Brazilian Higher Education and STEM Fields

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Abstract

There is extensive empirical evidence that an individual's level of educational attainment affects labor market returns, and more recently the importance of field of study choices within these educational levels, particularly during the college years, has been highlighted by academic literature. This connection has spurred many initiatives seeking to track and encourage enrollment in STEM educational fields, especially amongst minorities and women. Developing countries, like Brazil, are now also turning their sights to the relevance of STEM higher education. This report provides an overview of STEM in Brazilian higher education, with attention to the issue of gender diversity in STEM fields. To this end we exploit administrative data and a novel STEM field classification methodology, tailored for Brazil and *INEP's* Higher Education Censuses.

Keywords: STEM fields, Brazilian Higher Education, Gender

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1 Introduction

A relevant component in determining future outcomes for college students is their field of study, since it may have a strong influence over career prospects in the labor market (Altonji et al., 2016; Bartolj & Polanec, 2012). In particular, STEM (Science, Technology, Engineering and Mathematics) fields are often associated with greater competition for seats (i.e. higher exam cutoff scores and more applicants per vacancies) at the college admissions stage and subsequently higher earnings. Yet little is known of STEM higher education in Brazil and about the gender gap in STEM enrollment locally.

A few of the selected references that have already investigated STEM higher education in Brazil are worth mentioning. Maciente et al. (2014) exploit demographic census data to map the distribution of STEM degree holders across different regions in Brazil, finding that these individuals are increasingly located in the richest areas of the country. Gusso & Nascimento (2015) use Brazilain Higher Education Censuses (HECs)[1] data and find that the number of enrollments in STEM fields grew from 2000 to 2013, but this expansion was concentrated in institutions with low academic performance indicators. Lemos (2019) combines several administrative data-sets (including HECs) to examine the gender gap in test scores and college major choices using a discrete choice model. Results indicate that female applicants are 4.5 percentage points less likely to select STEM fields in Brazil's centralized admissions platform. Similarly, Traferri (2011) focuses on how subjective bias can impact the probability of women choosing STEM majors in Brazil, in the context of a specific decentralized admissions process and finds that gender differences in college major choices are mostly explained by preferences, but that differences in entrance probabilities explain a large part of the gender gap in application to the most competitive majors.

Slightly modified definitions of STEM are used by each of the cited references, with very few details on the criteria applied in the selection of STEM fields. In this paper, we contribute to the discussion above by providing updated stylized facts relating to STEM higher education in Brazil, using the most recent HEC data-sets (2010 - 2019) and our own STEM classification, which is outlined in the document 'STEM Classification for Brazilian

[1]HEC data is collected by a government affiliated research institute called the *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira - INEP*

Higher Education'. Our proposed methodology is consistent over time, in spite of recent revisions to the *ISCED*[2] higher education division of fields of study. To the best of our knowledge this is the first analysis of STEM in Brazilian higher education that includes data spanning the entire 2010 decade.

The remaining sections are divided as follows. Section 2 summarizes the data used to produce the descriptive statistics displayed in this paper. Section 3 provides a general overview of Brazilian higher education enrollment and STEM, including comparisons to the international setting and, in particular, US figures. Section 4 focuses on the evolving outlook of STEM higher education fields, and Section 5 is directed specifically at gender diversity in Brazilian higher education STEM fields, both within bachelor's and technological degrees. Lastly, Section 6 discusses the main findings and provides some insight into potential next steps.

2 Data

This paper uses administrative data from the 2010 to 2019 yearly editions of the Brazilian Higher Education Census. HEC data is collected by *INEP*, and contains information on all higher education institutions and students, providing a rich panel of this market in Brazil.

Institutions and the degree programs within them have unique identification codes. Available institution and program characteristics include each program's field of study, the availability of seats, the type of administration and profit regimen, (e.g. public or private, federal or state, university or college, profit or non-profit). The HEC also contains data on each institution's infrastructure (e.g. number of labs), staff and teachers (their educational level and demographic characteristics).

After 2009 uniquely identified observations at the student level were made available with each edition of HEC. Previously data had been complied only at a more aggregate level. At this level each individual's observation can be linked to characteristics of the program(s)

[2]The *International Standard Classification of Education – ISCED* is used by *INEP* to classify all degree programs, and was revised in 2013. This revision was later adapted and implemented by *INEP*. Starting from the 2018 HEC data-set compatibility with previous years is an issue. This is remedied by our proposed STEM classification method.

and institution(s) attended, field of study and degree type (e.g. bachelor's, technological or licentiate). Student-level observation also provide details on date of entry, enrollment status, as well as demographic traits such as sex, race, age and place of birth. There are two versions of these data-sets. The version available to the public[3] contains re-codified unique identification codes, which allow us to track individual's overtime without disclosing their precise identities. A version with Brazilian Taxpayer Registry (*Cadastro de Pessoa Física or CPF*) numbers can only be accessed in Brasilia – in a secure room – with prior authorization from *INEP*. For the purpose of this classification report, the former was used as the main source.

Crucially, from 2010 onward there is almost no missing data (less than 1%) on *ISCED* fields of study codes. ISCED codes are the inputs for our recommended classification of STEM fields. The presence of these codes allows us to stack and collapse HEC data from 2010 to 2019, in order to generate reliable descriptive statistics for higher education, and in particular, STEM fields in Brazil.

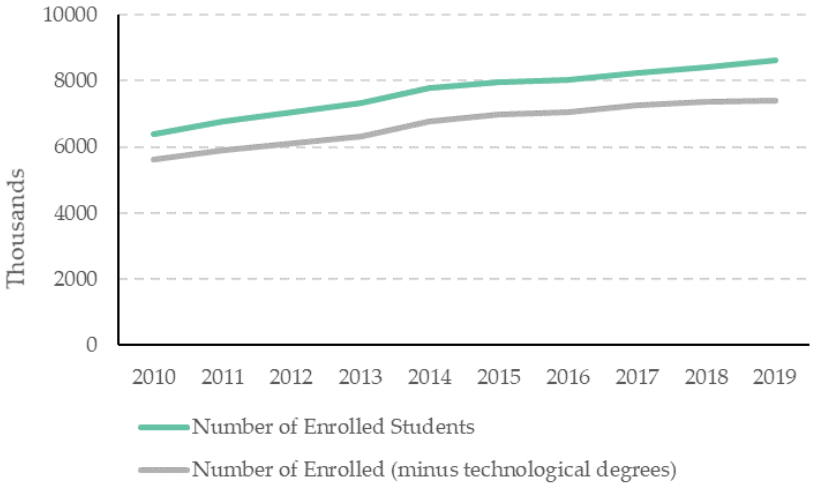
3 Overview

3.1 Brazilian Higher Education

Throughout the last decade, higher education enrollment has expanded in Brazil, in part due to an increase in college seats, online options, centralized assignment mechanisms, affirmative action and other recent changes that have improved access to Brazilian higher education. As seen in Figure 1, in 2010, less than 6.5 million students were enrolled in higher education as a whole, ten years later Brazil had over 8.6 million students enrolled in bachelor's and shorter-cycle technological degrees, across all fields of study. This represents a 32% increase in total enrollments in a ten year window.

[3] Accessible at https://www.gov.br/inep/pt-br/acesso-a-informacao/dados-abertos/microdados/censo-da-educacao-superior

Figure 1: Brazilian Higher Education Expansion



Source: Author's calculations based on INEP's annual Higher Education Censuses

In Brazil, traditional undergraduate degrees (i.e bachelor's or licentiate) last 4 to 6 years and technological degrees last 2 to 3 years. These three types of certificate are considered tertiary education level degrees and admissions require having obtained a high-school diploma or equivalent.[4] Technological degrees are vocational programs, to some extent. In other words, they are more practice oriented, with less emphasis on research and theory, although many still require a mandatory undergraduate research thesis, known as *Trabalho de Conclusão de Curso*. There is also a non-tertiary vocational education path that students can follow in Brazil. Even before finishing school, individuals can enroll in technical courses, which differ from a technological degrees, in that attending technical courses does not require having graduated from high-school and this type of course is not legally considered a higher education certificate, but rather a secondary or post-secondary level education extension. Technical courses can last anywhere from 2 months to 3 years and are also practice oriented. 53% of students enrolled in technical courses are at the upper-secondary education stage, the rest are at the post-secondary, non-tertiary education level.

