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Investigating gender inequalities in the Italian academic sector

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Introduction

This thesis aims to provide a comprehensive picture of the current existing gender disparities in the academic field in Italy through quantitative tools. The phenomenon is investigated starting from a snapshot of the current composition of academic staff, enriched with additional data regarding leadership positions and technical administrative staff. An attempt will then be made to go to the roots of the phenomenon by investigating educational data regarding the tertiary as well as secondary education cycle. Finally, the issue of academic productivity will be explored to understand whether it has an influence in gender inequality. Considering the methods used, the thesis does not aim to answer the reason of such disparities. It is instead, an attempt to provide a clear illustration of such disparity as it emerges from the numbers and eventually to provide additional insightful statistics to its regards and to the existing literature. It is also an attempt to show that is possible to use advanced analytics solution in order to explore a social issue and doing so with open-source tools and data.

The thesis is structured as follows:

The following chapter outlines the technique used in this investigation, with an emphasis on dataset building. A transparent and well-defined technique is essential for assuring the dependability and validity of future studies. This chapter describes the procedures used to acquire, organize, and improve data, laying the groundwork for the subsequent inquiry.

Given the complexities of the issues to be discussed, the second chapter clarifies crucial definitions and key concepts of data analysis and gender inequalities. A clear understanding of gender-related vocabulary and concepts, academic roles, and other relevant issues is required for the upcoming chapters to be discussed coherently and clearly. This chapter serves as a conceptual framework, offering context for the subsequent in-depth analysis.

The third chapter provides a thorough examination of gender disparities, based on data from both Italian and international databases. The examination covers various elements of an academic career, beginning with the starting period characterized by first employment contracts and advancing to higher positions such as associate and full professor. This chapter also looks at occupations like Administrative and Technical Staff, bringing attention on the widespread gender discrepancies even in the universities' administrative jobs. Furthermore, the chapter investigates the scarcity of female leaders in academia, such as rectors and presidents of research institutes, providing a full picture of gendered dynamics within the academic hierarchy.

The fourth chapter examines the paths leading to an academic career, in order to understand whether the discrepancies in terms of study choice and field of study might manifest already in a relatively early stage of education. The investigation examines the sources of this horizontal segregation by examining data from high schools and Ph.D. programs. Furthermore, researching Ph.D. programs sheds light on the phenomena

of the leaky pipeline, possibly highlighting the reasons that contribute to the decline in female representation in academia.

In chapter fifth, the research of gender inequality is further explored, with a special emphasis on authoring output among instructors who are actively employed. Finding any quantifiable hurdles that contribute to gender inequality is the aim, particularly with regard to productivity and academic returns. The results reached throughout the chapter are strengthened and consolidated by the addition of current research and studies to this analytical inquiry.

1. Methodology

This master's thesis' methodology part acts as a compass, leading the reader through the steps of data gathering, analysis, and research design. A strong and organized methodology is necessary to prove the legitimacy and credibility of the study's conclusions. The methodical approach used to address the research questions and accomplish the investigation's goals is described in this part.

The main guideline of the research is represented in the She Figures report form the European Commission. Considering that the current research is mainly quantitative, the report provides a rich and depth context to understand the numbers. The research was guided by the report, which provided various rich insights and helped identify the important points to investigate further. For this reason, there might be some overlaps with the report, although the main focus was to articulate the research at the country level, specifically by looking at the country Italy.

The methodology of this research has two distinct approaches: first, it carefully examines data that has been taken directly from official databases such as Eurostat, OECD, and MIUR; second, it carefully examines data that has been taken from these databases but has been further refined by national or supranational institutes, bodies and agencies. The choice to use a combination of unprocessed and processed data stems from an understanding of the complementing benefits that each source offers the research project. Official databases provide raw data that guarantees a minimum level of accuracy and reliability, but elaborated data provide a more sophisticated and contextualized viewpoint, enhancing the analysis's depth.

The report (She Figures) serves as a bridge between the larger European framework and the special peculiarities of Italy. It promotes a comprehensive understanding of gender inequities in academia, providing an opportunity for evaluating the success of policies and initiatives on a regional and national scale. This layered method, which combines overall European patterns with specific data, adds depth and applicability to the study, promoting a fuller understanding of the multifaceted issue under consideration.

The chapter where this method is involved are chapters 3 and 4. Chapter 5, instead, comprises a short literature review regarding gender and academic productivity in order to frame and understand the phenomenon, findings from the She Figures report and data scraped from the web, that for the sake of simplicity and clarity we are going to address it as “authors’ dataset”. This last part is going to be described in the following paragraph.

1.2 Data retrieval

The following paragraph describes the step taken in order to extract the data from the web and building the authors’ dataset. The scraping of the data was done thanks to usage of Python and its powerful open-source libraries.

