DOUBLE BARRIERS: GENDER AND MIGRATION BACKGORUND IN STEM STUDIES ACCESS

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Abstract. Gender segregation in STEM higher education is creating a gender gap, meaning that in some disciplines female representation does not even reach 30% of the total. In Italy, according to the latest data released by the Ministry of University and Research (MUR), women represent nearly 56% of all university enrolments in the 2024/2025 academic year, but less than 38% in STEM fields. Furthermore, national and international literature highlights significant challenges for foreign students in the transition to university studies (Buonomo *et al.*, 2024). It is hypothesized that in Italy, both gender and citizenship may play an important role in the choice of a STEM path, and that foreign girls could be doubly disadvantaged. This study, based on a longitudinal dataset derived from record linkage of ISTAT survey data on second-generation students (2015) and University Student Registry administrative data (from the 2015-2016 to the 2022-2023 academic years), aims to provide an initial contribution to identifying potential individual and family factors underlying the choices of second-generation students.
Using logistic regression models, the STEM choices of second-generation girls are analysed by taking into account potential interaction effects related to personal characteristics, educational background, and family status.

1. General framework and research hypothesis

Despite notable progress, students with an immigrant background continue to face significant disparities in opportunities to achieve their full academic potential (Alarcón, Parella, & Yiu, 2014). Often part of socioeconomically disadvantaged communities, these students' aspirations and achievements are strongly influenced by family background and social networks (Alba & Holdaway, 2013), frequently resulting in lower academic and professional outcomes compared to native-born peers.

Research on the educational aspirations (Conti & Prati, 2020) and achievements of immigrant students in Italy (Buonomo *et al*., 2023; Buonomo *et al*., 2024) indicates that foreign students not only show a lower inclination to pursue higher education but also encounter greater challenges than Italians in realizing their goals.

Multiple factors—including personal, familial, and relational characteristics—shape both aspirations and outcomes (Buonomo *et al.,* 2025).

International literature has highlighted the importance of ethnic and socioeconomic factors in educational trajectories, particularly in STEM fields (Science, Technology, Engineering, and Mathematics). For instance, Canadian research shows that students' decisions to pursue STEM are strongly affected by high school preparation in mathematics and science, parental education, and family income, with additional variations by gender and ethnicity (Finnie & Child, 2018). Similarly, socioeconomic and occupational backgrounds of parents significantly influence STEM achievement, with gender and ethnic origin further affecting outcomes (Gutfleish & Kogan, 2022).

In Italy, according to the Ministry of University and Research (MUR), 26.5% of university students were enrolled in STEM disciplines in 2022-2023, a proportion higher among international students (40.5%). Gender disparities are substantial: 38.3% of males versus 17.4% of females in STEM. Among foreign students who graduated from Italian high schools, 26.3% enrol in STEM, with an even wider gender gap: 45.1% of males versus 15.6% of females.

There remains a lack of detailed analysis on the personal and family factors influencing second-generation students' educational choices. This study uses an original dataset derived from record linkage of ISTAT survey data on second-generation students (2015) and MUR administrative data (2015-2016 to 2022-2023) to address this gap.

Second-generation students face multiple selection processes in transitioning to higher education. Not all remain in Italy, and many—more than Italian peers—opt not to enrol in university. Data also suggest that foreign students tend to make certain educational choices more frequently. This study traces the pathways toward university for foreign students in upper secondary schools, focusing on factors (territorial, school-related), behaviors (relational, participatory, cultural), and characteristics (personal, familial, migratory) associated with the choice of scientific-disciplinary groups, particularly STEM.

We hypothesize that gender and citizenship play a critical role in the selection of STEM pathways in Italy, potentially placing foreign girls at a double disadvantage. Previous research indicates that gender differences in education may be shaped by the migration experience (Ravecca, 2010).

2. Data and methods

The "Integration of the Second Generation" (ISG) survey, conducted by Istat in 2015 with funding from Italy's Ministry of Interior and the European Union's Fund

for the Integration of Third-Country Nationals, examined the integration of second-generation immigrants. The survey focused on students in secondary schools with at least five foreign students and included those with an immigrant background, particularly students with non-Italian citizenship, including those born in Italy to foreign parents. To provide a comprehensive understanding of integration, the survey also included Italian-citizen students as a control group (Conti & Quattrociocchi, 2017; Conti & Prati, 2021).

