WILEY

KYKLOS

ORIGINAL ARTICLE OPEN ACCESS

Citizenship, Math and Gender: Exploring Immigrant Students' Choice of Majors

Marina Murat

Università degli Studi di Modena e Reggio Emilia, Modena, Italy

Correspondence: Marina Murat (marina.murat@unimore.it)

Received: 28 January 2025 | **Accepted:** 13 February 2025

Funding: The financial support provided by Progetti Rilevante Interesse Nazionale (PRIN) through The Economics of Culture: Ethnicity, Gender, and their Interactions (2017KHR4MB) and Inequalities in Teriary Education (E53D23019320001 - P2022C572P) are gratefully acknowledged.

Keywords: citizenship | gender inequality | higher education | immigrant students | math gender gaps

ABSTRACT

This study examines the impact of host-country citizenship on immigrant students' choice of academic majors, using data from an Italian university and incorporating characteristics of students' countries of origin. The analysis focuses on enrolment in fields of study categorized by mathematical content. The findings reveal three main points: First, obtaining citizenship reduces the likelihood of choosing math-related disciplines; second, this effect is more pronounced among women, further widening the gender gap in math-intensive fields; and third, these gaps are larger among students from more gender-equal countries but are less affected by the acquisition of citizenship. These results are supported by matching techniques, two-stage least squares, and robustness and sensitivity analyses. Given that math-intensive fields are linked to higher earning potential, the findings suggest that investment in mathematical skills may serve as a safeguard against labour market risks—a necessity that lessens upon acquiring citizenship, especially for women. Although this shift could adversely affect future earnings, it also contributes to a more even distribution of students across disciplines, potentially enhancing diversity in occupations where immigrants are traditionally under-represented.

JEL Classification: I21, I23, J16

1 | Introduction

Citizenship in the host country significantly enhances the civil, social and economic status of immigrants. It grants them the right to vote and often opens up opportunities for employment in the public sector and various professions. Closely linked to institutional support during periods of unemployment, illness or old age, citizenship provides benefits at both national and international levels. In the context of the host country being a member of the European Union (EU), many of these rights extend to the other 26 member states.

Hence, the acquisition of citizenship holds such transformative power that it can be expected to significantly influence the long-term decisions of immigrants across various dimensions of their lives. This impact includes their performance in the labour market, social integration and, notably, their decisions regarding investments in the type, length and quality of education. In the latter context, recent empirical investigations reveal that citizenship influences the educational choices of students with an immigrant background, particularly concerning the duration and quality of their secondary education. Studies by Patler (2017), Fibbi et al. (2007), Avitabile et al. (2014), Gathmann et al. (2021) and Labussière et al. (2021) have found that immigrant students who acquire citizenship spend a higher number of years in secondary education. Additionally, studies by Kilpi-Jakonen (2014) and Ferrara and Brunori (2023) indicate a tendency among immigrant students with citizenship to transition from vocational to general schools. However, it is crucial to note that the impact of citizenship on the type of tertiary education, and in particular

on major choices, remains largely unexplored.[1] This research gap is noteworthy, given the crucial importance of tertiary education choices for both the individuals involved and the composition of the human and social capital of the host country.

Most of the empirical research on the choice of majors links students' choices to their attitudes, preferences, cultural influences, and school and social backgrounds (Porter and Umbach 2006; Staniec 2004). However, an often overlooked yet crucial factor is the effective level of empowerment students can anticipate after graduation, especially in the job markets. Notably, all else being equal, a lower sense of security may motivate students—particularly those in vulnerable groups, such as those with an immigrant background[2]—to choose majors that prioritize economic prospects over other characteristics, such as intrinsic interest. In this context, the enhanced economic protection and social stability conferred by citizenship significantly broaden their range of viable options and reduce the relative appeal of pursuing higher paying but more demanding career paths.

Hence, it is reasonable to expect that citizenship status may influence the choice of major, with naturalized citizens potentially less likely to major in the high-paying fields of study compared to non-citizens. To narrow it down further, given that these fields are typically characterized by above-average mathematical content, one might expect that immigrant students acquiring citizenship will decrease the math intensity of the majors chosen.[3]

This research focuses on the impact of citizenship on major choice among immigrant students at the University of Modena and Reggio Emilia (Unimore) in Italy. It utilizes data encompassing detailed information on 1.5- and second-generation students with an immigrant background, as well as information on their parents. The dataset is complemented by characteristics of the countries of origin. The fields of education are categorized into four main areas, ranked by decreasing mathematical content: (1) physical sciences, mathematics, engineering, economics and business economics; (2) life sciences; (3) social sciences; and (4) humanities. The primary inquiries guiding this research are as follows: Does citizenship play a role in influencing the major choices of immigrant students? To what extent does citizenship impact gender gaps in the four specified areas of study? To what extent do citizenship and social norms interact in influencing these gender gaps?

The first question is aligned with the hypothesis made above, suggesting that, holding all else constant, the choice of majors should be related to students' levels of empowerment and social protection, particularly citizenship. The second question is tied to the extensive body of literature on gender gaps, which documents the disadvantage school girls face in math (Guiso et al. 2008; Nollenberger et al. 2016) and women encounter in science, technology, engineering and mathematics (STEM) (Chise et al. 2021; Granato 2023). It aims to uncover whether the empowerment represented by citizenship reduces women's disadvantage in math-related fields. The third question is connected to the approach that links math gender gaps to gender-related social norms, with these norms being approximated by gender inequalities in students' countries of origin (Rodríguez-Planas and Nollenberger 2018). This study explores whether citizenship weakens the impact of these norms on the choice of majors, especially of female students. The identification strategy employs matched covariate samples and instruments the citizenship variable with indicators of Italian emigrant stocks abroad and the shares of naturalized citizens among immigrants in Italy during the period considered.

This study contributes to two domains of the education literature: one pertaining to citizenship and majors' choices and the other addressing gender gaps in educational fields and gender-related inequality. To the best of my knowledge, it is the first analysis to specifically examine the effects of citizenship on the choice of majors, rather than on the duration of schooling or school quality. Moreover, it explores the impact of citizenship on gender differences in these choices and its interplay with gender inequalities.

The findings of this study are as follows. First, citizenship plays a significant role in shaping academic preferences. Specifically, immigrant students who acquire citizenship in the host country exhibit a substantial decrease in the likelihood of majoring in math-intensive fields, with corresponding increases in other areas of study. Second, gender gaps in favour of men in math-related fields widen with citizenship, as women are more likely to shift to low-math areas of study upon becoming citizens. Third, citizenship interacts with cultural and gender social norms in the choice of majors. Notably, female students from countries with high gender inequality are the most likely to enrol in math-intensive fields and are also the most likely to shift to other areas as they gain citizenship. Results are robust across a wide range of controls and specifications and are corroborated by matching and instrumental variable strategies.

The rest of the paper is structured as follows: Section 2 reviews the related literature; Section 3 briefly describes the Italian setting; Section 4 describes the data and presents some descriptive statistics; Section 5 sketches the empirical strategy; Section 6 shows the results; Section 7 makes use of identification strategies; and Section 8 concludes the paper.

2 | Related Literature

Most research on the choice of university fields is based on models of rational individuals who select from a set of post-secondary education options with the aim of maximizing their utility (Berger 1988; Porter and Umbach 2006; Staniec 2004; Turner and Bowen 1999). Empirical studies reveal several recurring determinants of this choice, including prior education, socioeconomic status, parental education, wages and labour market conditions. However, to my knowledge, they do not consider the effects of acquiring citizenship in the country of residence on this choice.

A partial exception is Nores (2010), who divides the entire student population of two Texas (USA) universities into citizens (including natives and—although not explicitly stated—naturalized immigrants) and non-citizens (comprising documented and undocumented immigrants as well as international students). The study finds that non-citizens are more likely than citizens to major in STEM fields. Furthermore, when a policy is introduced that reduces the fees paid by undocumented

immigrants, their likelihood of majoring in STEM fields decreases. Although the study examines the different choices made by various groups within the student population, it does not explore the effects of changes in the citizenship status of immigrants.

Most of the research on citizenship and education focuses on its influence on the duration of secondary studies. Citizenship is seen as fundamental in facilitating integration within the host country. In Dustmann (2008), acquiring citizenship reduces intentions to return to the home country and thus enhances the returns on investments in human capital. Expanded job opportunities associated with citizenship status further reinforce these effects (Gathmann and Garbers 2023; Gathmann and Keller 2017; Simonsen 2017).

Relatedly, Bean et al. (2011) and Patler (2017), both using survey data, observe a positive impact of parents' naturalization on the length of their children's education in the United States. Similarly, Fibbi et al. (2007) report comparable findings based on data from Switzerland, whereas Avitabile et al. (2014) and Gathmann et al. (2021) present analogous results for Germany and Labussière et al. (2021) for the Netherlands.

On the other hand, studies focusing on some southern European countries exhibit different results. For instance, Contini and Azzolini (2016), using longitudinal data for the province of Trento in Italy, find that immigrant students tend to choose vocational rather than academic schools more than natives, but the difference is significant only for boys. Fellini and Guetto (2022), using data from southern Europe, find that naturalization reduces labour market discrimination, particularly for low-skilled workers, which may have mixed implications for the academic performance of immigrant students and their expected years of education.

In the context of educational quality, Kilpi-Jakonen (2014), using stratified sample data from Finland, shows that immigrant students who acquire citizenship are more inclined to opt for an academic rather than a vocational path. Given that the academic route is often lengthier and more conducive to tertiary studies, these results align with findings on the extended duration of education. Considering Fellini and Guetto's (2022) findings, Ferrara and Brunori (2023) employ cross-sectional survey data to show that second-generation immigrants with Italian citizenship are more likely than their non-naturalized counterparts, and even native students, to enrol in academic school tracks.

A segment of the research delves into the gendered effects of citizenship. Drawing from cross-sectional data across 13 European countries, Dronkers and Fleischmann (2010) show that citizenship is positively correlated with the educational achievements of second-generation female immigrants, particularly when their parents have low education levels. In contrast, no significant effects are observed among male immigrants.

A limitation of these findings is that they are particularly dependent on the characteristics of countries, such as citizenship laws, educational systems and the composition of the immigrant population. Dronkers and Fleischmann (2010) show that the openness of naturalization laws in the 13 European countries they consider is positively associated with the educational attainment of both male and female second-generation immigrants. At the same time, they highlight that variations in the composition of immigrant populations in host countries, coupled with diverse cultural approaches to education, can significantly impact results.

Self-selection and endogeneity present potential challenges (Peters et al. 2016). For example, if immigrants applying for citizenship are inherently more ambitious and invest more in education than average, standard estimates are likely to be biased upwards (Hainmueller et al. 2018; Jensen et al. 2019). To address these issues, researchers employ a variety of methodologies. Cygan-Rehm (2018) uses longitudinal data to exploit a 2000 reform of German citizenship law with a two-stage estimation approach, whereas Felfe et al. (2020) apply the same reform in difference-in-differences regressions. Their findings suggest that the reform increased educational returns for citizen immigrants, improved primary school outcomes for their children and raised their likelihood of choosing an academic track.

Gathmann et al. (2021), also employing longitudinal data and adopting a marginal treatment effects framework, use both the 2000 German reform and an earlier one in 1991 to assess the effects of naturalization and birthright citizenship on school outcomes. They observe positive effects for both policies and especially for the latter. This indicates that earlier citizenship acquisition leads to better results. To account for time-invariant household characteristics in the Netherlands, Labussière (2023) employs longitudinal data to study siblings' variation in exposure to naturalization. Her findings indicate that the academic performance of children acquiring Dutch citizenship surpasses that of non-citizens. Similarly, improvements are more pronounced when students gain citizenship in early childhood.