The first step consisted in retrieving the generalities of the authors from the Italian Ministry of Education and Research (MIUR) database on university teachers[1]. The data retrieval was randomized and only a sample of teachers was retrieved. The data retrieved consisted of different information, including academic rank, name and surname, gender, field of study (expressed in S.S.D. and S.C.) and university affiliation.

The second step entailed retrieving the teachers' data regarding the publications produced. Among different providers, it was chosen Semantic Scholar for their open-source API[2]. The API provides different endpoints; for the sake of simplicity and loads of computation, it was chosen to access the API via the author endpoint[3], providing it with the lists of the university teachers' names retrieved in the step before. Thanks to this method it was also reduced the number of calls towards the API, considering that the papers' information were retrieved in the author endpoint. In order to avoid any homonymy problem, authors with the same name and surname were dropped from the list. The information retrieved consisted of the author's name and surname, its aliases, the H-INDEX, the number of papers published, the number of citations received and the information regarding the papers published. As it can be seen from the API documentation, the information regarding the publications consisted, among others, of the publication ID, the year of such publication, the venue and the name of the author. Therefore, the resulting dataset at this stage is a dataset "exploded" for the papers published by each author: this is mainly due to the structure of the API.

The third step consisted of merging the dataset resulting from step one and step two, in order to have an enriched dataset and a comprehensive overview of the author, and a dataset that would give information not only on the author publication history but also on its current status (academic career rank and disciplinary field, among others). The key to merge the dataset was the name and surname of the authors. Considering that name and surname might appear different in a publication (usually with abbreviation), the second step entailed a further processing of the author's name as retrieved from the Semantic Scholar API. The reason of this processing was to match the resulting author's name from the API with the one originally fed at the endpoint (i.e. C. IMPERATORE becomes CLAUDIA IMPERATORE). This process was carried out successfully thanks to the fuzzywuzzy library[4], setting a threshold of similarity of the 50%. After having cleaned the data, the two datasets are matched, and the dataset is further cleaned of its duplications. An important step was to get rid of those authors that might have cannibalize others during the process of name matching; this was done by eliminating those authors that presented more than five authors' names (retrieved via the API and attributed to them). The threshold of five was chosen discretionally by the author after having inspected the dataset. At this step, the dataset is ready to be analyzed. The further analysis of the academic productivity was instead conducted on a subset of the dataset; the rationale behind it is explained in paragraph 5.2.2. In this paragraph it is important to highlight that the creation of the subset

[1] https://cercauniversita.cineca.it/php5/docenti/cerca.php
[2] https://www.semanticscholar.org/product/api | For further reference: https://www.semanticscholar.org/paper/The-Semantic-Scholar-Open-Data-Platform-Kinney-Anastasiades/cb92a7f9d9dbcf9145e32fdfa0e70e2a6b828eb1
[3] https://api.semanticscholar.org/api-docs/#tag/Author-Data
[4] https://pypi.org/project/fuzzywuzzy/ | For further reference on fuzzywuzzy: https://towardsdatascience.com/fuzzywuzzy-fuzzy-string-matching-in-python-beginners-guide-9adc0edf4b35

required an extensive data cleaning and data validation work that could not be automated for the sake of data consistency. Therefore, this fine-tuning work was conducted by the author manually on Excel. Among others, the refining work on excel required checking for homonymous authors that could have resulted from the API's database and that might have been wrongfully attributed to the current authors.

1.3 Limitations

Several limitations have been encountered in the research; the main one regards the quality and the availability of the data. The gender variable is not always found in the official databases, and this might be a problem in the investigation. In particular the database from the Ministry of Education shows several weaknesses for the scope and work of a data professional: the entity has created ad hoc tables with gender variables that often cannot be matched with the one already available in the other sections; furthermore, the data have an historical depth that only goes from 2012 to 2021. In certain cases, the gender variable are available only on a three-year period bases or as an aggregate, the variables regarding class and field of enrollment are not granular and also difficult to cross with each other (an example might be the gender dataset devoted to the doctoral graduate and students). These factors hinder a detailed and accurate analysis, and they undermine any attempt of advanced analytic, such as the development of a machine learning solution. Similarly, the gender variables are often not found in the supra-national databases, such as OECD and Eurostat, considering that in most cases the countries' agency or entities are accountable for the collection of such variable. Clearly, there are some exceptions, such as in the case of the She Figures report, where the research committee in some instances has collected national data on gender on its own.

When it comes to Sematic Scholar, the limitations of the API consisted in the fact that homonymous author's information stored in the database might be attributed wrongfully while searching for author's name and surname; a more refined search therefore entails utilizing the author ID as more accurate endpoint, although, even in this case, an author can be attributed more than one ID rightfully. Furthermore, not all author's publications might appear in the results from the API.