The sample follows a two-stage selection process. The first-stage units are schools with at least five foreign students, and the second-stage units are individual students. The selection list was based on the archive of the Ministry of Education, University, and Research. A total of 1,448 schools were selected. Istat interviewed 38,054 foreign students, along with an equivalent number of Italian students as a control group. This sample allows for detailed analysis at a territorial level and represents the top ten nationalities, three of which are also represented at the regional level. In this study, the focus is limited to students attending upper secondary school in 2015.

To study university transitions and educational choices of second-generation students, data from the Ministry of University and Research (MUR) on university enrolments from the academic years 2015–2016 to 2022–2023 were used. An integrated dataset was built through record linkage between administrative data and the ISG 2015 survey, allowing longitudinal analysis of students' educational trajectories from high school to university, including their field-of-study choices (STEM vs. non-STEM).

The analytical dataset combines selected information from multiple sources: the ISG 2015 survey, the Base Register of Resident Individuals (2018–2022), and the MUR archives on university enrolments and degree programs (2015–2023).

Overall, the cohort of upper secondary school students consists of approximately 1,308,000 individuals (corresponding to 35,025 respondents to the survey), with over half located in the North (54.1%), one-quarter in Central Italy (25.1%), and one-fifth in the South (20.8%). In 36.3% of cases, students attend academic high schools (licei), while 63.7% attend technical or vocational schools. Males represent 51.7% of the cohort and females 48.3%, and approximately 12% are foreign students.

The integration of ISG 2015 data with the Base Register enabled tracking of students' life trajectories over time. Specifically, it allowed identification of both their presence or absence in the population register and any transitions to Italian citizenship—two key indicators for analysing social and civic integration processes

Linkage with MUR data enabled analysis of transitions to tertiary education and students' choices regarding STEM versus non-STEM disciplines. Additionally, the ISG 2015 survey provided crucial variables not available in administrative sources, such as migratory background, family socio-economic and employment conditions,

social integration, and aspirations of second-generation students. These variables were included in statistical models as potential factors associated with the likelihood of choosing a STEM degree. Overall, the construction of this integrated dataset allows for a longitudinal and multidimensional study of the educational and social pathways of second-generation youth.

Through descriptive and multivariate analyses, we aim to investigate the relationship between the decision to pursue a STEM course of study at university and the socio-demographic characteristics of respondents and their families

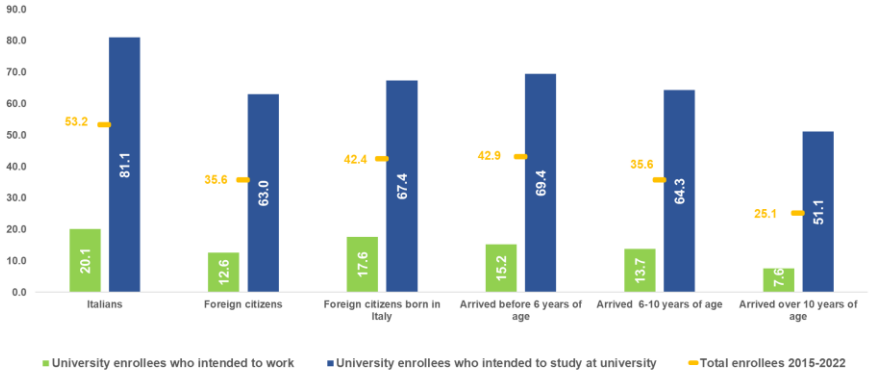
3. Descriptive results

Considering the stability of the presence in Italy and also the inclusion process the record linkage reveals that in 2022, 8,9% of foreign students enrolled in upper secondary school in 2015 were no longer listed in the resident population register, suggesting possible international mobility or a discontinuity in their migration trajectory. At the same time, 35% had acquired Italian citizenship, marking a significant milestone in their stabilization process and a tangible indicator of social inclusion.

About the education paths the record linkage stresses that among students at high-school in the 2015 (Istat ISG), a share of 50,0% enrolled in university for at least one academic year over 2015-2016 and 2022-2023. This share drops to 41.2% among foreign students were born in Italy and it rises to 52.0% among the Italians control group. The share of females enrolled in university is higher than male peers, this gender gap increases among the second-generation group of students. The Lyceum students are more likely to enrol in university (8 out of 10 students) compared to technical or vocational school students (3 out of 10). According to Paba and Bertozzi findings (2017), our study confirms the high proportion of foreign students with a Lyceum diploma who do not continue their study compared to Italian native peers. Among Italians more than 8 out of 10 were enrolled in university compared to 6 out of 10 students of foreign background.