The difference in content between technical courses and a technological degrees in the

[4]Formerly, students performing over a certain threshold in ENEM could receive a high-school diploma, allowing entrance to higher education. Since 2017, this is no longer possible, but there is a specific national exam called *Encceja* that is now used for this purpose.

same field can be blurred, but typically technical courses only focus on operational tasks and technological degrees may also address management issues and some theory. In this sense, technical courses can be described as trade mentoring programs. For instance, computer networks is a very popular subject choice for individuals pursing technical courses and technological degrees. A computer networks technician student, at *SENAI* – one of the largest private providers of technical courses – learns how to install, repair and provide technical support in this area. In contrast, an individual enrolled in a leading Computer Networks technological program from the Federal University of Ceará (UFC) learns many of these same skills but over a longer period, with a larger emphasis on mathematics, theory, communications and general management. They also are required to produce a research thesis as a prerequisite for graduation.[5]

In sum, a technological degree typically functions as a middle ground between technical courses and the academic undergraduate format. Acquiring this higher education certificates allows graduates to qualify for a number of careers with higher paying salaries in Brazil, especially in public service, without having to go through the traditional higher education cycle, that lasts at least 4 years.

According to data from the School Census (also produced by INEP), over 1.9 million students were enrolled in technical courses in 2019. These include students that have not completed secondary school. In contrast, Higher Education Census data indicates that only about 1 million tertiary level students were enrolled in technological degrees in 2019 (see Table 1). Several factors might explain why technical courses are a more popular educational option than technological degrees. For individuals and employers seeking the qualification signal offered by higher education certificates in Brazil, technological degrees may still be seen as "second tier" options, with content that resembles a simpler technical course. The higher opportunity, financial and effort costs of enrolling in a technological degree versus a technical course may push students into choosing the latter.

Even so, the number of graduates with technological degrees has expanded rapidly in

[5]References for the coursework in both of the cited examples are accessible at https://www.mundosenai.com.br/cursos/cursos-tecnicos/tecnico-em-redes-de-computadores/ and https://si3.ufc.br/sigaa/public/curso/ppp.jsf?lc=pt_BR&id=657516

last decade. According to the the 2019 Higher Education Census, 23% of entering students and 18% of graduates were registered in these shorter length certificates. From 2010 to 2019, technological degrees have been the fastest growing category in an expanding tertiary education setting. In this period, the number of students enrolled in bachelor's degrees grew 34%, licentiate degrees only 25%, while technological degrees grew 57%.

3.2 Comparison to Other Higher Education Systems

The Brazilian tertiary education structure contrasts with the standards for content and length set in most developed countries in the *OECD*. The Bologna Process unified the framework of higher education in 46 European countries under the *European Higher Education Area (EHEA)*. In terms of length and format, higher education was divided into three cycles. The first cycle consists of undergraduate degrees that can generally be completed in three years within signatory countries, if minimum credit requirements are met by students. The second cycle is an optional extension of 1 or 2 years that awards students the master's degree and the third cycle is a continuation to a doctorate's degree which varies in length. Therefore, Brazilian technological degrees are actually closer in length to standard undergraduate certificates in Europe than our local bachelor's and licentiate options.

The United States also offers two main types of shorter cycle higher education options, namely certificates (that 1 year or less) and associate's degrees (that last 2 to 3 years). These programs are usually hosted by community colleges, vocational or technical institutes. Certificates are fully skill oriented and, thus, closer in length to the short technical courses in Brazil. Associate's degrees are similar in length to our technological degrees. However, unlike Brazil, it is common for US students to transfer credits from an associate's degree to a bachelor's degree, spending the first half of their undergraduate education at a cheaper two year college and the second half at a more prestigious 4 year college, in what is known as the "2 + 2" model. In total, 47% of American residents between 25 and 30 are either bachelor's and / or associate degree holder and 36% are bachelor's degree holders.

These types of shorter higher education programs are a far more common choice in the US than in Brazil. In fact, according to a 2020 report, entitled *'The Overlooked Value Of*

Certificates And Associate's Degrees', produced by Georgetown University[6], more than half of all US higher education students pursue certificates and associate's degrees instead of traditional bachelor's programs. In contrast, in Brazil only 14% of higher education students are enrolled in the shorter technological degrees.

When it comes non-tertiary vocational options, Brazil also lags the developed world in relative terms. Only 8% of students are enrolled in vocational programs in Brazil, versus an average of 32% in *OECD* member and partner countries. Similarly, 11% of high-school or upper-secondary students currently opt for vocational training through short-cycle programs (i.e. technical courses), which is well below the reported average of 42% for OECD member and partner countries.[7].

3.3 Brazilian Higher Education and STEM

Note, some figures and tables in this subsection compare Brazilian and American statistics. Data for the United States is extracted from *'OECD's Education Statistics public database (2019/1 Edition)'* and refer to 2017, which is last available year in the dataset. Therefore, when contrasting the two countries, data points from the 2017 edition of Higher Education Census are used, even though the data stretches up to 2019.

Table 1 compares statistics on STEM enrollment for Brazil and the United States. The number of short-cycle students enrolled in the US is much greater than that of Brazil, both in absolute and relative terms. This is explained by the notable presence of community colleges, online and post-high-school associate courses in the American higher education system. For the sake of consistency, when comparing STEM between these countries we will also focus only on bachelor's (or equivalent) degrees which are similar in length and format. Brazil had close to 1.4 million students enrolled in STEM bachelor's degrees (19.7% of bachelor's total), versus 2.0 million in America. STEM enrollment as a share of total bachelor's enrollment is slightly higher for the US (22.1%), suggesting a greater focus on STEM fields at the tertiary education level[8], at least within the more traditional academic undergraduate format.

[6] Accessible at cew.georgetown.edu/SubBA

[7] See the country note for Brazil *OECD - Education At A Glance (2020)* report, accessible at https://download.inep.gov.br/acoes_internacionais/eag/documentos/2020/EAG_2020_CN_BRA.pdf

[8] In the case of Brazil, licentiate degrees are considered equivalent to bachelor's (i.e. non-short cycle higher

Table 1: Higher Education Enrollment in Brazil and the United States (2017)

(in thousands of enrollments)

		Brazil	United States
Total Enrollment	Bachelor's or Equivalent	7256	9058
	Technological / Short-Cyle	999	6915
	All Degrees	8255	15973
STEM Enrollment	Bachelor's or Equivalent	1426	2004
	Technological / Short-Cyle	261	1126
	All Degrees	1688	3130
STEM Share (%)	Bachelor's or Equivalent	19.7%	22.1%
	Technological / Short-Cyle	26.1%	16.3%
	All Degrees	20.4%	19.6%

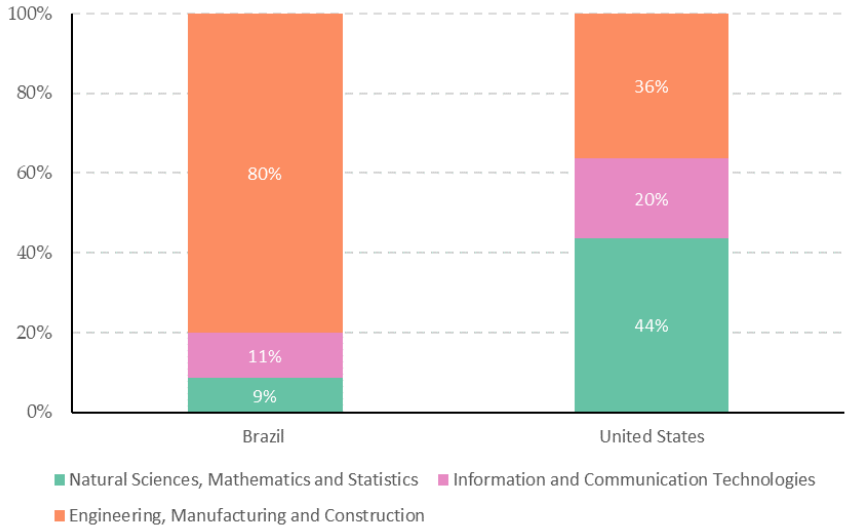
Source: Author's calculations based on INEP's (Higher-Education Censuses) and OECD's (Education At A Glance - 2019), public data-sets.

When analysing STEM enrollment shares represented by each of *SAGA's* three STEM broad fields[9], between the two countries (see Figure 2), the bulk – over 80% – of STEM enrollment in Brazil seems to be concentrated in Engineering, Manufacturing and Construction. On the other hand, in the US, bachelor's students in STEM are more evenly dispersed across the three fields. Only 36% of total STEM enrollment is accounted for by Engineering, Manufacturing and Construction degrees in the US, and Natural Sciences, Mathematics and Statistics represents the largest SAGA STEM field (44% of STEM bachelor's degrees), whereas in Brazil it represents less than 10% of total STEM bachelor's enrollment.

education certificates) and thus are included in the count, although they do not affect the count of enrollment for STEM, since no licentiate degree is included in the STEM fields.