A parallel line of research examines gender differences in students' choices and outcomes across various fields of education, revealing a male advantage in math-intensive disciplines and a female advantage in those centred around reading. In an influential study, Guiso et al. (2008) utilized PISA-OECD cross-country data on 15-year-olds to demonstrate that gender inequality, reflective of cultural norms and gender stereotypes, can account for a significant portion of the gender gap in math. More recently, to isolate the effects of culture from other country-specific characteristics, a segment of this research adopted the epidemiological approach (Fernández 2011) and narrowed the focus to immigrant students. By linking gender gaps in maths to gender inequalities in students' countries of origin, Nollenberger et al. (2016) support Guiso et al. (2008), though only in the case of developing countries (Anghel et al. 2020).

However, other studies reveal opposite findings, with gender gaps being smaller or even reversed in countries with higher gender inequality, including some Muslim nations (Fryer and Levitt 2010) and former communist economies (Lippmann and Senik 2018). Considering tertiary-level studies and gender gaps in STEM, Stoet and Geary (2018) find that the proportion of women in STEM disciplines increases with the level of gender

inequality in countries, and Breda et al. (2020) show that the stereotype associating math with men is stronger in more egalitarian and developed countries. Conversely, Jergens (2023), expanding the research to a broader sample of countries, provides evidence that women's relative representation in STEM does not seem to decline as equity increases.[4]

To sum up, research on citizenship neglects to examine its link with the choice of academic majors, focusing mainly on its association with the duration and quality of secondary education and occasionally considering gender differences. This study diverges by investigating the influence of citizenship on the choice of majors and on gender differences in these choices.

3 | The Italian Setting

The Italian citizenship framework operates under the principle of jus sanguinis. Individuals with Italian ancestry have the right to Italian citizenship, regardless of their birthplace. Conversely, children born in Italy without an Italian parent or ancestor are considered foreign nationals. Second-generation immigrants in Italy may apply for citizenship upon turning 18, provided they have continuously resided in the country since birth and meet specific restrictive conditions. Applications must be submitted before they reach 19 years of age.

Alternatively, if these conditions are not met, they can pursue naturalization, a more stringent and uncertain process, particularly for immigrants from non-EU countries. Requirements for naturalization include a minimum residence period of 10 years (which is shorter for EU nationals). In turn, obtaining a residence permit takes approximately 3 years from the application and requires a valid work permit. Children of immigrant parents who become naturalized Italians benefit from a more direct and certain route to citizenship.

In the Italian education system, the process of tracking between schools commences at the age of 14, with upper secondary education divided into lyceums, technical and vocational schools. Although all pathways offer access to tertiary education, students enrolled in lyceums and in technical schools with higher education standards are more likely to pursue further studies. Notably, this tracking system exhibits a pronounced gender bias, with girls disproportionately attending schools characterized by curricula with lower mathematical content.

The percentage of immigrant students in upper secondary education increased from approximately 7% in 2006 to 17% in 2015 (OECD 2018) at the national level. However, in Emilia-Romagna, where Unimore is located, these percentages are significantly higher than the national average.

4 | Data and Descriptive Statistics

Unimore is a medium-sized university located in the Emilia-Romagna region, in northern Italy, with an average enrolment of 20,000 students between 2000 and 2022, offering a broad range of academic programmes across 12 departments. Approximately 7% of its student body consists of foreign or immigrant students—a proportion slightly above the national average but similar to that of other universities in northern Italy (MIUR 2018), where a large share of Italy's immigrant population resides. Regions like Emilia-Romagna have a GDP per capita above the national average and a modern industrial economy, making them more comparable to regions in central Western Europe than to those in southern Italy. This economic structure also affects educational demographics; in Emilia-Romagna, around 9% of school-age children are from immigrant backgrounds, aligning with the higher rates of immigrant students at universities in the region.

Administrative data on transition rates from high school to higher education in Italy for 2015–2016 indicate that 55% of Italian students and 34% of foreign students enrolled in university after completing high school (MIUR 2017). Based on these figures, the expected proportion of immigrant students in universities nationwide should be under 6%. However, in northern Italy—particularly in Emilia-Romagna—this proportion is higher, likely due to strong job prospects in the industrial sector, especially for graduates in math-related fields.

This is confirmed by data on graduates (both natives and immigrants) made available through the Ministry of Education's open data portal (MIUR, Open Data). These data also reveal that the distribution of Unimore graduates across major fields of study from 2001 to 2021 aligns with the national distribution but is more similar to that of universities in northern Italy (Figure S1), where industrial production is concentrated, and math-related fields at university are more likely to be chosen. Overall, Unimore appears representative of a medium-sized university in northern Italy.

The dataset used in this study combines administrative and survey data sourced from Unimore, concentrating on individual student demographic characteristics and their course enrolments. Additionally, the dataset includes extensive information from national databases, particularly AlmaLaurea, which annually provides a comprehensive overview of Italian graduates within the public university system.

In this study, all disciplines are categorized into four main areas, arranged in descending order based on their mathematical content. This sequence generally aligns with standard classifications, with two exceptions. The areas are as follows: The first includes physical sciences, technology, mathematics, engineering, economics and business economics (PEEB); the other three are life sciences, social sciences and humanities. The exceptions are economics and business economics (business hereafter), which are classified here within PEEB rather than the social sciences, as is typically the case, due to their mathematical content being closer to the PEEB average than to that of the social sciences (a detailed list of fields in each area is provided in Table A3).[5]

The sample utilized is narrowed to immigrant students with foreign parents from the 1.5 and second generations who were either born in Italy (strictly second generation) or born abroad but live in Italy with a regular residence permit and graduated from an Italian high school.[6] Although precise data on the age

of immigration are not provided by the Unimore dataset, the extended and uncertain process of obtaining residence in Italy suggests that students are more likely to have immigrated during their primary school years rather than at later stages of schooling.[7]

Furthermore, the sample is restricted to the first level of tertiary studies—comprising 3-year bachelor's programmes and 5- or 6-year single-cycle courses—and includes high school graduation years from 1996 to 2021. It excludes EU citizens due to the similarity in rights afforded by EU citizenship compared to those of Italian citizenship. The resulting sample consists of 3701 observations. Table 1 presents the main variables used in this study, selected in relation to the literature on the choice of majors and gender gaps in mathematics; it shows their distribution across field areas along with other relevant statistics. Subsequent analyses will expand the sample to include students with one Italian parent.[8]

Data in Table 1 indicate that the overall proportion of students enrolling in PEEB is higher than in other fields. This proportion is particularly elevated among non-citizens, males, students with stronger mathematics backgrounds in high school and those from more gender-unequal countries. Enrolment in several fields within the life sciences and certain humanities disciplines is restricted to a specified number of students, selected through entrance examinations.

The last four rows of Table 1 present the mean wage levels of Unimore graduates (a three-value categorical variable ranging from 0 to 2) 1 year after graduation. The number of observations is smaller than the rest of the sample, as the data are only available from 2011 onwards and pertain exclusively to graduates who participated in the AlmaLaurea survey. Columns 1–4 in these rows highlight the alignment between wages and the mathematical content of the four areas. Specifically, in the rows *Wages Males* and *Wages Females*, wages are highest in the life sciences, followed by PEEB and the other two areas. However, in the rows *Wages° Males* and *Wages° Females*, where entry restrictions in fields are accounted for (as detailed in the notes of Table 1), wages and mathematical content follow the same ordering across the four areas, with PEEB in the highest position.[9]

5 | Empirical Strategy

This study tests three main hypotheses. The first, and primary, hypothesis is that acquiring citizenship in the host country influences the choice of university majors. The second hypothesis is that this influence varies by gender. The third hypothesis is that citizenship and culture interact in the choice of majors.[10]

To explore these hypotheses, I model the decision-making process for choosing a major by assuming that students select from a set of alternatives. Specifically, student i derives utility, U, from each alternative j such that

$$U_{ij} = \boldsymbol{\beta}'\mathbf{x}_{ij} + \varepsilon_{ij} \tag{1}$$

where $\mathbf{x}_{ij}$ is the covariate vector with the first element being 1 and $\boldsymbol{\beta}'$ is the vector of unknown parameters, with the first element being the intercept. Covariates include personal characteristics, family background and country of origin characteristics, and ε_{ij} is the unobserved random component. The student chooses the alternative that maximizes utility. When there are J choices, the probability of choosing k is

$$Pr(y = k) = Pr\big(U_k > U_j \text{ for all } j \neq k\big) \tag{2}$$

In this analysis, the dependent variable represents the choice made by students when enrolling at university. As in Table 1, it is denominated *Area* and defined as follows: PEEB ($y = 1$), Life Sciences ($y = 2$), Social Sciences ($y = 3$) and Humanities ($y = 4$). These categories constitute the dependent variable, that is, $y = j$, where $j = 1, ..., 4$. Following McFadden (1973), this leads to a multinomial logistic regression model, assuming that all ε_{ij} for the J choices are independent and identically distributed, following the Weibull distribution of the form $f(\varepsilon) = \exp[-\varepsilon - \exp(-\varepsilon)]$.

The selection of the independent variables included in the model, $\mathbf{x}$, aside from the variables concerning citizenship, is based on literature regarding major selection and studies on gender gaps in mathematics. The individual-level variables are as follows: *Citizenship*, a binary variable set to 1 if the student holds Italian citizenship and 0 otherwise; *Female*, a variable set to 1 if the student is female and 0 otherwise; *High School Math*, an ordered categorical variable reflecting the mathematics content of the high school curriculum (low, intermediate or high); *High School Grade* (final), a continuous variable ranging from 60 to 100; *Status*, a categorical variable indicating whether the student is currently enrolled, has dropped out, graduated or transferred; and *Socioeconomic Status*, based on the university fees paid by the student, which are a proxy of family income. Average wages in each field would also be included among the covariates if sufficient observations on the variable were available, but, as shown in Table 1, their number is too small.

Macroeconomic indicators include the *GII*, a continuous variable ranging from 0.018 to 0.728, where higher values indicate greater inequality, and the *GDP per Capita*, in logarithmic form, of the country of origin, serving as a proxy for the country's development level. Literature on math gender gaps suggests that the *GII* captures cultural factors that help explain gender disparities in major choice. Dummies for countries or regions of origin, Italian areas of residence (north, centre and south) and high school graduation year are included in all models. Full models also include an interaction between gender and the country/region of origin, which is meant to capture time-invariant characteristics of origin countries that may differentially influence the likelihood of male and female students enrolling in specific field areas. Standard errors are clustered by country/region of origin. The country/region list is in Table A1.