The access to university is a difficult goal for the children of immigrants even when they aspire to continue their studies (Buonomo *et al*., 2023; Buonomo *et al*., 2024). In the cohort of Istat ISG students 78.5 per cent of the students who intended to enrol in university realized their aspiration over the academic year 2015-2016 and 2022-2023. There are high differences again between Italians and the immigrant children (80.3 per cent compared to 62.2 per cent). Among second-generation students, the share of students with a realized aspiration to continue their studies at university is higher among those who have fully completed their studies in Italy because they were born in Italy or arrived before primary school (Fig.1).

Figure 1 – *High-school students of ISTAT Second Generation Survey 2015 enrolled in university (at least one year in the period 2015-2023), by future intentions expressed during the survey and migratory generation by gender (%).*



Source: elaboration on Istat and MUR data

Building on what has been explored in previous research, this work aims to specifically explore the transition towards STEM fields.

According to the literature, STEM choice is gender-driven. The longitudinal analysis of integrated data founds that gender disparities are clearly visible across all categories (Tab.1). Overall, women are more likely to be enrolled in university than men (58.6% vs 42.0%), and this outcome is especially pronounced among Italian students (60.5% for women vs 44.2% for men). However, this female advantage diminishes sharply in STEM fields, where only 11.2% of women are enrolled compared to 18.6% of men. This suggests persistent gender segregation in academic disciplines, with women underrepresented in STEM despite their overall higher university participation.

Ethnic disparities are also evident. Foreign citizens have substantially lower enrolment rates than Italians, both overall and within STEM and non-STEM fields. For instance, only 34.8% of foreign students are enrolled, compared to 52.0% of Italian students (Tab.1). The gap is even more striking among foreign males, whose enrolment rate is just 25.0%. This suggests that foreign students, particularly males, face structural or socioeconomic barriers to accessing higher education. Many studies have individuated several factors that make it more difficult for foreign-born students to access university education in Italy (Buonomo *et al.* 2024, Buonomo *et al*. 2025). It is interesting to note that among men, the differences between Italian and foreign students narrow when we consider STEM fields. When foreign students decide to pursue university studies, they appear to choose STEM fields more frequently than their Italian peers—perhaps also because, as a result of a more

selective process, it is often the most capable students who make it to enrol in university. It should also be considered that families likely view STEM pathways as a more secure investment in their children's future.

It is different when we consider the situation for girls.

Combining both gender and ethnic lenses reveals compound disadvantages: foreign females are doubly marginalized in STEM, with an enrolment rate of just 8.5%, the lowest of any group. On the other hand, Italian females are the most represented in non-STEM fields (48.9%), indicating a strong gendered preference or channelling into certain disciplines.

Table 1 – *High-school students of ISTAT Second Generation Survey 2015 enrolled in university, STEM and not-STEM, at least in one academic year between 2015-2023 by gender (%).*

	Enrolled in university			Enrolled not STEM			Enrolled STEM		
	Male	female	total	male	female	total	male	female	Total
Italian	44.2	60.5	52.0	24.8	48.9	36.4	19.3	11.6	15.6
Foreign citizens	25.0	44.9	34.8	12.4	36.5	24.2	12.6	8.5	10.6
Total	42.0	58.6	50.0	23.4	47.4	35.0	18.6	11.2	15.0

Source: elaboration on Istat and MUR data

Considering both gender and the different countries of citizenship - Albania, Romania, Morocco, the Philippines, and China - clear differences emerge not only in overall participation in higher education but also in the specific field of STEM, reflecting varying cultural, educational, and possibly socio-economic factors. About gender Albanian students show a remarkable imbalance in university enrollment, with a very high rate of female participation (55.0%) compared to males (23.2%). However, when it comes to STEM fields, both genders register much lower percentages, and the gender gap narrows considerably (12.0% male, 10.3% female). This suggests that although many Albanian women pursue higher education, they may tend to choose fields outside of STEM (Tab.2). Chinese and Romanian males are the most likely to pursue STEM disciplines, while female students, particularly from Morocco and the Philippines, are the least represented in these areas. Chinese students show a relatively balanced university enrollment between genders (34.9% male, 36.9% female), yet a striking difference emerges in STEM: Chinese males (21.4%) are more than twice as likely as females (10.0%) to pursue studies in these fields. China stands out for having the highest male participation in STEM.

