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Missing women in STEM occupations: The impact of university education on the gender gap in graduates' transition to work

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ABSTRACT

This paper contributes to the literature on the drivers of the gender gap in STEM by focusing on a critical career juncture: the bridge between university study in STEM fields and work. We investigate the effect of selected characteristics of recent STEM graduates' university education on the difference between women and men in their likelihood of obtaining STEM occupations shortly after graduation. Using unique data on a large sample of graduates in male-dominated STEM fields, we show that a diversified university curriculum increases the likelihood of women graduates getting STEM occupations shortly after graduation, while it does not affect men. In contrast, doing internships during university studies and participating in study abroad programs reduce the likelihood of men graduates entering STEM occupations, but does not affect women. Additionally, students' graduation grades increase the probability of both women and men securing STEM occupations.

1. Introduction

Science, Technology, Engineering, and Mathematics (STEM) fields are increasingly critical to the stimulation of innovation and economic growth, and have thus garnered much attention among researchers and policymakers (Black et al., 2021; Kuschel et al., 2020; Rothwell, 2013). Consequently, several countries have developed programs and initiatives devoted to attracting and retaining people in STEM (Poggesi et al., 2020). Although such initiatives address both men and women, the latter group has consistently been underrepresented in many university degree programs in STEM fields and, subsequently, in STEM occupations (Blickenstaff, 2005; Nimmesgern, 2016), especially at the higher levels of the corporate hierarchy (Adams and Kirchmaier, 2016).[1]

To explain this gender gap, researchers and policymakers often invoke the “leaky pipeline” metaphor (e.g., Berryman, 1983; Etzkowitz et al., 2000; Lerchenmueller and Sorenson, 2018; Wickware, 1997). The STEM pipeline leaks individuals at various career junctures: secondary school students interested in STEM sometimes change their minds when applying to university; others enroll in degree programs in STEM fields, but change majors before graduation, or graduate in STEM but later obtain non-STEM occupations. Women leak out more than men, and this differential leaking creates a gender-based filter that almost removes women from the stream and leaves only men at the end of the pipeline (e.g., Blickenstaff, 2005; Buck et al., 2020).[2] For context, it is worth recognizing the large differences in women's participation across STEM fields: women are a high share of the graduates in certain STEM fields (e.g., biological sciences and mathematics), but significantly underrepresented in others (e.g., computer science, engineering, and construction) (Cheryan et al., 2017).

Since modern economic systems increasingly require employees qualified for STEM careers (e.g., National Science Board, 2019), it is crucial to understand the factors associated with the shortage of women in these careers. Accordingly, many scholars have spent the last decade trying to explain why more women than men leak out from the STEM pipeline (e.g., Avolio et al., 2020; Delaney and Devereux, 2019; Rosenzweig et al., 2021). Most studies have considered starting or continuing education in STEM (e.g., Aschbacher et al., 2010; Armstrong and Crombie, 2000; Buffington et al., 2016; Schwab et al., 2015) or investigated the retention of women already employed in STEM occupations, i.e., any jobs within the science, engineering, mathematics, and

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[1] Women represent only 28 % of the STEM workforce in the USA (AAUW, 2022). This gap becomes even wider in some of the fastest-growing and highest-paid jobs, like computer science and engineering (AAUW, 2022).

[2] In line with the broad literature on the leaky pipeline and the gender gap in STEM, this work adopts a binary approach to gender, equaling it to biological sex. In the concluding section, we discuss how adopting a non-binary approach to gender could enrich this research stream.

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information technology domains[3] (e.g., Buse et al., 2013; Fouad et al., 2016). However, few studies have focused on STEM graduates' transition to work (Jasko et al., 2020; Mansour et al., 2022; Sassler et al., 2017; Schwerter and Ilg, 2021). Examining this career juncture is critical: while the proportions of women studying and graduating in STEM fields have increased significantly over the years, women's representation in the STEM workforce has grown marginally or declined (Michelmore and Sassler, 2016). Therefore, we investigate the bridge between university study in STEM subjects and work. Unlike previous research that has often treated all STEM fields as a homogenous category or has solely focused on single fields, we focus on particular fields where women are significantly underrepresented among graduates. These fields are hereafter referred to as male-dominated STEM fields. They are a particularly relevant context because the low number of women left in the STEM pipeline after the first junctures makes leaks in the subsequent junctures especially concerning.

In line with the extant studies on the drivers of women's segregation among workers in STEM occupations, which have recognized the crucial influence of educational factors (Avolio et al., 2020), we assume that university education affects the gender gap in the transition to work among graduates in male-dominated STEM fields. This education is the primary source of skills, knowledge, and contacts that recent STEM graduates can apply to STEM occupations. Thus, it must influence graduates' access to STEM jobs. Studies exploring the role of university education have related gender differences in pursuing STEM occupations after graduation with university professors' gender (Mansour et al., 2022) and the STEM degree field (Schwerter and Ilg, 2021). In this study, we examine the relationship between certain unexplored characteristics of university education in male-dominated STEM fields and the differences between women and men in their likelihood of garnering STEM occupations after graduation.

It is well accepted that the science-is-male stereotype—which relates study and work activities in STEM fields with men more than with women (Master and Meltzoff, 2016)—affects gender segregation in STEM occupations. The stereotype influences not only the career aspirations of graduates in these fields, but also employers' evaluations of said graduates as job applicants (Thébaud and Charles, 2018). The strength of the science-is-male stereotype and the associated gender segregation vary across STEM fields (Cheryan et al., 2017; Leslie et al., 2015). In particular, we posit that, in male-dominated STEM fields where the stereotype is strong, women graduates are less likely to look for STEM occupations than their male counterparts; ceteris paribus, employers are less willing to hire women than men in STEM occupations. We argue that university education can dampen the effect of this stereotype by helping STEM graduates develop competencies and abilities valued by employers and conveys the quality of graduates' abilities to uninformed prospective employers.

As we explain in the following sections, we consider four characteristics of recent graduates' university education: graduation grade, university curriculum specialization in specific male-dominated STEM fields, completion of internships, and participation in study abroad programs. These characteristics have already been examined in studies on graduates' professional careers or research on the gender gap in STEM, but never related to the gap in graduates' transition to work. Graduation grade is associated with and can signal the quality of recent graduates' abilities. In contrast, university curriculum specialization, participation in internships, and involvement in study abroad programs are associated with and can signal STEM graduates' possession of abilities that employers appreciate. We thus argue that when the science-is-male stereotype is strong, these four characteristics of university education affect STEM graduates' transition to work. Reflecting on the effects of these university education characteristics, we formulate hypotheses on their links with men and women's different likelihoods of obtaining STEM occupations after graduation. To test these hypotheses, we use unique data on the university curriculum and the five-year, post-graduation work status of a large sample of graduates, who obtained both a Bachelor (BSc) and a Master of Science (MSc) in male-dominated STEM fields from 38 Italian universities between 2007 and 2014.

Our study reveals a significant disparity in the initiation of STEM careers, with women exhibiting a lower likelihood compared to men. Regarding the influence of university education characteristics, the results indicate that higher graduation grades increase the likelihood of getting STEM occupations shortly after graduation for graduates in male-dominated STEM fields, but they have no differential impact on women and men. For women, the diversification of the university curriculum positively impacted the transition to STEM occupations, but no similar effect was observed for men. Conversely, doing internships during university studies and participating in study abroad programs reduced the likelihood of recent men graduates getting STEM occupations. This negative effect was not found among women. The conclusion section discusses these results in terms of their research contributions and policy implications for universities hoping to encourage more women to pursue STEM careers.

2. Theoretical framework

The studies exploring gender segregation in the labor force often consider the characteristics of workers and employers: respectively, the “supply-side” and “demand-side” of labor depicted in classical microeconomic theory (Thébaud and Charles, 2018). Supply-side explanations (see, e.g., Correll, 2001) relate to how individual aptitudes, preferences, and cultural beliefs about gender differentially influence the early career decisions of men and women. On the other hand, demand-side explanations (e.g., Booth and Leigh, 2010) attribute gender segregation to the influence of gender stereotypes on employers' evaluations of male and female job applicants and subsequent hiring decisions.

Works on the supply side of the labor market have widely analyzed the drivers of individuals' career decisions (e.g., Lent and Brown, 2013; Lent et al., 1994, 2000). Most of these studies highlight the relevance of perceived self-efficacy – i.e., the individual's judgment about her or his ability to perform specific actions to achieve a goal (Bandura, 1997) – in identifying career interests and translating them into choices (Lent and Brown, 2013). The culture in which individuals are embedded constrains what they believe they can do and shapes their career aspirations. The higher individuals' self-assessment of their specific abilities, the higher their aspirations for occupations requiring these abilities (Correll, 2004). The persistence of female segregation in many STEM educational and occupational fields has contributed to spreading the science-is-male stereotype, which claims that men (vs. women) are naturally adapted to technical and math-intensive (vs. expressive and human-centered) fields (Charles and Bradley, 2009; Deemer et al., 2014). Over time, this segregation has also fostered the expectation that being successful in male-dominated STEM fields requires stereotypically masculine math ability and traits such as assertiveness, competitiveness, dominance, and strong identification with work (e.g., Bailyn, 2003; Cooper, 2000), thus weakening women's perceived self-efficacy in these fields. Several studies have corroborated this argument by showing that girls/women have lower confidence in their math and science ability than boys/men and are biased toward their fit to male-dominated STEM fields, which affects their educational and career aspirations and choices (Correll, 2004; Deboer, 1986; Sterling et al., 2020). Accordingly, we argue that recent female graduates in male-dominated STEM fields will be less confident about their technical abilities and perceive STEM occupations as a worse fit than their male counterparts. In short, they will have lower perceived self-efficacy in STEM occupations than men. Prior studies show that, in the transition to first jobs, women from STEM degree courses look for less competitive jobs in STEM or non-STEM occupations

[3] A few examples of STEM occupations include scientists in STEM fields, software developers, IT specialists, engineers, and data scientists.

(Sassler et al., 2017). In this vein, we argue that recent women graduates in male-dominated STEM fields are less likely to look for STEM occupations than their male counterparts.

Works on the demand side suggest that, since employers have imperfect information about job applicants' future productivity, they infer it from applicants' easily observable characteristics, such as gender (Correll and Benard, 2006; England, 1994). In particular, employers observe the dispersion of occupational performance among different groups and develop images of the ideal employees for these occupations. These images are affected by cultural beliefs about gender (Ridgeway, 2001). For instance, when gender stereotypes exist and suggest that, in a given occupation, individuals of one gender (e.g., women) do not perform well or perform worse than those of the other gender (i.e., men), employers will describe the ideal employee for this occupation as a man and will discriminate against women applicants (for similar arguments, González et al., 2019; Powell, 1987). In the case of STEM occupations, the science-is-male stereotype will lower employers' perceptions of the qualifications of recent women graduates in male-dominated STEM fields, even if they are objectively qualified. In line with prior studies indicating that the science-is-male stereotype becomes a barrier to recruiting women in STEM occupations (Cheryan, 2012; Reuben et al., 2014), we posit that employers will be less likely to hire recent women graduates in STEM occupations than their male counterparts.