The coefficients on the *Citizenship* variable across each of the four field areas considered are used to test the main hypothesis

TABLE 1 | Cross-tabulation and descriptive statistics of the main variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	PEEB	**Life sciences**	**Social sciences**	**Humanities**	**Column %**	**SD**	**Min**	**Max**	**Obs.**
Citizenship									3701
Non-citizens	62.12	13.54	9.23	15.11	60.28	0.49	0	1	
Citizens	48.57	16.94	12.18	22.31	39.72				
Gender									3701
Male	75.81	8.39	7.93	7.87	40.88	0.49	0	1	
Female	43.56	19.38	12.11	24.95	59.12				
High School Math									3701
Low	30.19	18.85	14.27	36.69	21.21	0.41	0	1	
Medium	61.77	11.89	10.52	15.82	33.64	0.47	0	1	
High	65.47	15.26	8.5	10.77	45.15	0.50	0	1	
Generation									3701
First	56.31	14.96	10.56	18.17	0.95	0.20	0	1	
Second	66.89	13.25	6.62	13.25	0.5				
Student Status									3701
Dropout	61.41	10.74	9.84	18.01	42.02	0.49	0	1	
Attending	53.95	15.18	12.41	18.46	26.34	0.44	0	1	
Graduate	54.37	20.02	7.94	17.67	29.96	0.46	0	1	
Transferred	25.81	22.58	37.1	14.52	1.68	0.13	0	1	
					Mean				
High School Grade	76.30	77.90	75.30	74.40	76.00	11.60	60	100	3694
Socioeconomic Status	4.46	4.68	4.49	4.63	4.53	3.03	0.00	8.48	3690
GII	56.36	15.74	11.09	16.8	0.37	0.15	0.02	0.72	3640
Ln *GDP per Capita*	9.09	9.14	9.22	9.16	9.12	0.70	6.06	11.2	3643
Admission	0	91.53	0	8.47	8.3	0.27	0	1	3701
Further Study	29.03	14.92	40.73	15.32	0.43	0.49	0	1	584
Wages Males	0.792	0.889	0.778	0.636	0.79	0.599	0	2	115
Wages Males*	0.855	0.543	0.848	0.707	0.81	0.120	0	2	
Wages Females	0.616	0.874	0.609	0.493	0.665	0.820	0	2	278
Wages Females*	0.706	0.687	0.702	0.567	0.625	0.130	0	2	

Note: The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. The last four rows are based on a smaller sample derived from survey data on the wages of first-cycle students 1 year after graduating from Unimore. Columns 1–4 in the last four rows report the mean wages of males and females 1 year after graduation in each field area. Mean values in the rows $Wages^{\circ}\ Males_{ij}$ and $Wages^{\circ}\ Females_{ij}$ account for entry restrictions in some fields and are the predicted values from the following OLS regressions: $Wages^{\circ}\ Males_{ij}\ (Wages^{\circ}\ Females_{ij}) = \gamma + \alpha_j Area_{ij} + \beta_j Admission_j + \varepsilon_{ij}$, estimated separately for each gender, where i represents the student and $j = 1, \ldots, 4$ denotes the field area. *Area* is a categorical variable denoting the four areas of study, and *Admission* is equal to 1 if a field within each area has restricted entry and 0 otherwise. Overall values of the $Wages^{\circ}\ Males_{ij}$ and $Wages^{\circ}\ Females_{ij}$ variables in Column 5 are the predicted values from the OLS regressions: $Wages^{\circ}\ Males_{ij}\ (Wages^{\circ}\ Females_{ij}) = \gamma + \beta_j Admission_j + \varepsilon_{ij}$.

regarding the effects of citizenship on the choice of majors. The second hypothesis, which addresses the gendered effects of *Citizenship*, focuses on the coefficients of an interaction between the *Citizenship* and *Female* variables, which is added to the full model. The third hypothesis, regarding the interplay between culture and citizenship in shaping gendered choices, considers the coefficients of a triple interaction among *Citizenship*, *Female* and *GII*, which is also added to the model, alongside the interactions between *GII* and *Female*, and *GII* and *Citizenship*. Initial regressions are conducted on the raw sample; subsequently,

instrumental variables and matched samples are utilized to assess the robustness of the results.

6 | Results

6.1 | Choice of Majors

The influence of citizenship on the choice of majors is tested with the multinomial logistic regression of Equation (2). As the estimates from the multinomial logit model are not easy to interpret, Table 2 reports the average marginal effects.[11]

The coefficients on *Citizenship* in Table 2 are negative and significant at the 1% level in the PEEB area. They indicate that a change in status from non-citizen to citizen reduces the likelihood of enrolling in math-based fields by over 10 percentage points in both the base and full regression models. Predictive margins for the *Citizenship* variable in the same full regression of Columns 5–8 show that the likelihood of majoring in PEEB decreases from 61% for non-citizens to 50% for citizens. Conversely, the average marginal effects on *Citizenship* for the other three areas are positive, though smaller, and are significant at the 1% level only in the humanities area. The shift away from PEEB results in an increase in the overall life sciences area of only 2.5 percentage points. A larger increase, of 5 percentage points, is observed in the humanities, the area with the lowest average wages 1 year after graduation.

The coefficients on other variables corroborate previous findings in the literature: Being female reduces the likelihood of majoring in PEEB by about 30 percentage points (with likelihoods of majoring in this area of 74% for males and 34% for females), while increasing the likelihood of majoring in all other areas, particularly the humanities. Having attended a school with a higher math content increases the likelihood of majoring in PEEB and decreases the likelihood of choosing other fields, again, particularly the humanities. These results support prior findings in the literature regarding enrolments in the STEM area (Chise et al. 2021; Granato 2023) and in the field of economics (Bertocchi et al. 2023). Additionally, a higher final grade at high school is positively associated with the probability of majoring in PEEB and, to a lesser extent, in the life sciences, while negatively influencing the likelihood of majoring in the other two areas. The socioeconomic status positively affects the likelihood of majoring in PEEB, with significance at the 10% level.

6.2 | Gender Discrepancies in the Choice of Majors

The second hypothesis tested in this study, that citizenship may affect female and male students differently in their choice of majors, is explored by adding to the full regression of Columns 5–8 of Table 2 the interaction between the *Female* and the *Citizenship* variables and by calculating the average marginal effects of *Citizenship* at the two values of the *Female* dummy. Results in Table 3 show that women shift away from PEEB more than men, with a fall among female students corresponding to 12.4 percentage points, whereas that of males is 8.7 percentage points. At the same time, women's likelihood of enrolling in the humanities increases by 6.3 percentage points, whereas the increase among males is only 3.4 percentage points. Predictive margins of the same interacted variable show that the likelihood of females majoring in PEEB falls from 49.4% as non-citizens to 37% as citizens, whereas the much higher males' likelihood decreases from 77.9% to 69.3%.

The larger fall in women's likelihood of majoring in the math-related fields implies an increase in the gender gap in this area. More precisely, gender gaps are defined as follows:

$$\frac{Males^{'}\ likelihood_j - Females^{'}\ likelihood_j}{Females^{'}\ likelihood_j} = \frac{Males^{'} likelihood_j}{Females^{'} likelihood_j} - 1 \tag{3}$$

where the likelihoods among each gender of majoring in area j are the predictive margins on the *Female* binary variable of the multinomial logistic regression of Equation (2), with j denoting PEEB, Life Sciences, Social Sciences and Humanities. Positive numbers in (3) indicate a gap in favour of males, negative numbers a gap in favour of females, and equal likelihoods among males and females a gap equal to 0.

Figure 1 shows that gender gaps in each area change with citizenship. The gap in favour of males increases in PEEB, whereas that in favour of females shrinks in the life sciences and does not change significantly in the other two areas. The only change in gender gaps large enough to be statistically significant is in the PEEB area. Hence, the results are that citizenship affects the choice of majors differently across genders, with a shift away from PEEB and towards other areas that is larger for females and with an increase in the gender gap that is large and significant in the math-related fields.

6.3 | Cultural Factors and Citizenship in the Choice of Math-Related Majors

As the only significant change in gaps due to citizenship pertains to PEEB fields, this section focuses on this area. Specifically, it examines culture and social norms as potential explanations for gender disparities in PEEB enrolment, once all other factors are considered, and explores the potential contrast between the effects of household social norms and citizenship. As mentioned in Section 3, culture and social norms are approximated by indicators of gender inequality in immigrants' countries of origin. Table 2 shows that the aggregate coefficients on the *GII* variable are non-significant; however, this may hide heterogeneities at a more disaggregated level.

To explore this possibility, a triple interaction between the variables *Citizenship*, *Female* and *GII* is added to a logistic regression with PEEB as the dependent variable and the same covariates and fixed effects as in Equation (2). The probabilities of majoring in PEEB by men and women at different levels of gender inequality are evidenced by the predictive margins of the triple interaction computed at five different levels of *GII*. The regression results are in Table S1.

The predictive margins of the triple interaction in Figure 2 show that, for women, the likelihood of enrolling in PEEB increases with gender inequality, whereas the likelihood for men decreases.

TABLE 2 | Choice of majors: Multinomial logistic regression.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: *Area*	**PEEB**	**Life Sciences**	**Social Sciences**	**Humanities**	**PEEEB**	**Life Sciences**	**Social Sciences**	**Humanities**
Citizenship	−0.108***	0.028**	0.031**	0.048***	−0.105***	0.025**	0.030*	0.051***
	(0.021)	(0.013)	(0.015)	(0.017)	(0.014)	(0.012)	(0.016)	(0.018)
Female					−0.297***	0.108***	0.047***	0.142***
					(0.006)	(0.004)	(0.003)	(0.005)
Medium High School Math					0.238***	−0.043**	−0.027**	−0.168***
					(0.023)	(0.017)	(0.012)	(0.020)
High High School Math					0.229***	0.013	−0.047***	−0.195***
					(0.019)	(0.013)	(0.012)	(0.019)
Attending					−0.111***	0.060***	0.046**	0.005
					(0.026)	(0.020)	(0.020)	(0.024)
Graduate					−0.041**	0.075***	−0.029***	−0.005
					(0.018)	(0.015)	(0.009)	(0.015)
Transferred					−0.273***	0.079	0.259***	−0.066**
					(0.066)	(0.049)	(0.078)	(0.031)
Second Generation					0.096**	−0.039*	−0.010	−0.048
					(0.040)	(0.022)	(0.025)	(0.029)
Socioeconomic Status					0.005*	0.001	−0.003	−0.003
					(0.003)	(0.002)	(0.002)	(0.003)
High School Grade					0.191***	0.104*	−0.092**	−0.203***
					(0.057)	(0.060)	(0.036)	(0.038)
GDP per Capita					−0.033	0.033**	0.006	−0.006
					(0.027)	(0.013)	(0.013)	(0.029)
GII					−0.101	0.058	0.080	−0.037
					(0.210)	(0.111)	(0.082)	(0.186)
Female Country/Region*	No				Yes			

(Continues)

TABLE 2 | (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: *Area*	**PEEB**	**Life Sciences**	**Social Sciences**	**Humanities**	**PEEEB**	**Life Sciences**	**Social Sciences**	**Humanities**
Time dummies	Yes				Yes			
Country/region FE	Yes				Yes			
Italian region FE	Yes				Yes			
Observations	3701				3607			
Log-pseudolikelihood	−4079.56				−3523.38			
$\chi^2(144)$–(207)	336.39				8276.94			
Pseudo-R^2	0.0406				0.1487			

Note: Average marginal effects of the multinomial logistic regression of Equation (2). The base groups are the same as those in Table 1. The dependent variable is *Area*. The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. Robust standard errors, clustered at the country/region level, in parentheses; $^{***}p<0.01$, $^{**}p<0.05$ and $^{*}p<0.1$. The Hausman test indicates that the specification of major choices in the estimated regressions does not violate the IIA assumption. The likelihood ratio (LR) tests for combining outcome categories support the use of the four-group choice. Test details are available from the author.

Regarding female students, this result contrasts with studies finding a positive relationship between social gender equality and girls' performance in mathematics at school (Guiso et al. 2008; Nollenberger et al. 2016). Instead, it supports other research that uncovers a negative relationship between gender equality and women's outcomes in mathematics (Breda et al. 2020; Jergens 2023; Stoet and Geary 2018). Men's choices of math-based fields, which are less explored in the literature, display a reverse pattern compared to women's: Men from more gender-equal households are more likely to choose math-related fields. This trend contributes to increasing the segregation of women in the PEEB area as gender social norms become more equal.