[9] *SAGA* is a program created by *UNESCO* in partnership with Sweden, tracking gender diversity in STEM education. *SAGA's* three STEM broad fields, seen in Figure 2, follow the current *International Standard Classification of Education*, and are precisely identifiable both in INEP and OECD data, through ISCED codes.

Figure 2: Share of STEM bachelor's Enrollment by Broad Fields of Study (2017)



Source: Author's calculations based on INEP's annual Higher Education Censuses. Note that the data in this figure refers only to bachelor's or Equivalent degrees.

Table 2 details Brazil's five most popular STEM bachelor's (Panel A) and STEM technological degrees (Panel B), within these broader fields. Three of the top five bachelor's degree, in terms of enrollments are Engineering related, in contrast the three top choices for technological degrees are all related to Information and Communication Technologies.

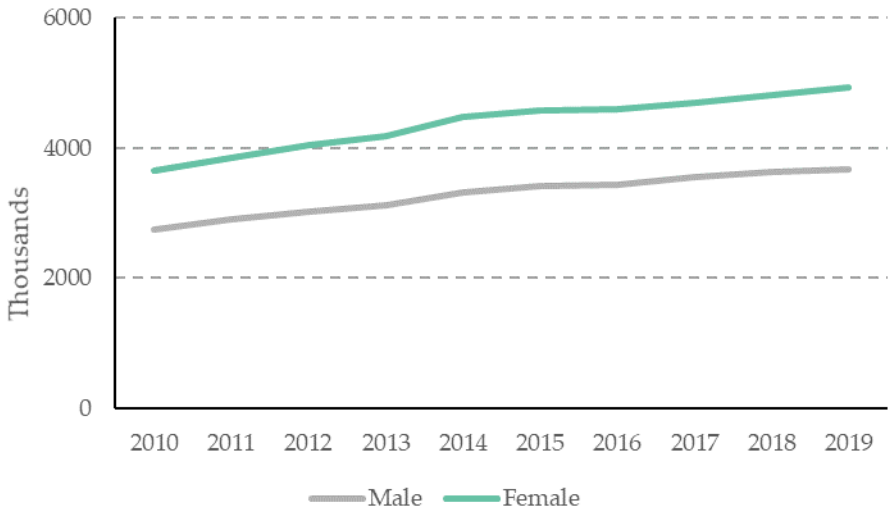
Table 2: Top STEM Degrees in Brazil (2019)

Rank	Name of Degree	Number of Enrolled Students
	Panel A: Bachelor's or Equivalent Degrees	
1	Civil Engineering	394,133
2	Information Systems	294,146
3	Production Engineering	209,493
4	Architecture and Urbanism	202,691
5	Mechnical Engineering	175,330
	Panel B: Technological Degrees	
1	Information Technologies Managment	54,800
2	Computer Networks	30,667
3	Internet Systems	14,927
4	Industrial Automation	11,656
5	Industrial Production	9,563

Source: Author's calculations based on INEP's 2019 Higher-Education Censuses. Names of degrees are translated to english from INEP's portuguese denominations for unique ISCED codes.

In terms of the evolution of gender representation in Brazilian higher education over time, the absolute rise in enrollment levels in the last decade (see Figure 3) has been relatively even across genders, so that the share of women pursing higher education certificates (of all types) remained almost unchanged since 2010.

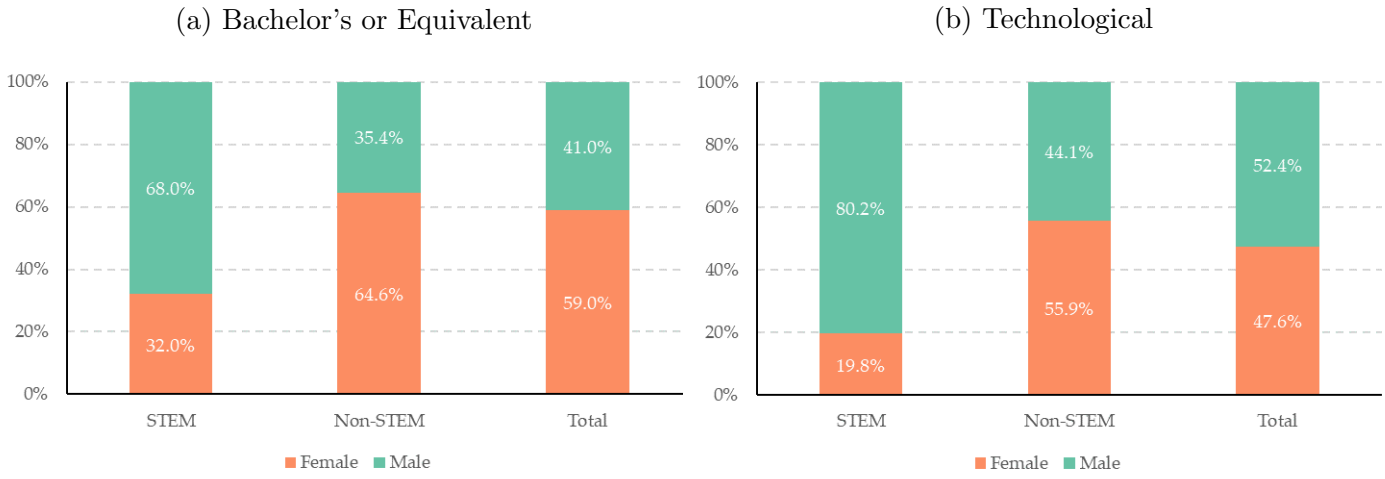
Figure 3: Brazilian Higher Education Enrollment by Gender



Source: Author's calculations based on INEP's annual Higher Education Censuses.

Female enrollments represented a majority 57.4% of higher education enrollments in bachelor's and technological degrees in 2019, the last census edition. However, as seen in Figure 4, both types of STEM degrees attract far less women. The female enrollment share in technological degrees (19.5%) is even lower than the share in bachelor's or equivalent degrees (32%), which could be connected to the more practical,"hands-on", content offered in technological fields.

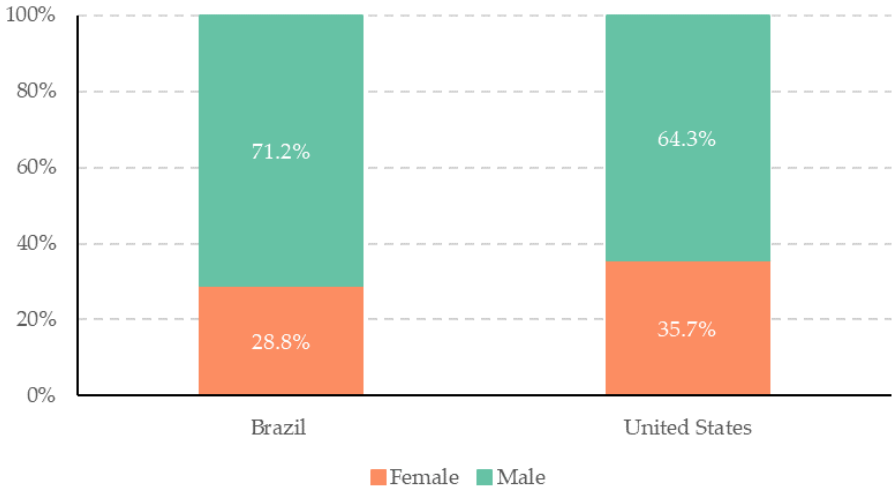
Figure 4: Enrollment Share by Gender and Degree (2019)



Source: Author's calculations based on INEP's annual Higher Education Censuses.

When comparing female representation in STEM, Brazil also lags the United States. As seen in Figure 5, men represent the majority of comparable enrollments in STEM bachelor's degrees, in both countries. Women account for less than a third (exactly 28.8% in 2017 and 32.0% in 2019) of STEM bachelor's degree enrollments in Brazil. In the US, the share of women is almost 25% higher, perhaps suggesting greater success at improving access and encouraging female participation in STEM educational fields.

