the course, the fraction of lectures attended, the fraction of tutorial sessions attended, and the overall course satisfaction. All outcomes are self-reported in the endline survey and standardized for analysis. One point estimate represents one regression that includes the full set of controls. Error bars indicate 95% confidence intervals.

Figure A.5. Counterfactual Dropout Rate under Alternative Group Assignments



Notes: The graph shows how the counterfactual dropout rate varies with the number of gender-balanced and female-majority (or male-minority) groups. I first partial out study program and cohort fixed effects and derive the residuals of dropout. From the dropout residuals, we know the actual average dropout rate among women (0.013) and men (-0.009)—the horizontal dashed lines—as well as the dropout rate by gender and group gender composition. As shown previously, women in female-majority groups have the lowest dropout rate, and those in gender-balanced groups have the second-lowest dropout rate. Men in gender-balanced and female-majority groups also have a low dropout rate, but those in male-only groups have a higher dropout rate. Fixing the sample size of students—259 women and 361 men—and forcing the number of female-minority groups at zero, I vary the number of female-majority groups, from 1 to 85—with two groups per step. I assign the rest of the women into gender-balanced groups, which pins down the number of gender-balanced groups. Accordingly, we know the number of men in female-majority and gender-balanced groups. The rest of the men are assigned to male-only groups. For each assignment, I then calculate the average dropout rate for women and men as plotted. In the optimal scenario, men’s counterfactual dropout rate is similar to the actual level, while women’s counterfactual dropout rate is lower than the actual level by about 2 percentage points. In this scenario, there are 47 female-majority groups, 59 gender-balanced groups, and 49 male-only groups.

Table A.11. External Validity of the Effect of Minority Status on Female Dropout

	(1)	(2)	(3)	(4)
	Observable Characteristics			
Basic controls	Yes	Yes	Yes	Yes
High school controls	No	Yes	Yes	Yes
Parental background	No	Yes	Yes	Yes
Personality traits	No	No	Yes	Yes
Baseline expectations	No	No	No	Yes
$\Phi(\text{TE}=0)$	2.41	2.39	2.11	1.82
$\Phi \in [1, 2]$	[0.02, 0.06]	[0.02, 0.06]	[0.01, 0.06]	[-0.01, 0.05]

Notes: The table presents two measures of external validity as proposed by Andrews and Oster (2019). Φ captures the degree of private information (unobservable characteristics) about the treatment effect (TE) used in participation decisions. $\Phi = 1$ means that private information plays no role at all, and $\Phi = 2$ means that private information and observable characteristics are equally important in the participation decision. $\Phi(\text{TE}=0)$ is the value of Φ corresponding to a zero average TE for the population. $\Phi \in [1, 2]$ corresponds to lower and upper bounds of TEs when Φ takes values between 1 and 2. The table examines the treatment effects of minority status on women’s dropout, and I consider different sets of observable characteristics in the analysis. The basic effect is the impact of minority status without any controls estimated with the sample without missing values of the observable characteristics.

Table A.12. Romano-Wolf p -Values

(1) Outcome	(2) Variable	(3) Coef.	(5) p -value		
			(4) Original	Bootstrap	(6) Romano-Wolf
Dropout	Minority	0.116	0.041	0.016	0.049
	Minority \times Male	-0.121	0.168	0.078	0.211
Perceived Share of Women	Minority	-0.045	0.056	0.021	0.056
	Minority \times Male	0.083	0.007	0.001	0.007
Educational Expectations	Minority	-0.395	0.021	0.006	0.032
	Minority \times Male	0.173	0.513	0.418	0.418
Interaction with Peers	Minority	-0.538	0.032	0.015	0.044
	Minority \times Male	0.400	0.262	0.160	0.271

Notes: The table shows the Romano-Wolf step-down p -values (Romano and Wolf 2005, 2016) for the main results of the paper. Column 4 shows the original p -values based on standard errors clustered at the group level. Column 5 shows the bootstrap resampling p -values with 1,000 resampling of clusters (study groups) within randomization strata (cohort and study program). Column 6 shows the Romano-Wolf corrected p -values.