When disaggregated by citizenship status, Figure 2 confirms that citizenship is associated with a decrease in the likelihood of both male and female students majoring in PEEB, with a more marked decline among women. However, it also reveals that although the decline for men is not influenced by the level of gender inequality, the decline for women is affected by it: Women from more gender-unequal environments are more likely to shift away from PEEB (the slope of the women's probabilities decreases with citizenship). As a result, after acquiring citizenship, their likelihood of majoring in PEEB not only falls but also becomes more similar to that of women from more gender-equal societies.

The predictive margins of the triple interaction between *Citizenship*, *Female* and *GII*, in a logistic equation with PEEB as the dependent variable and the covariates of Equation (2), are also used to calculate gender gaps in the area at different levels of inequality. Figure 3, where margins are calculated at the same five inequality levels as in Figure 2, shows that gender gaps in favour of males, for both citizens and non-citizens, are smaller in more gender-unequal countries (corresponding to high levels of *GII*) and grow as equality increases. It also shows that gender gaps are larger among citizens, with the increase being more pronounced in households with higher levels of gender inequality. This is because, as previously discussed, women from such households are more likely to shift away from PEEB after acquiring citizenship.

More broadly, citizenship appears to counterbalance the effects of culture and social norms, as reflected by the *GII*, on women's choice of majors. *Citizenship* reduces the influence of household influence on women's choices, particularly impacting women from more gender-unequal households by making their choices more similar to those of women from origin countries with more gender equality. While this shift may signal positive integration, it paradoxically worsens women's relative disadvantage in math-based fields relative to men. Thus, citizenship appears to moderate the cultural influence on women's choice of majors, yet it also seems to diminish their motivation to pursue more demanding and potentially higher paying careers.

7 | Robustness and Sensitivity

7.1 | Matching

Before examining the results in greater detail, it is essential to account for the potential unobserved heterogeneity between immigrant students who are citizens and those who are not.

TABLE 3 | Choice of majors: Male and female students.

Dependent variable: *Area*	PEEB	Life Sciences	Social Sciences	Humanities
Male Citizens	−0.087***	0.031	0.022	0.034*
	(0.021)	(0.022)	(0.014)	(0.021)
Female Citizens	−0.124***	0.023	0.037	0.063**
	(0.020)	(0.017)	(0.023)	(0.026)
Covariates and FE	Yes			
Observations	3607			
Log-pseudolikelihood	−3523.07			
$\chi^2(240)$	9350.3			
Pseudo-R^2	0.1488			

Note: Average marginal effects of the interacted variable *Citizenship*Female*. The interacted variable is added to the full multinomial logistic regression of Equation (2). Base groups are *Male Non-Citizen* and *Female Non-Citizen*. The dependent variable is *Area*. Covariates and FE as in Equation (2) and Table 2 (Columns 5–8). The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. Robust standard errors, clustered at the country/region level, in parentheses; ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

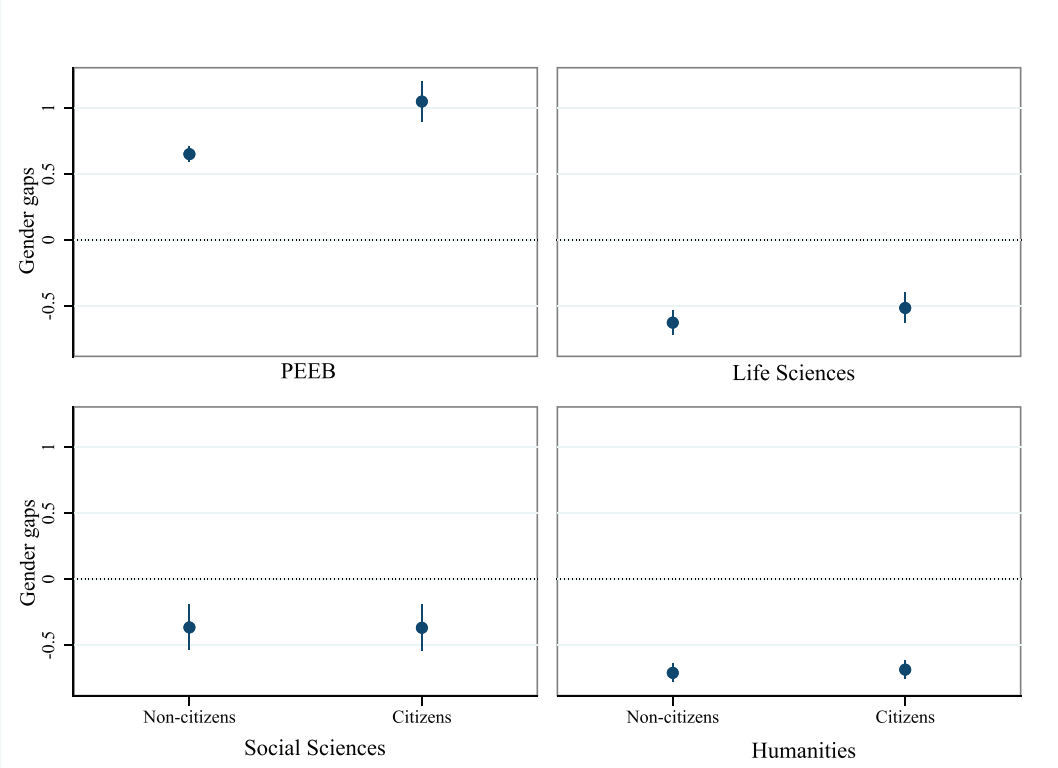

FIGURE 1 | Citizenship and gender gaps in the four field areas. Gender gaps in each area are calculated as described in Equation (3). Predictive margins are computed on the interacted *Citizen*Female* variable, added to the full multinomial regression of Equation (2). Values above 0 in the *y* axis indicate gaps favouring males, and values below 0 indicate gaps favouring females. Vertical lines represent 95% confidence intervals based on standard errors clustered at the country/world region level. The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. [Colour figure can be viewed at wileyonlinelibrary.com]

This step is crucial because unmatched specifications fail to address this heterogeneity, which could introduce bias into the estimates. To address this issue, I employ matching estimators that restrict comparisons to students with similar observable characteristics, differing only in their citizenship status. Although matching can only account for observable traits, the extensive range of factors considered is sufficiently comprehensive to reasonably expect balance in unobservable characteristics as well.

In essence, by matching on individual characteristics and those of countries of origin, the aim is to control for unobservable

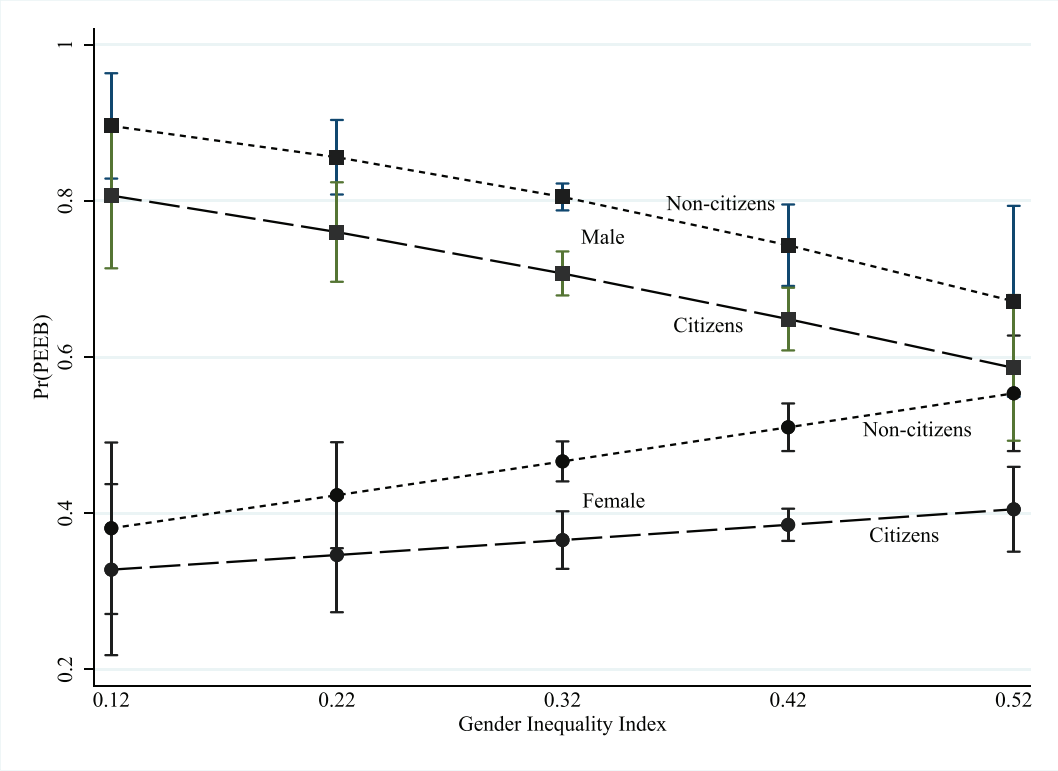

FIGURE 2 | Probabilities of enrolling in PEEB by gender at five progressive levels of inequality. Predictive margins of *Citizenship* Female* at five increasing levels of *GII*, derived from a logistic regression with *PEEB* as the dependent variable and the triple interacted variable *Citizenship* Female* GII* added to the covariates of Equation (2). Capped vertical lines represent 95% confidence intervals based on standard errors clustered at the country/world region level. The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. [Colour figure can be viewed at wileyonlinelibrary.com]

factors that may influence both the eligibility for citizenship and the incentives to apply for it. As a matching strategy, I employ kernel matching with multivariate distance (MD) across all covariates and exact matching of world regions of origin. The results of the multinomial logistic regression from Equation (2), run on the matched sample and presented in Table 4, confirm those in Table 2: Citizenship lowers the probability of enrolling in PEEB and increases the likelihood of enrolling in the other three field areas. Table S2 and Figure S2 provide details on the matching strategy.

Results thus far suggest that citizenship reduces students' need to secure an economically stable future through a degree in the PEEB area, leading them to shift towards less quantitative and less demanding fields of study. It could be argued, however, that because the sample includes only first-cycle and single-cycle levels of study, it cannot be excluded that the seemingly less ambitious choices of citizens are offset by a longer duration of their studies compared to non-citizens. A longer duration of studies would align with some findings in the literature on citizenship, which, however, concern secondary-level rather than tertiary-level education choices (Gathmann and Garbers 2023; Gathmann and Keller 2017; Simonsen 2017).

As the Unimore dataset includes survey data on students' post-graduation study and career plans, it is possible to test whether the students' intentions to continue studying are influenced by their citizenship status. These survey data, available from 2011 onwards and solely from graduates, comprise 584 observations. For 3-year bachelor's graduates, the continuation of studies primarily involves master's courses, whereas for single-cycle graduates, it pertains to specialization or PhD programmes. The data indicate that 43% of students intend to continue their studies (Table 1). These survey responses are used to construct a dummy variable, *Further Study*, which takes the value of 1 if students plan to continue studying and 0 otherwise. *Further Study* is then used as the dependent variable in a logistic regression, with the same covariates as in Equation (2), plus the variable *Area* and its interaction with *Citizenship*. To improve the precision of the results, the regression is conducted on the matched sample.