Combining demand- and supply-side arguments, we argue that among recent graduates in male-dominated STEM fields, women are less likely than men to obtain STEM occupations after graduation. As prior studies have already provided evidence to support this statement, we consider this to be a baseline hypothesis.

We further develop our reasoning by proposing that when the science-is-male stereotype is strong, university education may reduce gender segregation in STEM occupations by affecting both the supply and demand of labor. In the next section, we discuss how specific characteristics of university education differently affect the demand and supply of female and male labor in STEM occupations—and, by extension, the differences in the likelihoods of recent men and women graduates obtaining STEM occupations after graduation. It is worth acknowledging that the four university education characteristics under scrutiny may have effects on graduates' transition to work in STEM occupations beyond what is discussed below. Here, we are not trying to predict the overall impact of these characteristics, but rather we are interested in examining the differential impact between women and men stemming from the science-is-male stereotype. Therefore, the following section will only address the effects that vary between genders.

3. Hypotheses on the differential impact of recent STEM graduates' university education for women and men

When the science-is-male stereotype is strong, university education affects the transition to STEM occupations by enhancing graduates' perceived self-efficacy and providing employers with more information about these applicants. In the following, we discuss the effects of four factors: graduation grades, which signal the quality of abilities that recent graduates developed through university studies, and specialization of the university curriculum, completion of internships, and participation in study abroad programs, that reflect recent graduates' possession of particular abilities that employers appreciate. In particular, we discuss how the supply- and demand-side effects of these university education characteristics differ for recent women and men graduates in male-dominated STEM fields. As mentioned in the introduction, we focus on these four characteristics because previous studies have examined their effects on graduates' transition to work or the gender gap in STEM, but not their impact on the transition to work among recent women and men graduates in male-dominated STEM fields.

3.1. Quality of recent STEM graduates' abilities

In several works examining graduates' transition to work (e.g., Colombo and Piva, 2020; Donhardt, 2004; Venhorst and Cörvers, 2018), the graduation grade has been considered a proxy for the quality of a recent graduate's abilities. Higher grades generally correspond to better learning proficiency during university education and a higher base of knowledge and skills (Unger et al., 2011). The grade also signals the quality of a recent graduate's abilities to uninformed third parties, as high-quality individuals are more likely to obtain high grades (Colombo and Piva, 2020).

We expect that the graduation grade influences the female labor supply in STEM occupations. Although the science-is-male stereotype weakens the perceived self-efficacy of recent women graduates in male-dominated STEM fields, those women who obtained high graduation grades are probably more confident in their abilities than their fellow women graduates. Hence, the former women are less likely than the latter to perceive that the science-is-male stereotype will impede their success in STEM occupations. As a result, women with higher grades are less likely to exit the STEM pipeline at the transition to work. The effect of the graduation grade will be smaller for men graduates in male-dominated STEM fields because their perceived self-efficacy in STEM occupations is likely to be high already.

As to the demand side, the graduation grade signals the quality of recent STEM graduates' abilities to uninformed employers looking for workers in STEM occupations. When these employers receive job applications from recent graduates in male-dominated STEM fields who obtained high graduation grades, this objective record of candidates' performance will reduce the possible gap between employers' perceptions of the applicant's abilities and true qualifications. This effect will matter more for recent women graduates than for their male counterparts due to the science-is-male stereotype feeding a larger discrepancy between women's perceived and actual abilities. Thus, employers' evaluations of men and women applicants will be less influenced by applicant gender among the graduates who got higher grades.

The combination of supply and demand-side arguments suggests that the gender of recent graduates in male-dominated STEM fields and their graduation grades interact to affect their likelihood of getting a STEM occupation after graduation. In particular, we formulate the following hypothesis.

H1. Among recent graduates in male-dominated STEM fields, the higher the graduation grades, the smaller the differences in the probabilities of women and men getting a STEM occupation after graduation.

3.2. Recent STEM graduates' possession of particular abilities

Three characteristics of university education reflect graduates' development of skills and competencies appreciated by employers; namely, the specialization of the university curriculum in a specific STEM field, the completion of internships, and participation in study abroad programs. For recent women graduates in male-dominated STEM fields, possessing these abilities may alleviate the adverse effects of the science-is-male stereotype on their likelihood of obtaining STEM occupations after graduation.

3.2.1. Specialization of university curriculum

Since the seminal work by Lazear (2004), the specialization of the university curriculum has frequently been examined among the drivers of a specific career choice: namely, opting for a career as an entrepreneur rather than as a salaried employee. A STEM graduate's university curriculum is more specialized when most knowledge and skills developed by the graduate through university studies are in a specific STEM field. Conversely, the curriculum is less specialized (or, phrased differently, more diversified) when it provides knowledge and skills in various

STEM fields. Regardless of the courses taken during university studies, a STEM graduate will have a more specialized university curriculum if s/he obtained both a BSc and MSc in the same STEM field. By contrast, if the graduate obtained the BSc in one STEM field and the MSc in a different STEM field, the university curriculum will be less specialized. Specialization in a given field provides graduates with more profound domain knowledge than graduates following a diversified curricula (Colombo and Piva, 2020). We expect that the curricula specialization affects both the supply and demand side of the labor market.

On the supply side, recent women graduates who have specialized university curricula in male-dominated STEM fields (e.g., women who obtained both BSc and MSc degrees in electronic engineering) may perceive themselves as more competent in their chosen field than those women graduates who developed competencies in multiple male-dominated STEM fields (e.g., women who obtained a BSc degree in mathematical engineering and an MSc degree in electronic engineering). Consequently, women graduates with specialized university curricula are less likely to be daunted by the science-is-male stereotype than women with diversified curricula; thus, the former will be more likely to look for STEM occupations shortly after graduation. Conversely, men graduates in male-dominated STEM fields do not suffer from low perceived self-efficacy; thus, curriculum specialization will have smaller effects on their likelihood of looking for STEM jobs after graduation.

On the demand side, opposing forces may come into play. Previous research generally suggests that specialization is advantageous in the labor market. Applicants with a focused identity – such as a specialized university curriculum consistent with a specific skill set – typically enjoy more hiring opportunities than those with a more diversified background (Merluzzi and Phillips, 2016). Furthermore, applicants with specialized curricula have more profound knowledge in their chosen field(s), making them more attractive to employers looking for experts (Lazear, 2004). Building on these arguments, we posit that recent women graduates with specialized university curricula in male-dominated STEM fields will be attractive to employers irrespective of their gender. In contrast, the science-is-male stereotype will probably make women graduates with diversified curricula less attractive to employers than their male counterparts. That said, there are situations where having specialized university curricula can become a liability. When applicants with specific skill sets are plentiful relative to demand, and applicant evaluators possess a strong institutionalized screening mechanism (as in the case of recent STEM graduates whose quality can be assessed based on the degree grade), employers tend to reward applicants with broader competencies who differentiate themselves from other candidates (Merluzzi and Phillips, 2016). Under such circumstances, recent STEM graduates with diversified university curricula will be more attractive in the labor market than their specialized counterparts. This increased attractiveness of graduates with diversified curricula is more beneficial for women graduates in male-dominated STEM fields, who tend to be more unattractive to employers than for their male counterparts due to stereotyping.

When we combine these supply- and demand-side explanations, it is unclear which of the described forces is more likely to prevail. Thus, we do not present a hypothesis here and leave the question to the empirical analysis.

3.2.2. Internships

Several studies examining the gender gap in STEM have considered the effects of internships (e.g., Piva and Rovelli, 2022; Sterling and Fernandez, 2018). Internships combine work- and curriculum-based educational experiences through partnerships between educators and employers that occur before completing a university program (Ocampo et al., 2020). Internships aim to provide students with real work experiences strictly related to their degree fields, allowing them to initiate contact with employers and acquire unique skills to thrive in the labor market (Toohey et al., 1996). These skills include communicative, analytical, professional, leadership, negotiation, and teamwork skills that are difficult to teach in a classroom (Bayerlein and Jeske, 2018; Kavanagh and Drennan, 2008), but represent the practical experience that many employers seek from recent graduates (Maskooki et al., 1998; Raymond et al., 1993). Hence, internships are an integrative source of information for employers looking for specific applicants' abilities and skills (Sterling and Merluzzi, 2019). Furthermore, internships offer employers firsthand or more accessible information that can replace assumptions about candidates' characteristics (Sterling and Fernandez, 2018).

Although doing internships could be helpful for all recent graduates, it might be particularly beneficial for women graduates in male-dominated STEM fields. On the supply side, as student interns accumulate work experiences related to their degree fields, internships may enhance women students' identification with a career in STEM jobs, thus reducing the perceived lack of fit between their abilities and the qualities required for being successful in STEM occupations—and thus reducing their higher likelihood of exiting the STEM pipeline during the transition to work. On the demand side, two separate effects probably overlap. On the one hand, internships are often used by employers as a means of screening entry-level candidates for internal positions (Callanan and Benzing, 2004). Internships allow employers to directly observe candidates' productivity and skill sets and replace mere assumptions with firsthand information that is not available during job interviews (Sterling and Fernandez, 2018). As the science-is-male stereotype leads employers to doubt that recent women graduates in male-dominated STEM fields have the necessary skills, these graduates are more likely than their male peers to benefit from the chance to display their skills and abilities. On the other hand, internships signal graduates' possession of skills that are useful in the workplace, leading employers to evaluate these applicants more favorably (Bittmann and Zorn, 2020). This increased attractiveness will be more beneficial for female STEM job applicants (who are typically considered less attractive in male-dominated STEM fields) than for their male counterparts.

The combination of these supply- and demand-side arguments suggests that the gender of recent graduates in male-dominated STEM fields and their completion of internships interact to affect their likelihood of getting a STEM occupation after graduation. Specifically, we formulate the following hypothesis.

H2. Among recent graduates in male-dominated STEM fields, the differences in the probabilities of women and men getting STEM occupations after graduation are smaller for graduates who did internships during university studies.

3.2.3. Study abroad programs

Scholars have shown that participation in study abroad programs facilitates entry into the labor market (e.g., Kopp et al., 2004), especially for job seekers exhibiting some socio-demographic characteristics (Waibel et al., 2017). In particular, women benefit more than men from studying abroad (Poot and Roskruge, 2013; Sorrenti, 2017). Studying abroad helps university students develop unique skills (Crossman and Clarke, 2010): first, it allows students to develop specific knowledge about host location, such as language skills, a local network, and the local market (Di Pietro, 2015). In addition, graduates who participate in study abroad programs exhibit enhanced cross-cultural adaptability, i.e., flexibility and openness to new ideas and practices, empathy, ability to interpret cultural cues, psychological strength in coping with new situations, and ambiguity tolerance (Kelley and Meyers, 1995). These unique skills are required in most organizations (Chan and Dimmock, 2008) and constitute a behavioral repertoire that is critical in adapting to complex work environments (Little, 2001).