B Ethical Considerations

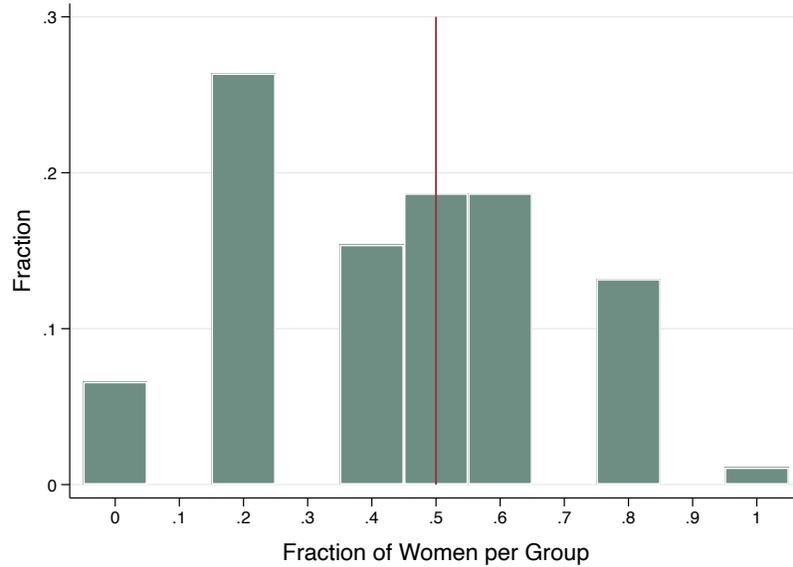
In this paper, I show that women assigned to female-minority groups are more likely to drop out of an introductory economics course than women in other groups. In order to assess the ethics of this experiment, it is necessary to think about students' counterfactual decisions and behaviors in the absence of my experiment. The experiment took place in a first-semester course at a Swiss university. Even without my experiment, the setting has three key features: (1) students have a demand for new peers and they do study with each other for the course; (2) the course is male-dominated, and it is common that students form male-dominated social networks by themselves; and (3) a high fraction of students drop out of the course during the semester.

1) *Demand for new peers.* Based on survey data collected in 2017—before I conducted the experiment, about 50% of students reported that they studied with others for the course, and more than 65% of the study mates were new peers that they met in the university.

2) *Male-dominated environment.* The fraction of women taking the course is 30% to 40% depending on the cohort. That means women are generally exposed to a male-dominated environment, and it is likely that students form male-dominated networks. Based on students' self-reported social network data, I find that without the experiment, about 45% of the networks that students formed by themselves are male-dominated (see Figure B.1).

3) *High dropout rate.* A unique feature of the higher education system in Switzerland is that students with a high school degree can, in most cases, register for any study program at college. Partly because of that, it is also common that students drop out or switch their majors, especially in the first semester at university. Historical administrative records show that the overall dropout rate in the economics course is always around 9%.