The results in Table 5, derived from a fully controlled logistic regression on the matched sample, indicate that the likelihood of pursuing further studies decreases with citizenship across the four areas of study. Additional regressions reveal that this decline is more pronounced among males: Their probability of pursuing further studies is 51% for non-citizens and 27% for citizens, whereas for females, these figures are 52% and 35%, respectively. Overall, these results suggest that citizenship is associated with less ambitious investments in human capital after the first-cycle degree. This finding partially diverges from Ferrara and Brunori (2023), who report that second-generation immigrants with Italian citizenship are more likely than their non-naturalized counterparts—and even native students—to

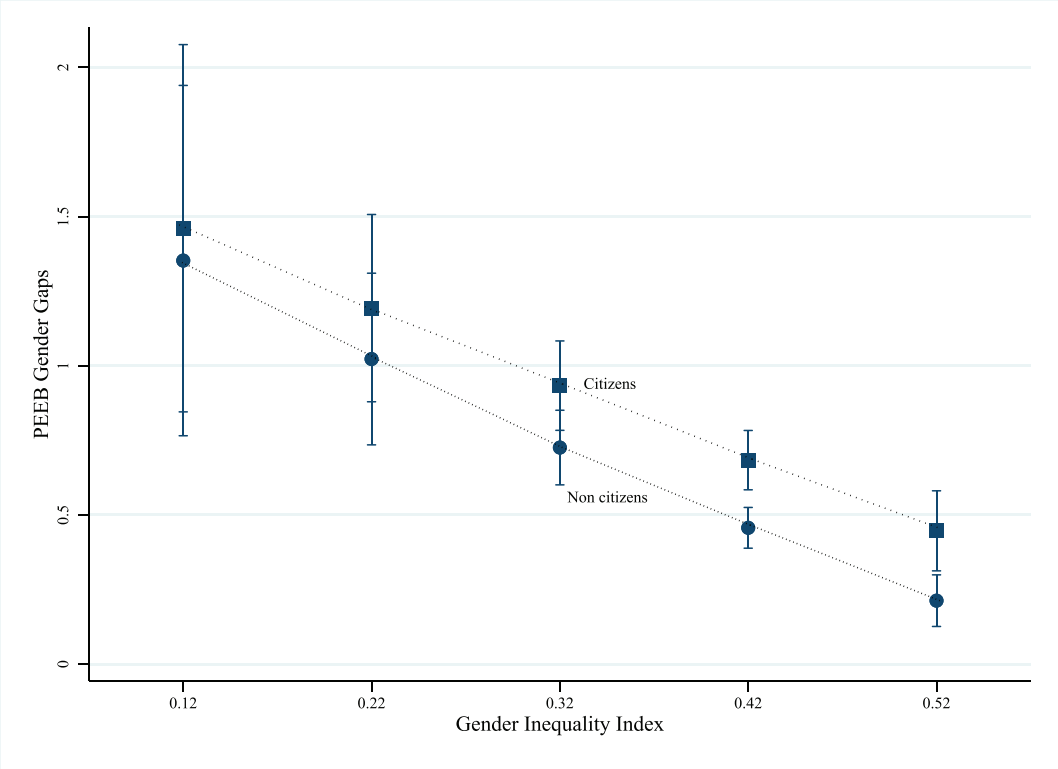

FIGURE 3 | PEEB gender gaps, citizenship and gender inequality. Gender inequality increases to the right on the *x* axis. Positive values in the *y* axis denote gender gaps to the advantage of men. Gender gaps are calculated from predictive margins, as described in Equation (3). The predictive margins of the triple interaction *Citizenship* Female* GII* are derived from the full regression of Equation (2), which here includes the covariates listed in Equation (2) and the triple interaction term. Vertical capped lines represent 95% confidence intervals based on standard errors clustered at the country/world region level. The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 4 | Choice of majors: Balanced sample.

Dependent variable: *Area*	PEEB	Life Sciences	Social Sciences	Humanities
Citizenship	−0.095***	0.031**	0.029*	0.035
	(0.026)	(0.013)	(0.015)	(0.029)
Covariates and FE	Yes			
Observations	3573			
Log-pseudolikelihood	−2762.58			
$\chi^2(237)$	9350.3			
Pseudo-R^2	0.1739			

Note: Average marginal effects of the multinomial logistic regression of Equation (2). The sample is a balanced sample with ATT weights from Table A4. The dependent variable is *Area*. The base group is *Non-Citizen*. Covariates and fixed effects are as in Table 2. The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. Robust standard errors, clustered at the country/region level, in parentheses; ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

enrol in academic school tracks, which are more conducive to continuing studies at the tertiary level.

A potential reason for this difference is the age of students at the levels of education considered: Ferrara and Brunori focus on secondary education decisions, which in Italy are made when students are 14 years old, whereas this study examines investments in human capital beyond the first university degree, when students are, on average, 10 years older. It is possible that citizenship increases the ambition to choose less vocational school tracks at earlier stages of education. However, motivations may differ when postgraduate studies are compared to immediate job opportunities. Citizen students, who have greater access to public sector jobs and regulated professions compared to non-citizens, might feel less inclined to pursue further studies after obtaining a first degree, as they can rely on more favourable labour market conditions. These differing incentives could help to explain the observed divergence in results.

TABLE 5 | Length of studies and citizenship: Balanced sample.

Dependent variable: *Further Study*	
Citizenship: PEEB	−0.171**
	(0.076)
Citizenship: Life Sciences	−0.275***
	(0.071)
Citizenship: Social Sciences	−0.305***
	(0.106)
Citizenship: Humanities	−0.103*
	(0.057)
Covariates	Yes
Observations	570
Log-pseudolikelihood	−248.35
$\chi^2(24)$	86.71
Pseudo-R^2	0.1491

Note: Logistic regression on the sample balanced with ATT weights from kernel MD matching. The dependent variable is *Further Study*, a binary indicator set to 1 if the student intends to continue studying beyond the first cycle and 0 otherwise. Covariates and fixed effects are those in Table 2 (Columns 5–8), with the addition of *Area* and the interaction *Area* Citizenship*. Coefficients represent average marginal effects on the *Citizenship* variable, calculated across the four *Area* categories. The base category is *Non-Citizens*. The sample consists of first-cycle Unimore graduates who completed secondary education between 2011 and 2021. Robust standard errors, clustered by world region, in parentheses; ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

A further potential issue with this study's findings concerns the timing of students' immigration. As noted above, only about a fifth of students in the Italian school system immigrated after the age of 10 (Footnote 7). This proportion might be even lower at the university level if students who arrived at younger ages are more likely to continue their studies into tertiary education. However, even this small group could affect the results if unobserved factors influence both the likelihood of obtaining citizenship and the choice of major. For instance, given the lengthy process required to obtain citizenship, students who immigrated in late childhood might be less likely to hold Italian citizenship than those who arrived earlier and may also have lower proficiency in the Italian language, which can lead them to prefer fields other than the humanities or social sciences.

Although there are no data on age at arrival, a related variable is age at university enrolment. Latecomers are more likely than other students to have repeated school years after arriving in the country—grade repetition being common in the Italian educational system—and consequently may more frequently enrol at university after the standard age of 19. Due to its high correlation with the date of secondary education completion, age at enrolment is not included in this study's regressions. However, a binary variable, *Normal Age*, has been created, which takes the value of 1 if the student enrolled at age 19 or younger and 0 otherwise.

To control for its influence, two approaches were adopted. First, the kernel matching procedure was repeated with *Normal Age* included among the covariates and with exact matching on *Normal Age* (Table S3A). The resulting coefficients do not differ significantly from previous results (Table 2), supporting the study's findings. Secondly, the multinomial logistic regression from Equation (2) was applied to the restricted sample of students who enrolled at university at a normal age (Table S3B). In this case as well, the results remain consistent with previous findings.

7.2 | Two-Stage Least Squares

The results may still be susceptible to bias if the impact of unobservable factors is not adequately addressed. Therefore, this section proposes a two-stage procedure in which citizenship is instrumented with two variables: the proportion of the immigrant population from each country of origin who hold Italian citizenship, referred to as *Immigrant Proportion*, and the stocks of Italian emigrants in those same countries, referred to as *Emigrant Stock*. The proportion of immigrants from each country of origin who hold the host country's citizenship can influence students' willingness to seek citizenship themselves, as it signals the existence of immigrant social networks that can make citizenship more accessible. In turn, the proportion of naturalized immigrants is expected to be shaped by historical or structural factors (such as past immigration inflows and policies), rather than by current students' preferences for specific university majors.

The second instrument, the stocks of Italian emigrants in the students' countries of origin, can also influence students' perceptions or decisions about citizenship. For example, diaspora links can make citizenship more accessible or desirable for students from countries with larger Italian emigrant populations. Students from these countries are also more likely to have Italian ancestors, which makes citizenship more accessible to them due to Italy's jus sanguinis law. At the same time, emigrant outflows are determined by factors unrelated to students' choices of university majors, such as economic conditions in both origin and destination countries. Thus, although emigration might affect the likelihood of a student acquiring citizenship, it should not directly impact a student's choice of major. Moreover, structural factors that do not change over time, such as past migration and policies, as well as foreign countries' laws on dual citizenship, culture in origin countries and cultural ties with Italy—which could also positively affect the acquisition of citizenship—are controlled for by the model's country/region fixed effects.

Column 1 in Table 6 includes the instrument *Immigrant Proportion* only, whereas Column 2 contains *Emigrant Stock* only, and Column 3 comprises both instruments. The coefficients on the instrumented *Citizenship* variable are negative and significant at the 1% level for the PEEB outcome in all regressions, whereas the coefficients are positive and significant for the life sciences (Column 4) and social sciences (Column 5) outcomes. The underidentification (Kleibergen–Paap statistics), overidentification and the Sanderson–Windmeijer (SW) *F* tests confirm the suitability of the instruments.

Both instruments used in Table 6 meet the requirement of monotonicity. However, to further check whether the results are driven by observations from countries with the largest

TABLE 6 | 2SLS: Citizenship and choice of majors.

	(1)	(2)	(3)	(4)	(5)	(6)
Stage I dependent variable: *Citizenship*	PEEB	PEEB	PEEB	Life Sciences	Social Sciences	Humanities
Immigrant Proportion	0.035***		0.016****	0.016****	0.016****	0.016****
	(0.007)		(0.010)	(0.010)	(0.010)	(0.010)
Emigrant Stock		0.085***	0.080***	0.080***	0.080***	0.080***
		(0.011)	(0.013)	(0.013)	(0.013)	(0.013)
Covariates and FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage II dependent variable: *Area*	**PEEB**	**PEEB**	**PEEB**	**Life Sciences**	**Social Sciences**	**Humanities**
Citizenship	−0.312***	−0.190**	−0.205***	0.102*	0.071**	0.032
	(0.086)	(0.082)	(0.072)	(0.057)	(0.036)	(0.057)
Covariates and FE	Yes	Yes	Yes	Yes	Yes	Yes
S–W *F* test	21.45	52.89	25.96	25.96	25.96	25.96
Test[a]	7.245	13.304	14.345	14.345	14.345	14.345
p value	0.007	0.000	0.001	0.001	0.001	0.001
Test[b]			0.95	1.18	1.702	3.385
p value			0.3298	0.2774	0.192	0.066
Observations	3607	3607	3607	3607	3607	3607
Uncentred R^2	0.132	0.161	0.158	0.0214	0.011	0.1

Note: Two-stage least squares linear probability (2SLS-LPM). *Immigrant Proportion* is the time-invariant proportion of citizens from each country over total immigration from the country during 1996–2021. *Emigrant Stock* is the time-varying natural log of stocks of Italian emigrants to each country during 1996–2021. Covariates and FE as in Table 2 (Columns 5–8). The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. Robust standard errors in parentheses, clustered at the world region level. ****$p < 0.11$, ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

[a]Underidentification test (Kleibergen–Paap).

