Students enrolled in STEM disciplines in Italy: The role played by field of study and gender in course switching

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Abstract

Ongoing technological change has led to a steadily growing demand for Science, Technology, Engineering and Mathematics (STEM) graduates worldwide. Not only do STEM disciplines have a low attractiveness in some contexts, such as in the U.S. and Italy; it is also a matter of persistence in pursuing STEM studies, affected by high rates of course switches in several countries. Using administrative microdata from the Italian Ministry for Universities and Research and selecting students enrolled in a STEM discipline between 2010 and 2014, our aim is to explore how the student's gender, the field of study, and the gender composition of the course can help identify at-risk students likely to switch away from STEM fields, often delaying and/or compromising their academic journeys. Overall, the findings show that the propensity to abandon STEM programmes is very high, especially among students enrolled in Soft STEM fields. We find that (female and male) students in female-dominated programmes tend to have a lower probability of switching to enroll in another STEM course compared to those in male-dominated programmes. These findings emphasise that institutional contexts and course-level gender composition matter for STEM persistence, calling for university-level strategies aimed at fostering more inclusive and supportive learning environments.

Keywords: university students, STEM, gender, course switch, Italy

1. Introduction

Ongoing technological change has led to a steadily growing demand for graduates from Science, Technology, Engineering and Mathematics (STEM) worldwide, due to their prominence in the development, productivity, and growth of contemporary economies. Skills in STEM disciplines are thus becoming an increasingly important part of basic literacy in today's economy. Several actions have been put in place to increase the (low) attractiveness of degree programmes in science and technology, and thus satisfy the growing demand for future scientists and engineers: as stated by the European Schoolnet, "to keep Europe growing, we will need one million additional researchers by 2020." Also, in the U.S., increasing the number of undergraduate STEM majors has recently emerged as a national priority (Kuenzi, 2008); thus, in the last years, they have concentrated on expanding existing STEM education programmes, but also on implementing new programmes to increase the number of students entering STEM disciplines (Thompson and Bolin, 2011).

Not only do STEM disciplines have an issue of attraction, but also of retention. Indeed, many students who decide to enrol in a STEM discipline then change their minds, switching to another course or, even worse, dropping out of university studies. The first few years of enrolment are crucial in this respect, and this is a particular concern for the STEM disciplines, which are the most affected by both practices with respect to other disciplines such as Business or Education fields (Chen et al., 2018; Thompson and Bolin, 2011). Among those who switch to another course, most students switch to a non-STEM field (Isphording and Qendrai, 2019). Consequently, despite the increase in enrolment in STEM fields in some countries (like the U.S.), this rise has not been followed by a higher number of graduates. Against these premises, the high number of undergraduate students leaving the STEM course of first enrolment represents an issue of societal concern (Seymour and Hewitt, 1997).

Various individual and contextual characteristics may influence this academic outcome. At the individual level, a few studies identified a lack of association between the student's gender and course switch (Thompson and Bolin, 2011), whereas students' prior math achievement and quantitative skills have been identified as the most important predictors of STEM study success (De Winter and Dodou, 2011). The social context and the peer effect also have a role, too (Raabe et al., 2019). Some STEM disciplines, such as biology, have a significant female presence. Barone and Assirelli (2020) suggest that although biology, as a pure science, may not entirely be considered a care-oriented field, its links to healthcare (e.g., medicine, nursing, biotechnology) might attract (and retain) women, who are also encouraged by society to pursue careers related to caregiving.

Given these premises, in this work, we focus on university students who decided to enrol in a STEM course for the first time in Italy and then changed major. We concentrate on this peculiar subgroup, which is understudied in the literature with respect to other academic students, such as those who dropped out. Whilst some of these course switches may be considered strategic, most of them are unplanned at the beginning of the academic career and represent a waste of resources both at the individual and the societal level, at least in the short term (course switch can result in long-term benefits). At the individual level, a successful academic career is undoubtedly beneficial for the students themselves. Students who begin and conclude their academic careers within the same field do not cause damage to self-esteem, which can occur when initial expectations do not match real-world experiences (Casanova et al., 2021). Moreover, students who switch courses tend to increase the time (and money) spent on education, translating into additional time waiting to enter the labour market (Witteveen and Attewell, 2021). At the societal level, the public has both direct and indirect interests in university students' success, given that in Italy public universities receive funds from the

government (deriving from taxes) and that the prosperity of a country is strongly affected by its citizens' education and skills, as well as its quality of human resources (Becker, 2009; Schultz, 1971).

Several individual and institutional factors may play a role when dealing with students' course switches in STEM fields, but most empirical research dealt with flexible educational systems, with a smooth transition between majors. Instead, the Italian higher education system is rigid and bureaucratic; thus, changing a major may have more impactful consequences for a student's academic, personal, and professional career. Even more, in Italy, the association between individual/institutional factors and a major switch may be different, given the heavier effort required of students who intend to change their course. While we believe that the importance of math competencies may be similar across educational systems and contexts, other factors, such as gender (previous literature identified a higher propensity in course switch of female students), may be context-dependent, as well as the gendered peer effect may be relevant with respect to the course considered in the STEM disciplines.

Accordingly, we are interested in understanding the influence of the student's gender, the field of study, and the gender composition of the course of first-time enrolment in affecting students' course switch among those enrolled in a STEM course. STEM disciplines are highly heterogeneous, displaying markedly different gender compositions; therefore, it is essential to analyse switching dynamics taking into account both the distinction between mathematics-intensive (namely, hard) and life science–oriented (that is, soft) fields and the degree of gender segregation of the disciplines, given that gender imbalance may have several consequences on educational programmes (e.g., Li et al., 2025). Moreover, the content of the original programme may play a decisive role in shaping the subsequent choice, potentially influencing whether students remain within the STEM domain or exit it altogether. Accordingly, our first research question (RQ#1) is: *Does the propensity of students' course switch towards a soft stem, a hard stem, or a non-stem course differ according to students' gender and the soft/hard STEM course of origin?*

Second, the role of (same-gender) peers cannot be neglected when predicting students' course switch among those enrolled in a STEM course. Thus, we secondly aim to check if being enrolled in male- or female-dominated courses may have an association with students' propensity to course switch according to the students' gender, answering to our second research question (RQ#2): *Does the gender composition of the course have an impact on students' course switch towards a soft STEM or a hard STEM course also according to students' gender and the soft/hard STEM course of origin?* While it is acknowledged that non-academic factors (such as the gender composition of the course) play a more significant role than academic considerations in the departure of women from STEM fields (Astorne-Figari & Speer, 2019), it remains unclear whether similar pathways may be at play for male students, too. Given that success in STEM subjects seems to go beyond the mere attractiveness and ability and that contextual factors like scientific macro-fields may be relevant for women's academic career and progression (e.g., Gaiaschi, 2025), university advisors may pay attention to the gender balance of the courses and thus mitigate the relevant switch rates observed in undergraduate STEM education.

The paper proceeds as follows. Section 2 presents the STEM disciplines in higher education across contexts and over time, and gendered performances and choices towards these subjects. In Section 3, we summarise previous knowledge on course switches in higher education, with a focus on STEM students and the role of peers. Section 4 presents the data used and the methodology applied. Section

5 describes the results of our analyses. Section 6 concludes the paper by giving some policy implications.

2. Preferences by gender in STEM disciplines in higher education

The STEM disciplines have different attractiveness in diverse contexts. The United States, for example, needs to improve STEM education (Kuenzi, 2008) and thus has concentrated in recent years on expanding existing STEM education programmes and implementing new programmes (Thompson and Bolin, 2011). The same holds for several European countries, with the subsequent number of graduates in a STEM programme that slightly increased in the last decades (for example, in Italy, it passed from 13.8‰ in 2013 to 18.5‰ of people aged 20-29 in 2022: see Fig. 5 in the Appendix).

But in many Western countries (Italy included), women are underrepresented in the STEM fields (European Commission, 2025), as a result of a mixture of gender discrimination and gender differences in preferences (for a review, see Azmat & Petrongolo, 2014). Most STEM disciplines are male-dominated majors, with the largest disparities in the physical sciences, computer science, and engineering (UNESCO, 2012). The gender difference in choosing a career in a STEM field is commonly explained by cultural and structural factors, but other dynamics—such as discrimination, cultural barriers, and stereotypes—may play a role (see Kahn & Ginther, 2017, for a review). Also, women's and men's preferences are not exclusively innate but are intrinsically linked to cultural factors (Cheryan et al., 2017). An essentialist gender culture contributes to gender segregation in higher education, with the choice among majors more associated with vocational interests and peers' expectations, which are usually highly gendered, than other factors such as individual future expectations (Ochsenfeld, 2016). The transmission of cultural norms and preferences from parents to children also reinforces the gender gap in STEM, for example, with maternal gendered role attitudes influencing girls' performance in mathematics (Dossi et al., 2021). Nowadays, the gender gap in higher education is slightly less marked, with a percentage of females in male-dominated sectors that is increasing, but at a slow pace.