Figure B.1. Distribution of Self-Formed Social Networks by the Share of Women



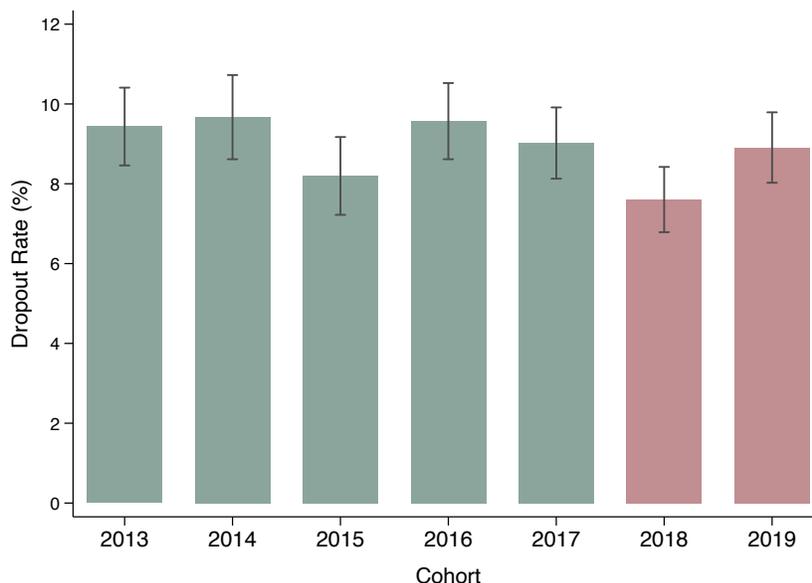
Given the institutional background, my experiment did two things. First, it offered students the opportunity to have a study group and meet new peers. Second, for students who wanted a study group, I randomly assigned them to groups of four. Next, I discuss the ethics of the experiment from two perspectives: (1) how the provision of study groups affected students; (2) conditional on having a group, how the group composition affected students.

Provision of study groups It is very unlikely that providing students with the opportunity to have a study group will harm them. When deciding whether to sign up for a study group, students were explicitly informed of the following: (1) the study groups are provided for free; (2) the sign-up decision and participation in group activities have no direct influence on the grade; and (3) if they sign up, they will be randomly assigned to a group with three other students. The voluntary sign-up procedure means that only students with a demand for random study partners registered for study groups; they would very likely find a study partner anyway, with or without the experiment. Furthermore,

if they did not like the assigned study group, they still had the option of finding their own study partners. For students who preferred to study by themselves or had their own study partners, the experiment hardly affected them.

Instead, by meeting students' demand for new peers in a new environment, the experiment is potentially beneficial. Students could use the group to exchange information, discuss course materials, and work on problem sets together. More generally, social interaction with peers can enforce the sense of belonging at university and help students develop social-emotional skills—especially skills related to teamwork, which is ubiquitous and has become much more prevalent in the workplace and academic research (Devine et al. 1999; Lazear and Shaw 2007; Rath and Wohlrabe 2016).

Figure B.2. The Overall Dropout Rate by Cohort



Notes: Error bars indicate standard errors of the mean.

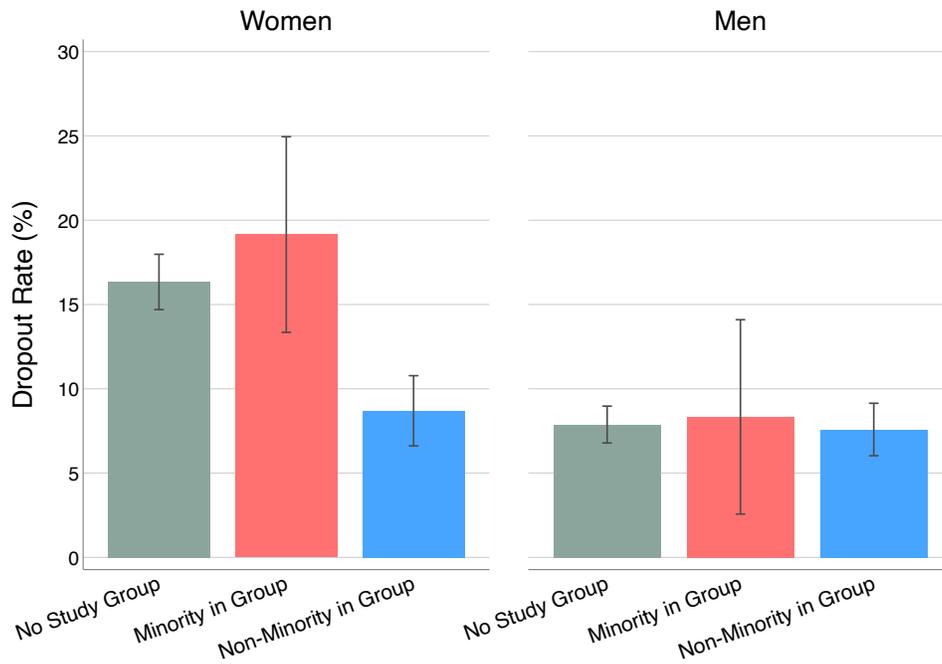
Ex-post evidence also suggests that providing study groups does not harm students. If anything, study groups help lower the dropout rate of students, especially women. Figure B.2 plots the overall dropout rate across cohorts from 2012 to 2019. As the graph