[b]Overidentification test.

concentration of Italian emigrants, or the highest proportions of immigrants holding Italian citizenship, the regressions in Table 6 have been re-run after excluding, first, the highest decile of the variable *Immigrant Proportion*; second, the highest decile of *Emigrant Stock*; and third, excluding the highest deciles of both variables. In all three cases, results were confirmed.

In subsequent regressions, a third instrumental variable is introduced to the 2SLS specification in Table 6: the number of immigrants who have acquired Italian nationality, categorized by their former nationality. This time-varying variable captures the size of citizen networks by country of origin rather than the proportion of citizens within immigrant networks. The results, in this case as well, reinforce the study's findings (Table S4).

7.3 | Households With One Parent Holding Italian Citizenship

Although the sample thus far has included only students with no Italian parents, examining the effects of citizenship when one parent is Italian can help assess the sensitivity of the results. Italian citizenship law grants individuals with one Italian parent the right to become citizens themselves. To thoroughly test the effects on students' choice of fields, it would be useful to know the timing of the parent's acquisition of citizenship, as the further back in time it happened, the longer students have been aware of their own right to citizenship and made their educational choices with this knowledge (Bean et al. 2011; Patler 2017). However, the dataset does not specify the date of the parent's naturalization, nor does it differentiate between native Italian parents and naturalized immigrants. Despite this lack of data, it can reasonably be presumed that a greater degree of certainty regarding one's own citizenship rights could influence the choice of majors.

Hence, the sample is enlarged to include students with one parent holding Italian citizenship, increasing the number of observations to 5123. A binary variable, *Parent*, which takes the value of 1 if one parent holds Italian citizenship and 0 otherwise, is added to the list of covariates in Equation (2), and the multinomial logistic regression is run on the extended sample. The results from this regression mirror those obtained with the restricted sample: With citizenship, the likelihood of majoring in PEEB decreases by 9 percentage points, with significance at the 1% level, whereas the likelihoods of majoring in social sciences and humanities increase by 2 and 5 percentage points, with significance at the 10% and 1% levels, respectively. There is no effect in the area of life sciences (Table S5).

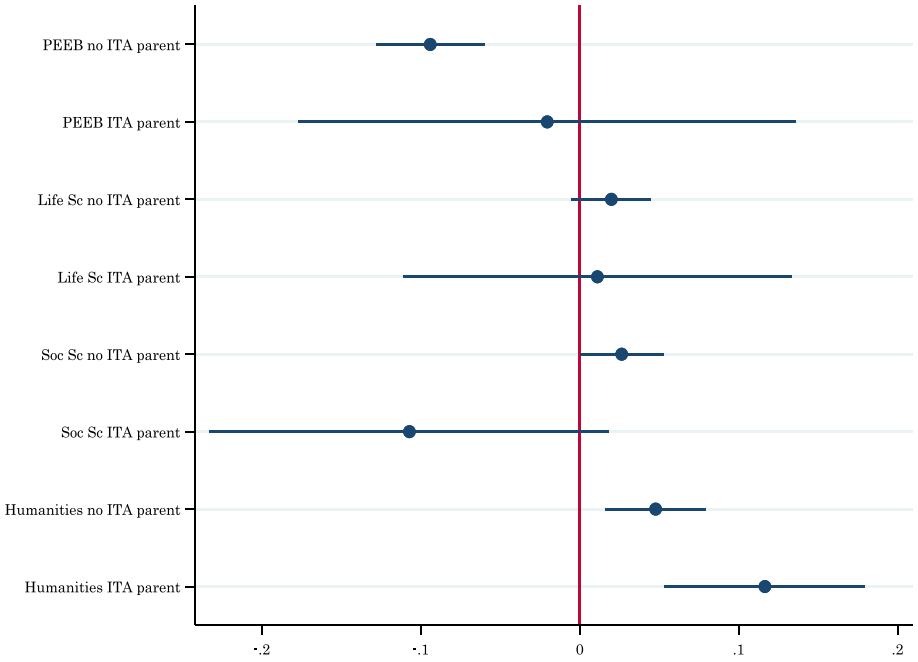

FIGURE 4 | Effect of citizenship with one parent holding Italian citizenship. Average marginal effects of the interaction between *Parent* and *Citizenship*. *Parent*, a binary variable indicating that one parent holds Italian citizenship, is included among the covariates in the multinomial logistic regression specified in Equation (2) and Table 2, Columns 5–8, with *Area* as the dependent variable. The sample consists of first-cycle university students who completed secondary education between 1996 and 2021. Horizontal lines represent 95% confidence intervals, based on standard errors clustered at the country or world region level. [Colour figure can be viewed at wileyonlinelibrary.com]

To better explore the effects of citizenship on the choice of majors when a parent holds the Italian citizenship, the list of covariates is further extended to include the interaction between *Citizenship* and *Parent*. The average marginal effects of the interacted variable are depicted in Figure 4, where the coefficients of students with no Italian parents reproduce the findings of the previous sections. Regarding students with one Italian parent, the figure indicates that citizenship leads to significant modifications only in the area of the humanities, where these students' likelihood of enrolling increases by more than 10 percentage points. These results can be interpreted as a confirmation of previous findings: Because citizenship can act as a buffer against labour market fragilities, the greater the certainty of obtaining citizenship status, the less this buffer is needed, and the more the humanities can be the chosen area.

Taken together, the findings of this study suggest that citizenship, by expanding students' opportunities in the labour market after graduation and at least partially liberating them—particularly women—from the cultural influence of their households, increases their likelihood of pursuing career paths that may be less economically rewarding but also less demanding.

To what extent can these results be generalized? Everything else given, they appear to depend on the extent to which citizenship increases security and empowerment and thus on labour market conditions and national welfare systems in the destination country. It has already been mentioned that, in several respects, the Italian region where Unimore is located is representative of central Western Europe. The region is industrialized and has higher levels of employment overall, particularly in modern sectors of the economy, compared with regions in Southern Italy or less developed areas of Europe. This makes enrolment in PEEB fields conducive to good income prospects after graduation, even with only a bachelor's or single-cycle degree.

At the same time, Italy's regulations—similar to those of most European and other developed countries—restrict employment in the public sector and access to certain professions to citizens, while providing them with substantial welfare protections. Because most jobs in the public sector and many of the restricted professions are not related to PEEB fields, obtaining citizenship appears to reduce the income premium associated with math-related knowledge. At a broad level, this aligns with the findings of Even et al. (2023), who report that, across 11 OECD countries, greater employment protection is associated with a lower STEM premium. The change in status from non-citizen to citizen entails an increase in overall protection within a country.

8 | Conclusions

The impact of citizenship on the selection of majors among immigrant students remains a relatively unexplored area. However, it holds substantial importance as it sheds light on how security and integration in the host country influence individuals' types of investment in human capital.

This study utilized comprehensive data on immigrant students at a representative, medium-sized Italian university, supplemented with information on the characteristics of their countries of origin, to analyse the effects of citizenship on the choice of majors. After controlling for several factors that influence these choices and employing matched samples and instrumenting citizenship, the results indicate that citizenship reduces the

likelihood of choosing majors in math-related fields and encourages shifts to other academic disciplines.

One likely explanation for this shift lies in the positive association between math-related fields and post-graduation earnings, which makes these fields potentially more appealing to non-citizens, who face greater uncertainty regarding their prospects after graduation. Citizens, by contrast, may choose fields with less mathematical content without encountering the same level of risk, as they benefit from higher levels of social and economic protection and access to a broader range of job opportunities exclusively available to them.

In response to this result, one might argue that citizenship could potentially extend the duration of studies, as Ferrara and Brunori (2023) found at the secondary school level, thereby mitigating the economic disadvantage of shifting to low-math disciplines. However, the analysis of Unimore students' plans regarding further studies shows that citizenship tends to reduce their willingness to continue studying beyond their first degree. This finding is consistent with the higher level of protection provided by citizenship, which makes the additional effort of attaining a further degree less beneficial for citizens compared to non-citizens.

In line with prevailing trends in the literature on gender disparities in mathematics at the school level, this study reveals a gender gap in math-related fields at university. Notably, this gap widens with citizenship. The widening is driven by a proportionately larger decline in female enrolments in math-intensive fields compared to their male counterparts. In other words, with citizenship—despite the empowerment and broader job opportunities it offers—women are less, rather than more, encouraged to pursue traditionally male-dominated PEEB fields. Instead, they tend to choose areas associated with less demanding careers but also lower income prospects.

Moreover, this shift is more pronounced among women from countries of origin with more unequal gender norms. This is particularly interesting because these women, as non-citizens, are the most likely to enrol in math-intensive majors. This may reflect their greater need for independence, pursued through studies in the PEEB fields, as a response to households with strong gender stereotypes. Alternatively, it may stem from parents in more gender-unequal countries being more supportive of math-related careers for their children, regardless of gender. In any case, once these female students acquire citizenship, they seem to distance themselves from household influences and align more closely with their peers from more gender-equal countries. However, in doing so, they forgo the more economically rewarding career paths.

From a general perspective, the overall shift to less math-intensive majors has the positive implication of increasing diversity in knowledge sectors—especially social sciences and humanities—which are often mostly ethnically homogeneous and dominated by natives. Greater diversity across all sectors of the economy, and not just in those based on mathematical knowledge, can positively affect innovation, growth and social integration. At the same time, however, the fact that women are disproportionately making this shift is less positive.

The findings that gender gaps in math-related fields are often wider in more gender-equal societies and that these gaps expand with citizenship and integration suggest that social development alone may not reduce gender disparities in these areas of knowledge and professions. In fact, some features of developed societies may even exacerbate the under-representation of women in math-related fields. Consequently, policy efforts should prioritize identifying the underlying institutional, rather than solely cultural, causes of this segregation and take active steps to address them.

Acknowledgements

Open access publishing facilitated by Universita degli Studi di Modena e Reggio Emilia, as part of the Wiley - CRUI-CARE agreement.

Data Availability Statement

The dataset generated and analyzed in this study uses information coming from the administrative archives of the University of Modena and Reggio Emilia. It is not publicly available due to restrictions related to data ownership. However, together with all do files, it is available from the author on reasonable request by remote connection to a dedicated server.

Endnotes

[1] One partial exception is Nores (2010), who analyses the choice of majors of nonimmigrant and immigrant students. Her analysis, however, focuses on the effects of reduced tertiary education fees for undocumented immigrants, rather than on the implications of citizenship acquisition.

[2] This possibility aligns with Borgen and Hermansen (2023), who compare the educational choices of immigrants with those of natives in Norway and find that immigrants exhibit a higher concentration of choices in high-paying fields.

[3] Even et al. (2023) find a consistent wage premium associated with STEM jobs across 11 OECD countries. Using US data, Berger (1988) and Staniec (2004) uncover a positive relationship between the mathematical content of majors and labour market earnings. Noonan (2017) reports that STEM workers earn about 29% more than non-STEM workers after controlling for a wide range of worker characteristics. Deming and Noray (2020) confirm the role of quantitative skills in driving higher earnings. Greenwood et al. (2011) and Yao (2019) find a STEM wage premium in the United Kingdom, whereas Croce and Ghignoni (2020) provide evidence for Italy.

[4] Although most of the research on math gender gaps relies on school-level data, a few exceptions focus on tertiary education. Among them, Chise et al. (2021) and Granato (2023) uncover the significant influence of parents' education on gender gaps in STEM fields. Recently, attention has expanded to economics, a field sharing mathematical content with STEM, where a substantial gender gap in favour of males is observed (Avilova and Goldin 2018). Bertocchi et al. (2023) find that this gap is strongly associated with the mathematical content of the high school curriculum and that a lower socioeconomic status increases the likelihood of women enrolling in the field.