Studying abroad has been recognized as particularly important for STEM students (Niehaus and Inkelas, 2016). Despite the clear need to prepare a diverse and globally minded STEM workforce (NSF, 2014), research indicates that STEM students are less inclined to participate in study abroad programs compared to their non-STEM peers (Niehaus and

Inkelas, 2016). Therefore, participation in study abroad programs will have demand-side effects on the likelihood of recent women and men graduates in male-dominated STEM fields getting STEM occupations. Employers will interpret applicants' study abroad experiences as signals of desirable attributes and, ceteris paribus, evaluate them more positively than other recent graduates when screening applicants and making job offers (Hilmer, 2002; Kopp et al., 2004). We expect women graduates to benefit more than their male counterparts from this increased attractiveness, again due to the science-is-male stereotype. Thus, we envisage that smaller differences will appear in employers' evaluations of male and female applicants among recent STEM graduates who participated in study abroad programs than those who did not.

Participation in study abroad programs might also have supply-side effects on the likelihood of women and men graduates obtaining STEM occupations. Graduates with study abroad experiences are probably aware of the valuable abilities they have developed. Given the relatively low percentage of STEM students studying abroad, women graduates in male-dominated STEM fields might feel that their study abroad experiences equipped them with useful workplace skills. This increased perceived self-efficacy is likely to reduce the probability of women leaving the STEM pipeline after graduation. Meanwhile, we expect participation in study abroad experiences to have negligible effects on men STEM graduates exiting the pipeline post-graduation.

In line with these arguments, we anticipate that the gender of recent graduates in male-dominated STEM fields and their participation in study abroad programs have an interactive effect on their likelihood of getting a STEM occupation after graduation. More specifically, we formulate the following hypothesis.

> H3. Among recent graduates in male-dominated STEM fields, the differences in the probabilities of women and men getting STEM occupations after graduation are smaller for the graduates who participated in study abroad programs.

4. Research design and methodology

4.1. Data

To test the hypotheses reported above, we used unique data about graduates who obtained BSc and MSc degree titles from Italian universities affiliated with AlmaLaurea. AlmaLaurea[4] is an interuniversity consortium currently comprising 80 of the 94 Italian universities and covering nearly 90 % of Italian graduates. The consortium created and regularly updates a database featuring information about the university curricula and first employments of graduates from affiliated universities. These universities collect data about their graduates' university curricula by asking their students to fill in a questionnaire immediately before the degree exam. AlmaLaurea subsequently surveys the respondents one, three, and five years after graduation regarding their jobs.

As this study concentrates on the STEM fields where women are underrepresented among graduates, we leveraged the International Standard Classification of Education (ISCED-F 2013) to focus on graduates in the male-dominated STEM fields of Information and communication technologies (ISCED code 06) and Engineering, manufacturing and construction (ISCED code 07). We excluded Natural Sciences, Mathematics, and Statistics (ISCED code 05) from our analysis since these latter STEM fields are less segregated.

[4] Detailed information about AlmaLaurea is available on the official website (https://www.almalaurea.it/en/our-data/almalaurea-surveys).

From the AlmaLaurea dataset, we extracted information about the university background and five-year post-graduate occupations[5] of 42,945 graduates. This is the population of graduates who i) received both a BSc and an MSc degree title in the above-mentioned STEM domains, ii) obtained the MSc degree title between 2007 and 2014 from one of the 38 universities that were already part of AlmaLaurea in 2007, iii) were employed in the private sector[6] five years after MSc graduation, iv) were younger than 65 at MSc graduation, and v) obtained this degree title in less than ten years.

4.2. Methodology: The main econometric estimates

To test our hypotheses, we estimate Logit regressions. The dependent variable – *STEM_Occupation* – is a dummy equal to one for the graduates with a STEM occupation in the private sector five years after graduation and zero for the remaining graduates. Building this variable was not trivial, as there is no widely accepted classification of STEM occupations (Grinis, 2019; Speer, 2020). To identify the graduates with STEM occupations, we did not consider the industries where sample graduates worked because workers might have STEM jobs in non-STEM industries (e.g., workers who carry out R&D activities in agriculture to improve farming techniques) or non-STEM jobs in STEM industries (e.g., workers responsible for corporate management of engineering companies; for similar arguments, Bosworth et al., 2013). Instead, we followed prior works (e.g., Grinis, 2019; Wright et al., 2017) that used the coding frameworks adopted by state and statistical agencies to classify workers into occupational categories. Specifically, we relied on the STEM Occupation definition determined by the European Centre for the Development of Vocational Training (Caprile et al., 2015; Shapiro et al., 2015), which adopts the International Standard Classification of Occupations (ISCO) proposed by the European Union. We labeled STEM occupations as the job categories classified under ISCO/21 (Science and Engineering professionals), ISCO/25 (Information and Communication professionals), ISCO/31 (Science and Engineering associate professionals), and ISCO/35 (Information and Communication technicians).

The key explanatory variable is *Woman_Graduate*, a dummy equal to one for women and zero for men. To test the hypotheses presented above, the econometric models include both *Woman_Graduate* and its interactions with the explanatory variables that capture the four characteristics of university education under scrutiny: *Graduation_Grade, Curriculum_Specialization, Internship*, and *Study_Abroad*.

Graduation_Grade is the grade the focal graduate obtained at the end of the MSc. It ranges from 66 to 113.[7] The remaining explanatory variables are dummies: *Curriculum_Specialization* captures the specialization of the focal graduate's university curriculum. To build it, we classified each degree program using the ISCED and set *Curriculum_Specialization* equal to one if the focal graduate obtained the BSc and MSc degree titles in the same two-digit degree field, zero otherwise. *Internship* equals one for the graduates who did internships in private companies during their MSc studies and zero for the remaining ones. Finally, *Study_Abroad* equals one for the graduates who participated in study abroad programs, such as the ERASMUS/SOCRATES programs, during their MSc studies

[5] The data on graduates' employment collected through the surveys administered one and three years after graduation do not allow us to identify the graduates with STEM occupations. Hence, we had to focus on graduates' occupations five years after graduation.

[6] We focused on employees in the private sector because the data collected through the survey administered five years after graduation did not allow us to identify which self-employed graduates and graduates working in public organizations had STEM occupations.

[7] In the Italian grade system, the minimum grade is 66, whereas the maximum is 110. For outstanding students, degrees may be awarded a cum laude distinction, which corresponds to 113.

and zero for the remaining graduates.

The models also include a set of controls. First, we controlled for graduates' age at graduation (continuous variable: *Age*), as it can affect the probability of entry into STEM occupations (Deming and Noray, 2020). We then assessed graduates' family status at graduation through the dichotomous variable *Children*, which takes the value of one if the focal graduate has at least one child and zero otherwise. We also included *Time_To_Degree*, a continuous variable capturing the time elapsed between enrolment in the MSc degree program and graduation. Next, we added a control for the environmental characteristics: specifically, we included *Regional_Gender_Index* to assess the geographical differences in gender equality among Italian regions (Amici and Stefani, 2013). *Regional_Gender_Index* is a continuous variable that takes values from zero to one: the higher the value, the better the conditions for women in the region where the focal graduate was working five years after graduation.[8] Finally, we considered a large set of dummy variables capturing the university, the STEM field, and the graduation year where the focal graduate got the MSc title.

The descriptive statistics for the variables included in the econometric estimates (except the university, field, and year dummies) and the correlation matrix are reported in Tables 1 and 2.

4.3. Methodology: Additional analyses

We are aware that the results of the main estimates may be susceptible to endogeneity issues and selection bias. We thus conducted several additional analyses to alleviate these concerns.

Endogeneity may arise from reverse causality, unobserved factors, and self-selection. Reverse causality may occur because some recent STEM graduates may have chosen their university curricula to increase their likelihood of getting a STEM occupation after graduation. Moreover, unobserved factors may influence both the explanatory variables and the probability of getting a STEM occupation after graduation. For instance, a taste for variety may induce some STEM graduates to participate in study abroad programs and pursue work opportunities in non-STEM occupations. Furthermore, endogeneity may be due also to self-selection (Clougherty et al., 2015). All sample graduates enrolled in degree programs offered at universities in the AlmaLaurea consortium. This self-selection represents an excluded variable that may correlate with both the variables capturing the characteristics of university education and the likelihood of pursuing STEM occupations after graduation.

Both reverse causality and unobserved heterogeneity are particularly severe for three of the variables whose values strictly depend on individual choices: *Curriculum_Specialization, Internship,* and *Study_Abroad.* To mitigate these endogeneity concerns, we implemented an instrumental variable approach. We estimated three first-stage regressions to predict *Curriculum_Specialization, Internship,* and *Study_Abroad*; we computed the predicted values from these regressions, and we re-estimated the main models by replacing each variable with the predicted value. In each first-stage regression, we included one instrumental variable: respectively, *Curriculum_Specialization_Peers*, *Internship_Peers*, and *Study_Abroad_Peers*. To build these variables, we drew inspiration from Colombo and Piva (2020). According to these authors, students try to simplify the complex task of designing their university curricula by relying on information provided by their peers, i.e., other students enrolled in the same degree program in the same period (e.g., Borgida and Nisbett, 1977). Hence, they tend to design university curricula and make relevant choices—such as enrolling in an MSc in the same field as the BSc, starting an internship, or studying abroad for some months—by mimicking their peers. Therefore, it is reasonable to expect that the sample graduates who designed a specialized university curriculum, participated in study abroad programs, or did internships had higher shares of peers who made similar choices. Relying on these reasonings, we built *Curriculum_Specialization_Peers* as the share of peers of the focal graduate who obtained the MSc and the BSc degrees in the same two-digit ISCED degree fields, while *Internship_Peers* and *Study_Abroad_Peers* were the shares of the focal graduate's peers who did an internship and participated in a study abroad program, respectively. *Curriculum_Specialization_Peers, Internship_Peers*, and *Study_Abroad_Peers* are valid instruments because peers' education choices do not directly influence a focal graduate's likelihood to work in STEM occupations shortly after graduation.

To alleviate the selection-based endogeneity concern, we reran the main estimates on the subsample of graduates who did not graduate at the university closest to their residence. The rationale behind these additional estimates is the following: a university's geographical closeness to one's place of residence is one of the reasons why some graduates enroll in a specific degree program. However, it cannot explain why some graduates enroll in a university far from home. These latter graduates probably chose the degree course for other reasons, including obtaining a university education suitable for STEM occupations. Therefore, if a self-selection bias influenced our results, its effects should be stronger for those who did not graduate at the university closest to their residence.