shows, the dropout rate fluctuates slightly over time. The cohorts of 2018 and 2019, with the experiment in place, have a similar dropout rate as in previous years. The trend is similar after controlling for basic characteristics of students in the course, such as study program, gender, course retaking status, and nationality.

Focusing on the experimental cohorts and comparing students with study groups to students without study groups, I find that study groups are associated with a lower dropout rate. Figure B.3 shows that women without study groups and women assigned to female-minority groups have similar dropout behavior. Nevertheless, compared to women without study groups, those not in the minority in study groups are less likely to drop out. For men, group registration and minority status in groups do not seem to affect their dropout. The results suggest that overall, having a study group correlates with a lower dropout rate for students, especially for women.

Random composition of groups The key ethical concern regarding the random assignment of groups is that it creates female-minority groups, which may increase women’s dropout rate—the hypothesis tested in this study. First, even though the tokenism concept famously hypothesizes the challenges faced by women in the minority (Kanter 1977), rigorous testing of the concept is very limited (Zimmer 1988). In effect, the literature shows conflicting evidence on whether it is beneficial for women (and men) to have more female peers. For example, Huntington-Klein and Rose (2018) and Bostwick and Weinberg (2021) show that women are more likely to persist in male-dominated settings if they have more female peers. However, Zölitz and Feld (2021) and Brenøe and Zölitz (2020) find that women become less likely to choose highly skilled and high-paying majors if they have more female peers. For men, Oosterbeek and Van Ewijk (2014) and Zölitz and Feld (2021) also find opposite effects of a higher share of female peers on men’s educational outcomes.

Figure B.3. Group Registration, Minority Status, and Dropout



Notes: The figure shows how dropout varies with the status of group registration and, if registered for a study group, the minority status in the assigned group. Error bars indicate standard errors of the mean.

Second, as mentioned above, even without the experiment, students also form networks or groups where women are in the minority. In practice, compared to the self-formed groups, randomly assigned groups are equally or less likely to be female-minority. Simulations before conducting the experiment show that if 30% of the students who sign up for study groups are women, the fraction of female-minority groups is about 45%. If 40% of the registered students are women, the share of female-minority groups is around 30%. In the realized assignment of my experiment, 34% of the study groups are female-minority groups—in contrast to 45% for endogenous groups. The results suggest that random assignment of study groups does not increase the risk of women being assigned to female-minority groups.

Taken together, by providing and randomizing study groups, the experiment is un-

likely to and also did not harm students in the setting. If anything, it created additional benefits. Furthermore, randomizing peer groups is very common in educational institutions and economic research. For example, the previously cited studies by Oosterbeek and Van Ewijk (2014), Huntington-Klein and Rose (2018), and Zölitz and Feld (2021) are all based on randomly assigned workgroups, classes, or teaching sessions. Other influential studies by Sacerdote (2001), Carrell, Sacerdote, and West (2013), and Booij, Leuven, and Oosterbeek (2017) also exploit or conduct random assignment of dormitories, squadrons, and tutorial groups. The outcomes analyzed in these studies are also high-stakes decisions and behaviors, such as major choice, academic performance, and dropout.