[5] The ordering is based on Granato (2023) where fields of study in the Italian university system are classified in terms of their mathematical content.

[6] The empirical literature designates immigrants arriving in the host country during infancy or early adolescence as the 1.75 or 1.5 generation.

[7] A 2015 census shows that among schoolchildren with an immigrant background, over 30% were born in Italy. Of those who arrived from

abroad, more than 80% were under the age of 10 at the time of arrival. The proportion of children originating from two of the most represented countries, Albania and Morocco, who immigrated at over 10 years old, is about 10%, and more than 40% were born in Italy (ISTAT 2020).

[8] Because the dataset does not differentiate between students born as Italian citizens and those who are second-generation naturalized citizens, some second-generation immigrant students are unintentionally excluded from the sample. However, the overall percentage of second-generation immigrants holding Italian citizenship is exceedingly low (ISTAT 2020), which suggests that the expected proportion of such omitted observations is minimal.

[9] Entry restrictions are particularly binding in the high-paying fields of medicine and dentistry, which are also 6-year courses. Relatedly, Croce and Ghignoni (2020), in highlighting the age premium associated with STEM jobs in Italy, exclude graduates in medicine from their sample due to the unique nature of their education-to-work transitions.

[10] The choice of restricting the sample to immigrant students who are either born or most likely living since infancy into the country lines up with the epidemiological approach, where individual choices are presumed to be influenced by the culture, or social norms, of their country of origin but not by its institutions, economy or other characteristics. Following this approach, I focus on norms related to gender inequality in countries of origin, proxied with the Gender Inequality Index (GII) provided by the United Nations Development Programme (UNDP) (Table A2). The Global Gender Gap Index, published by the World Economic Forum, employs comparable indicators and is commonly utilized in empirical research, but the GII is the preferred metric for this study due to its broader coverage of both years and countries.

[11] In what follows, both average marginal effects and predictive margins will be employed. For a discrete covariate, average marginal effects are the effect of a discrete change of the predictive margins of the covariate, whereas for a continuous covariate, average marginal effects are the first derivative of the response with respect to the covariate.

References

Anghel, B., N. Rodríguez-Planas, and A. Sanz-de-Galdeano. 2020. "Is the Math Gender Gap Associated With Gender Equality? Only in Low-Income Countries." *Economics of Education Review* 79, no. C: 102064. https://doi.org/10.1016/j.econedurev.2020.102025.

Avilova, T., and C. Goldin. 2018. "What Can UWE Do for Economics?" *American Economic Review: Papers and Proceedings* 108: 186–190. https://doi.org/10.1257/pandp.20181003.

Avitabile, C., I. Clots-Figueras, and P. Masella. 2014. "Citizenship, Fertility, and Parental Investments." *American Economic Journal: Applied Economics* 6: 35–65. https://doi.org/10.1257/app.6.4.35.

Bean, F. D., M. A. Leach, S. K. Brown, J. D. Bachmeier, and J. R. Hipp. 2011. "The Educational Legacy of Unauthorized Migration: Comparisons Across U.S.-Immigrant Groups in How Parents' Status Affects Their Offspring." *International Migration Review* 45, no. 2: 348–385. https://doi.org/10.1111/j.1747-7379.2011.00852.x.

Berger, M. C. 1988. "Predicted Future Earnings and Choice of College Major." *ILR Review* 41, no. 3: 418–429. https://doi.org/10.2307/2523907.

Bertocchi, G., L. Bonacini, and M. Murat. 2023. "Adams and Eves: High School Math and the Gender Gap in Economics Majors." *Economic Inquiry* 61, no. 4: 798–817. https://doi.org/10.1111/ecin.13156.

Borgen, S. T., and A. S. Hermansen. 2023. "Horizontal Advantage: Choice of Postsecondary Field of Study Among Children of Immigrants." *Demography* 60, no. 4: 1031–1058. https://doi.org/10.1215/00703370–10547232.

Breda, T., E. Jouini, C. Napp, and G. Thebault. 2020. "Gender Stereotypes Can Explain the Gender-Equality Paradox." *PNAS Proceedings of the National Academy of Sciences of the United States of America* 117, no. 49: 31063–31069. https://doi.org/10.1073/pnas.2008704117.

Chise, D., M. Fort, and C. Monfardini. 2021. "On the Intergenerational Transmission of STEM Education Among Graduate Students." *B.E. Journal of Economic Analysis & Policy* 21: 115–145. https://doi.org/10.1515/bejeap-2020–0128.

Contini, D., and D. Azzolini. 2016. "Performance and Decisions: Immigrant–Native Gaps in Educational Transitions in Italy." *Journal of Applied Statistics* 43, no. 1: 98–114. https://doi.org/10.1080/02664763.2015.1077375.

Croce, G., and E. Ghignoni. 2020. "The Evolution of Wage Gaps Between STEM and Non-STEM Graduates in a Technological Following Economy." *Applied Economics* 52, no. 23: 2427–2442.

Cygan-Rehm, K. 2018. "Estimating the Effect of Early-Childhood Citizenship on Education Using Policy Changes as Instruments." *Applied Economics Letters* 25, no. 20: 1426–1431. https://doi.org/10.1080/13504851.2018.1429594.

Deming, J. D., and K. Noray. 2020. "Earnings Dynamics, Changing Job Skills, and STEM Careers." *Quarterly Journal of Economics* 135, no. 4: 1965–2005. https://doi.org/10.1093/qje/qjaa021.

Dronkers, J., and F. Fleischmann. 2010. "The Educational Attainment of Second Generation Immigrants From Different Countries of Origin in the EU Member-States." In *Quality and Inequality of Education*, edited by J. Dronkers, 163–204. Springer.

Dustmann, C. 2008. "Return Migration, Investment in Children, and Intergenerational Mobility: Comparing Sons of Foreign- and Native-Born Fathers." *Journal of Human Resources* 43, no. 2: 299–324. https://doi.org/10.3368/jhr.43.2.299.

Even, W. E., T. Yamashita, and P. A. Cummins. 2023. "The STEM Wage Premium Across the OECD." *New Horizons in Adult Education and Human Resource Development* 35, no. 1: 5–19. https://doi.org/10.1177/19394225231171575.

Felfe, C., H. Rainer, and J. Saurer. 2020. "Why Birthright Citizenship Matters for Immigrant Children: Short- and Long-Run Impacts on Educational Integration." *Journal of Labor Economics* 38: 143–182. https://doi.org/10.1086/708207.

Fellini, I., and R. Guetto. 2022. "Legal Status and Immigrants' Labour Market Outcomes: Comparative Evidence From a Quasi-Experiment in Western and Southern Europe." *Journal of Ethnic and Migration Studies* 48, no. 11: 2740–2761. https://doi.org/10.1080/1369183X.2021.1880024.

Fernández, R. 2011. "Does Culture Matter?" In *Handbook of Social Economics*, edited by J. Benhabib, A. Bisin, and M. O. Jackson, vol. 1, 481–510. North-Holland. https://doi.org/10.1016/B978-0-444-53187-2.00011–5.

Ferrara, A., and C. Brunori. 2023. "Immigrant Generation, Gender, and Citizenship: Evidence on Educational Track Choices From Italy." *Journal of Ethnic and Migration Studies* 50, no. 6: 1549–1571. https://doi.org/10.1080/1369183X.2023.2218047.

Fibbi, R., M. Lerch, and P. Wanner. 2007. "Naturalisation and Socio-Economic Characteristics of Youth of Immigrant Descent in Switzerland." *Journal of Ethnic and Migration Studies* 33, no. 7: 1121–1144. https://doi.org/10.1080/13691830701541655.

Fryer, R. G., Jr., and S. D. Levitt. 2010. "An Empirical Analysis of the Gender Gap in Mathematics." *American Economic Journal: Applied Economics* 2, no. 2: 210–240. https://doi.org/10.1257/app.2.2.210.

Gathmann, C., and J. Garbers. 2023. "Citizenship and Integration." *Labour Economics* 82: 102343. https://doi.org/10.1016/j.labeco.2023.102343.

Gathmann, C., and N. Keller. 2017. "Access to Citizenship and the Economic Assimilation of Immigrants." *Economic Journal* 128: 3141–3181. https://doi.org/10.1111/ecoj.12592.

Gathmann, C., C. Vonnahme, A. Busse, and J. Kim. 2021. "Marginal Returns to Citizenship and Educational Performance." CEPR Discussion Paper No. 16636. The Centre for Economic Policy Research (CEPR).

Granato, S. 2023. "Early Influences and the Gender Gap in Scientific Curricula (STEM): Can Policies Facilitate Girls' School-to-Work Transition?" *Journal of Policy Modeling* 45, no. 3: 494–521. https://doi.org/10.2139/ssrn.3845391.

Greenwood, C., M. Harrison, and A. Vignoles. 2011. "The Labour Market Value of STEM Qualifications and Occupations." Institute of Education/Royal Academy of Engineering. https://raeng.org.uk/media/pvdeuknv/the-labourmarket-value-of-stem-qualifications-and-occupations.pdf.

Guiso, L., F. Monte, P. Sapienza, and L. Zingales. 2008. "Culture, Gender, and Math." *Science* 320: 1164–1165. https://doi.org/10.1126/science.1154094.

Hainmueller, J., D. Lawrence, J. Gest, M. Hotard, R. Koslowski, and D. Laitin. 2018. "A Randomized Controlled Design Reveals Barriers to Citizenship for Low-Income Immigrants." *Proceedings of the National Academy of Sciences of the United States of America* 115: 939–944. https://doi.org/10.1073/pnas.1715495115.

ISTAT. 2020. "Identità e percorsi di integrazione delle seconde generazioni in Italia." https://www.istat.it/it/archivio/240930.

Jensen, K. K., P. Mouritsen, E. C. Bech, and T. V. Olsen. 2019. "Roadblocks to Citizenship: Selection Effects of Restrictive Naturalisation Rules." *Journal of Ethnic and Migration Studies* 47: 1047–1065.

Jergens, W. 2023. "Gender Equity and the Gender Gap in STEM: Is There Really a Paradox?" *Journal of Population Economics* 36, no. 4: 3029–3056.

Kilpi-Jakonen, E. 2014. "Citizenship and Educational Attainment Amongst the Second Generation: An Analysis of Children of Immigrants in Finland." *Journal of Ethnic and Migration Studies* 40, no. 7: 1079–1096.

Labussière, M. 2023. "Timing of Citizenship Acquisition and Immigrants' Children Educational Outcomes: A Family Fixed-Effects Approach." *European Sociological Review* 40, no. 4: 1–15. https://doi.org/10.1093/esr/jcad027.

Labussière, M., M. Levels, and M. Vink. 2021. "Citizenship and Education Trajectories Among Children of Immigrants: A Transition-Oriented Sequence Analysis." *Advances in Life Course Research* 50: 100433. https://doi.org/10.1016/j.alcr.2021.100433.

Lippmann, Q., and C. Senik. 2018. "Math, Girls and Socialism." *Journal of Comparative Economics* 46, no. 3: 874–888. https://doi.org/10.1016/j.jce.2018.03.001.

McFadden, D. 1973. "Conditional Logit Analysis of Qualitative Choice Behavior." In *Frontiers in Econometrics*, edited by P. Zarembka, 105–142. Academic Press.

MIUR. 2017. "Gli alunni stranieri nel sistema scolastico italiano, A.S. 2015/16." Ufficio Statistica e Studi.

MIUR. 2018. "Gli alunni con cittadinanza non italiana, A.S. 2016/2017." Ufficio Statistica e Studi.