Gender differences in scientific and technological subjects tend to increase with educational programmes, too. In many countries, girls attain equivalent average grades in STEM subjects compared to boys during childhood and adolescence (Voyer & Voyer, 2014), whereas Italy records one of the widest gaps in maths—16 score points in 2018 and 21 in 2022 (OECD, 2019; OECD, 2023)—with female adolescents severely underperforming in mathematics achievements compared to males (Contini et al., 2017). The gender gap in maths affects younger ages, too, with girls losing ground relative to boys when progressing in the education system (Contini et al., 2017). Italian female students' low performances in maths should not be surprising: Italy, which stands below the European average in gender equity (European Institute for Gender Equality, 2024), is a country where cultural factors still contribute (among others) to keeping women away from STEM disciplines. Moving to higher education data, in 2020, in Italy, among male graduates aged 25-34, one in three was in a STEM major, whereas among female graduates aged 25-34, only one in six (ISTAT, 2021).

There have been several proposed theories to explain why women are underrepresented in STEM (e.g., Ceci et al., 2009; Eccles, 1994; Gottfredson, 1981; Lent et al., 1994; Lent et al., 2011; Nosek et al., 2009; Wang, Eccles, & Kenny, 2013). Moreover, not all STEM fields show the same gender imbalance: gender gaps in first-time enrolment in STEM majors are larger in computer science, engineering, and physics than in biology, chemistry, and mathematics (e.g., Priulla et al., 2021). For

example, in the U.S., over half of undergraduate degrees in biology and chemistry are held by women (National Science Board, 2014), perhaps because of their connections to healthcare professions (Barone & Assirelli, 2020). On the contrary, women's greater underrepresentation in computer science, engineering, and physics has been attributed to: a masculine culture of those disciplines that signals to women a lower sense of belonging than to men; insufficient early educational experience in those topics; and larger gender gaps in self-efficacy in computer science, engineering, and physics (Cheryan et al., 2017). Gender differences in math ability do not seem, instead, to account for the lower representation of women in computer science, but recent studies highlight how females tend to have stronger mathematical skills to choose STEM subjects (Contini et al., 2023, for high school choice; Priulla et al., 2025, for university enrolment). Indeed, the gender gap among mathematics graduates is nearly balanced, whereas it persists in computer science.

To sum up, students' choices are made within a larger social and structural environment, which operates in tandem to pull girls and women toward some STEM fields while pushing them away from others. This results in a significant gender imbalance in fields of study and, consequently, these gendered career choices contribute to persistent labour market inequalities, including differences in wages and career advancement, as care-oriented fields, preferred by women, tend to be lower-paid and offer fewer opportunities for upward mobility (Barone & Assirelli, 2020; Grassi & Savioli, 2025). Moreover, computer science, engineering, and physics, in which women are underrepresented, overlook the advantages that gender diversity brings, such as collective intelligence, creativity, and innovation (Page, 2007; Woolley et al., 2010), as well as additional scientists to keep up with their increasing demand.

3. Course switch in higher education

Research indicates that a substantial proportion of students undergo major changes during their time in college, indicating that the decision-making process regarding majors is dynamic and evolves over time (Chen, 2013). Despite the extensive body of literature addressing the topic of major choice, relatively little is known about the patterns of major switching, especially among those involved in STEM majors that suffer higher switching rates compared to other fields of study. Even more, changing a field of study varies significantly across contexts. For instance, changing a major in American colleges is generally a relatively flexible process, particularly in institutions that follow the liberal arts education model. These colleges encourage students to explore various disciplines during their initial years, which facilitates a smoother transition between majors, as students are not required to specialise immediately. In other contexts, such as the Italian or French higher education system, changing a major is feasible but less flexible compared to American universities, or universities in Nordic countries or the Netherlands, too. In Italy, this is primarily due to the rigid structure of academic programmes and specific administrative procedures, which can significantly impact both the duration and cost of completing a degree when compared to other, more flexible systems.

The Human Capital Model (HCM) of Becker (1962) assumes that individuals have a full set of information regarding their skills and preferences before starting university and, therefore, can perfectly choose the level and field of education that better fit them. Several attempts have been made to amend the classical HCM to explain unsolved phenomena by this theory, such as delayed graduation, university dropouts, and course switches. The available explanations have followed different theoretical approaches (Aina et al., 2019). For example, Comay and colleagues (1973) and

Manski (1989) agree that the decision to invest in education does not take place instantaneously, but rather is made year after year: thus, an individual's choice is a sequential choice, to be renewed over time. Altonji (1993) summarises and generalises these previous contributions, highlighting the importance of factors that were unnoticed before, such as individual preferences, the level of background achieved at high secondary school, talent, and interest in a certain field of study.

The decision to change an academic programme after the initial enrolment is driven by two main individual mechanisms. The first mechanism, which is the preference mismatch, refers to the misalignment between a student's preferences regarding a course of study or institution and the actual choice made regarding the course of study or institution they enrol in. This phenomenon can occur when a student selects a course of study or institution that does not align with their true preferences, often due to external pressures or circumstances that limit their options (Astorne-Figari & Speer, 2019). This discrepancy can lead to disengagement and a reevaluation of academic choices. Furthermore, university years are formative, and students often discover new academic passions or refine their career goals through exposure to diverse subjects (Briggs et al., 2012). As students gain a clearer understanding of their strengths and long-term objectives, they may opt for a course that better aligns with their revised aspirations. The second main source of mismatch is the academic mismatch, which refers to the misalignment between a student's academic abilities and the requirements or expectations of an institution or study programme. This concept is often associated with the phenomenon of admitting students with lower scores or levels of preparation compared to the academic demands of the programme into which they are admitted. In this respect, institutional factors, such as inadequate academic support, poor teaching quality, or unwelcoming academic environments, can contribute to dissatisfaction and prompt students to switch courses (Usala et al., 2024; Seymour and Hewitt, 1997). Next to these two mechanisms, socio-economic factors also play a significant role. Financial constraints may push students toward fields perceived to offer higher job security or better financial prospects. Even more, students from underrepresented groups or disadvantaged backgrounds may face external pressures, such as family expectations, that influence their choice of study and lead to course switching if their initial choices are not aligned with their true interests (Tinto, 2017).

Course switching has several important implications at the individual level. One immediate consequence is financial, as changing programmes can prolong studies, increase tuition costs, and delay labour market entry, creating additional strain for students relying on loans or family support (Denice, 2020). The psychological impact is also relevant: realising that an initial choice was unsuitable may generate stress, anxiety, or feelings of failure, with potential negative effects on mental health and academic performance (González-Arias et al., 2025).
At the same time, switching courses can produce long-term benefits. Realigning academic paths with personal interests and abilities is often associated with greater satisfaction, stronger motivation, improved performance, and better career prospects (Tinto, 2017). Course switching can also reshape students' social networks: although leaving established peer groups may be challenging, entering a new academic environment offers opportunities to build broader social and professional connections (Yorke & Longden, 2004).

Course switch has important implications at the meso and macro levels, too. At the family level, course switching can lead to extended periods of study and additional costs, and thus increase the emotional and financial burden on students' families. At the macro level, widespread course switching can impact institutional efficiency and national education policy. Universities face higher

administrative costs and disruptions when students frequently change their academic paths, which can strain resources allocated to advising and programme coordination. Nationally, a high rate of course switching can contribute to skill mismatches in the labour market, potentially undermining economic productivity.

3.1 Course switch among STEM students: different gender approaches

When students switch majors, their choices often align with demographic characteristics such as gender and race. For instance, women seem to be more inclined to avoid environments perceived as highly competitive; thus, they are significantly more likely to depart from STEM majors compared to men. Although poor academic performance strongly correlates with leaving STEM fields, it does not account for the entirety of the gender disparity. When dealing with major switching, the *distance* between majors, namely, how the second major is different from the first one chosen, may also be taken into account. Some major changes represent "major changes", while others are smaller corrections. When women exit STEM disciplines, they often transition to majors that maintain a similar level of scientific and mathematical content but differ in terms of gender composition, grading standards, and perceived student ability, such as fields in healthcare. This suggests that the decision to leave STEM is not driven by a lack of competence or disinterest in science per se. Indeed, previous scholarship posits that the departure of women from STEM fields implies that non-academic factors play a more significant role than academic considerations in understanding this phenomenon (Astorne-Figari & Speer, 2019).