Finally, the quantitative method chosen might pose some limitations for the scope of the research. Quantitative research can help understand the "what", but it is difficult only with numbers and statistic to understand the "why". This is the reason why some nuances, context and underlying reasons behind the phenomenon might not emerge from this research.

2. Definitions

As one attempts to untangle the intricate web of gender inequality, this chapter provides a starting point by carefully explaining the terms and ideas that are crucial for understanding the subsequent discussion in a sophisticated manner, in particular to thoroughly grasp the data analysis provided. In doing so, it will be created a more nuanced understanding of the complex nature of the gender gap, which will improve the interpretation and consequences of the data analysis that follows.

Overall, it is possible to notice the following phenomenon in the gender studies, with two sociological metaphor that help to describe the gender gap:

- **Horizontal segregation**: it refers to the concentration of men and women in different sectors and/or professions. In the education field this phenomenon corresponds to having a high or low concentration of a specific gender into a specific field of education (European Commission, 2021);
- **Vertical segregation:** it alludes to an abundance of either males or females in the highest positions, meaning roles with authority or decision-making authority. These positions are frequently linked to "desirable" characteristics like higher salary, prestige, and social security. For instance, in the academic sector this is represented by men being the majority of presidents of universities (European Commission, 2021);
- **Glass ceiling:** it refers to "the structural barriers that impede women's access to top decision-making and managerial positions in organizations of all types and domains" (European Commission, 2021, p. 178). The reason these impediments are referred to as "glass" barriers is that, in contrast to clear and equal career growth opportunities for men and women inside organizations, they appear to be invisible and are typically connected to the upholding of the status quo in organizations (EIGE, 2022);
- **Leaky pipeline:** the phenomenon (metaphor) according to which women leaves career pipeline in different stages and at a higher rate than men (EIGE, 2022).

The above phenomena are broadly found in every segment and sector of society and economy, and they are part of the Research&Innovation (R&I) sector too.

For the scope of the data analysis, the terms listed below will be used. Their definitions correspond to the ones reported in *She Figures 2021*:

- **Gender parity**: it alludes to a 50:50 ratio between the number of males and women;
- **Gender balance**: it describes a gender distribution where women and men make up between 40% and 60% of the overall population;
- **Under-representation** and **over-representation**: it describes situations in which the percentage of women or men is, respectively, less than 40% and more than 60%.

With a common vocabulary and a better grasp of the terminologies, it is possible to move on to the empirical analysis that will be covered in the following chapters. The definitions given here are clearly dynamic,

which guide the search into the fundamental issue of gender inequality and encourage an ongoing debate outside the scope of this thesis. In conclusion, this chapter has prepared the groundwork for a clear analysis of the gender gap in education.

3. The gender disparity in the academic sector

Currently, gender inequalities are broadly experienced in Europe. When it comes to education, the *She Figures* report from the European Commission helps to frame the European advancement (or the declines) in the European countries regarding the presence of women in the Research and Innovation field (R & I). The *She Figures* report is an initiative by the European Commission to provide information and statistics on gender equality in Research and Innovation; among the paper devoted to this issue, *She Figures* stands as the most comprehensive and authoritative data source. The goal of the *She Figures* report is to track the advancement of gender equality in various domains by providing information on topics like women's participation in leadership roles, research funding, and academia. Through data-driven insights, policy-making, awareness-raising, and promoting a global dialogue on the importance of inclusivity and diversity in these vital sectors, the study serves as a valuable tool for promoting gender equality, for evaluating the gender component of science and research, and the results it produces can guide the development of programs and policies that advance gender equality.

As stated in the report "equality between women and men is one of the EU's founding values" (European Commission, 2021, p. 18) and the Commission is putting its effort into ensure that the value is being enforced (European Commission, s.d.). In particular, in the R&I sector the EU aims "to create a fair higher education system where women and men researchers benefit from equal opportunities and equal treatment, allowing them to thrive in their careers" (European Commission, 2021, p. 2). The European Commission therefore is committed to make gender equality a priority. In the R & I sector, equality is crucial in order to establish an effective European Research Area, which is "the [European Commission] ambition for a single market for research, innovation and technology across the EU" (European Commission, 2021, p. 6). According to the European Institute for Gender Equality (2022) , the benefits of pursuing gender equality in Research & Innovations are multiple: i) the pursuit of gender equality in research and innovation has several advantages: achieving equity in the field and giving all participants equal opportunities; ii) keeping talent in academic institutions and research organizations and preventing the "leaky pipeline" by creating a better work environment; iii) improving the caliber of research: research teams comprising participants of different genders have been shown to be more creative, inventive, and aware of gender biases; iv) reaping financial rewards because implementing a gender lens increases an organization's competitiveness and yields better financial returns. Furthermore, implementing a policy of diversity and inclusion can help universities to better represent the national communities they belong to and create an inspiring environment for learning (League of European Research Universities, 2019). Furthermore, Research shows that women have slower academic advancement, fewer leadership responsibilities, and lower pay compared to men in identical positions (Abramo, Aksnes, & D'Angelo, Gender differences in research performance within and between countries: Italy vs. Norway, 2021).