Figure 5: STEM bachelor's Enrollment in Brazil and the United States by Gender (2017)



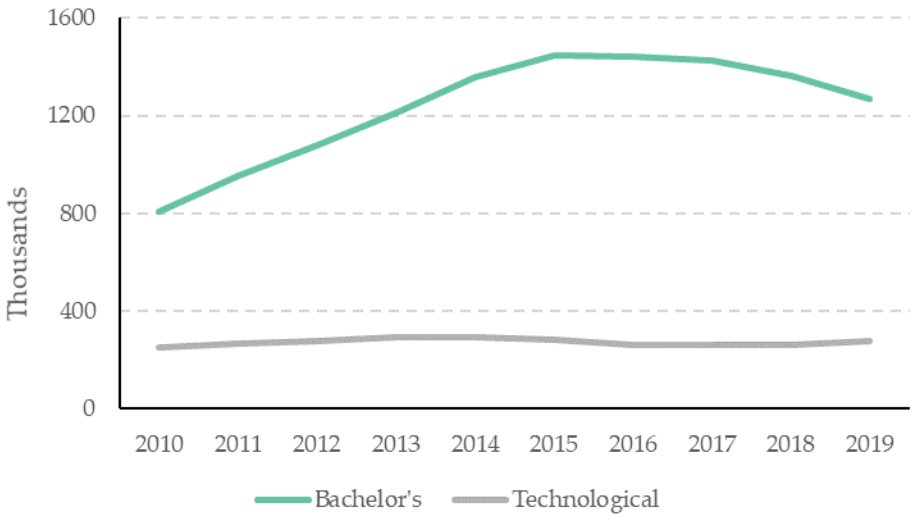
Source: Author's calculations based on INEP's (Higher Education Censuses) and OECD's (Education and Glance - 2019), public data-sets.

4 STEM over time

In this section, we have divided STEM degrees into four subject groups (as opposed to the three broad fields used by SAGA). These groups more accurately and consistently represent STEM fields in the context of Brazilian higher education. We also make the distinction between undergraduate and technological degrees clear in our figures.

Figure 6 indicates that in recent years, in-spite of the continued expansion of higher education as a whole, the popularity of STEM fields has decreased, particularly in the case of bachelor's degrees. This is – at least partially – a consequence of the deceleration of Brazil's Economy, and the subsequent harsh recession. Engineering related markets were heavily affected by the crisis, and the future prospects of students pursing these careers took a hit as well. As we shall see ahead, Engineering and related degrees are the largest of all STEM groups, and indeed seem to be driving down STEM enrollment as a whole.

Figure 6: Share of STEM Enrollment by Degree Type (over Time)



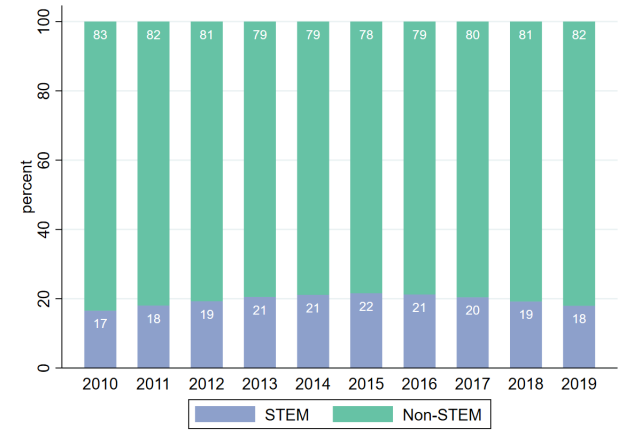
Source: Author's calculations based on INEP's annual Higher Education Censuses.

Figure 7 depicts the changes in shares of STEM and Non-STEM entrants, those enrolled and those graduating. Whilst the share of enrollment rose (Panel a) at the start of the decade and then fell, slightly, the number of Entrants (Panel b) has decreased and the number of graduates has increased slightly (Panel c), suggesting, first that these two movements are

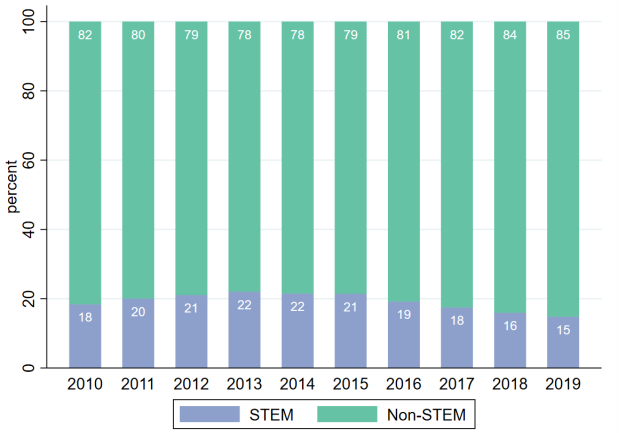
part of the reason why enrollment has started to fall, and second that it will continue to do so, since there is a lag in the response of enrollment to the reduction of inflows (new entrants) and the increase of outflows (graduates).

Figure 7: higher education Share by STEM and Enrollment Status

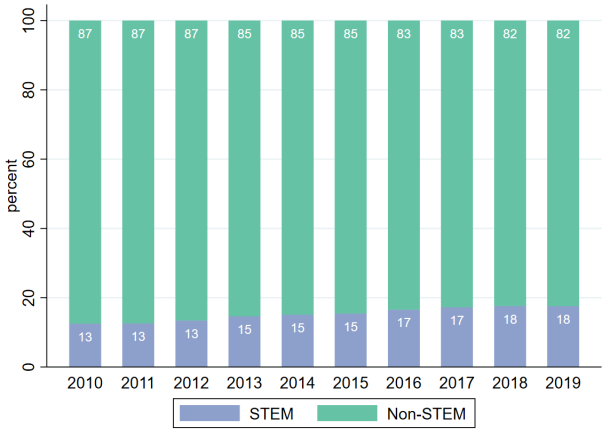
(a) % of Enrolled



(b) % of Entrants



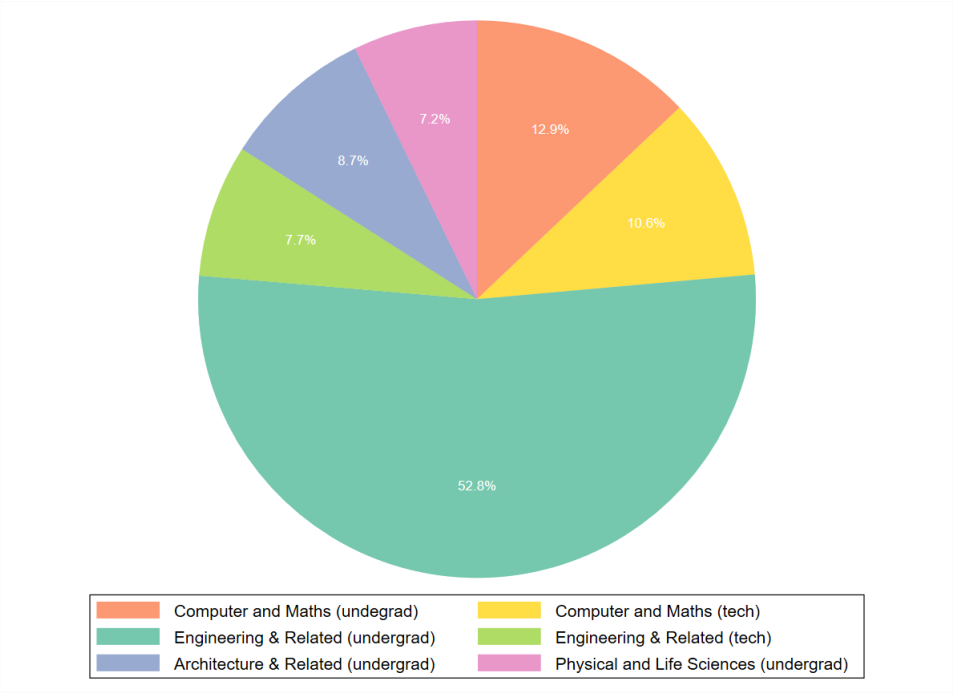
(c) % of Graduating



Source: Author's calculations based on INEP's annual Higher Education Censuses.

Using a division of STEM by subject groups and degree types, we are able to determine that in spite of the recent downturn, Engineering and Related bachelor's degrees (i.e. undegraduate courses) alone represent 52.8% of STEM enrollment.