Along this line of enquiry, a mechanism at play in course switching could be the concept of "fit" between personal identity and perceived field characteristics. As noted by Ma (2011), women are more likely to switch out of STEM programmes when they feel that their values and identities do not align with the culture of the field. For instance, women who value communal goals—such as helping others or contributing to society—may find fields like engineering or computer science less fulfilling, as these are perceived as less aligned with such goals (Cheryan et al., 2017).

Finally, social factors also influence gendered patterns of course switching. Women are more likely to face external pressures related to traditional gender roles, which may lead them to reconsider their place in STEM fields. For example, women may feel compelled to switch to fields perceived as more "feminine" or socially acceptable for their gender, such as the life sciences or healthcare-related disciplines (Diekman et al., 2010). Fields in which women are stereotyped as less competent than men are more likely to show gender gaps in self-efficacy (Correll, 2001). Also, the influence of negative stereotypes in keeping women away from some disciplines and switching to more "feminine" ones manifests through the fear of confirming gender stereotypes (Steele et al., 2002). Even more, women in male-dominated STEM fields are less likely to have access to female mentors or role models, which can negatively impact their sense of belonging and confidence, such as the absence of institutional structures aimed at promoting inclusivity, diversity initiatives, or mentorship programmes (Riegle-Crumb et al., 2012). In such a situation, the field of study of first enrolment emerges as relevant in a student's future academic career. Recognising the heterogeneity within STEM fields and following prior literature distinguishing between mathematics-intensive and life-science-oriented STEM fields (e.g., Morgan et al., 2013; Eccles, 2007), we will analyse course switching by classifying STEM disciplines into "hard STEM" (the former) and "soft STEM" (the latter) disciplines. Using this distinction, we can classify STEM programmes into those in which

women are usually underrepresented, such as the physical sciences and engineering, and those in which they are much more prevalent, such as the biological and social sciences, thus considering differences existing among STEM fields that previous studies have commonly disregarded (Ehrlinger and Dunning, 2003; Park et al., 2011). Coherently with what we presented so far, when addressing our first research question (RQ#1) about whether students' propensity to switch to a soft STEM, hard STEM, or non-STEM course varies according to their gender and the type of STEM course of origin, *we hypothesise that female students are more likely to make cross-type major changes, shifting toward soft-STEM and non-STEM courses that feature a lower competitive environment. This trend primarily involves exiting the hard-STEM area. Conversely, male students are expected to show a greater tendency to remain in content-similar disciplines, often re-enrolling in a same-type STEM discipline.*

3.2 The role of peers in course switch

The peer group effect is potentially a powerful force with a pivotal effect on gender segregation in higher education, both in terms of attraction and track of male and female students in different fields of study. One key mechanism through which peers influence students' decisions to switch courses in higher education is social comparison, where students evaluate their academic abilities and preferences against those of their peers. This comparison can lead to a reevaluation of their chosen field if they perceive themselves as less capable or less satisfied than their peers (Zafar, 2013). Additionally, peer influence often occurs through the diffusion of information about academic experiences and future career prospects, which can alter students' perception of a discipline's value or alignment with their interests (Sacerdote, 2011). The dynamics of peer support networks, where students share advice and guidance, can either facilitate persistence in a challenging major or promote transitions to other fields perceived as more suitable or manageable (Bayer & Rouse, 2016; Tinto, 1997).

According to Anelli and Peri (2019), the gender composition of peers also plays a significant role, as students exposed to gendered norms may feel encouraged or discouraged to pursue certain majors, prompting course switching. For women pursuing STEM degrees during college and graduate school, the role of peers is extremely important in this respect. For instance, Anelli and Peri (2019) demonstrate that male students surrounded by predominantly male peers are more likely to persist in STEM majors, as their peer group reinforces the alignment of masculinity with technical fields. Conversely, female students may experience a different effect, where being in male-dominated environments may exacerbate feelings of isolation and discourage their continuation in STEM, especially when they lack a supportive network of female peers (Herzig, 2002; Margolis et al., 2000; Zeldin & Pajares, 2000). Moreover, an environment with gender-normative ideas pushes girls out of the STEM pipeline (van Der Vleuten et al., 2018). On the contrary, students tend to adjust their preferences to those of their friends, and female students tend to retain their STEM preferences when other females in their classroom do so (Raabe et al., 2019). In line with this, Margolis and colleagues (2000) argue that forming close, supportive bonds with other (male and female) computer science students may be vital for women's retention in the field. Again, peer support of STEM achievement was a factor emphasised by several women when interviewed about those factors that had facilitated their progress toward high-level STEM careers (Zeldin and Pajares, 2000). Nonetheless, a higher percentage of women in STEM courses is positively linked to the success of all students without

significant differences between males and females (Bowman et al., 2022; Griffith and Main, 2019). Consequently, understanding the role of peers in course switching in STEM disciplines is crucial for developing strategies to improve both students' outcomes and the broader efficiency of higher education systems.

Thus, it is the combination of course destination and gendered peer that seems to play a role in course switch. But if grading standards may be considered (at least) similar in different countries, other institutional and compositional aspects may differ across educational systems. For example, the gendered composition of a course may differ according to the percentage of women enrolled in STEM courses, and some courses with a quite balanced gender composition in a country like the U.S. could be gender unbalanced in Italy. Accordingly, when answering to our second research question (RQ#2), which looks at the impact of the gender composition of the course on students' course switch towards a stem or non-stem course, *we expect that when female representation in a programme is low, switches occur predominantly within the STEM domain, driven by potentially unwelcoming environments that push students to search for a "better-fit" STEM course rather than to leave the field. By contrast, as the share of female students increases, the probability of switching within STEM is expected to decline, and observed changes are more likely to be driven by genuine changes in interests and preferences. Moreover, we expect this relationship to be stronger in environments, such as some engineering majors or ICT majors (namely, into the Hard STEM disciplines; OECD, 2023). As for male students, we expect that their propensity to switch courses is not related to the gender composition of the courses.*

4. Data & methods

4.1 Data and sample selection criteria

In the present contribution, we used data coming from MOBYSU.it, an administrative database that was created[1] to record and monitor the careers of all university students enrolled in a degree programme at an Italian university since 2010. The database is provided by the Ministry of University, and Research (MUR), with the involvement of Italian universities. More specifically, it contains individual longitudinal data, with information about students' demographic characteristics (i.e., gender, area of residence, citizenship) and information on both high school careers (i.e., type of high school attended, final mark) and university careers (i.e., degree programme chosen, number of formative university credits achieved per year, type of degree, year in which they get the degree and final grades). In the following, we describe the criteria we considered to select the sample, its features, and the variables and models used in our analysis.

We focused on the cohorts of students enrolled from 2010–2011 through 2014–2015.[2] Moreover, considering the aim of our study, to obtain a set of students consistent with our research goals, we selected students who chose a STEM bachelor's degree or a single-cycle master's degree[3] at their

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[1] This database has been realised thanks to the Italian Ministerial grant PRIN 2017 "From high school to job placement: micro-data life course analysis of university student mobility and its impact on the Italian North-South divide" (PI: Massimo Attanasio).

[2] We excluded students attending online universities.

[3] The single-cycle master's degree is a type of academic degree programme in the Italian higher education system, typically lasting 5 or 6 years and equivalent to a combined bachelor's and master's degree, which has been created for forming professionals of specific careers. Among STEM courses of first enrolment, we include the single-cycle master's degree in Architecture.

first university enrolment and then switched their course within the fifth year after their academic enrolment. Regarding the definition of a STEM degree, according to the ISCED-F classification of fields of education, we kept only students enrolled in the following three categories: Natural sciences, mathematics, and statistics (ISCED-F code 5); Information and Communication Technologies (ISCED-F code 6); Engineering, manufacturing, and construction (ISCED-F code 7). Finally, we excluded those students switching from ISCED-F code 5 to 9 (Health and Welfare). These transitions are very likely planned pathways—for example, from biology and related fields into health-related programmes, especially medicine.

The final sample comprises 60,700 students[4] (37.7% females, 62.3% males), among which 33,586 (55.33%) students abandoned the STEM field for enrolling in a non-STEM course within five years from first enrolment.

4.2 Variables and modelling strategy

To answer our research questions, we classified STEM courses[5] into Soft and Hard categories based on the average percentage of female students enrolled: courses with up to 40% female representation, on average, at the national level were classified as Hard STEM, while those with a higher average percentage were classified as Soft STEM[6] (see Table 1 in the Appendix for the full list of courses and their classification). Among students who switched their course within the fifth year after their academic enrolment, 36.1% chose a Soft STEM discipline in their first academic year, with 58.3% of them being female, distributed across an average of 283 courses per year. Meanwhile, the remaining 63.9% of students in the sample enrolled in a Hard STEM course, with 26.1% of them being female, distributed across an average of 214 courses offered each year.