Table 2 – *High-school students of ISTAT Second Generation Survey 2015 enrolled in university (Total and STEM) at least in one academic year between 2015-2023 by gender and selected countries of citizenship (%).*

Countries of citizenship	Enrolled in university			Enrolled in STEM		
	male	Female	Total	male	female	Total
Albania	23.2	55.0	38.4	12.0	10.3	11.2
Romania	27.6	45.5	36.9	14.1	8.2	11.0
Morocco	17.4	42.5	29.9	8.0	7.5	7.7
Philippines	25.7	41.5	34.9	11.1	9.1	10.0
China	34.9	36.9	36.0	21.4	10.0	14.9
Total Foreign countries	25.0	44.9	34.8	12.6	8.5	10.6

Source: elaboration on Istat and MUR data

Differences emerge across a variety of academic and socio-demographic characteristics (Tab. 3).

Table 3 – *Percentage of STEM students from the ISTAT Second-Generation Survey 2015 with at least one year of enrollment (2015–2023), by gender and family characteristics and educational background..*

	Gender		
	male	female	Total
Repeating a school year			
Yes	7.1	3.2	5.6
No	24.0	13.5	18.7
Academic performance			
Good/very good	25.0	13.6	19.0
Low academic performance	12.3	7.4	10.4
Post secondary-school plans			
Work	6.3	3.4	5.3
Other plans	16.9	6.4	11.8
University	36.4	16.1	23.2
Parental Education			
Up to lower secondary education	9.9	6.2	8.1
Upper secondary diploma	20.1	12.2	16.2
University degree or higher	30.0	18.3	24.6
Type of High-School			
Academic high school	38.6	18.2	25.9
Technical or vocational institute	12.4	5.4	9.6
Math grade			
Above average of 8	30.9	19.9	25.2
Below average of 8	16.8	9.2	13.2
Total	19.6	11.7	15.8

Source: provisional elaboration on Istat and MUR data

For instance, students who have repeated a school year are underrepresented in STEM, particularly among females, who account for only 3.2% of STEM enrollees in this group compared to 7.1% of males. Academic performance also plays a key role: among students with good or very good grades, males constitute 25.0% of STEM enrollees, whereas females make up 13.6%.

Future educational intentions are strongly correlated with STEM enrollment. Students who plan to attend university are overrepresented, with males at 36.4% and females at 16.1%. Parental education also appears to be influential: children of parents with a university degree are more likely to enrol in STEM, with males representing 30.0% and females 18.3%. School type and math performance similarly exhibit a pronounced gender gap. Students from academic high schools and those with math grades of 8 or higher are more likely to enrol in STEM, with males dominating both categories.

4. Regression model

A logistic regression model was used in this analysis to explore the relationship between various individual, familiar, and contextual factors and students' educational choices, as suggested in literature[1]. The analysis is limited to students who attended upper secondary school during the ISG survey and were enrolled in an Italian university for at least one year between 2015 and 2022. The outcome variable is: whether a student enrolled in a STEM course or in a non-STEM course.

The results of the logistic regression model offer a clear picture of the factors that influence students' educational choices. Among all the variables considered, gender and citizenship emerge as particularly significant in shaping these trajectories.

Starting with gender, the effect is both substantial and highly significant. Female students, when compared to their male peers, are much less likely to reach the considered outcome. The odds ratio is 0.250, indicating that, all other factors being equal, girls have 75% lower odds than boys. This is a striking result, which points to a persistent gender gap. It suggests that girls may encounter specific barriers that limit their progression or aspirations within the education system.

Citizenship is also a key variable. Compared to Italian students (the reference group), several foreign student groups show a higher likelihood of enrolling in STEM programs. Notably, students from China are the most likely to choose STEM, with an odds ratio of 1.709, suggesting they are over 70% more likely than Italians to do so. It should be remembered that these are Italian students from the control group, and they are not representative of all Italian upper secondary school students.

[1] Normalized weights were applied to individuals in the model.