This chapter explores the different implications of gender inequalities in the academic sector first by looking at the advancing in the academic career for university staff; then the analysis focuses on the highest

academic positions that can be reached, namely the rectorate position and leadership of research institutes. Gender disparities exist not only among academics and researchers but also among the administrative staff that makes up the elite educational institutions, as the European Commission has pointed out. While the primary focus of this research is on the former group, it is necessary to thoroughly examine the latter group as well. The above-mentioned implications will be analyzed at European level and at Italian level when possible. The data will show that in Italy the gender gap in the academic career has slightly improved in recent years but still being persistent, especially in the top positions: from the recent studies, it is proved that on average, Italian women take half more years to progress in the positions, with relative changes in the field of studies and with greater struggles in the first years of their career (Falco, Cuntrera, & Attanasio, 2023).

3.1. Women Representation in the Academic Career

Although in 2021 Europe has almost reached gender parity in doctorate graduates, disparities still persist when looking at the academic career ladder (European Commission, 2021). Indeed, the gender imbalance is evident. According to the *She Figures* 2021[5] report, there is an evident under representation of women in the top academic positions. As they rose to higher ranks, the proportion of women on academic staff fell sharply, and since 2015, there has been little change in this statistic as figure 6.1 from the report shows. The figure shows that at Bachelor's and Master's level (ISCED 6&7) the gender situation was balanced, with women outnumbering men; at the Doctoral level (ISCED 8) gender parity was almost achieved. Regarding the academic career, in the first step of the career is registered a situation of gender balance (grade C[6]) although the proportion of women starts decreasing. In the latest and highest step (grade B and A) it's evident the disparity in distribution of genders, with women accounting only for the 40% and 26% of the population. The data and the figure clearly show the vertical segregation that women face while climbing the academic ladder. Moreover, it is possible to notice that the percentages change very slightly from 2015 especially in the top grade (from 24.1% to 26.2%), meaning that few improvements were done for increasing women's representation.

The vertical segregation is clearer in Figure 6.2. Figure 6.2 represents the same pathway explored in figure 6.1 but with a particular focus to the STEM fields. The figure displays an under-representation of women in all the higher grades considered, with a particular wide gap at the Grade A positions (19% W): if women have low chances of graduating and pursuing a doctoral title in the STEM field, they hold even less chances to access the highest-grade positions in their career. These findings also imply that women's career pathways

[5] The data elaborated in the report are mainly from 2018.

[6] "The academic staff grades presented in She Figures are based on national mappings according to the following definitions: A: The single highest grade / post at which research is normally conducted within the institutional or corporate system • B: All researchers working in positions that are not as senior as the top position (A) but definitely more senior than the newly qualified PhD holders (C) (i.e. below A and above C) • C: The first grade/post into which a newly qualified PhD (ISCED 8) graduate would normally be recruited within the institutional or corporate system • D: Either postgraduate students not yet holding a PhD (ISCED 8) degree who are engaged as researchers (on the payroll) or researchers working in posts that do not normally require a PhD" (European Commission, 2021, p. 179)

exhibit a greater degree of vertical segregation in the STEM fields. Since 2015, very little to no progress has been made in this instance.

Figure 3-1 Figures 6.1 and figure 6.2 Source: European Commission, Directorate-General for Research and Innovation. She Figures Reports 2021

Figure 6.1 Proportion (%) of men and women in a typical academic career, students and academic staff, EU-27 & EU-28, 2015-2018