We built the outcome variable *Course switch* by observing the first student's major change within five years from first enrolment. Indeed, the highest number of switches is registered in the second academic year, or rather, they happened during the first academic year. We distinguished between students who have changed the initial STEM course towards a non-STEM course (*Switch to non-STEM*), those who have changed the initial STEM course towards a Soft STEM course (*Switch to Soft STEM*), and those who have changed the initial STEM course towards a Hard STEM course (*Switch to Hard STEM*). Among our key explanatory variables, we had only one individual-level variable, the student's gender, and two course-level variables: the type of course of origin (Soft vs. Hard STEM) in which the student was enrolled, and the percentage of female students out of all students enrolled in that course per cohort.

For the analysis, we run two-level multinomial logistic models, with students nested within the course-by-cohort units in which they first enrolled. In total, we had 2,483 courses as second-level units. These models allowed us to investigate the role of individual- and course-level characteristics in predicting students' academic outcomes, with three possible outcomes: *Switch to non-STEM,*

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[4] Students with a missing value on the high school final mark, the type of high school attended and the area of residence were excluded from the final sample because their numerosity was less than 3% of the overall sample.

[5] In this article, we refer to a course as the Italian "classe di laurea." In the Italian higher education system, these are nationally defined categories that group university degree programmes according to educational objectives, learning outcomes and core curricular requirements, thus ensuring comparability across institutions. In most universities, there is just one course for each classe di laurea, whereas only a minority of them have more than one course for each classe di laurea.

[6] The average was calculated on the sample of students who switched course after initially enrolled in a STEM discipline.

Switch to Soft STEM, Switch to Hard STEM. In the first model specifically designed for answering RQ#1 (Model 1), we focused on how the type of course of origin interacts with the student's gender in shaping the probability of switching to a non-STEM, a Soft STEM, or a Hard STEM course. For answering RQ#2, we extended the model by incorporating the percentage of female students in the course-cohort of first enrolment and its interaction with gender (Model 2). By running Model 2, we aim to examine if the level of female representation in the course impacts students' major switch and whether this association changes according to the student's gender. Since Soft and Hard STEM categories were constructed based on the average share of female students, we stratified Model 2 by the type of course (Model 2a for Soft STEM and Model 2b for Hard STEM). When applying Model 2, we restricted the analysis to observations within approximately the central 98% of the distributions of the percentage of female students, to minimise the influence of outliers and to reduce potential distortion in the association between female representation and the outcome. This resulted in a sample of 21,559 students enrolled in Soft STEM courses, with female representation ranging from 25% to 85%,[7] and 38,171 students enrolled in Hard STEM courses, with female representation ranging from 5% to 50%.[8] As robustness checks, we replicated the analysis restricting the sample to the central 90% of the distribution (see Appendix Fig. 6 and Fig. 7)[9] and by categorising the percentage of female students into terciles (results available upon request); the pattern of associations remained virtually unchanged.

For Model 1, we presented the predicted probabilities of switching to non-STEM, Soft STEM, and Hard STEM disciplines (see Fig. 1 and Fig. 2), whereas for Model 2, we focused on the predicted probabilities of switching to Soft STEM and Hard STEM disciplines (see Fig. 3 and Fig. 4). The confidence intervals were computed via bootstrapping using 100 resampled datasets composed of course-by-cohort clusters, which were drawn with replacement so that each bootstrap sample contains the same number of clusters as the original dataset, though some may appear multiple times. Specifically, the average size of the bootstrapped sample was 60,608 for Model 1 (vs. 60,700 observations in the original data), and 21,483 (vs. 21,559) and 37,928 (vs. 38,171) for Model 2 applied on the sample of students initially enrolled in Soft STEM and Hard STEM disciplines, respectively.

Individual-level covariates included in both Model 1 and Model 2 were the cohort of enrolment, the citizenship (Italian or foreign), and a dummy variable indicating if the student was resident in a macro-area (NUTS 1 level: North-West, North-East, Centre, South, Islands) other than that in which the university is located, because international students and non-local students could have diverse academic outcomes and trajectories (Rienties, 2012; Smith, 2020; D'Agostino et al., 2022; Genova & Boscaino, 2025). Moreover, previous knowledge and competencies are important elements in profitable academic careers. Thus, we also controlled for the type of high school (scientific high school, classical high school, foreign language high school, technical institute, vocational institute, and other institutes), the high school final mark (in five categories: 60-69; 70-79; 80-89; 90-99; 100 and 100 with honours). Regarding variables at the course-by-cohort level, we included the macro area where the university is located (NUTS 1 level) and the average number of credits granted in the first year in that course per cohort, in order to obtain a summary measure of course quality. The number

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[7] The range of female representation in the baseline sample of students initially enrolled in Soft STEM who then switched course is between 0% and 100%. From this sample, we dropped 353 students and 66 course-by-cohort observations.
[8] The range of female representation in the baseline sample of students initially enrolled in Hard STEM who then switched course is between 0% and 72%. From this sample, we dropped 617 students and 56 course-by-cohort observations.
[9] In this case, the sample comprised 20,053 students enrolled in Soft STEM courses, with female representation ranging from 35% to 80%, and 35,439 students enrolled in Hard STEM courses, with female representation ranging from 10% to 40%.

of students per cohort included in the analysis, with some descriptive statistics, is shown in Table 2 of the Appendix.

5. Results

To address RQ#1, predicted probabilities of switching into Soft STEM, Hard STEM, and non-STEM disciplines, disaggregated by gender, for students initially enrolled in Soft and Hard STEM fields are presented in Fig. 1 and Fig. 2, respectively (Model 1, see Table 3 in the Appendix for the full model). Overall, the probability of switching to non-STEM disciplines is higher than that of switching to STEM disciplines, with the likelihood of same-type STEM changes (i.e., from Soft STEM to Soft STEM, and from Hard STEM to Hard STEM) higher than that of cross-type STEM changes (i.e., from Hard STEM to Soft STEM and vice versa). These differences are statistically significant for both male and female students. Focusing on students initially enrolled in Soft STEM disciplines, females show a higher likelihood of switching to a non-STEM or a Soft STEM discipline within five years compared to males – 69.5% vs. 62.6% in the former case, and 23.1% vs. 21.1% in the latter. In contrast, the gender gap is in favour of males and widens further when the switch is to a Hard STEM discipline: 16.3% of males are likely to make this transition versus only 7.4% of females (with a gender gap of 8.9 pp). The gender gaps are similar when moving from a Hard STEM course: the propensity is higher for females that switch to a non-STEM or a Soft STEM course (65.5% vs. 62.7% and 18.9% vs. 15.3%, respectively), whereas male students are more likely to switch within Hard STEM disciplines (22.1% for males vs. 15.6% for females – a gender gap of 6.5 percentage points, namely pp). These gender confidence intervals do not overlap across all transitions except for switches within Soft STEM and from Hard STEM to non-STEM courses.

Fig. 1 *Predicted probabilities of students first enrolled in a **Soft STEM** course at an Italian university switching to a non-STEM, a Soft STEM, or a Hard STEM course within five years from their first enrolment by gender. Academic cohorts enrolled between 2010 and 2014 (Model 1).*
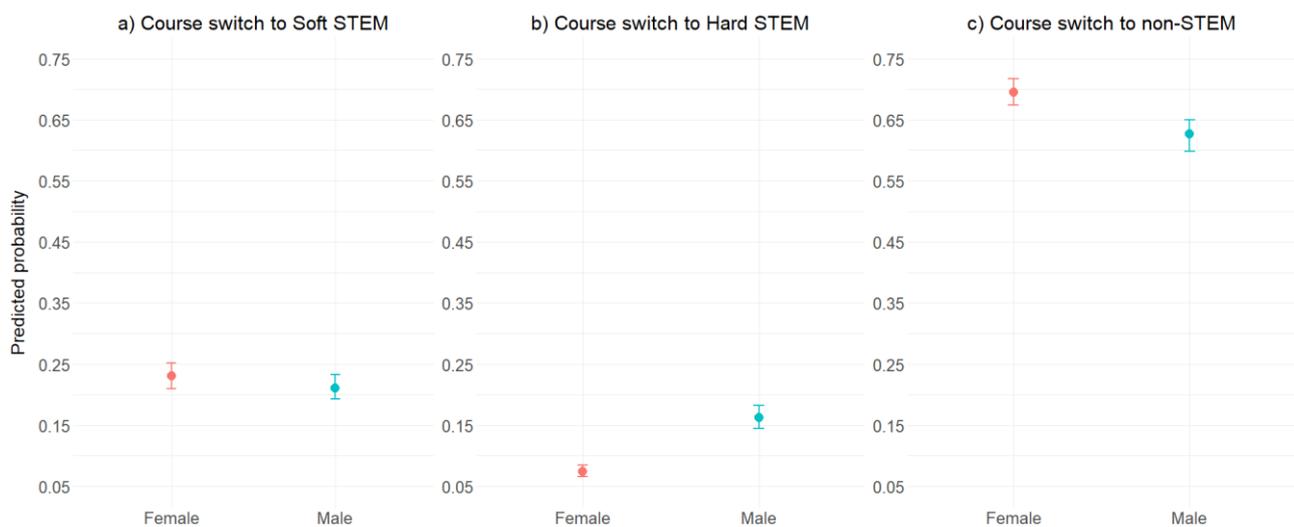
Note: The model controls for gender, cohort of enrolment, citizenship, non-resident student, type of high school, high school final mark, university macro area and average number of credits granted per course-by-cohort.