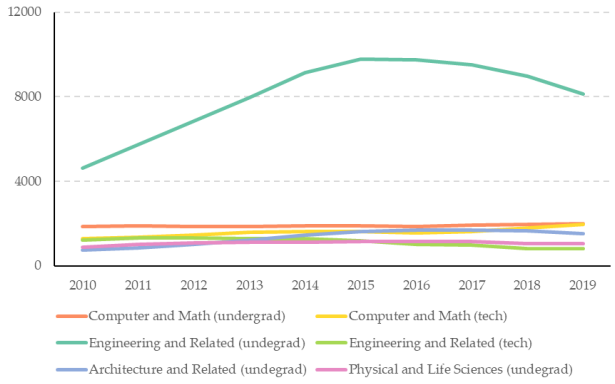
Figure 8: Share of STEM Enrollment by Group and Degree Type (average 2010 - 2019)



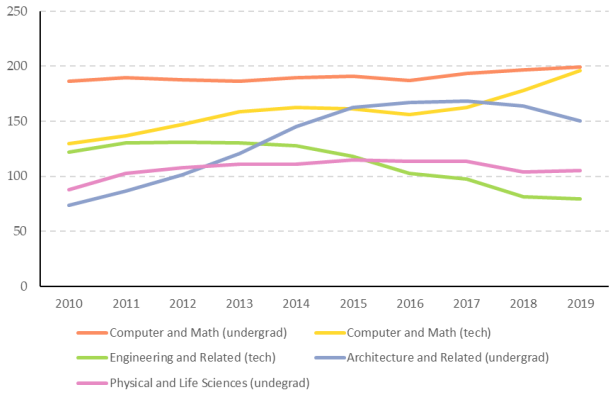
Source: Author's calculations based on INEP's annual Higher Education Censuses.

Engineering and Related undergraduate degrees have dominated STEM enrollment (see Figure 9). Enrollment in this STEM group reached its peak mid-decade and has been falling in absolute and relative terms ever since. When we exclude this group from the graph, it is easier to see the absolute and relative changes in smaller STEM groups. Panels (b) and (d) indicate that Computer and Math degrees (in particular technological degrees), have been growing in popularity amongst college students. This trend is likely correlated with an increase in labor-market demand for skilled IT technicians and professionals at all levels of training. Architecture related degrees had been rising since the start of the last decade, and this movement was partially reversed (maybe, also motivated by economic conditions). Physical and Life Sciences have remained stable, in terms of enrollment, throughout the decade.

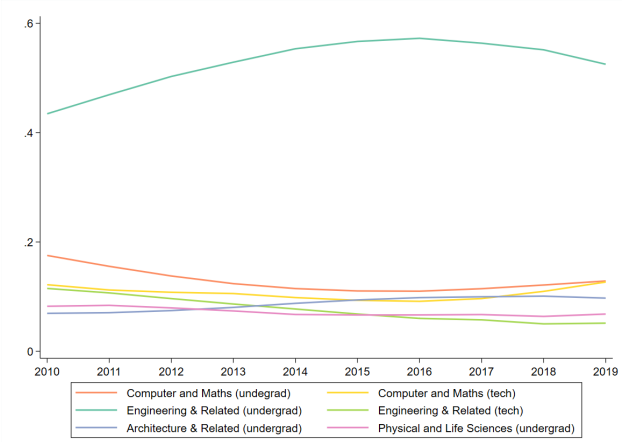
Figure 9: STEM Enrollment by Group and Degree Type in Absolute and Relative Terms



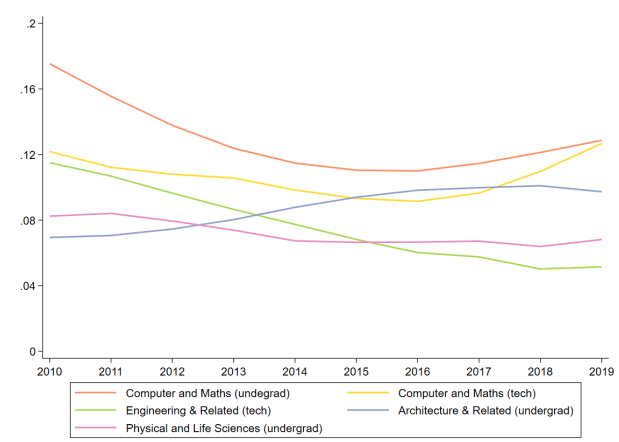
(a) Total Enrollment in Thousands



(b) Total Enrollment in Thousands (zoom)



(c) Total Share



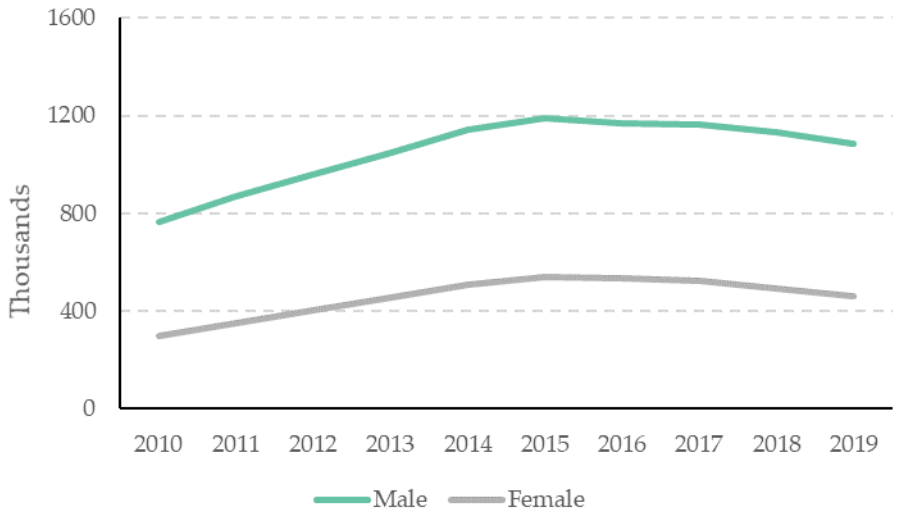
(d) Total Share (zoom)

Source: Author's calculations based on INEP's annual Higher Education Censuses.

5 STEM and Gender

STEM enrollment had been growing in absolute terms up to 2015, across both genders. Male and female enrollments in STEM (see bellow Figure 10) have followed almost perfectly parallel trends. In 2015, STEM enrollment plateaued – in large part driven by the fall in enrollment for the Engineering and Related undergraduate courses – and has been decreasing ever since.

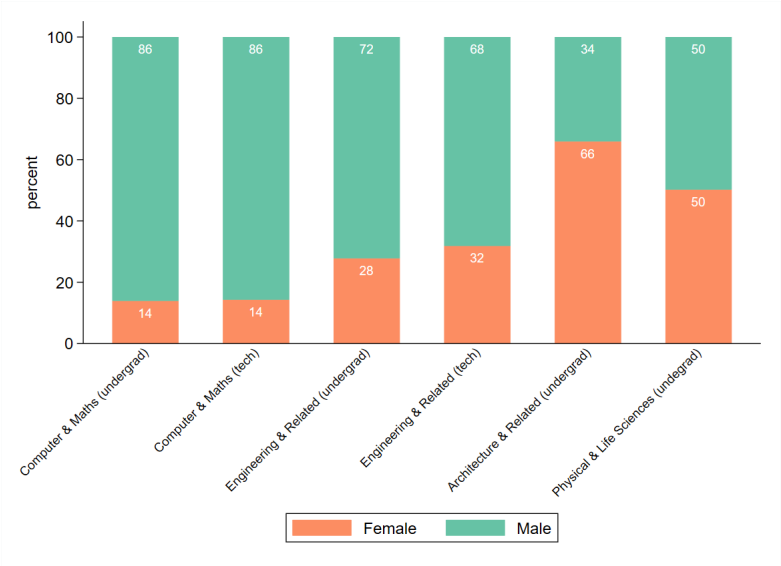
Figure 10: Share of STEM Enrollment by Gender



Source: Author's calculations based on INEP's annual Higher Education Censuses.

In 2019, (last available Higher Education Census data-set), women still occupied only about 30% of STEM seats, whilst representing over 63% of enrollment outside of STEM fields. Much of this gender gap is down to the lack of female participation in Engineering and Related and Computer and Math degrees in Brazil (Figure 11). Women make up half of enrollments in Physical and Life Sciences and over two thirds of Architecture Related degrees.