In addition, we tried to alleviate the two types of selection biases that can affect our results. First, we had to deal with an attrition bias because, in the survey that AlmaLaurea conducted five years after graduation (hereafter, the fifth-year survey), we lost 30 % of the survey respondents administered before graduation. This response drop may affect our overall results because individuals who do not respond to follow-ups usually differ from respondents. Second, we need to consider selection into work in the private sector. As we already mentioned, our sample excludes the graduates who were not working as employees in the private sector five years after graduation because they chose to attend additional educational programs, were self-employed or unemployed, or were working in public organizations.

To account for these two types of selection bias, we used an inverse probability weights approach—a technique designed to control selection into treatment (Azoulay et al., 2009; Fini et al., 2021; Robins and Finkelstein, 2000). This method allows us to correct the analyses by assigning each graduate a weight equal to the product of the inverse of the probabilities of responding to the fifth-year survey and working as an employee in the private sector five years after graduation. Essentially, the graduates who, based on observable characteristics, are unlikely to answer the fifth-year survey or to be employed in the private sector five years after graduation are given larger weights than those more likely to do so. To compute the individual weights, we applied two separate estimates (see section 5.2 for details) to calculate the predicted probability of answering the fifth-year survey and the predicted probability of private-sector employment five years after graduation. Using these predicted probabilities, we can compute the weight for each sample graduate and use this vector of weights to balance the sample and make it representative of the target population.

5. Results

This section is organized as follows. In section 5.1, we discuss the results of the main estimates. In section 5.2, we first account for endogeneity issues by implementing the instrumental variable approach described above and rerunning the main estimates on sample individuals who did not graduate at the university closest to their

[8] The index relies on the Gender Equality Index developed by Plantenga et al. (2009). The index comprises four dimensions, each including two subdimensions translated into indicators. In the overall index, the scores of all indicators are combined. The dimensions cover the relevant aspects of civil life, namely: *equal sharing of paid work* (labor force participation, unemployment), *equal sharing of money* (pay, income), *equal sharing of decision-making power* (political power, socioeconomic power), and *equal sharing of unpaid time* (caring time, leisure).

Table 1
Descriptive Statistics.

	Variables	Mean	SD	Min	Max	Women graduates		Men graduates	
						Mean	SD	Mean	SD
1	*Stem_Occupation*	0.74	0.44	0	1	0.71	0.45	0.75	0.44
2	*Woman_Graduate*	0.32	0.46	0	1	–	–	–	–
3	*Graduation_Grade*	106.83	6.05	74	113	107.91	5.44	106.33	6.25
4	*Curriculum_Specialization*	0.58	0.49	0	1	0.58	0.49	0.58	0.49
5	*Internship*	0.33	0.47	0	1	0.38	0.48	0.31	0.46
6	*Study_Abroad*	0.17	0.37	0	1	0.18	0.38	0.16	0.37
7	*Age*	25.83	1.98	22	63	25.63	1.74	25.92	2.07
8	*Children*	0.10	0.30	0	1	0.12	0.32	0.09	0.28
9	*Time_To_Degree*	2.93	1.73	1	10	3.32	2.04	2.76	1.54
10	*Regional_Gender_Index*	0.39	0.07	0.14	0.47	0.39	0.08	0.39	0.07

$N = 42{,}495$.

Table 2
Correlation Matrix.

		1	2	3	4	5	6	7	8	9
1	*Stem_Occupation*	1								
2	*Woman_Graduate*	−0.035*	1							
3	*Graduation_Grade*	0.078*	0.121*	1						
4	*Curriculum_Specialization*	0.037*	−0.003	−0.027*	1					
5	*Internship*	−0.024*	0.065*	−0.001*	−0.127*	1				
6	*Study_Abroad*	−0.037*	0.021*	0.053*	−0.015*	−0.008	1			
7	*Age*	0.031*	−0.070*	−0.223*	0.040*	−0.025*	−0.087*	1		
8	*Children*	−0.004	0.046*	−0.033*	0.006	0.025*	−0.043*	0.137*	1	
9	*Time_To_Degree*	0.095*	0.151*	−0.097*	0.301*	0.003	0.000	0.353*	0.054*	1
10	*Regional_Gender_Index*	−0.008	−0.015*	−0.046*	−0.085*	0.079*	0.029*	−0.099*	−0.020*	−0.102*

* significant at 0.05 or above; N = 42,495.

residence. We then used inverse probability weights to overcome the aforementioned selection bias.

5.1. Effects of university education on the difference in the likelihood of getting STEM occupations between recent women and men STEM graduates

A preliminary statistical analysis of our sample confirmed the finding of prior studies (e.g., Schwerter and Ilg, 2021) that the gender gap in STEM becomes larger after graduation. Despite the difference between the overall shares of men and women graduates in male-dominated STEM fields being large and significant (women represent only 32 % of our sample: 13,553 graduates out of 42,945), the disparity grows even larger when looking at the shares of men and women who obtain a STEM occupation shortly after graduation. In particular, we observed that 51 % of sample graduates (i.e., 21,917 individuals) were men with a STEM occupation five years after graduation, while women graduates with a STEM occupation represented only 22 % of the sample (9655 individuals). A non-parametric Mann–Whitney test confirmed that these differences between men and women are statistically significant ($z = 7.27$, $p < 0.000$).

The main estimates are presented in Table 3. Model 1 includes only the control variables, Model 2 adds the explanatory variables, and Models 3–6 separately include the interaction terms between *Woman_Graduate* and the variables capturing the characteristics of university education.

Model 1 reveals that most controls affect graduates' likelihood of having a STEM occupation five years after graduation. In particular, the negative coefficient of *Children* (−0.103, $p < 0.05$) and the positive coefficient of *Time_To_Degree* (0.093, $p < 0.001$) indicate that STEM graduates are more likely to work in STEM occupations five years after graduation when they do not have kids and took more time to graduate.

In line with the results of the preliminary statistical analysis, the negative and significant coefficient of *Woman_Graduate* in Model 2 (−0.430, $p < 0.001$) shows that recent women STEM graduates are less likely to have STEM occupations five years after graduation than their male counterparts. The magnitude of the effect is not negligible. Based on Model 2, with all the controls at their mean value, the estimated probability of having a STEM occupation five years after graduation is nearly 10 % higher for men (77 %) than women (68 %). As expected, the baseline hypothesis is confirmed.

The estimates of Model 2 also reveal that all the characteristics of university education affect our dependent variable. In particular, the positive and significant coefficient of *Graduation_Grade* (0.032, $p < 0.001$), alongside the negative and significant coefficients of *Curriculum_Specialization* (−0.076, $p < 0.001$), *Internship* (−0.166, $p < 0.001$) and *Study_Abroad* (−0.228, $p < 0.001$), reveal that while higher graduation grades are associated with a greater likelihood of having STEM occupations, the other three characteristics of university education increase graduates' likelihood of exiting the STEM pipeline after graduation.

Model 3 tests Hypothesis 1 by including *Woman_Graduate*×*Graduation_Grade*. The non-significant coefficient of this interactive term indicates that, contrary to our expectations, higher graduation grades were not associated with lower differences between women and men in the likelihood of securing STEM occupations after graduation. In other words, H1 is not supported in our sample. Instead, the positive and significant coefficient of *Graduation_Grade* (0.031, $p < 0.001$) suggests that higher grades favor both genders' transition to work in STEM occupations.

In Model 4, we inserted *Woman_Graduate*×*Curriculum_Specialization* and found the coefficient of this interactive term to be negative and significant (−0.298, $p < 0.001$). To better understand the effect of curriculum specialization, we pursued a graphical analysis in line with Hoetker (2007). The simple slope analysis in Fig. 1 suggests that when all variables are at their means, the probability of getting STEM occupations is significantly greater for women when the university curriculum is diversified, while it does not affect the likelihood of men.

Model 5 tests H2 by including *Woman_Graduate*×*Internship*. The positive coefficient of this interactive term (0.247, $p < 0.001$) aligns

Table 3
Estimates of Logit models on the determinants of recent STEM graduates' likelihood of having a STEM occupation after graduation.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Woman_Graduate		−0.430***	−0.757	−0.264***	−0.517***	−0.478***
		(0.026)	(0.435)	(0.038)	(0.031)	(0.028)
Graduation_Grade		0.032***	0.031***	0.032***	0.032***	0.032***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Curriculum_Specialization		−0.076**	−0.076**	0.014	−0.076**	−0.077**
		(0.025)	(0.025)	(0.029)	(0.025)	(0.025)
Internship		−0.166***	−0.167***	−0.167***	−0.249***	−0.167***
		(0.025)	(0.025)	(0.025)	(0.030)	(0.025)
Study_Abroad		−0.228***	−0.228***	−0.227***	−0.229***	−0.317***
		(0.029)	(0.029)	(0.029)	(0.029)	(0.036)
Woman_Graduate x Graduation_Grade			0.003			
			(0.004)			
Woman_Graduate x Curriculum_Specialization				−0.298***		
				(0.049)		
Woman_Graduate x Internship					0.247***	
					(0.050)	
Woman_Graduate x Study_Abroad						0.266***
						(0.061)
Age	−0.003	0.002	0.002	0.000	0.002	0.002
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Children	−0.103**	−0.072	−0.072	−0.071	−0.074	−0.071
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
Time_To_Degree	0.093***	0.134***	0.134***	0.142***	0.134***	0.134***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Regional_Gender_Index	1.087***	1.015***	1.016***	1.008***	0.999***	1.011***
	(0.201)	(0.203)	(0.203)	(0.203)	(0.203)	(0.203)
Constant	1.605***	−1.871***	−1.782***	−1.927***	−1.804***	−1.852***
	(0.236)	(0.365)	(0.384)	(0.364)	(0.365)	(0.365)
University dummies	Yes	Yes	Yes	Yes	Yes	Yes
Field dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.028	0.040	0.040	0.041	0.040	0.040
Number of observations	42,945	42,945	42,945	42,945	42,945	42,945

Robust Standard errors are in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

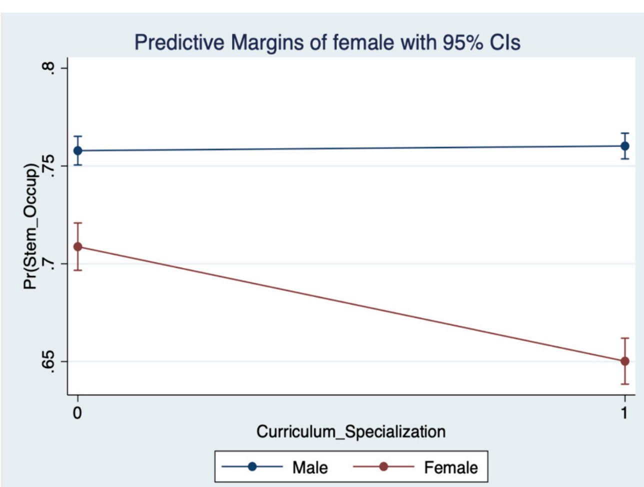

Fig. 1. Marginal effect of Curriculum_Specialization on STEM_Occupation for women and men graduates.