Fig. 2 *Predicted probabilities of students first enrolled in a **<u>Hard STEM</u>** course at an Italian university switching to a non-STEM, a Soft STEM or a Hard STEM course within five years from their first enrolment by gender. Academic cohorts enrolled between 2010 and 2014 (Model 1).*
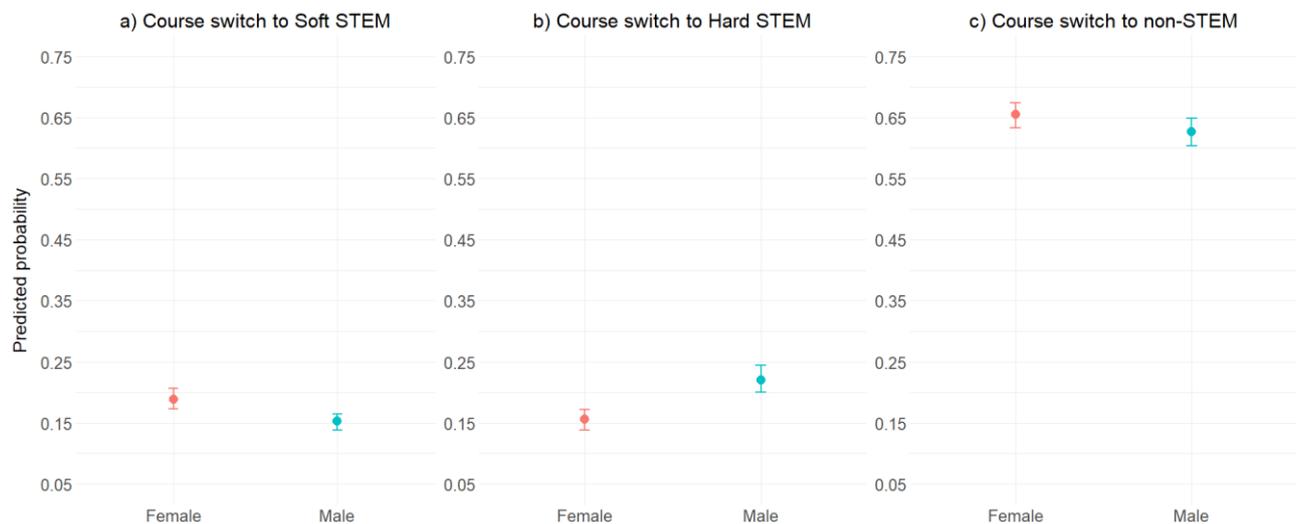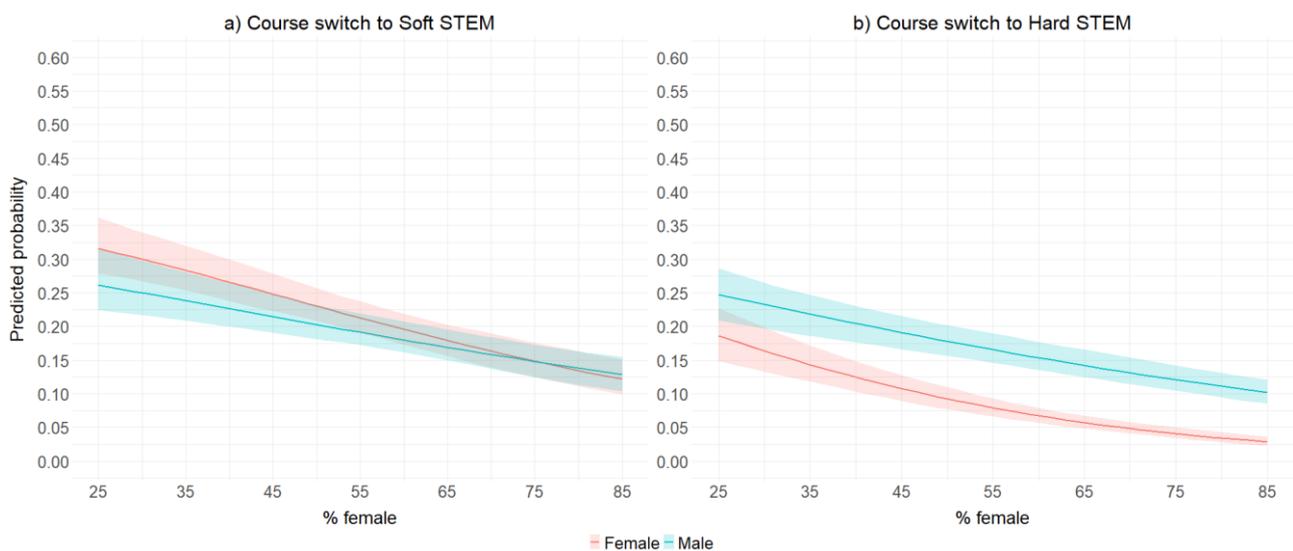

Note: The model controls for gender, cohort of enrolment, citizenship, non-resident student, type of high school, high school final mark, university macro area, and average number of credits granted per course-by-cohort.

We then augmented the model by adding the percentage of female students in the course of origin and its interaction with the student's gender, in order to answer the second research question (Model 2a and 2b, see Table 4 in the Appendix for the full models). To limit the impact of outliers and reduce potential distortion, this part of the analysis was restricted to observations within the central 98% of the distribution of the percentage of female students within Hard and Soft STEM fields. Fig. 3 and Fig. 4 report the predicted probabilities of switching for students enrolled in a Soft and a Hard STEM, respectively. Regarding students who initially chose a Soft STEM discipline, their probability of switching to a STEM course decreases as the percentage of female students increases. This trend holds for switches to both Soft and Hard STEM fields and both genders, but is more pronounced among females. Indeed, the probability of switching to another Soft STEM course declines as the proportion of female students increases—from male-dominated Soft STEM courses (with the minimum of 25% female students) to female-dominated ones (with the maximum of 85% females)— by 13.3 p.p. for males and by 19.4 p.p. for females. Similarly, the likelihood of switching decreases when students transition from Soft to Hard STEM disciplines as the share of female students enrolled increases, and the reduction amounts to 14.5 p.p. for males and 15.7 p.p. for females. Although the likelihood of switching from Soft to Hard STEM differs significantly by gender at varying levels of female representation within the course of origin, no significant gender differences emerged in transitions between Soft STEM disciplines (in accordance with Model 1).

For students initially enrolled in a Hard STEM course, as the proportion of female students in the course increases, an opposite pattern emerges in the likelihood of switching to same-type or cross-type STEM disciplines. Specifically, the propensity to switch from a Hard STEM to another Hard STEM course decreases, while the likelihood of switching to a Soft STEM course increases. As for switches from Soft STEM disciplines, the likelihood to switch between Hard STEM courses decreases by 6.8 p.p. for males and 16.5 p.p. for females when moving from courses with 5% female students to those with 50%. In contrast, the likelihood of switching from a Hard to a Soft STEM

course increases by 22.5 p.p. for males and 37.5 p.p. for females as the share of female students increases. Gender patterns are similar, with confidence intervals partially overlapping for highly male-dominated courses. As the percentage of female students increases, the (non-overlapping) confidence intervals point to patterns consistent with a higher likelihood that female students switch from a Hard to a Soft STEM discipline, and a lower likelihood that female students switch to a Hard STEM discipline regardless of the STEM discipline of first enrolment.

Fig. 3 *Predicted probabilities of students first enrolled in a **<u>Soft STEM</u>** course at an Italian university switching to a Soft STEM or a Hard STEM course within five years from their first enrolment, by gender and percentage of female students in the course of first enrolment. Academic cohorts enrolled between 2010 and 2014. Model 2a – Estimates on observations within the central 98% of the distributions of the percentage of female students*

Note: The model controls for gender, cohort of enrolment, citizenship, non-resident student, type of high school, high school final mark, university macro area and average number of credits granted per course-by-cohort.