Table 4 – *Determinants of STEM choice among students enrolled in university for at least one academic year in the period 2015-2023. Odds-ratio and p-values of selected characteristics with adding control variables [(a)]. Logistic regression model. Students enrolled upper secondary school in 2015 (grades 11-13).*

Variables	Odds – ratio	p-values[(b)]
Gender (ref. Boys)		
- Girls	0,250	***
Parental Education (ref. Upper secondary diploma)		
- Up to lower secondary education	0,985	
- University degree or higher	1,187	***
Geographical Area of residence (ref. North)		
- Central Italy	0,864	***
- South and Islands	1,000	
Country of Citizenship (ref. Italy)		
- Albania	1,244	***
- Romania	1,144	**
- China	1,709	***
- Philippines	1,183	
- Morocco	1,137	
- Other Country of citizenship (rif. Italy)	1,231	***
Repeating a school year (ref. No)		
- Yes	*0,638*	***
Academic performance (ref. good/very good)		
- Low academic performance	0,920	***
Perceived Economic Condition (ref. neither poor nor rich)		
- Rich/very rich	0,723	***
- Poor/Very poor	1,004	
Post secondary-school plans (ref. University)		
- Work	0,537	***
- Other plans	0,794	***
Type of High-School (ref. academic high school)		
- Technical or vocational institute	0,858	***
Math grade (ref. above average of 8)		
- Below average (ref. above average of 8)	0,561	***
Pseudo R2	0.3772	
N	15875	

(a) Control variables: Gender, Area of Residence, Parental Education, Country of Citizenship, School Experiences path variables as Repeating a School Year, Academic Performances, Math Grade, Type of High School, Post Secondary School Plans.

*(b): Statistical significance of the relationship is marked by * if p<0,1, ** if p<0,05, *** if p<0,01*

Source: our elaboration on ISG data (2014/15) and MUR data on university students in the period 2015-2023

Students from Albania and Romania also have significantly higher odds (OR = 1.244 and 1.144, respectively), indicating a clear tendency among some foreign groups to pursue STEM studies.

Other variables also play a meaningful role. Students with highly educated parents are more likely to enter STEM fields, while those with lower parental education do not differ significantly from the reference group. Educational path is especially important: students who have repeated a grade, those with low math performance, or those who report poor general academic performances are all significantly less likely to choose STEM. This highlights the role of prior preparation and confidence in academic ability in influencing study choices.

Furthermore, students who plan to enter the labor market immediately after high school are much less likely to enrol in a STEM degree (OR = 0.537), as are those attending technical and vocational schools compared to those from Lyceum programs. Interestingly, coming from a rich or very rich family is associated with a lower likelihood of choosing STEM (OR = 0.723), which might suggest that wealthier students may have access to broader career options and may be drawn to other fields, such as economics, law, or the humanities.

5. Discussion and further steps

Despite increasing presence in Italian schools and gradual integration in terms of language and academic participation, second-generation students continue to face structural barriers and unequal opportunities, which affect their transitions into higher education.

A key result is the persistent role of gender and citizenship in shaping academic choices. Other important factors include academic background and family characteristics. Students with higher academic performance, no grade repetition, and higher parental education levels are more likely to pursue STEM paths. Conversely, those from technical or vocational schools, or who plan to enter the workforce immediately after high school, are significantly less likely to choose STEM. Interestingly, students from wealthier families are also less likely to choose STEM programs, possibly because they have access to broader academic and career options outside the scientific-technological fields. Unfortunately, the survey does not allow us to take into account some factors that are considered important in the literature for university choice, such as teachers' recommendations and the influence of parents and peers. However, this work could be further developed in the future. It is important to acknowledge that the analysis may be subject to selection effects. Students who reach university - especially among foreign young people- are often

those with stronger academic profiles or higher motivation, which could partially explain their overrepresentation in certain fields like STEM.

Future research should aim to apply models that account for potential selection mechanisms, in order to better understand the dynamics underlying educational inequality. A further step would be to consider separately those who were identified as foreign in the 2015 survey but have since acquired Italian citizenship, to gain a clearer understanding of the relationship between integration pathways and educational choices.

It would also be valuable to extend the study with a model that includes an interaction between gender and country of citizenship, to investigate how gender and migration jointly influence STEM choices. The development of science, technology, engineering, and mathematics (STEM) fields requires more qualified professionals; however, gender segregation in higher education continues to produce a notable gender gap (Verdugo-Castro *et al.*, 2022).

There are indications that foreign students may be more inclined to embrace the challenges posed by new technologies by choosing STEM pathways, but this trend seems to hold primarily for male students.

Overall, this study highlights the complex interplay of gender, citizenship, and academic preparation in shaping access to STEM education. Addressing these disparities will require targeted policy measures, improved guidance in secondary schools, and broader efforts to support the educational ambitions of second-generation students, particularly girls.

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