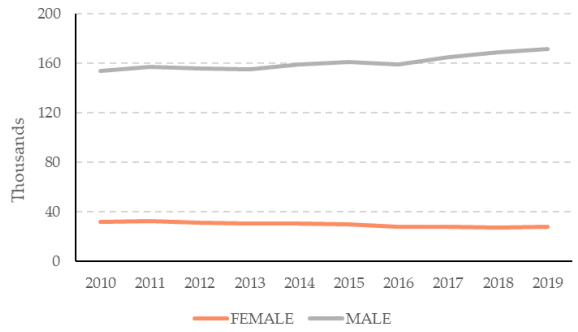
Figure 11: Share of STEM Enrollment by Gender, Group and Degree Type (2019)



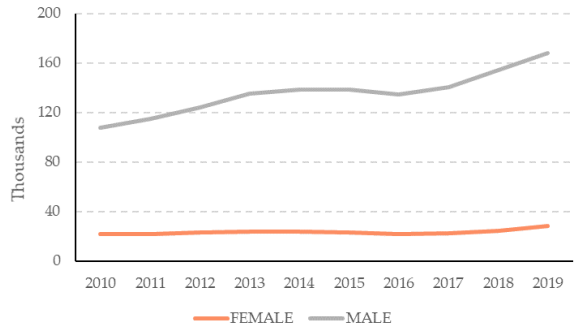
Source: Author's calculations based on INEP's annual Higher Education Censuses.

In Figure 12, we see that the growth of the Computer and Math field is explained by male enrollments. For other STEM groups, the evolution of enrollment over time mostly remained parallel across genders. This implies that the share of women in each STEM group remained almost constant throughout the decade, in-spite of absolute changes in enrollment, with the exception of Computer and Math degrees, where female participation fell slightly (see Figure 13).

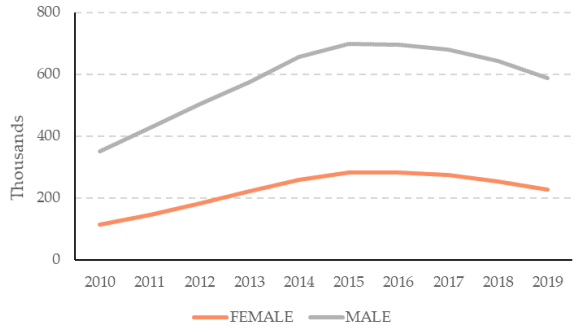
Figure 12: Female Share of STEM Enrollment by Group, Degree Type



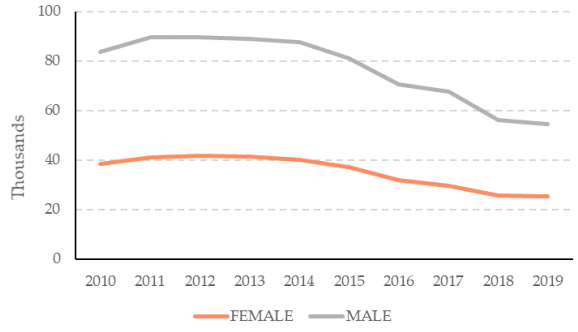
(a) Computer and Mathematics (undegraduate)



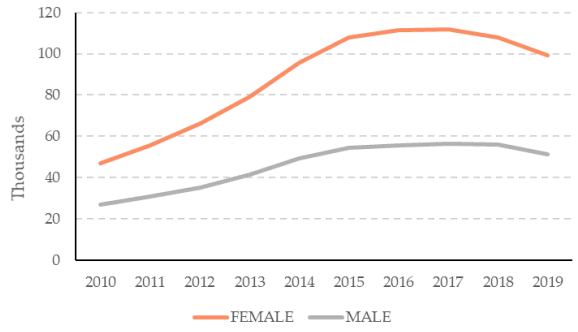
(b) Computer and Mathematics (technological)



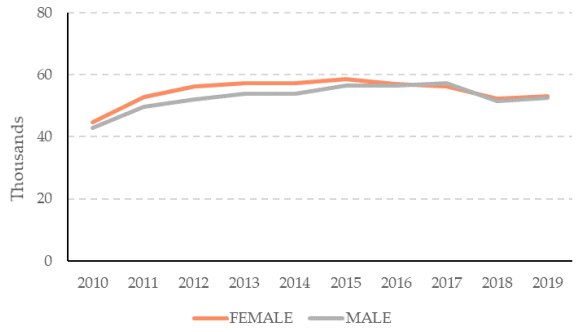
(c) Engineering and Related (undegraduate)



(d) Engineering and Related (technological)



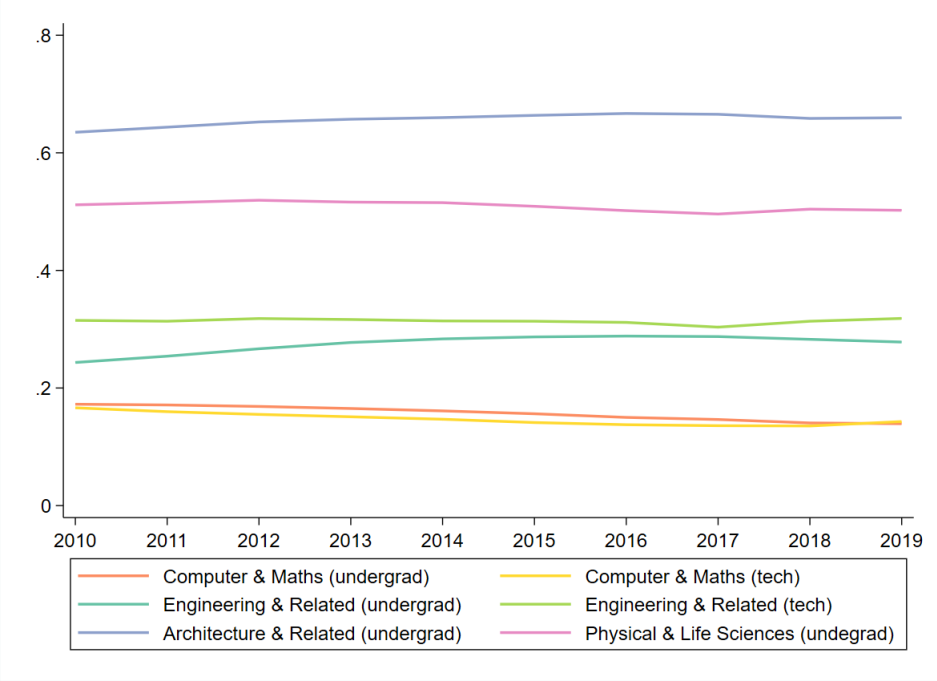
(e) Architecture and Related (undegraduate)



(f) Physical and Life Sciences (technological)

Source: Author's calculations based on INEP's annual Higher Education Censuses.

Figure 13: Share of STEM Enrollment by Group, Degree Type and Gender (over time)



Source: Author's calculations based on INEP's annual Higher Education Censuses.

Overall, in Brazilian higher education, women represent the majority of graduates, outnumbering men both in absolute and relative terms (see Appendix A Table A1). However, given that women represent a much smaller fraction of individuals entering STEM degrees than men, they also represent a minority of STEM graduates.

Figure 14 focuses on the relevance of female students to two important measures of flows in and out of STEM, namely, entrance and graduation. Even though, in most STEM groups, women are the minority – both in terms of entrants and graduates – they also tend to represent a larger share of graduates in STEM than they do of entrants. With the exception of the two STEM technological groups. Broadly, this pattern suggests that women are more likely to graduate then men, even in STEM degrees, where they do not represent a majority of students. Thus, encouraging their participation in these fields may lead to significant human capital gains.A few other trends in Figure 14 standout.

Both the share of women entering and leaving Computer and Math undergraduate degrees (Panel a) has been decreasing, in a field where they are already vastly underrepresented. This is expected, given that the relation between entering students and graduates in a same field

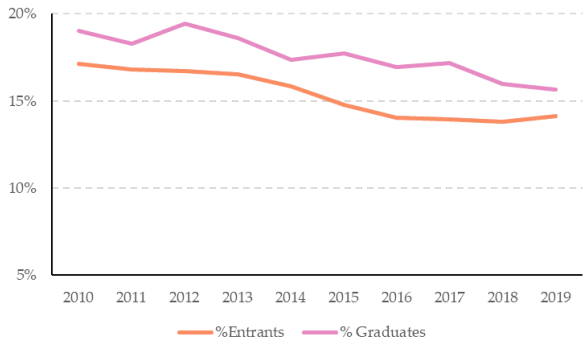
is lagged, but all else equal, when less women join Computer and Math degrees, graduation shares are expected to go down as well, but only after 4 years or more, in the case of undergraduate degrees and at least 3 years in the case of technological degrees. Unlike the Computer and Math undergraduates, technological degrees (Panel b) saw a convergence that closed the gap between the share of female entrants and graduates.