Fig. 4 *Predicted probabilities of students first enrolled in a __Hard STEM__ course at an Italian university switching to a Soft STEM or a Hard STEM course within five years from their first enrolment, by gender and percentage of female students in the course of first enrolment. Academic cohorts enrolled between 2010 and 2014. Model 2b – Estimates on observations within the central 98% of the distributions of the percentage of female students*

Note: The model controls for gender, cohort of enrolment, citizenship, non-resident student, type of high school, high school final mark, university macro area and average number of credits granted per course-by-cohort.

6. Conclusions and discussion

In this paper, we examined how gender, the type of STEM course of origin, and the female representation of the course environment interact in shaping students' switching patterns, among university students who decided to enrol in a STEM course for the first time in Italy. The attention dedicated to STEM disciplines, especially in recent years, depends on the importance of these subjects for guaranteeing the technological advancement of industrialised countries. Moreover, the importance of encouraging women's participation in STEM disciplines is paramount, broadly speaking, for guaranteeing gender equality. For example, the disaffection of women towards STEM fields does not contribute to closing gender pay gaps, whilst worsening it. This issue is particularly relevant not only in countries like Italy, where gender equality remains low (with a score of 69.2), but also in nations where gender equality is high (for example in Sweden, with a score of 82.0; see European Institute for Gender Equality, 2024), yet the gender pay gap remains large (with a gender pay gap of 11.49 in Italy and 9.46 in Sweden in 2022; see European Institute for Gender Equality, 2025).

Despite several attempts to enhance affection towards STEM disciplines, the issue of attracting and retaining students remains at the forefront in many high-income countries. Among the various factors that may influence this outcome, we considered whether the presence of female students in the chosen degree programme might have played a role in the decision to continue or abandon studies in that programme. We also acknowledge that the proportion of female students within a course may have different implications depending on the student's own gender and on the perceived selectivity and competitiveness of the discipline. To account for such heterogeneity within the STEM domain,

we therefore classified STEM fields into Soft and Hard disciplines, recognising that not all STEM areas are alike.

According to our results, and in line with our expectations, female students are more likely to exit the Hard STEM area, with a negligible propensity of enrolling there if coming from a Soft STEM and a probability of 16% to choose another Hard STEM course. Conversely, male students exhibit a stronger tendency to remain in the Hard STEM, with those originating from Soft STEM still displaying a non-negligible probability—around 16%—of transitioning into Hard STEM, while approximately 22% of those already enrolled in Hard STEM remain within that category. Overall, the propensity to abandon STEM programmes is very high, especially among students enrolled in Soft STEM fields. Among those who remain within a STEM discipline even after the course switch, students mainly attempt to switch to programmes with similar content or that do not deviate substantially from their initial field of enrolment, as shown by the likelihood of same-type STEM changes, which are higher than that of cross-type STEM changes.

Overall, switches are more likely to occur within STEM courses when female students are under-represented in the first-enrolment course compared to more male-dominated contexts; thus, they do not seem to be driven by a lack of interest in the STEM field per se. Conversely, they may reflect attempts to leave competitive and hostile environments, which are often associated with a low female presence in academia. By contrast, a higher proportion of female students appears to reduce the likelihood of switching to other STEM disciplines: in these contexts, programme changes are more often towards non-STEM fields, and this likely reflects a shift in interests and inclinations. While this pattern holds for most of the transitions and is especially pronounced, as expected, for changes within Hard STEM courses, an opposite pattern emerges when the course of origin is a Hard STEM, and the destination is a Soft STEM discipline. This finding goes against our expectations and calls for further investigation beyond the associations identified here. Nevertheless, some hypotheses can be advanced. It is well known that women who initially choose a Hard STEM degree tend to be a highly selected group, given the overall lower female participation in these fields. Among them, those who enrol in the most male-dominated courses are likely to be even more selected and particularly determined to pursue that type of degree. Therefore, it is plausible to assume that female students who initially enrol in Hard STEM courses and later decide to switch are more likely to move to another Hard STEM field—closer to their initial choice—rather than to a Soft STEM one. This is consistent with our findings, which show that among female students in the most male-dominated courses, the probability of switching to a Hard STEM field is about 25%, compared to only 10% for switching to a Soft STEM field. As the share of female students in a course increases, however, it is plausible that the female component becomes less self-selected and, consequently, less inclined to remain in the STEM domain (particularly in Hard STEM) when faced with various academic challenges. Hence, as female representation grows within a course, the propensity to leave the Hard STEM domain may also increase—an interpretation that aligns with our results.

Contrary to our expectations and previous literature, the patterns are similar for male and female students. In particular, the findings for male students do not align with our initial expectation that their switching propensity would not be related to the gender composition of the course. The fact that the identified associations hold for both male and female students, and only slightly less pronounced for the former, suggests that the mechanisms at play are not exclusively gender-specific. Low female representation may signal (or contribute to) competitive settings that shape the switching behaviour of all students, regardless of gender, making moves to other STEM disciplines more likely without

implying a desire to abandon the STEM field altogether. Conversely, when female representation is higher, the environment may be perceived as more inclusive and academically diverse, and switches (which in this case are more likely towards non-STEM courses) may reflect genuine shifts in interest or academic fit for both male and female students rather than reactions to adverse conditions.

To sum up, the gender composition of cohorts appears to shape the climate of STEM programmes, with low female representation potentially associated with more competitive and less welcoming environments that influence the switching behaviour of all students, who nevertheless *choose* to remain within the STEM field. The possible mechanisms at play could be based on the democratisation of female-dominated courses and the lower degree of competition. Thus, this result seems to suggest that universities aiming to enhance the retention of women in STEM disciplines could consider factors other than the mere content of courses or the preparedness of female students in science.

Several policy indications may derive from our results. For example, creating some unified academic tracks that could group several STEM courses could help rebalance gender disparities in underrepresented courses, increase female enrolment, and improve overall student retention rates. Furthermore, the establishment of interdisciplinary courses that introduce women to STEM disciplines—particularly those with lower female participation and higher competitiveness—could facilitate a smoother transition from other scientific fields, such as biology. This approach may help mitigate the high level of selection currently present in programmes like ICT courses. As a consequence (but not necessarily), facilitating smoother transitions between programmes may further enhance retention and completion rates, especially among STEM disciplines. Finally, support pathways for students facing academic difficulties should be implemented, including pre-transfer tutoring programmes that facilitate successful course transitions. Effective strategies could be identified by analysing fruitful transitions, such as from biology to medicine, mathematics to statistics, or computer engineering to computer science. Additionally, gender-specific support measures could help reduce dropout rates among underrepresented groups, particularly women leaving STEM programmes with low female enrolment.

Concerted efforts aimed at promoting inclusivity, dismantling stereotypes, and enhancing accessibility to STEM education are imperative for fostering a diverse and dynamic STEM workforce capable of addressing complex global challenges. Addressing societal perceptions and enhancing educational pathways in STEM fields are essential endeavours for cultivating a skilled workforce equipped to navigate the demands of the contemporary labour market and drive innovation in an increasingly technology-driven world.

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Fig. 5 *Graduates in a STEM programme aged 20-29 per 1,000 inhabitants of the same age class from 2013 to 2022 in some selected European countries*
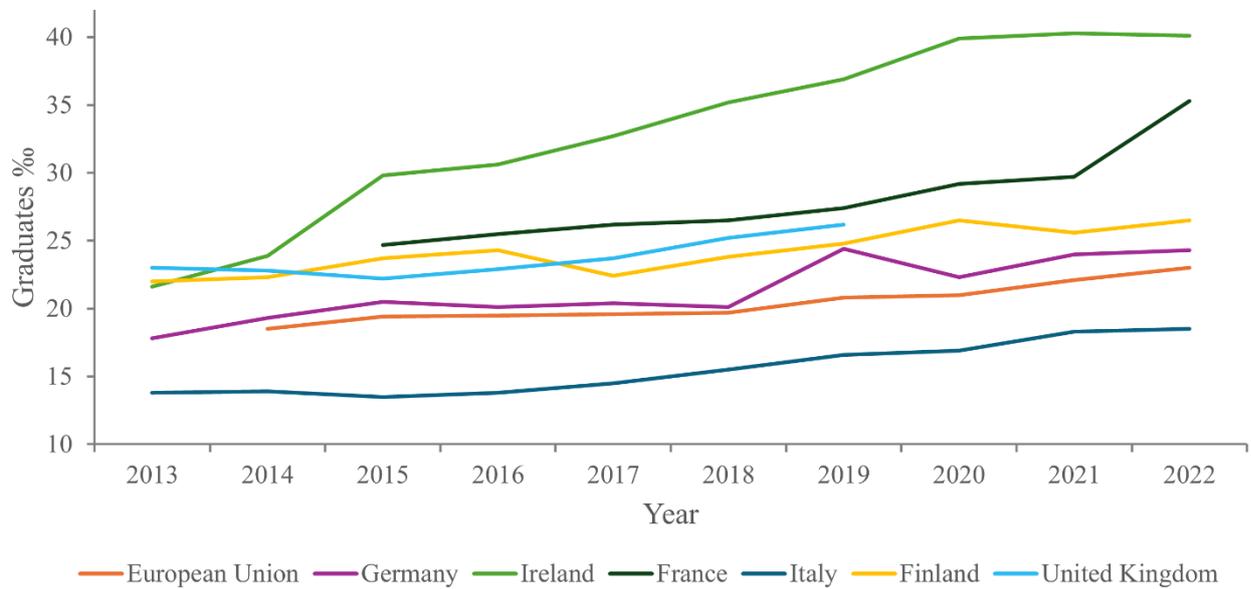
Source: Eurostat.