with the hypothesis. The estimates also provide insights on the overall impact of doing internships for women and men graduates. As Fig. 2 reveals, doing internships does not affect the probability of women graduates working in STEM occupations after graduation, but it considerably reduces the likelihood of men graduates.[9]

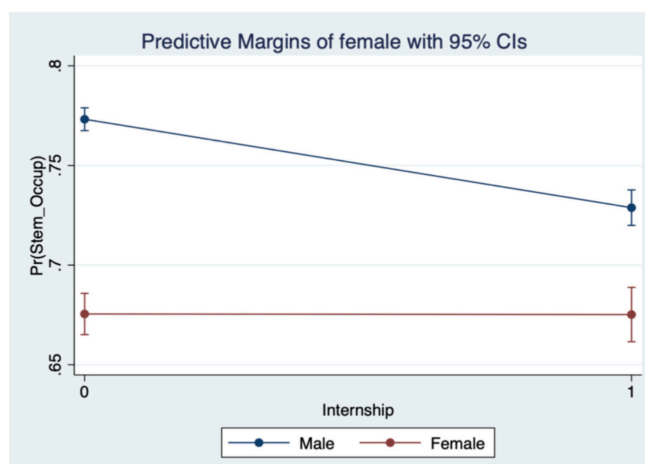

Fig. 2. Marginal effect of Internship on STEM_Occupation for women and men graduates.

Finally, in Model 6 tests H3 by including

[9] To check the robustness of these results, we conducted supplementary analyses by including in the models both *Internship* and a dummy equaling one for the graduates who did internships during BSc studies. The coefficients of this latter variable and its interactive term with *Woman_Graduate* exhibited signs similar to those of *Internship* and *Woman_Graduate*×*Internship*, but their values were comparatively smaller.

Woman_Graduate×*Study_Abroad*. The positive coefficient of this interactive term (0.266, $p < 0.001$) aligns with the hypothesis. Interestingly, as Fig. 3 shows, participation in study abroad programs diminishes the likelihood of male STEM graduates working in STEM occupations soon after graduation, while it has negligible effects on women.

5.2. Additional analyses

To mitigate the endogeneity concerns described in section 4.3, we first estimated three first-stage regressions to predict *Curriculum_Specialization, Internship,* and *Study_Abroad* (see Models 1.a, 2.a, and 3.a in Table 4) and we computed the predicted values from these regressions (namely, *Curriculum_Specialization_Predicted, Internship_Predicted*, and *Study_Abroad_Predicted*). In the first-stage regressions, we included the controls inserted in the main estimates and one instrumental variable per equation, namely *Curriculum_Specialization_Peers* in Model 1.a, *Internship_Peers* in Model 2.a, and *Study_Abroad_Peers* in Model 3.a. The share of peers with a specialized university curriculum (*Curriculum_Specialization_Peers*) was built by considering as peers all the students who received the same BSc degree title as the focal graduate in her/his year of BSc graduation. Instead, the shares of peers who did internships (*Internship_Peers*) and participated in study abroad programs (*Study_Abroad_Peers*) were built by considering as peers all the students who obtained the same MSc degree title of the focal graduate in her/his year of MSc graduation. Then, we re-estimated the Models presented in Table 3 by replacing each variable with the predicted value (see Models 1.b, 2.b, and 3.b in Table 5). In these latter estimates, the coefficients of *Internship_Predicted* (-0.107, $p < 0.001$) and *Study_Abroad_Predicted* (-0.120, $p < 0.001$) were negative and significant, as in the estimates reported in Table 3. The coefficient of *Curriculum_Specialization_Predicted* was not significant at conventional levels.

To assess the validity of the instruments, we first assessed F-statistic values for the first-stage models. We also report the under-identification test, the Weak identification test (Kleibergen-Paap F-Statistic test). All F-statistic values were higher than the suggested threshold of 10 (Staiger and Stock, 1994) and all tests were significant at the 5 % level, confirming the validity of the selected instruments.

We performed a further check by repeating the instrumental variable analysis using different operationalizations of peers to compute the instruments. Specifically, we considered peers of a focal graduate to be all those who were enrolled in the same degree program as the focal graduate the year *before* her/his graduation. The estimates obtained using these alternative instrumental variables (see Appendix Table A1 and Table A2) did not differ from those reported in Tables 4 and 5. Together, these results alleviate the reverse causality and unobserved heterogeneity concerns, at least regarding participation in internships and study abroad programs.

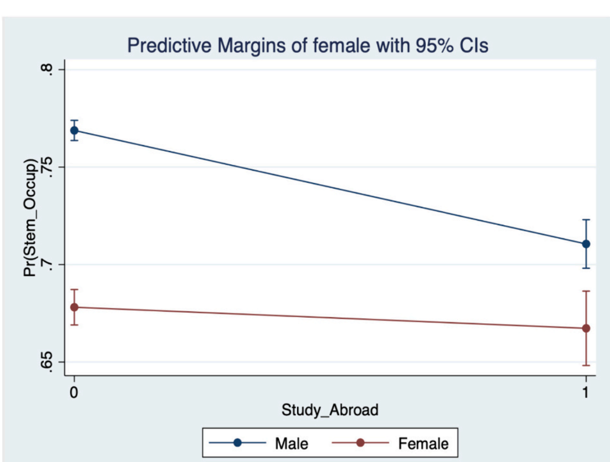

Fig. 3. Marginal effect of Study_Abroad on STEM_Occupation for women and men graduates.

Appendix Table A3 reports the estimates of the main models run on the subsample of individuals who did not graduate at the university closest to their residence. These results parallel those reported in Table 3, thus alleviating the endogeneity concern that self-selection may bias our findings.

To account for the two types of selection bias described in section 4.3, we first considered the population of graduates who answered the survey that AlmaLaurea administered before their graduation and ran a Logit model where the dependent variable was a dummy equal to one for those who also answered the survey conducted five years after their graduation. The set of explanatory variables comprised measures of individuals' demographic characteristics (*Female_Graduate, Age*), the university education characteristics (*Graduation_Grade, Internship, Study_Abroad*, and *Time_To_Degree*), and *ICT_Knowledge*, a variable reflecting individuals' level of computer web skills. This estimate (reported in Appendix Table A4) was used to calculate the predicted probability of answering the fifth-year survey. Next, we considered the respondents to the fifth-year survey and ran another Logit model with a dependent dummy variable equaling one for the graduates working in the private sector five years after graduation and zero for the remaining graduates. The explanatory variables included measures of the focal individual's demographic characteristics (*Woman_Graduate, Age*), the university education characteristics (*Graduation_Grade, Internship, Study_Abroad*, and *Time_To_Degree*), and the control for the average employability of the graduates from the university where the focal individual graduated (*Graduates_Employability*). We also added *Regional_Employment_Rate*, a continuous variable that can take values from zero to 100 and indicates the percentage of the working population employed in the private sector in each Italian region using ISTAT (Italian National Institute of Statistics) data. These additional estimates (see Appendix Table A5) were used to compute the predicted probability of employment in the private sector five years after graduation. We then used the product of the inverse of these two predicted probabilities as the vector of weights that could correct for selection. Specifically, we re-estimated Models 2–6 presented in Table 3 using this vector of weights (see Appendix Table A6). The results are robust and in line with those discussed in Section 5.1.

6. Discussion and conclusions

This study explored the differences between women and men in their likelihood of securing STEM occupations shortly after graduation, with a specific focus on the impact of four characteristics of the university education received by graduates in male-dominated STEM fields. These characteristics include the graduation grade, the specialization of the university curriculum, the completion of internships, and participation in study abroad programs. We started from the premise that in male-dominated STEM fields, a science-is-male stereotype engenders gender segregation in STEM occupations by affecting recent STEM graduates' career aspirations and employers' evaluations of them as job applicants. We theorized that the aforementioned university education characteristics would influence both the supply and demand of labor, with differential effects on men and women graduates' transition to work in STEM occupations.

To test our hypotheses, we leveraged data on the university curricula and five-year, post-graduation occupations of a large sample of graduates in male-dominated STEM fields. The results confirmed that women are generally less likely to get STEM occupations shortly after graduation than their male counterparts. In line with our hypotheses, there were smaller differences between women and men in their probabilities of transitioning to STEM occupations when the recent graduates participated in internships or study abroad programs during university studies. Interestingly, those internships and study abroad experiences did not affect recent women graduates' (admittedly low) likelihood of

Table 4
First stage models for estimating the predicted values of Curriculum_Specialization, Internship, and Study_Abroad.

	Model 1.a (Curriculum specialization)		Model 2.a (Internship)		Model 3.a (Study abroad)	
Woman_Graduate	0.120* (0.047)		−0.058* (0.029)		0.003 (0.031)	
Curriculum_Specialization_Peers	−6.596*** (0.057)					
Internship_Peers			5.547*** (0.064)			
Study_Abroad_Peers					6.801*** (0.127)	
Age	−0.044*** (0.011)		−0.015* (0.007)		−0.149*** (0.010)	
Children	−0.017 (0.061)		0.173*** (0.042)		−0.320*** (0.053)	
Time_To_Degree	0.161*** (0.016)		−0.058*** (0.010)		0.043*** (0.011)	
Regional_Gender_Index	−0.987** (0.307)		0.095 (0.240)		0.113 (0.274)	
Constant	4.177*** (0.359)		−2.617*** (0.276)		0.549 (0.330)	
University dummies	Yes		Yes		Yes	
Field dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Pseudo R2	0.583		0.271		0.111	
Number of observations	42,945		42,945		42,945	
Test	Statistic	*P*-value	Statistic	P-value	Statistic	P-value
F-Test	85,114.07	0.000	15,247.05	0.000	3664.06	0.000
Underidentification test	140,000.00	0.000	6558.18	0.000	1916.09	0.000

Robust Standard errors are in parentheses.
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$.

Table 5
Estimates controlling for possible endogeneity of Curriculum_Specialization, Internship, and Study_Abroad.