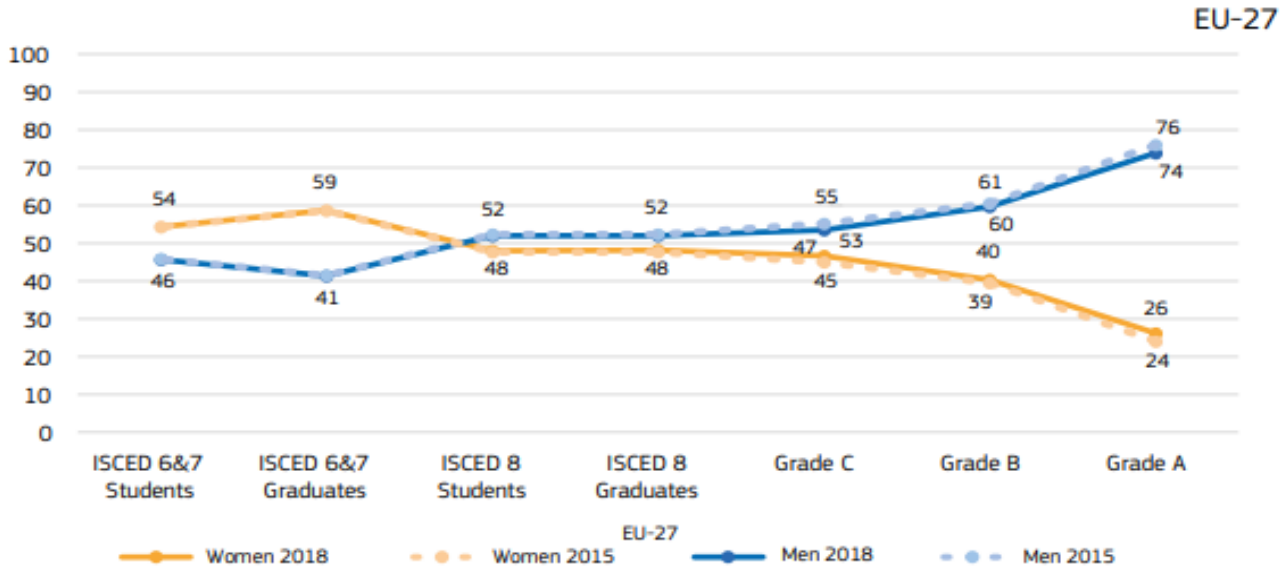
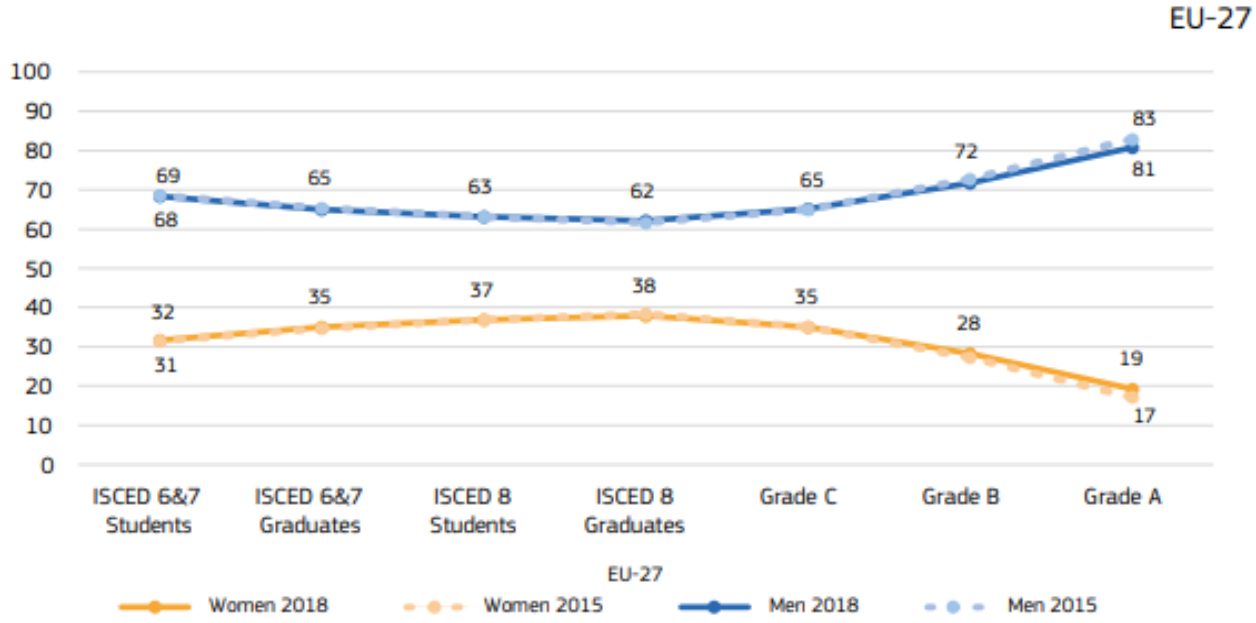


Figure 6.2 Proportion (%) of men and women in a typical academic career in science and engineering, students and academic staff, EU-27 & EU-28, 2015-2018