Table 1 *STEM courses classification in Soft and Hard STEM. Percentage of female students within each course-by-cohort. Summary statistics based on the sample of students who switched course after first enrolment*

Classification	Course	% female students	
		Mean	**SD**
All STEM	All courses	36.61	19.92
Soft STEM			
	Pharmaceutical Sciences	76.50	7.69
	Conservation of Cultural Heritage	73.95	10.99
	Biology	71.33	5.98
	Biotechnology	65.00	7.37
	Environmental and Natural Sciences	58.04	9.88
	Architecture and Construction Engineering	53.60	8.20
	Architectural Sciences	53.53	6.56
	Mathematics	53.23	12.10
	Chemistry	50.24	10.51
	Territorial Planning Sciences	46.95	10.62
	Statistics	41.35	9.48
	Building Science and Technology	40.10	9.06
Hard STEM			
	Geology	39.28	10.61
	Physics	33.09	10.38
	Civil and Environmental Engineering	32.19	6.35
	Navigation Sciences	27.51	11.53
	Information Engineering	22.40	8.41
	Industrial Engineering	21.93	5.93
	Informatics	13.88	5.74

Fig. 6 *Predicted probabilities of students first enrolled in a **<u>Soft STEM</u>** course at an Italian university switching to a Soft STEM or a Hard STEM course within five years from their first enrolment, by gender and percentage of female students in the course of first enrolment. Academic cohorts enrolled between 2010 and 2014. Model 2a – Estimates on observations within the central 90% of the distributions of the percentage of female students*

Fig. 7 *Predicted probabilities of students first enrolled in a **<u>Hard STEM</u>** course at an Italian university switching to a Soft STEM or a Hard STEM course within five years from their first enrolment, by gender and percentage of female students in the course of first enrolment. Academic cohorts enrolled between 2010 and 2014. Model 2b – Estimates on observations within the central 90% of the distributions of the percentage of female students*
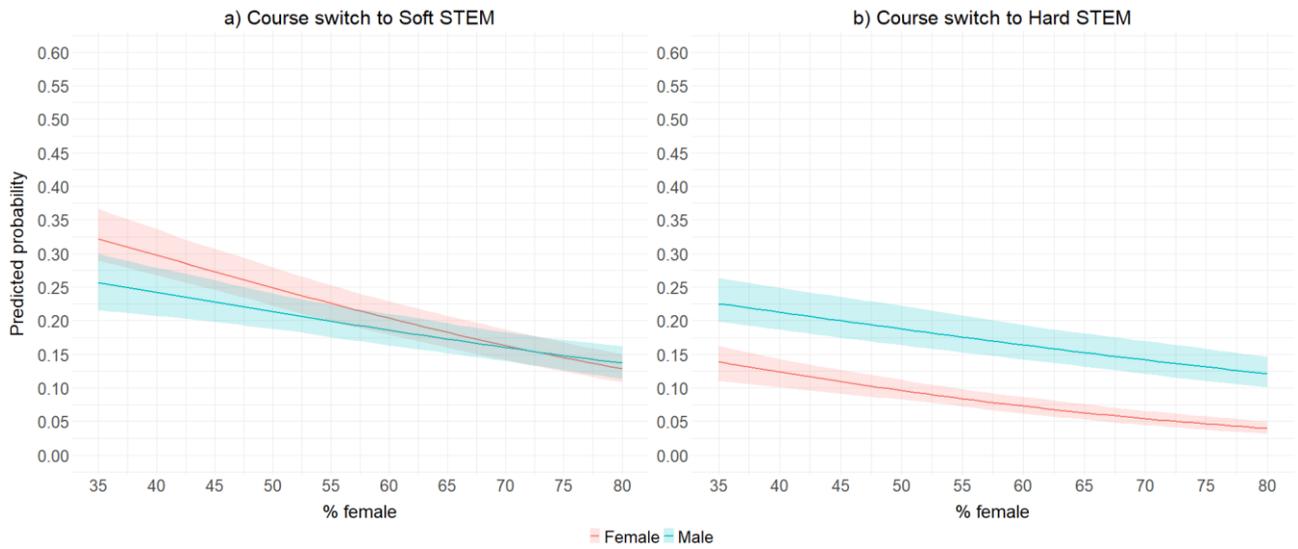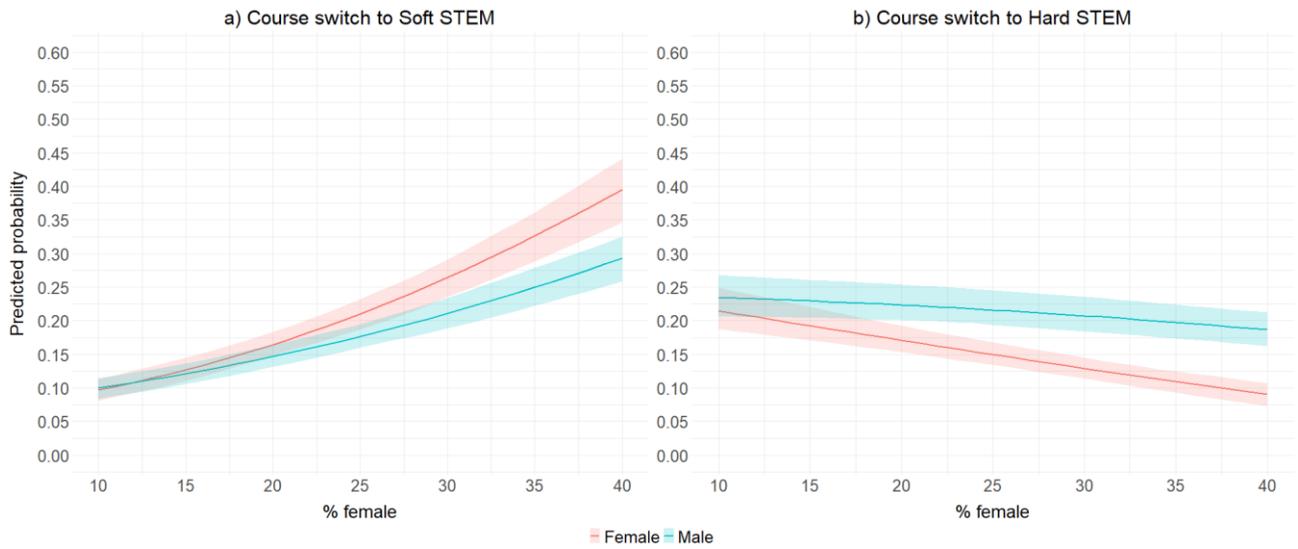
Table 2 *Descriptive statistics of the sample*