	Model 1	Model 2	Model 3
Women_Graduate	−0.431*** (0.026)	−0.417*** (0.026)	−0.426*** (0.026)
Graduation_Grade	0.032*** (0.002)	0.031*** (0.002)	0.032*** (0.002)
Curriculum_Specialization_Predicted	0.006 (0.005)		
Internship_Predicted		−0.099*** (0.010)	
Study_Abroad_Predicted			−0.120*** (0.015)
Age	0.010 (0.007)	0.005 (0.007)	−0.014* (0.007)
Children	−0.067 (0.038)	−0.050 (0.038)	−0.109** (0.039)
Time_To_Degree	0.121*** (0.010)	0.123*** (0.009)	0.138*** (0.010)
Regional_Gender_Index	1.009*** (0.204)	1.083*** (0.204)	1.025*** (0.204)
Constant	−2.106*** (0.365)	−2.253*** (0.362)	−1.918 (0.361)
Pseudo R2	0.038	0.040	0.039
Univeristy_dummies	Yes	Yes	Yes
Field dummies	Yes	Yes	Yes
Year_dummies	Yes	Yes	Yes
Sample	42,945	42,945	42,945

Robust Standard errors in parentheses.
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$.

obtaining STEM occupations after graduation, but they did decrease the high probability of men graduates. We explain these findings by arguing for two opposing effects at work. On the one hand, as we hypothesized, internships and study abroad experiences provide recent graduates with abilities that make them more attractive job applicants and enhance graduates' identification with a career in STEM occupations. This is beneficial for women graduates in male-dominated STEM fields because it reduces the negative impact of the science-is-male stereotype on both prospective employers' evaluations of women applicants (the demand side) and women graduates' self-efficacy (the supply side). Meanwhile, the positive outcomes of internships and study abroad experiences have negligible effects on both the demand and supply sides for men graduates, as they are not penalized by the stereotype. On the other hand, participation in internships and study abroad programs likely exposes recent STEM graduates to job opportunities in non-STEM occupations, which would otherwise go unidentified or be out of reach without these experiences. For example, during internships, STEM students may recognize that their technical competencies are also valuable in non-STEM occupations, such as sales jobs, and they may develop career aspirations in these occupations. Likewise, study abroad experiences equip graduates with cross-cultural adaptability, which may be useful in various occupations and thereby increase these graduates' attractiveness also for non-STEM occupations. These supply- and demand-side effects hold for both men and women. Our results suggest that these opposed effects counterbalance among women graduates, and push men out of STEM occupations more than women.

Notably, university curriculum specialization had a different impact on the transition to STEM occupations for women and men graduates in male-dominated STEM fields. Specifically, we found that the difference between women and men in getting STEM occupations was higher among recent graduates with specialized curricula. Despite curriculum specialization not affecting men graduates' likelihood of gaining STEM occupations, it reduced this same likelihood for women graduates. This finding indicates that, while the above-mentioned opposing effects of specialization on the transition to STEM occupations counterbalance for men, the benefits of diversification overcome those of specialization for women.

These results make two contributions to the broad literature on what drives the gender gap in STEM. First, we add to research on the critical junctures in the STEM pipeline. Research on the gender gap in STEM concurs that women tend to pour out of the STEM career pipeline more than men at critical junctures as opposed to dripping out at regular intervals. Scholars have examined the factors affecting this differential leaking, such as students' transition to higher education in STEM fields (e.g., Aschbacher et al., 2010; Armstrong and Crombie, 2000; Buffington et al., 2016; Schwab et al., 2015) and STEM graduates' transition to academic careers in science (Blickenstaff, 2005; Gaule and Piacentini, 2018). Here, we consider a juncture that is still relatively unexplored: STEM graduates' transition to work. Second, we provide a better understanding of how the university education itself influences the retention of women STEM graduates in the STEM career pipeline. The few prior studies on the topic have mainly looked at the social context that STEM graduates are exposed to during their university education. In particular, scholars have shown that having female university professors facilitates the retention of both women graduates in STEM occupations

(Mansour et al., 2022) and women Ph.D. students in academic careers (Gaule and Piacentini, 2018). The role model effect of these professors also explains the lower likelihood of leaving STEM careers among women who graduated in non-male-dominated STEM university courses compared to those who graduated in male-dominated courses (Schwerter and Ilg, 2021). Our results complement these findings by shifting attention from the social context to the skills acquired through university education.

Our work also adds to research about the effects that university education exerts over graduates' professional careers. Most scholars have discussed the impact of graduates' university education on the probability that they pursue a career as entrepreneurs (e.g., Breznitz and Zhang, 2019; Colombo and Piva, 2020). Instead, our work examined certain characteristics of university education and how they impact graduates' pursuit of STEM occupations.

Our study has several limitations, which suggest directions for future research. First, we formulated our hypotheses by arguing that certain characteristics of university education can mitigate the effect of the science-is-male stereotype on both the supply and demand of labor for STEM occupations. While our arguments help to explain our findings, our data do not allow us to measure the effects of the stereotype on graduates' career decisions or employers' evaluations of female and male applicants. Future works may address this weakness by collecting different data (e.g., through surveys) that can enable measurements of this stereotype, or at least generate qualitative evidence about its impact. Second, as we have information on graduates' occupations five years after graduation, we cannot discern if the sample graduates working in non-STEM occupations ever had work experiences in STEM occupations and then exited the STEM pipeline or simply never gained STEM occupations at all. STEM graduates' transition to work could be better understood by collecting data on their very first jobs after graduation. Third, we focused on male-dominated STEM fields because of the relevance of addressing the gender gap in these domains, particularly via university education. Moreover, we examined the impact of university characteristics based on data from the Italian context. Future research is needed to determine whether and to what extent our findings can be generalized to other contexts, particularly to female-dominated STEM fields (e.g., biological sciences and mathematics) and other countries. Fourth, as mentioned in the introduction (see footnote 2), we adopted a binary approach to gender (equaling it to biological sex) in line with the extant literature on leaks from the STEM pipeline. However, gender is far from a binary construct that mirrors biological sex. Although analyzing the different effects of university education characteristics on men and women is valuable, embracing a nonbinary perspective on gender may add nuance to our analysis. For instance, do the university education characteristics we scrutinized have different effects on graduates who do not conform to a stereotypical gender binary? Finally, to identify STEM occupations, we used the ISCO classification. However, it should be noted that this classification relies on predefined job descriptions, which may not always align perfectly with people's actual job tasks. This limitation can affect how STEM occupations are classified and impact the measurement of the gender gap. Future studies should go beyond traditional definitions of STEM jobs to encompass a more comprehensive description of job tasks. This approach would capture a broader spectrum of occupations and, consequently, provide a more accurate measurement of the gender gap in the specific job roles performed.

Despite these limitations, this study offers important insights for university managers. Specifically, our findings help clarify the implications of university curriculum design choices on graduates' transition to work. Moreover, given the apparent desirability of increasing the number of workers in STEM occupations (Black et al., 2021), our results may assist institutions in defining guidelines and actions that can prompt women graduates in male-dominated STEM fields to pursue STEM careers. In particular, our study suggests that universities should encourage STEM graduates to develop competencies in multiple STEM fields by following diversified university curricula, which favor female graduates' entry into STEM occupations. On that note, university managers should be aware that including internships and study abroad experiences in STEM university curricula can be a double-edged sword. Despite these experiences help students develop abilities that attract employers, as prior research has shown, they can potentially increase leaks in the STEM pipeline by exposing students to job opportunities in non-STEM occupations. University managers may counterbalance these undesired consequences by implementing initiatives to make STEM careers more appealing. For example, they could invite recent alumni with STEM occupations to talk to students about their work, thereby fostering an interest in these types of jobs.

CRediT authorship contribution statement

Azzurra Meoli: Writing – review & editing, Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **Evila Piva:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **Hérica Righi:** Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Appendix A

Table A1
First stage models to estimate the predicted values of Curriculum_Specialization, Internship, and Study_Abroad.

	Model 1.a (Curriculum_Specialization)	Model 2.a (Internship)	Model 3.a (Study_Abroad)
Female_Graduate	0.090 (0.048)	0.007 (0.028)	0.040 (0.031)
Curriculum_Specialization_Peers	−6.077*** (0.055)	–	–
Internship_Peers	–	3.498*** (0.058)	–
Study_Abroad_Peers	–	–	1.534*** (0.101)

(continued on next page)

Table A1 (*continued*)

	Model 1.a (Curriculum_Specialization)	Model 2.a (Internship)	Model 3.a (Study_Abroad)
Age	−0.057***	−0.022**	−0.180***
	(0.011)	(0.007)	(0.010)
Children	0.003	0.155***	−0.336***
	(0.062)	(0.042)	(0.054)
Time_To_Degree	0.174***	−0.029**	0.089***
	(0.017)	(0.009)	(0.010)
Regional_Gender_Index	−0.972**	0.587*	0.382
	(0.313)	(0.241)	(0.275)
Constant	4.617***	−1.987***	1.736***
	(0.435)	(0.282)	(0.344)
University dummies	Yes	Yes	Yes
Field dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Pseudo R2	0.559	0.189	0.037
Number of observations	38,570	37,810	37,810

Robust Standard errors in parentheses.
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$.

Table A2
Estimates controlling for possible endogeneity of Curriculum specialization, Internship and Study abroad.

	Model 1.b (STEM_Occupation)	Model 2.b (STEM_Occupation)	Model 3.b (STEM_Occupation)
Female_Graduate	−0.410***	−0.421***	−0.419***
	(0.027)	(0.028)	(0.028)
Graduation_Grade	0.032***	0.032***	0.031***
	(0.002)	(0.002)	(0.002)
Curriculum_Specialization	–	−0.121***	−0.092***
		(0.028)	(0.027)
Curriculum_Specialization_Predicted	−0.002	–	–
	(0.006)		
Internship	−0.172***	–	−0.173***
	(0.027)		(0.027)
Internship_Predicted	–	−0.751***	–
		(0.0769	
Study_Abroad	−0.209***	−0.206***	–
	(0.031)	(0.031)	
Study_Abroad_Predicted	–	–	−0.338***
			(0.061)
Age	0.008	−0.004	−0.059***
	(0.008)	(0.007)	(0.013)
Children	−0.060	−0.065	−0.189***
	(0.040)	(0.041)	(0.046)
Time_To_Degree	0.129***	0.131***	0.161***
	(0.011)	(0.010)	(0.012)
Regional_Gender_Index	0.919***	0.982***	1.030***
	(0.214)	(0.217)	(0.218)
Constant	−2.228***	−1.624***	−1.060**
	(0.411)	(0.388)	(0.404)
University dummies	Yes	Yes	Yes
Field dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Pseudo R2	0.039	0.041	0.039
Number of observations	38,570	37,810	37,810

Robust Standard Errors are in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A3
Estimates considering only the graduates who did not graduate from the university closest to home.