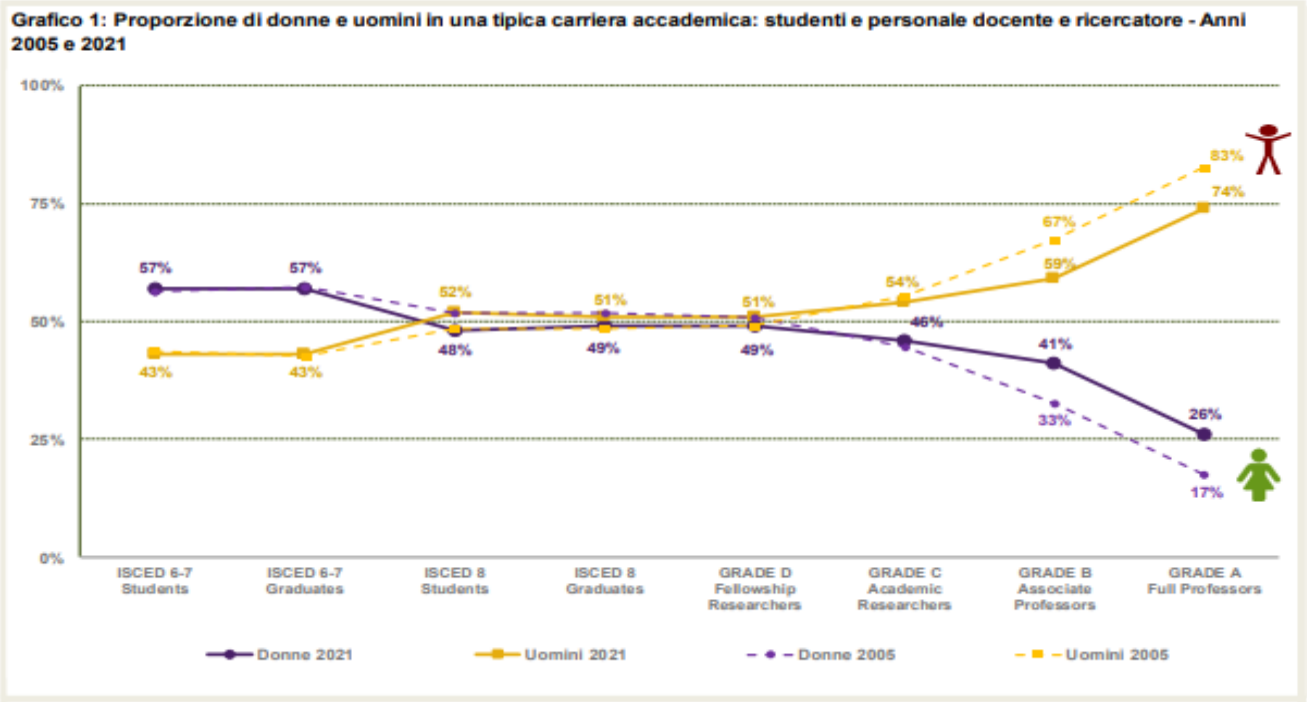


Italy exhibits pattern as the one commonly found in Europe. The Italian Ministry of Education[7] has provided similar analysis as the seen in the European Commission's report, with Grafico 1 and Grafico 2 highlighting

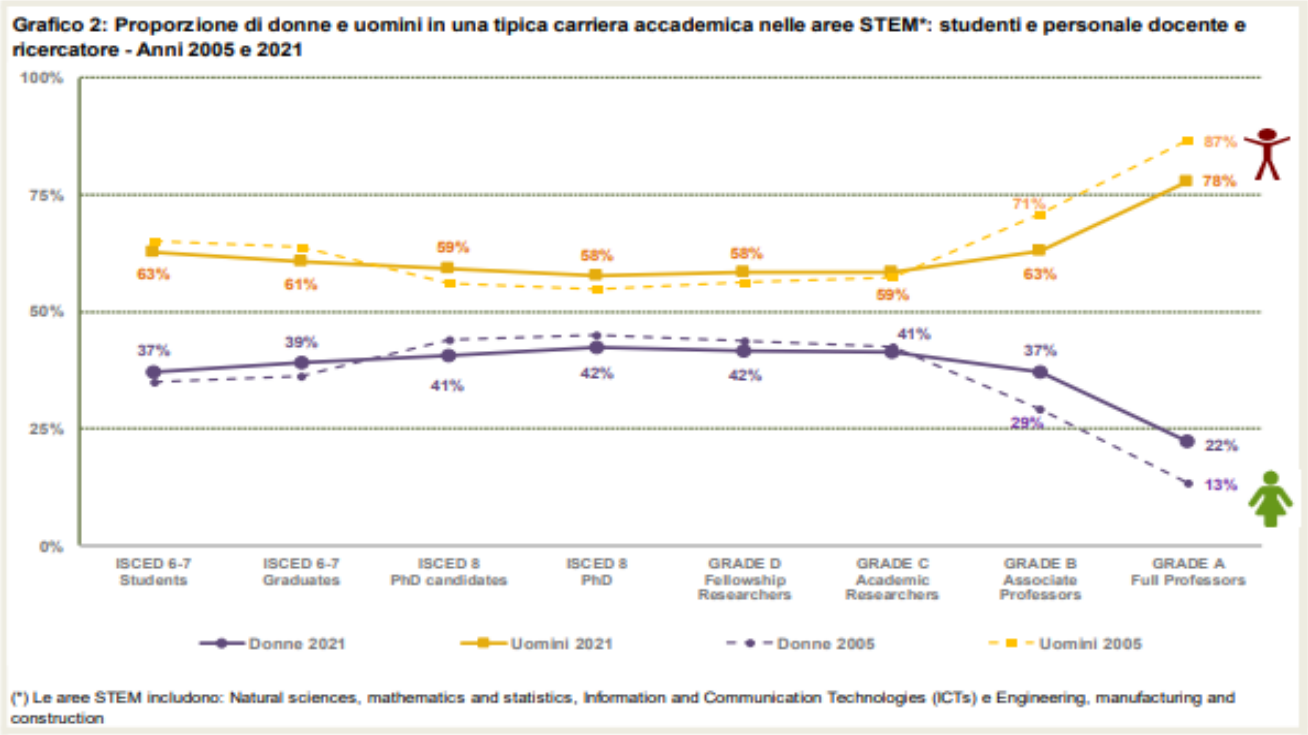
[7] Grade A corresponds to "Professore Ordinario"; Grade B corresponds to "Professore Associato"; Grade C corresponds to both "Ricercatore Tempo Indetererminato" and "Ricercatore Tempo Detererminato"; Grade D corresponds to "Assegnista di