Variables	Cohort 2010	Cohort 2011	Cohort 2012	Cohort 2013	Cohort 2014
Number of students	13,196 *(21.74%)*	12,881 *(21.22%)*	12,261 *(20.20%)*	11,051 *(18.21%)*	11,311 *(18.63%)*
Individual level					
Course switch					
Switch to Soft STEM	18.7%	18.7%	17.1%	16.7%	16.3%
Switch to Hard STEM	23.2%	25.1%	27.1%	30.3%	31.0%
Switch to non-STEM	58.1%	56.2%	55.9%	53.0%	52.7%
Gender					
Female	39.4%	38.3%	38.0%	36.1%	36.3%
Male	60.6%	61.7%	62.0%	63.9%	63.7%
Citizenship					
Italian	97.8%	97.8%	97.5%	97.3%	97.4%
Foreign	2.2%	2.3%	2.5%	2.8%	2.6%
Non-resident student					
No	86.8%	86.1%	85.6%	85.2%	84.5%
Yes	13.2%	13.9%	14.5%	14.8%	15.5%
Type of High school					
Scientific	55.7%	56.7%	58.5%	56.2%	57.4%
Classical	13.1%	12.8%	12.8%	11.7%	11.7%
Foreign Lang.	2.7%	2.9%	2.5%	2.6%	2.5%
Technical Inst.	14.4%	13.8%	14.2%	15.7%	15.2%
Vocational Inst.	7.5%	7.5%	6.3%	7.8%	7.3%
Other Inst.	6.6%	6.4%	5.8%	6.1%	6.0%
High school final mark					
60-69	25.7%	25.3%	24.5%	23.4%	23.3%
70-79	32.2%	31.9%	32.3%	31.3%	31.1%
80-89	23.9%	24.4%	25.6%	26.5%	26.5%
90-99	10.8%	10.8%	11.3%	12.2%	11.9%
100 or more	7.3%	7.6%	6.3%	6.6%	7.2%
Course-by-cohort level					
Course type – 1st enrol.					
Soft STEM	42.2%	37.1%	34.9%	32.6%	32.5%
Hard STEM	57.8%	62.9%	65.1%	67.4%	67.5%
University macro area					
North-East	16.3%	16.2%	15.8%	15.2%	15.0%
North-West	27.0%	27.4%	27.4%	30.4%	32.5%
Centre	24.3%	26.3%	26.1%	24.4%	25.0%
South	23.4%	22.2%	22.0%	21.6%	19.4%

Island	9.1%	7.9%	8.8%	8.5%	8.1%
# credits (avg)					
0-30	23.8%	20.5%	19.4%	15.3%	12.8%
30-50	73.5%	76.3%	78.5%	81.3%	83.0%
50+	2.7%	3.2%	2.1%	3.4%	4.2%

Table 3 *Estimates from multinomial logistic regression on students first enrolled in a STEM course at an Italian university who switched the course of study within the fifth year after their academic enrolment. Academic cohorts enrolled between 2010 and 2014 (Model 1)*

Variable	Coefficients	
	Switch to Soft STEM vs. Switch to non-STEM	*Switch to Hard STEM vs. Switch to non-STEM*
Individual level		
Male	-0.184***	0.392***
(ref: Female)	(0.033)	(0.030)
Foreign	-0.130	0.179**
(ref: Italian)	(0.077)	(0.066)
Non-resident student	0.106**	0.134***
(ref: Resident student)	(0.034)	(0.031)
Type of High School (ref: Scientific)		
Classical	-0.290***	-0.491***
	(0.035)	(0.038)
Foreign Lang.	-0.524***	-0.794***
	(0.072)	(0.087)
Technical Inst.	-0.220***	0.083**
	(0.036)	(0.029)
Vocational Inst.	0.354***	0.053
	(0.042)	(0.042)
Other Inst.	-0.186***	-0.777***
	(0.046)	(0.060)
High school final mark (ref: 60-69)		
70-79	0.157***	0.153***
	(0.03)	(0.029)
80-89	0.212***	0.303***
	(0.032)	(0.030)
90-99	0.260***	0.508***
	(0.041)	(0.038)
100 or more	0.255***	0.675***
	(0.050)	(0.044)
Course-by-cohort level		
Soft STEM – 1ˢᵗ enrol	0.139**	-0.834***
(ref: Hard STEM)	(0.054)	(0.056)
Soft STEM – 1ˢᵗ enrol × Male	0.201***	0.527***
	(0.048)	(0.052)
Cohort (ref: 2010)		
2011	0.003	0.067

	(0.070)	(0.067)
2012	-0.027	0.078
	(0.071)	(0.067)
2013	0.030	0.152*
	(0.072)	(0.068)
2014	-0.019	0.153*
	(0.072)	(0.068)
University macro area (ref: North-East)		
North-West	0.039	0.324***
	(0.071)	(0.068)
Centre	-0.087	-0.087
	(0.069)	(0.067)
South	-0.083	0.028
	(0.072)	(0.069)
Island	-0.030	0.030
	(0.088)	(0.084)
# credits (avg)		
30-50	0.063	-0.083
	(0.063)	(0.058)
50+	0.382**	-0.181
	(0.122)	(0.127)
(Intercept)	-1.288***	-1.334***
	(0.096)	(0.091)
Individuals	60,700	
Groups by course	2,483	

Note: Robust standard errors are in parentheses.

*p<.05; **p<.01; ***p<.001

Table 4 *Estimates from multinomial logistic regression on students first enrolled in a STEM course at an Italian university who switched the course of study within the fifth year after their academic enrolment. Academic cohorts enrolled between 2010 and 2014 (Model 2a and 2b)*

Variable	Soft STEM – 1st enrol Coefficients		Hard STEM – 1st enrol Coefficients	
	Switch to Soft STEM vs. Switch to non-STEM	*Switch to Hard STEM vs. Switch to non-STEM*	*Switch to Soft STEM vs. Switch to non-STEM*	*Switch to Hard STEM vs. Switch to non-STEM*
Individual level				
Male	**-0.361***	**-0.196**	**0.210**	**-0.033**
(ref: Female)	**(0.162)**	**(0.194)**	**(0.112)**	**(0.095)**
Foreign	0.050	0.438**	-0.279**	0.066
(ref: Italian)	(0.120)	(0.135)	(0.105)	(0.076)
Non-resident student	0.177***	0.195**	0.043	0.118***
(ref: Resident student)	(0.053)	(0.066)	(0.046)	(0.036)
Type of High School (ref: Scientific)				
Classical	-0.345***	-0.887	-0.238***	-0.341***
	(0.049)	(0.073)	(0.053)	(0.045)
Foreign Lang.	-0.385***	-1.167***	-0.849***	-0.685***
	(0.091)	(0.163)	(0.137)	(0.106)
Technical Inst.	-0.246***	-0.286***	-0.222***	0.147***
	(0.063)	(0.071)	(0.047)	(0.032)
Vocational Inst.	0.201**	-0.071	0.493***	0.075
	(0.065)	(0.077)	(0.056)	(0.051)
Other Inst.	-0.336***	-1.023***	0.050	-0.614***
	(0.059)	(0.094)	(0.078)	(0.083)
High school final mark (ref: 60-69)				
70-79	0.159***	0.052	0.153***	0.185***
	(0.046)	(0.057)	(0.042)	(0.034)
80-89	0.273***	0.282***	0.162***	0.307***
	(0.05)	(0.062)	(0.044)	(0.035)
90-99	0.270***	0.493***	0.258***	0.523***
	(0.064)	(0.079)	(0.055)	(0.044)
100 or more	0.309***	0.771***	0.241***	0.667***
	(0.081)	(0.094)	(0.066)	(0.05)
Course-by-cohort level				
% female students	**-2.513***	**-4.208***	**4.756***	**-1.974***
	(0.283)	**(0.321)**	**(0.395)**	**(0.406)**
% female students × Male	**0.616***	**1.856***	**-1.318***	**1.835***
	(0.276)	**(0.337)**	**(0.392)**	**(0.370)**
Cohort				

(ref: 2010)				
2011	0.053	0.170	-0.076	-0.037
	(0.099)	(0.095)	(0.082)	(0.085)
2012	-0.012	0.088	-0.018	0.050
	(0.101)	(0.097)	(0.082)	(0.085)
2013	0.067	0.093	-0.035	0.165
	(0.102)	(0.099)	(0.084)	(0.086)
2014	0.036	0.169	-0.091	0.119
	(0.102)	(0.098)	(0.084)	(0.086)
University macro area (ref: North-East)				
North-West	0.115	0.377***	-0.108***	0.324***
	(0.100)	(0.099)	(0.083)	(0.085)
Centre	0.079	0.163	-0.281***	-0.101
	(0.100)	(0.100)	(0.082)	(0.085)
South	0.248*	0.394***	-0.408***	0.054
	(0.107)	(0.106)	(0.086)	(0.087)
Island	0.034	0.333**	-0.142	0.061
	(0.126)	(0.125)	(0.105)	(0.107)
# credits (avg)				
30-50	-0.064	-0.113	0.014	-0.011
	(0.098)	(0.093)	(0.070)	(0.070)
50+	0.280	-0.221	-0.008	-0.404
	(0.153)	(0.154)	(0.251)	(0.251)
(Intercept)	0.267	-0.196	-2.321***	-0.904***
	(0.203)	(0.194)	(0.147)	(0.139)
Individuals	21,559		38,171	
Groups by course	1,349		1,012	

Note: Robust standard errors are in parentheses.

*p<.05; **p<.01; ***p<.001