	Model 1 (STEM_Occupation)
Female	−0.245***
	(0.030)
Graduation_Grade	0.019***
	(0.002)
Curriculum_Specialization	−0.070*
	(0.030)
Internship	−0.114***
	(0.030)
Study_Abroad	−0.155***

(*continued on next page*)

Table A3 (*continued*)

	Model 1 (STEM_Occupation)
	(0.033)
Age	0.005
	(0.008)
Children	−0.041
	(0.045)
Time to degree	0.073***
	(0.011)
Regional_Gender_Index	0.449*
	(0.201)
Constant	−1.118**
	(0.408)
University dummies	Yes
Field dummies	Yes
Year dummies	Yes
Pseudo R2	0.050
Number of observations	11,305

Standard errors in parentheses.
[*] $p < 0.05$
[**] $p < 0.01$
[***] $p < 0.001$.

Table A4
Logit model on the determinants of recent STEM graduates' likelihood of answering the fifth-year survey.

	Model a1
Female	−0.001
	(0.013)
Graduation_Grade	0.010***
	(0.001)
Internship	−0.008
	(0.015)
Study_Abroad	−0.196***
	(0.016)
Age	−0.014***
	(0.002)
Time_To_Degree	−0.001
	(0.004)
ICT_Knowledge	0.173***
	(0.033)
Constant	0.724***
	(0.163)
University dummies	Yes
Year dummies	Yes
Pseudo R2	0.0168
Number of observations	134,054

Robust Standard errors are in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A5
Logit model on the determinants of recent STEM graduates' likelihood of working in the private sector five years after graduation.

	Model a2
Female	−0.718***
	(0.018)
Graduation_Grade	−0.045***
	(0.002)
Internship	0.797***
	(0.025)
Study_Abroad	−0.170***
	(0.025)
Age	−0.045***
	(0.004)
Time_To_Degree	0.111***
	(0.007)
Regional_Employment_Rate	−0.009***
	(0.000)
Constant	8.455***

(*continued on next page*)

Table A5 (*continued*)

	Model a2
	(0.283)
University dummies	Yes
Year dummies	Yes
Pseudo R2	0.0909
Number of observations	85,462

Robust Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A6
Estimates of Logit models on the determinants of recent STEM graduates' likelihood of having a STEM occupation after graduation, including sample weights.

	Model b2 (STEM_Occupation)	Model b3 (STEM_Occupation)	Model b4 (STEM_Occupation)	Model b5 (STEM_Occupation)	Model b6 (STEM_Occupation)
Female_Graduate	−0.436***	−0.639	−0.279***	−0.517***	−0.490***
	(0.026)	(0.440)	(0.038)	(0.032)	(0.028)
Graduation_Grade	0.031***	0.031***	0.032***	0.031***	0.031***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Curriculum_Specialization	−0.069**	−0.069**	0.026	−0.069**	−0.070**
	(0.026)	(0.026)	(0.029)	(0.026)	(0.026)
Internship	−0.152***	−0.152***	−0.152***	−0.244***	−0.152***
	(0.025)	(0.025)	(0.025)	(0.030)	(0.025)
Study_Abroad	−0.211***	−0.211***	−0.210***	−0.211***	−0.313***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.036)
Female_Graduate×Graduation_Grade	–	0.002	–	–	–
		(0.004)			
Female_Graduate×Curriculum_Specialization	–		−0.283***	–	–
			(0.050)		
Female_Graduate×Internship	–		–	0.256***	–
				(0.050)	
Female_Graduate×Study_Abroad	–		–	–	0.277***
					(0.062)
Age	−0.002	−0.002	−0.004	−0.002	−0.003
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Children	−0.078*	−0.078*	−0.077*	−0.080*	−0.077*
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
Time_To_Degree	0.137***	0.137***	0.145***	0.138***	0.137***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Regional_Gender_Index	0.966***	0.966***	0.960***	0.952***	0.960***
	(0.208)	(0.208)	(0.208)	(0.208)	(0.208)
Constant	−1.688***	−1.628***	−1.761***	−1.623***	−1.664***
	(0.372)	(0.391)	(0.371)	(0.372)	(0.373)
University dummies	Yes	Yes	Yes	Yes	Yes
Field dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Weight1*Weight2	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.039	0.039	0.039	0.039	0.039
Number of observations	42,945	42,945	42,945	42,945	42,945

Standard errors in parentheses.
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$.

References

Adams, R.B., Kirchmaier, T., 2016. Women on boards in finance and STEM industries. Am. Econ. Rev. 106 (5), 277–281.
Amici, M., Stefani, M.L., 2013. A gender equality index for the Italian regions. Bank of Italy. Occas. Pap. 190.
Armstrong, P.I., Crombie, G., 2000. Compromises in adolescents' occupational aspirations and expectations from grades 8 to 10. J. Vocat. Behav. 56, 82–98.
Aschbacher, P., Li, E., Roth, E., 2010. Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. J. Res. Sci. Teach. 47 (5), 564–582.
Avolio, B., Chavez, J., Vilchez-Roman, C., 2020. Factors that contribute to the underrepresentation of women in science careers worldwide: a literature review. Soc. Psychol. Educ. 23, 773–794.
Azoulay, P., Ding, W., Stuart, T., 2009. The impact of academic patenting on the rate, quality, and direction of (public) research output. J. Ind. Econ. 57 (4), 637–676.
Bailyn, L., 2003. Academic careers and gender equity: lessons Learned from MIT. Gend. Work. Organ. 10, 137–153.
Bandura, A., 1997. Self-Efficacy: The Exercise of Control. W. H. Freeman and Company, New York.
Bayerlein, L., Jeske, D., 2018. The potential of computer-mediated internships for higher education. Int. J. Educ. Manag. 32 (4), 526–537.
Berryman, S.E., 1983. Who Will Do Science?: Minority and Female Attainment of Science and Mathematics Degrees: Trends and Causes. Rockefeller Foundation, New York.
Bittmann, F., Zorn, V.S., 2020. When choice excels obligation: about the effects of mandatory and voluntary internships on labour market outcomes for university graduates. High. Educ. 80 (1), 75–93.
Black, S.E., Muller, C., Spitz-Oener, A., He, Z., Hung, K., Warren, J.R., 2021. The importance of STEM: high school knowledge, skills and occupations in an era of growing inequality. Res. Policy 50 (7), 104249.
Blickenstaff, C.J., 2005. Women and science careers: leaky pipeline or gender filter? Gend. Educ. 17 (4), 369–386.
Booth, A., Leigh, A., 2010. Do employers discriminate by gender? A field experiment in female-dominated occupations. Econ. Lett. 107 (2), 236–238.
Borgida, E., Nisbett, R.E., 1977. The differential impact of abstract vs. concrete information on decisions 1. J. Appl. Soc. Psychol. 7 (3), 258–271.
Bosworth, D., Lyonette, C., Wilson, R., Bayliss, M., Fathers, S., 2013. The Supply of and Demand for High-Level STEM Skills. UK Commission for Employment and Skills, London.
Breznitz, S.M., Zhang, Q., 2019. Fostering the growth of student start-ups from university accelerators: an entrepreneurial ecosystem perspective. Ind. Corp. Chang. 28 (4), 855–873.