Nollenberger, N., N. Rodríguez-Planas, and A. Sevilla. 2016. "The Math Gender Gap: The Role of Culture." *American Economic Review* 106, no. 5: 257–261. https://doi.org/10.1257/aer.p20161121.

Noonan, R. 2017. "STEM Jobs: 2017 Update." US Department of Commerce, ESA Issue Brief #02-17. https://www.commerce.gov/sites/default/files/migrated/reports/stem-jobs-2017-update.pdf.

Nores, M. 2010. "Differences in College Major Choice by Citizenship Status." *Annals of the American Academy of Political and Social Science* 627: 125–141. http://www.jstor.org/stable/40607409.

OECD. 2018. *Education at a Glance 2018: OECD Indicators*. OECD Publishing. https://doi.org/10.1787/eag-2018-en.

Patler, C. 2017. "Citizen Advantage, Undocumented Disadvantage, or Both? The Comparative Educational Outcomes of Second and 1.5-Generation Latino Young Adults." *International Migration Review* 52: 1080–1110.

Peters, F., M. P. Vink, and H. Schmeets. 2016. "The Ecology of Immigrant Naturalization: A Life Course Approach in the Context of Institutional Conditions." *Journal of Ethnic and Migration Studies* 42, no. 3: 359–381.

Porter, S. R., and P. D. Umbach. 2006. "College Major Choice: An Analysis of Person–Environment Fit." *Research in Higher Education* 47, no. 4: 429–449. http://www.jstor.org/stable/40197411.

Rodríguez-Planas, N., and N. Nollenberger. 2018. "Let the Girls Learn! It Is Not Only About Math ... It's About Gender Social Norms." *Economics of Education Review* 62: 230–253. https://doi.org/10.1016/j.econedurev.2017.11.006.

Simonsen, K. B. 2017. "Does Citizenship Always Further Immigrants' Feeling of Belonging to the Host Nation? A Study of Policies and Public Attitudes in 14 Western Democracies." *Comparative Migration Studies* 5, no. 3: 1–17.

Staniec, J. F. O. 2004. "The Effects of Race, Sex, and Expected Returns on the Choice of College Major." *Eastern Economic Journal* 30, no. 4: 549–562. http://www.jstor.org/stable/40326147.

Stoet, G., and D. C. Geary. 2018. "The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education." *Psychological Science* 29, no. 4: 581–593. https://doi.org/10.1177/0956797617741719.

Turner, S. E., and W. G. Bowen. 1999. "Choice of Major: The Changing (Unchanging) Gender Gap." *Industrial and Labor Relations Review* 52, no. 2: 289–313. https://doi.org/10.2307/2525167.

Yao, K. 2019. "Heterogeneous Skill Distribution and College Major: Evidence From PIAAC." *Journal of Applied Economics* 22, no. 1: 504–526.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Appendix A

In Table A4, treatment effects are derived from multivariate distance kernel Epanechnikov matching, where treated students are citizens. Covariates are those in Table 2 (Columns 5–8). The specifications include exact matching on the world region of origin (as in Table 1) and an adjustment equation in which the dependent variable is *Area* and covariates are as in Table 2.

The findings in Table A4 corroborate those based on the raw sample (Table 2). In the matched sample as well, students who acquire citizenship are significantly less likely to major in PEEB fields and more likely to major in other fields. A gender-based analysis further reveals that the overall decline in PEEB enrolment is predominantly driven by female students (Column 5), whereas the treatment effect for male students in PEEB (Column 6) is less pronounced and not statistically significant. This reduction in PEEB enrolments is consistent with the findings in Table 3 and the associated increase in the gender gap in math-related fields, as shown in Figure 1.

TABLE A1 | Countries and world regions.

ALB		DOM	Central and North America	MOZ	Sub-Saharan Africa
MAR		DZA	North Africa and Middle East	MRT	Sub-Saharan Africa
MDA		ECU	South America	MUS	Sub-Saharan Africa
IND		EGY	North Africa and Middle East	MWI	Sub-Saharan Africa
UKR		ERI	Sub-Saharan Africa	MYS	East Asia
GHA		ESP	Europe	NGA	Sub-Saharan Africa
RUS		EST	Europe	NIC	Central and North America
CHE		ETH	Sub-Saharan Africa	NLD	Europe
BRA		FIN	Europe	NOR	Europe
ARG		FRA	Europe	NPL	Central Asia
PAK		GBR	Europe	NZL	East Asia
PER		GEO	Central Asia	PHL	East Asia
TUN		GIN	Sub-Saharan Africa	POL	Europe
CHN		GMB	Sub-Saharan Africa	PRT	Europe
AFG	Central Asia	GRC	Europe	PRY	South America
AGO	Sub-Saharan Africa	HND	Central and North America	ROU	Europe
ARE	North Africa and Middle East	HRV	Europe	SAU	North Africa and Middle East
ATG	Central and North America	HUN	Europe	SCG	Europe
AUS	East Asia	IDN	East Asia	SEN	Sub-Saharan Africa
AUT	Europe	IRL	Europe	SLV	Central and North America
BDI	Sub-Saharan Africa	IRN	North Africa and Middle East	SMR	Europe
BEL	Europe	IRQ	North Africa and Middle East	SOM	Sub-Saharan Africa
BEN	Sub-Saharan Africa	ISR	North Africa and Middle East	SRB	Europe
BFA	Sub-Saharan Africa	JEY	Europe	SVN	Europe
BGD	Central Asia	JOR	North Africa and Middle East	SVK	Europe
BGR	Europe	JPN	East Asia	SWE	Europe
BIH	Europe	KAZ	Central Asia	SYC	Sub-Saharan Africa
BLR	Europe	KEN	Sub-Saharan Africa	SYR	North Africa and Middle East
BOL	South America	KGZ	Central Asia	TCD	Sub-Saharan Africa
CAF	Sub-Saharan Africa	KOS	Europe	TGO	Sub-Saharan Africa
CAN	Central and North America	LAO	East Asia	THA	East Asia

(Continues)

TABLE A1 | (Continued)

CHL	South America	LBN	North Africa and Middle East	TKM	Central Asia
CIV	Sub-Saharan Africa	LBR	Sub-Saharan Africa	TUR	North Africa and Middle East
CMR	Sub-Saharan Africa	LBY	North Africa and Middle East	TWN	East Asia
COD	Sub-Saharan Africa	LKA	Central Asia	TZA	Sub-Saharan Africa
COL	South America	LTU	Europe	UGA	Sub-Saharan Africa
CRI	Central and North America	LUX	Europe	URY	South America
CSK	Europe	LVA	Europe	USA	Central and North America
CUB	Central and North America	MCO	Europe	UZB	Central Asia
CYP	Europe	MDG	Sub-Saharan Africa	VEN	South America
CZE	Europe	MEX	Central and North America	VNM	East Asia
DDR	Europe	MKD	Europe	YUG	Europe
DEU	Europe	MLI	Sub-Saharan Africa	ZAF	Sub-Saharan Africa
DJI	Sub-Saharan Africa	MNE	Europe	ZMB	Sub-Saharan Africa
DNK	Europe	MNG	East Asia		

Note: The first 15 countries in terms of the number of immigrant students, all other countries grouped within the respective world regions, are indicated in the corresponding row. The Italian areas are north, centre and south.

TABLE A2 | Variable description and sources.

Variable	Description	Source
Area	Categorical variable comprising PEEB, Life Sciences, Social Sciences and Humanities.	Unimore data
Citizenship	Binary: Takes a value of 1 when the student is an Italian citizen and 0 otherwise.	Unimore data
Female	Binary: Takes a value of 1 when the student is female.	Unimore data
High School Math	Ordinal variable: Takes a value of 0 when the mathematical content is low, 1 when it is medium and 2 when it is high.	Unimore data
High School Grade	Graduation grade at high school: Varies between 60 and 100.	Unimore data
Socioeconomic Status	University fees; increase with household income; vary from €0 to €4841.	Unimore data
Enrolment Status	Categorical variable indicating the student's current status: Dropout, attending, graduate or transferred.	Unimore data
GII	Gender Inequality Index: Varies between 0 and 1. Higher values denote more inequality. The *GII* evaluates the position of women in society through reproductive health, labour market participation, education and parliamentary seats.	United Nations Development Programme
GDP per Capita	Gross value added produced during the year in the economy divided by mid-year population.	World Bank Statistics
Emigrant Stock	Time-varying variable denoting the number of Italians residing abroad and registered with AIRE.	Anagrafe Italiani residenti all'Estero (AIRE)
Immigrant Proportion	Time-invariant ratio of citizens from each country to the total immigration from that country, measured over the period 1996–2021.	OECD statistics. Bilateral migration database
Parent	Binary variable equal to 1 if one parent holds the Italian citizenship and 0 otherwise.	Unimore data
Further Studies	Binary variable equal to 1 if the study plans to pursue further studies after the first cycle and 0 otherwise.	Unimore data
Admission	Binary variable equal to 1 if enrolment in the field of study is restricted by entrance examinations and 0 otherwise.	Ministero dell'Università e della Ricerca (MUR)

TABLE A3 | Main fields by area.

Physical sciences, technology, mathematics, engineering, economics and business economics (PEEB)	Life Sciences
Sciences	Healthcare and medical sciences
Chemistry	Nursing
Physics	Medicine and surgery
Computer science	Dentistry
Mathematics	Biology and biotechnology
Geological sciences	Pharmacy and herbal sciences
Natural sciences	Agricultural and environmental sciences
Agricultural and environmental sciences	Health management and public health
Engineering	
Chemistry and pharmacy	
Economics and business	
Social Sciences	**Humanities**
Law and legal sciences	Education and training
Public administration and services	Communication and cultural studies
Information and communication sciences	European languages and cultures
	Contemporary history and cultures

TABLE A4 | Citizenship and enrolment across areas: Kernel MD matching.

	(1)	(2)	(3)	(4)
	PEEB	Life Sciences	Social Sciences	Humanities
ATE	−0.106***	0.028**	0.031***	0.047***
	(0.018)	(0.013)	(0.012)	(0.014)
ATT	−0.105***	0.029*	0.037***	0.038**
	(0.020)	(0.015)	(0.012)	(0.017)
ATC	−0.107***	0.027*	0.027*	0.053***
	(0.020)	(0.015)	(0.014)	(0.016)
Obs.	3607	3607	3607	3607

	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	PEEB		Life Sciences		Social Sciences		Humanities	
	Female	Male	Female	Male	Female	Male	Female	Male
ATE	−0.070***	−0.030*	0.009	0.017**	0.016	0.014**	0.027*	0.018**
	(0.016)	(0.017)	(0.012)	(0.007)	(0.010)	(0.006)	(0.014)	(0.007)
ATT	−0.066***	−0.030	0.007	0.019**	0.018*	0.018**	0.010	0.024**
	(0.017)	(0.020)	(0.014)	(0.008)	(0.010)	(0.008)	(0.018)	(0.010)
ATC	−0.073***	−0.030	0.010	0.016**	0.015	0.012*	0.038**	0.013*
	(0.019)	(0.019)	(0.013)	(0.008)	(0.012)	(0.007)	(0.015)	(0.007)
Obs.	3607	3607	3607	3607	3607	3607	3607	3607

Note: Treated students are citizens. Kernel Epanechnikov multivariate distance matching. Adjustment regression with *Area* as the dependent variable and covariates as in Equation (2). Exact matching in world regions. In Columns 5–12, the outcome variable y takes a value of 1 in correspondence, respectively, to females and males majoring in each area and 0 otherwise. Standard errors. ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.