In contrast, Engineering and Related undergaduate degrees – by far the largest STEM group – saw a divergence between the share of female entrants and graduates. Up to 2013, these measures had been expanding, but afterwards, the share of female entrants started to fall and the share of female graduates continued its growth trajectory. Nevertheless, the decline in the share of female entrants is also likely to reflect in lower female graduation shares in future versions of the Higher Education Census, given the lagged relationship between the two flow measures. This may revert the highlighted growth in difference between the the share of women entering and graduating from this field one again.

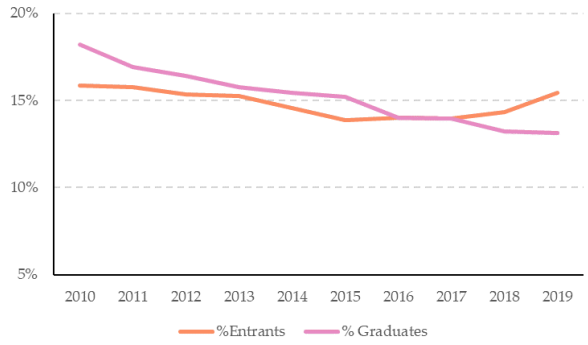
Similarly, in Panel e, we see that Architecture and Related degrees followed roughly parallel trends, but, in 2015 the gap between them started to widen. By 2018, the share of female graduates was over 7 percentage points larger then entering students.

Finally, the most stable difference between the share of women entering and graduating STEM is seen in the case of Physical and Life Sciences degrees (Panel f). Again, women consistently represent a larger share of graduates than they do entrants, the difference is consistently near the 5 percentage point magnitude. Still, as seen in Figure 9, both in relative and absolute terms, this group represents a very small fraction of STEM, even when excluding Engineering and Related undergraduates.

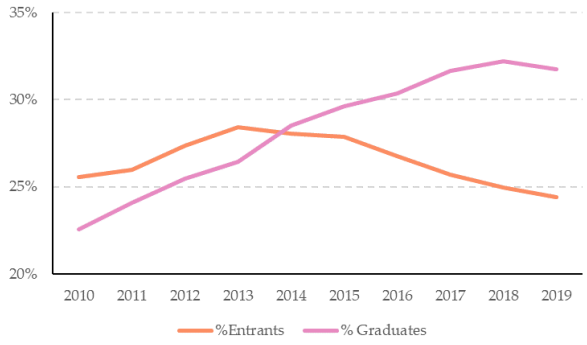
Figure 14: Share of Women Entering and Graduating STEM by Groups and Degree



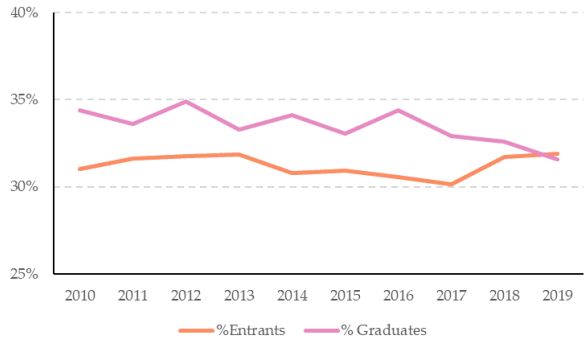
(a) Computer and Mathematics (undegraduate)



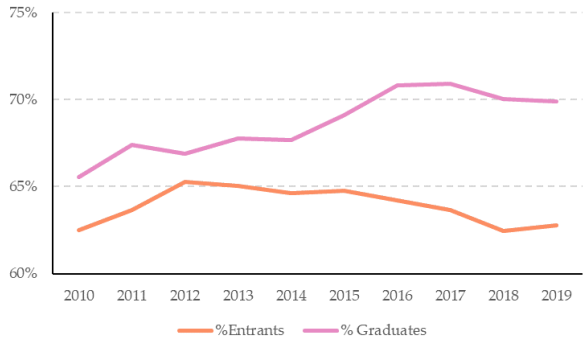
(b) Computer and Mathematics (technological)



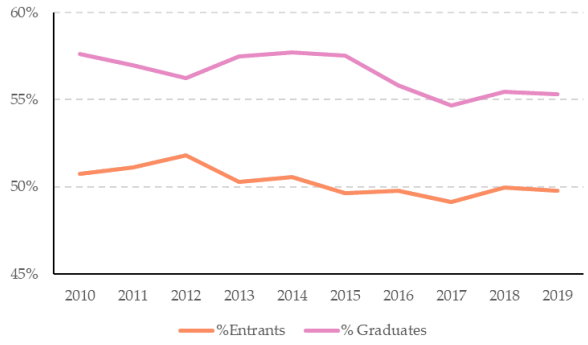
(c) Engineering and Related (undegraduate)



(d) Engineering and Related (technological)



(e) Architecture and Related (undegraduate)

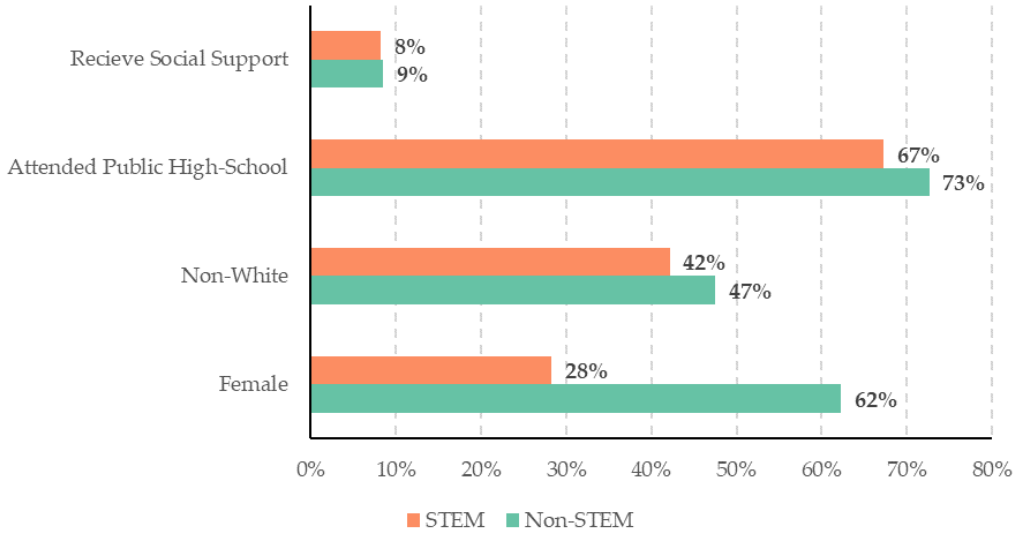


(f) Physical and Life Sciences (technological)

Source: Author's calculations based on INEP's annual Higher Education Censuses.

STEM and Non-STEM students also differ in several dimensions other than sex. Students enrolled in STEM are slightly less likely to receive social support and to have attended a public high-school and are more likely to be white. This suggests a higher socioeconomic status amongst students enrolled in STEM, which is likely connected to a greater demand for seats in STEM fields and the competitive advantage of wealthier, white students, who attended higher quality private high-schools and that do not require the same level of social support to attend college. However, the discrepancy in STEM enrollment by gender, which is not a marker of socioeconomic status, stands out above these other differences in participation by demographic trait. This can be verified in Figure 15.