trends that are aligned to those found at common level in the European Union (Ministero dell'Università e della Ricerca, MUR, 2023). In 2021, women made up the majority of students enrolled in universities and graduates in Italy in 2021 (56,6% and 57,2%, respectively). However, their share of enrolled and graduated students in doctoral programs decreased to 48% and 49%, respectively (Ministero dell'Università e della Ricerca, MUR, 2023). Overall, the data for the doctoral program highlight gender parity in the population, a trend that is seen among the fellowship researchers too. Gender disparities starts at the beginning of the academic tenure: grade C exhibits a slightly under representation of women of 46%, that widens at grade B with 41% and that further amplifies at grade A with women making up only the 26% of Italian full professors. From 2005 the patterns have not changed but clearly the balance of gender has improved, in particular at the Grade B field with an increase of 8 p.p (Grafico 1). For the STEM area it is registered a constant under representation of women at all the levels, that has improved only slightly since 2005 with noticeable difference only for the grade B and grade A levels (Grafico 2).

3-2 Grafico 1 and Grafico 2. Source: Ministero dell'Università e della Ricerca, MUR, 2023, p.8



Ricerca". https://dati-ustat.mur.gov.it/dataset/a60a221d-1c0d-4abb-bc8b-2199f61c205d/resource/17b34084-9c01-4e90-9260-982fcb982e6a/download/cod_grade.csv



The figures above display vertical segregation in reaching the highest academic positions and horizontal segregation in the over representation of women in certain fields of study. These aspect are further explored in Figura 1 (source: Ministero dell'Università e della Ricerca, MUR, 2023). The figure elaborated from the Italian ministry represents the ratio of women compared to men (the number of women for 100 men in the field/level) [8]. On the horizontal axis are shown the fields of study while on the vertical axis the level of the academic career, highlighting the horizontal or vertical segregation respectively.

[8] AS: Agricultural and veterinary science; H: Humanities and the arts; MS: Medical and health sciences; SS: Social Sciences; NS: Natural sciences; ET: Engineering and technology.

Figure 3-3 Figura 1 from Ministero dell'Università e della Ricerca, MUR, 2023, p.12

Figura 1: Tasso di femminilità secondo la carriera e gli ambiti disciplinari (*) - Anno 2021

Segregazione Orizzontale

Segregazione Verticale

Carriera accademica	FoRD						TOTALE
	AS	H	MS	SS	NS (STEM)	ET (STEM)	
ISCED 6-7 Students	95	359	203	125	136	38	130
ISCED 6-7 Graduates	95	418	217	120	144	43	134
ISCED 8PhD Candidates	123	142	154	108	90	51	92
ISCED 8 PhD	140	127	167	108	95	53	95
GRADE D Fellowship Researchers	126	122	238	117	95	52	97
GRADE C Academic Researchers	96	114	92	100	92	44	86
GRADE B Associate Professors	82	107	52	86	76	38	70
GRADE A Full Professors	31	64	24	44	37	20	36

ELEVATA PREVALENZA MASCHILE
MODERATA PREVALENZA MASCHILE
SOSTANZIALE PARITÀ
MODERATA PREVALENZA FEMMINILE
ELEVATA PREVALENZA FEMMINILE

(*) Fields of Research and Development (FoRD), Manuale di Frascati 2015
Le aree STEM includono: Natural sciences, mathematics and statistics, Information and Communication Technologies (ICTs) e Engineering, manufacturing and construction