Buck, G.A., Cross Francis, D., Wilkins-Yel, K.G., 2020. Research on gender equity in STEM education. In: Johnson, C.C., Mohr-Schroeder, M.J., Moore, T.J., et al. (Eds.), Handbook of Research on STEM Education. Routledge, New York, pp. 289–299.
Buffington, C., Cerf, B., Jones, C., Weinberg, B.A., 2016. STEM training and early career outcomes of female and male graduate students: evidence from UMETRICS data linked to the 2010 census. Am. Econ. Rev. 106, 333–338.
Buse, K., Bilimoria, D., Perelli, S., 2013. Why they stay: women persisting in US engineering careers. Career Dev. Int. 18, 139–154.
Callanan, G., Benzing, C., 2004. Assessing the role of internships in the career-oriented employment of graduating college students. Education+Training 46 (2), 82–89.
Caprile, M., Palmen, R., Sanz, P., Dente, G., 2015. Encouraging STEM Studies: Labour Market Situation and Comparison of Practices Targeted at Young People in Different Member States. European Union, Brussels.
Chan, W., Dimmock, C., 2008. The internationalisation of universities. Globalist, internationalist and translocalist models. J. Res. Int. Educ. 7 (2), 184–204.
Charles, M., Bradley, K., 2009. Indulging our gendered selves? Sex segregation by field of study in 44 countries. Am. J. Sociol. 114, 924–976.
Cheryan, S., 2012. Understanding the paradox in math-related fields: why do some gender gaps remain while others do not? Sex Roles 66 (3–4), 184–190.
Cheryan, S., Ziegler, S.A., Montoya, A.K., Jiang, L., 2017. Why are some STEM fields more gender balanced than others? Psychol. Bull. 143 (1), 1–35.
Clougherty, J.A., Duso, T., Muck, J., 2015. Correcting for self-selection based endogeneity in management research: review, recommendations and simulations. Organ. Res. Methods 19 (2), 1–62.
Colombo, M.G., Piva, E., 2020. Start-ups launched by recent STEM university graduates: the impact of university education on entrepreneurial entry. Res. Policy 49 (6), 103993.
Cooper, M., 2000. Being the go-to guy: fatherhood, masculinity, and the Organization of Work in Silicon Valley. Qual. Sociol. 23, 379–405.
Correll, S.J., 2001. Gender and the career choice process: the role of biased self-assessments. Am. J. Sociol. 106, 1691–1730.
Correll, S.J., 2004. Constraints into preferences: gender, status, and emerging career aspirations. Am. Sociol. Rev. 69, 93–113.
Correll, S.J., Benard, S., 2006. Biased estimators? Comparing status and statistical theories of gender discrimination. In: Thye, S.R., Lawler, E.J. (Eds.), Social Psychology of the Workplace. Elsevier Science, New York, pp. 89–116.
Crossman, J.E., Clarke, M., 2010. International experience and graduate employability: stakeholder perceptions on the connection. High. Educ. 59 (5), 599–613.
Deboer, G.E., 1986. Perceived science ability as a factor in the course selections of men and women in college. J. Res. Sci. Teach. 23 (4), 343–352.
Deemer, E.D., Thoman, D.B., Chase, J.P., Smith, J.L., 2014. Feeling the threat: stereotype threat as a conceptual barrier to women's science career choice intentions. J. Career Dev. 41 (2), 141–158.
Delaney, J.M., Devereux, P.J., 2019. Understanding gender differences in STEM: evidence from college applications. Econ. Educ. Rev. 72, 219–238.
Deming, D.J., Noray, K., 2020. Earnings dynamics, changing job skills, and STEM careers. Q. J. Econ. 135 (4), 1965–2005.
Di Pietro, G., 2015. Do study abroad programs enhance the employability of graduates? Education Finance and Policy 10 (2), 223–243.
Donhardt, G.L., 2004. In search of the effects of academic achievement in postgraduation earnings. Res. High. Educ. 45, 271–284.
England, P., 1994. Neoclassical economists' theories of discrimination. In: Burstein, P. (Ed.), Equal Employment Opportunity: Labor Market Discrimination and Public Policy. Walter de Gruyter, New York, pp. 59–70.
Etzkowitz, H., Kemelgor, C., Uzzi, B., 2000. Athena Unbound: The Advancement of Women in Science and Technology. Cambridge University Press, New York.
Fini, R., Perkmann, M., Michael Ross, J., 2021. Attention to exploration: the effect of academic entrepreneurship on the production of scientific knowledge. Organ. Sci. 33 (2), 688–715.
Fouad, N.A., Singh, R., Cappaert, K., Chang, W., Wan, M., 2016. Comparison of women engineers who persist in or depart from engineering. J. Vocat. Behav. 92, 79–93.
Gaule, P., Piacentini, M., 2018. An advisor like me? Advisor gender and post-graduate careers in science. Res. Policy 47 (4), 805–813.
González, M.J., Cortina, C., Rodríguez, J., 2019. The role of gender stereotypes in hiring: a field experiment. Eur. Sociol. Rev. 35 (2), 187–204.
Grinis, I., 2019. The STEM requirements of "non-STEM" jobs: Evidence from UK online vacancy postings. Econ. Educ. Rev. 70, 144–158.
Hilmer, M.J., 2002. Student migration and institution control as screening devices. Econ. Lett. 76 (1), 19–25.
Hoetker, G., 2007. The use of logit and probit models in strategic management research: critical issues. Strateg. Manag. J. 28, 331–343.
Jasko, K., Pyrkosz-Pacyna, J., Czarnek, G., Dukała, K., Szastok, M., 2020. The STEM graduate: immediately after graduation, men and women already differ in job outcomes, attributions for success, and desired job characteristics. J. Soc. Issues 76 (3), 512–542.
Kavanagh, M.H., Drennan, L., 2008. What skills and attributes does an accounting graduate need? Evidence from student perceptions and employer expectations. Account. Finance 48, 279–300.
Kelley, C., Meyers, J. 1995. CCAI Cross Cultural Adaptability Inventory Manual. Minneapolis, MN: National Computer Systems, Inc.
Kopp, J., Kreuter, F., Schnell, R., Klein-Schneider, H., 2004. The transition from higher education to work. Results from a survey among University of Konstanz Administrative Science graduates. Sozialwissenschaften und Berufspraxis 27 (2), 155–170.
Kuschel, K., Ettl, K., Díaz-García, C., Alsos, G.A., 2020. Stemming the gender gap in STEM entrepreneurship–insights into women's entrepreneurship in science, technology, engineering and mathematics. Int. Entrep. Manag. J. 16 (1), 1–15.
Lazear, E.P., 2004. Balanced skills and entrepreneurship. Am. Econ. Rev. 208–211.
Lent, R.W., Brown, S.D., 2013. Social cognitive model of career self-management: toward a unifying view of adaptive career behavior across the life span. J. Couns. Psychol. 60 (4), 557–568.
Lent, R.W., Brown, S.D., Hackett, G., 1994. Toward a unifying social cognitive theory of career and academic interest, choice, and performance [monograph]. J. Vocat. Behav. 45, 79–122.
Lent, R.W., Brown, S.D., Hackett, G., 2000. Contextual supports and barriers to career choice: a social cognitive analysis. J. Couns. Psychol. 47, 36–49.
Lerchenmueller, M.J., Sorenson, O., 2018. The gender gap in early career transitions in the life sciences. Res. Policy 47 (6), 1007–1017.
Leslie, S.J., Cimpian, A., Meyer, M., Freeland, E., 2015. Expectations of brilliance underlie gender distributions across academic disciplines. Science 347, 262–265.
Little, B., 2001. Reading between the lines of graduate employment. Qual. High. Educ. 7 (2), 121–129.
Mansour, H., Rees, D.I., Rintala, B.M., Wozny, N.N., 2022. The effects of professor gender on the postgraduation outcomes of female students. ILR Rev. 75 (3), 693–715.
Maskooki, K., Rama, D.V., Raghunandan, K., 1998. Internships in undergraduate finance programs. Financ. Pract. Educ. 8, 74–82.
Master, A., Meltzoff, A., 2016. Building bridges between psychological science and education: cultural stereotypes, STEM, and equity. Prospects 46 (2), 215–234.
Merluzzi, J., Phillips, D.J., 2016. The specialist discount: negative returns for MBAs with focused profiles in investment banking. Adm. Sci. Q. 61 (1), 87–124.
Michelmore, K., Sassler, S., 2016. Explaining the gender earnings gap in STEM: does field group size matter? Issue: the changing status of women and its effects on society. RSF: the Russell Sage Foundation. Journal of the Social Sciences 2 (4), 194–215.
National Science Foundation, 2019. The Skilled Technical Workforce: Crafting America's Science & Engineering Enterprise. Retrieved from: https://www.nsf.gov/nsb/publications/2019/nsb201923.pdf.
National Science Foundation, 2014. Investing in Science, Engineering, and Education for the nation's Future. Strategic Plan for 2014–2018. Washington, DC. Retrieved from. http://www.nsf.gov/pubs/2014/nsf14043/nsf14043.pdf.
Niehaus, E., Inkelas, K.K., 2016. Understanding STEM majors' intent to study abroad. Coll. Stud. Aff. J. 34 (1), 70–84.
Nimmesgern, H., 2016. Why are women underrepresented in STEM fields? Chemistry–a. Eur. J. Dermatol. 22 (11), 3529–3530.
Ocampo, A.C.G., Reyes, M.L., Chen, Y., Restubog, S.L.D., Chih, Y.-Y., Chua-Garcia, L., Guan, P., 2020. The role of internship participation and conscientiousness in developing career adaptability: a five-wave growth mixture model analysis. J. Vocat. Behav. 120 (4), 103426.
Piva, E., Rovelli, P., 2022. Mind the gender gap: the impact of university education on the entrepreneurial entry of female and male STEM graduates. Small Bus. Econ. 59 (1), 143–161.
Plantenga, J., Remery, C., Figueiredo, H., Smith, M., 2009. Towards a European union gender equality index. J. Eur. Soc. Policy 19, 19–33.
Poggesi, S., Mari, M., De Vita, L., Foss, L., 2020. Women entrepreneurship in STEM fields: literature review and future research avenues. Int. Entrep. Manag. J. 16 (1), 17–41.
Poot, J., Roskruge, M., 2013. Internationalisation of education and returns in the labour market. Studies in Regional Science 43 (1), 61–78.
Powell, G.N., 1987. The effects of sex and gender on recruitment. Acad. Manag. Rev. 12, 731–743.
Raymond, M.A., McNabb, D.E., Matthaei, C.F., 1993. Preparing graduates for the workforce: the role of business education. J. Educ. Bus. 68, 202–206.
Reuben, Ernesto, Sapienza, Paola, Zingales, Luigi, 2014. How stereotypes impair Women's careers in science. Proceeding at National Academy of Science USA 111 (12), 4403–4408.
Ridgeway, C.L., 2001. Gender, status, and leadership. J. Soc. Issues 57, 637–655.
Robins, J.M., Finkelstein, D.M., 2000. Correcting for noncompliance and dependent censoring in an AIDS clinical trial with inverse probability of censoring weighted (IPCW) log-rank tests. Biometrics 56, 779–788.
Rosenzweig, E.Q., Hecht, C.A., Priniski, S.J., Canning, E.A., Asher, M.W., Tibbetts, Y., Harackiewicz, J.M., 2021. Inside the STEM pipeline: changes in students' biomedical career plans across the college years. Science. Advances 7 (18), eabe0985.
Rothwell, J., 2013. The Hidden STEM Economy. Metropolitan Policy Program at Brookings, Washington, D.C.
Sassler, S., Glass, J., Levitte, Y., Michelmore, K.M., 2017. The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. Soc. Sci. Res. 63, 192–208.
Schwab, K., Samans, R., Hausmann, R., Zahidi, S., Bekhouche, Y., Ugarte, P.P., Ratcheva, V., 2015. The Global Gender Gap Report 2015. Retrieved from, World Economic Forum. http://www3.weforum.org/docs/GGGR2015/cover.pdf.
Schwerter, J., Ilg, L., 2021. Gender differences in the labour market entry of STEM graduates. European Journal of Higher Education 1–19.
Shapiro, H., Østergaard, S. F., Hougard, K. F. 2015. Does the EU Need More STEM Graduates. Final report. European Commission. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/60500ed6-cbd5-11e5-a4b5-01aa75ed71a1.
Sorrenti, G., 2017. The Spanish or the German apartment? Study abroad related outcomes and its recognition by the labour market. Econ. Educ. Rev. 60, 142–158.
Speer, J., 2020. STEM Occupations and the Gender Gap: What Can We Learn from Job Tasks? Working paper IZA n. 13734.
Staiger, D.O., Stock, J.H., 1994. Instrumental variables regression with weak instruments. National Bureau of Economic Research. Retrieved from: https://www-nber-org.ezproxy.unibo.it/system/files/working_papers/t0151/t0151.pdf.

Sterling, A.D., Fernandez, R.M., 2018. Once in the door: gender, tryouts, and the initial salaries of managers. Manag. Sci. 64 (11), 5444–5460.
Sterling, A.D., Merluzzi, J., 2019. A longer way in: tryouts as alternative hiring arrangements in organizations. Res. Organ. Behav. 39, 100122.
Sterling, A.D., Thompson, M.E., Wang, S., Kusimo, A., Gilmartin, S., Sheppard, S., 2020. The confidence gap predicts the gender pay gap among STEM graduates. Proc. Natl. Acad. Sci. 117, 30303–30308.
Thébaud, S., Charles, M., 2018. Segregation, stereotypes, and STEM. Sociol. Sci. 7 (7), 111.
Toohey, S., Ryan, G., Hughes, C., 1996. Assessing the practicum. Assess. Eval. High. Educ. 21 (3), 215–227.
Unger, J.M., Rauch, A., Frese, M., Rosenbusch, N., 2011. Human capital and entrepreneurial success: a meta-analytical review. J. Bus. Ventur. 26 (3), 341–358.
Venhorst, V.A., Cörvers, F., 2018. Entry into working life: internal migration and the job match quality of higher-educated graduates. J. Reg. Sci. 58 (1), 116–140.
Waibel, S., Rüger, H., Ette, A., Sauer, L., 2017. Career consequences of transnational educational mobility: a systematic literature review. Educ. Res. Rev. 20, 81–98.
Wickware, P., 1997. Along the leaky pipeline. Nature 390 (6656), 202–203.
Wright, R., Ellis, M., Townley, M., 2017. The matching of STEM degree holders with STEM occupations in large metropolitan labor markets in the United States. Econ. Geogr. 93 (2), 185–201.