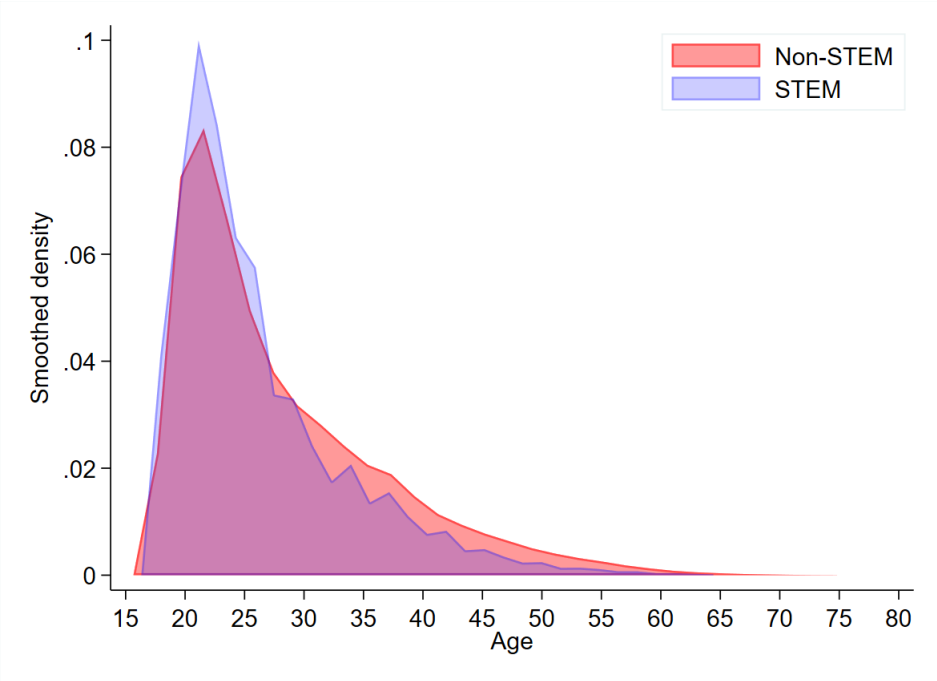
Figure 15: Share of Students by STEM Status and Demographic Trait (2019)



This figure depicts the share of enrolled STEM and Non-STEM students with certain demographic traits, namely, the share of students that receive some form of social support from their higher education institutions, the share of students that attended public high-schools, the share of non-white students (i.e. black, indigenous or mixed race) and the share of female students. Data on race is missing or not declared for 18% of the 2019 student observations and data on the type of school attended is also missing for 0.5% of the 2019 observations. The reported shares are calculated excluding observations with missing data from the total. Source: Author's calculations based on INEP's 2019 - Higher Education Census.

The age distribution of students is another trait that differs when comparing the sub-samples of students enrolled in STEM and Non-STEM degrees (see Figure 16). As seen in the smoothed density plot below, their is a rapid accumulation of mass at age 18, since this the age at which students regularly graduate from high-school. Most higher education students are in their early twenties, both in and out of STEM, but STEM students are a bit younger on average, with less variance and a thinner right tail, indicating that it is perhaps harder or less desirable to access STEM fields at an older age.

Figure 16: Age Distribution by STEM Status (2019)



This figure depicts the age distribution of students in STEM and Non-STEM degrees. For the purposes of visualization the histograms are slightly smoothed using a standard kernel density function. Source: Author's calculations based on INEP's 2019 - Higher Education Census.

6 Discussion

The paper provides an up-to-date view of STEM and gender in Brazilian higher education, based on a STEM classification developed to suit Higher Education Census data over time. A brief comparison with the US, taking into consideration only comparable bachelor's degrees, suggests that the share of students venturing into STEM is not too dissimilar from the US and perhaps other developed countries. In absolute terms, Brazil had almost 30% less students enrolled in STEM higher education courses than the US, but these students represent a similar share of total bachelor's enrollment (19.7% in Brazil and 22.1% in the US). However, the female participation in STEM fields differs significantly between the two countries. In 2017, only 29% of students enrolled in STEM bachelor's degree were women versus 36% in the US.

Additionally, very few students opt for shorter-cycle higher education programs, known as technological degrees, which represent only about 20% of the entire Brazilian higher education market. In contrast, over half of US students pursue shorter-cycle higher-education associate's degrees and certificates, and the problem of gender disparity is even starker in the STEM technological fields, where only 19.5% of enrolled students are women. No other explored demographic trait varies as widely as gender representation between between STEM and Non-STEM fields.

Also, unlike the US, STEM enrollment in Brazil is highly concentrated in a single STEM group. Of the 1.55 million Brazilian students currently enrolled in STEM, well over half (57.8%) are in the Engineering and Related STEM group (2019 Higher Education Census). The second largest STEM group is Computer and Math, combining bachelor's and technological degrees it accounts for only 25.6% of the STEM enrollment. The two remaining groups (i.e. Architecture and Related and Physical and Life Science) each represent less than 10% of STEM enrollments. A few trends extracted from the data stand out. The higher education sector expanded continuously over the 2010 decade, with over 30% growth in enrollment, but after 2014 (following an economic downturn) STEM enrollments started to drop, particularly amongst Engineering and Related degrees, which had seen a surge in popularity at the start of the decade, coinciding with booms in the infrastructure and commodities sectors. The

only STEM group to grow steadily during the decade is Computer and Math, this was driven mainly by a surge in enrollment in shorter (2 – 3 years) technological degrees. By 2017, enrollment in Computer and Math technological degrees had surpassed that Architecture and Related degrees.

Perhaps, a relevant consequence of the under-representation of women in STEM, is that overall completion rates in the field may be lower, since women represent the majority of graduates in higher education, both in relative and absolute terms and represent a larger share of graduates from STEM fields then they do of entering and enrolled students

Throughout the last decade, little progress seems to have been achieved in closing the gap between male and female participation in STEM. Women consistently represented 57% of students enrolled in higher education but only 28% of those in STEM in 2010 and 30% in 2019. Female participation in each of the STEM groups also remained stable, but there is still a lot of heterogeneity in gender representation across these groups. For instance, men and women are split evenly in Physical and Life Sciences and female students are over-represented (66%) in the Architecture and Related group but in Computer and Math only 14% of students are female. What this suggests is that the lack of female participation in STEM is concentrated in specific areas that warrant greater attention.

On a final note, one of our main goals going forward is to connect STEM education and career paths. With a few adaptations, the current STEM classification method used in combination with Higher Education Census data in this paper, can also be applied to decennial demographic censuses, to produce a crosswalk between higher education STEM fields and labor market outcomes.

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A Appendix A

Table A1: Higher Education Progression by Gender

		Freshmen		Enrolled		Graduating		Inactive	
		Male	Female	Male	Female	Male	Female	Male	Female
Panel A: STEM									
Computer and Math	*(number of individuals)*	62163	10242	171409	27754	16263	3021	78675	12284
(Undegraduate)	*(gender share in percent)*	85.9%	14.1%	86.1%	13.9%	84.3%	15.7%	86.5%	13.5%
Computer and Math	*(number of individuals)*	106298	19392	168144	28051	24699	3741	108420	18103
(Technological)	*(gender share in percent)*	84.6%	15.4%	85.7%	14.3%	86.8%	13.2%	85.7%	14.3%
Engineering and Related	*(number of individuals)*	169160	54597	586747	226144	82717	38487	260827	79081
(Undergraduate)	*(gender share in percent)*	75.6%	24.4%	72.2%	27.8%	68.2%	31.8%	76.7%	23.3%
Engineering and Related	*(number of individuals)*	28607	13401	54335	25379	8708	4020	31457	13379
(Technological)	*(gender share in percent)*	68.1%	31.9%	68.2%	31.8%	68.4%	31.6%	70.2%	29.8%
Architecture and Related	*(number of individuals)*	14315	24161	51264	99371	7243	16830	22716	32938
(Undergraduate)	*(gender share in percent)*	37.2%	62.8%	34.0%	66.0%	30.1%	69.9%	40.8%	59.2%
Physical and Life Sciences	*(number of individuals)*	17356	17195	52517	52996	6074	7514	18466	17032
(Undergraduate)	*(gender share in percent)*	50.2%	49.8%	49.8%	50.2%	44.7%	55.3%	52.0%	48.0%
Total: STEM	*(number of individuals)*	398830	139765	1086417	461539	145935	73863	521615	173581
	(gender share in percent)	74.1%	25.9%	70.2%	29.8%	66.4%	33.6%	75.0%	25.0%
Panel B: Non-STEM									
Undergraduate	*(number of individuals)*	874594	1569150	2162757	3949716	272351	576260	965512	1500535
	(gender share in percent)	35.8%	64.2%	35.4%	64.6%	32.1%	67.9%	39.2%	60.8%
Technological	*(number of individuals)*	288087	363218	416802	527295	79445	102385	269246	315817
	(gender share in percent)	44.2%	55.8%	44.1%	55.9%	43.7%	56.3%	46.0%	54.0%
Total: Non-STEM	*(number of individuals)*	1162681	1932368	2579559	4477011	351796	678645	1234758	1816352
	(gender share in percent)	37.6%	62.4%	36.6%	63.4%	34.1%	65.9%	40.5%	59.5%

Source: Author's calculations based on INEP's (Higher-Education Censuses), public data-sets.