From the figure (Figura 1) it is clear that in 2021 the number of women enrolled and graduated in tertiary education (Bachelor and Master, ISCED 6-7) is higher than the number of men. At this stage, women were more interested in the field of Humanities and Medical and Health sciences, less in the Engineering and technology: this data reinforces gender stereotypes and horizontal segregation. It is clear that as the level of academic career increased, the women's ratio decreased resulting to be very low for "Full Professors" level, and this phenomenon is reported in all of the fields. Indeed, while advancing the steps of the career, women face difficulty even in those fields that the data shows are predominantly populated by women, such as the Humanities field. This pattern is found at the European level too: at the grade A level women are more represented in the field of Humanities (34.41%) and the least represented in the field of "Engineering and Technology" (16.95%) (European Commission, 2021).

In Italy therefore, the academic career of men and women begins to sperate relatively early in the career: the research associate "ricercatori a tempo determinato" (grade C) for females do not reach the 50% of quota in none of the fields in 2021 (Ministero dell'Università e della Ricerca, MUR, 2023). This kind of researcher can access the level of associate professors at the end of its contract, if its in possession of the National Scientific Qualification (NSQ)[9] .

The structure of the Italian university system contributes to some of these discrepancies. The university system has seen changes in staff composition and numbers during the last ten years (National Agency for the Evaluation of Universities and Research institutes, ANVUR, 2023). The teaching staff has had a marked

[9] Abilitazione Scientifica Nazionale

expansion, while the technical administrative staff has experienced a large reduction, especially in public universities. The number of teaching staff increased starting in 2018 and reached approximately 61,000 in 2022 (roughly 4,000 more than the 57.3,000 teachers in 2012). This was following a reduction that lasted until the year 2017, mainly because the severe turn-over constraints that defined public universities until 2017 (ibid.). The trend has changed in part because of the exceptional plans for hiring university lecturers and the removal of some hiring budget restrictions (ibid.). According to the ANVUR (2023), indeed beneficial effects on the universities staff can be seen after the reformations started in 2012. In 2012 the Italian teaching staff composition followed a pyramidal scheme: a large basis of researchers with few Full professors at the top; in 2022 the composition was "rhomboidal" with the associate professors being the majority (Annex Figure 1). This data also explains the increased number of women at the level of associate professors (grade B) in Grafico 1 and Grafico 2. Another peculiar aspect to mention is the average age of university employees in Italy. Despite the turnover, Italy is among the only major European nations where most professors at universities are at least fifty years old, with a minor rise in the mean age of university instructors (51.1 years in 2022 versus 50.6 years in 2012) (National Agency for the Evaluation of Universities and Research institutes, ANVUR, 2023). As Annex 2 shows, from 2012 the mean age for Full professors and associate professors has slightly decreased while the age of the researchers has increased: in 2022 only the 0,2% of the staff was under 30 years old. The data from the Italian Ministry of Education allows to also explore a gender dimension in age distribution. In 2021 women were older than man in term of mean age for academic researchers ("tempo determinato A": 38,3 vs. 37,5 years old, "tempo determinato B" : 41,5 vs. 40,8 years old) and fellow researchers (33,9 vs. 33,4 years old). Women reported to be younger than men for full professors (58 vs. 58,1 years old), associate professors (51,7 vs. 51,9 years old) and academic researchers "tempo indeterminato" (54,1 vs. 55, 2 years old) (MUR, età media del personale accademico, 2023). Figure 4 further displays the age distribution of the Italian academic staff by sex and age groups: no remarkable differences can be highlighted for men and women; both genders follow the same trend and age distribution with younger people at the lowers levels and older people at the highest positions. Although it seems that for the grade D and C, the younger age distribution was more prominent for men: in grade D 69% vs 62,9% of the population was under 35 for women and man respectively; in grade C more than 50% under 44 for men, less than 50% for women. In addition, men were the only one reporting a presence of tenures under 35 years old for the grade B (associate professors).

3.2. Glass Ceiling Index

The *She Figures* report provides the Glass Ceiling Index (GCI) to measure and quantify the effort of women in advancing in their academic career. Having a measure that quantifies "invisible" structural barriers can therefore help in uncovering these impediments and in moving forward gender parity. The CGI summarizes therefore the gender disparities as described in the previous section. As illustrated in chapter 3, the Glass Ceiling effect is common among all industries and sectors and it is not only a peculiarity of the academic

career. In this stance, the index has been calculated[10] as a relative measure that compares the proportion of women in academia to the one of the women at the top positions (grade A) each year; the higher the value to 1, the stronger is the effect of the glass ceiling and the more challenging is for women to move towards higher positions. In 2018 the GCI was reported to a value of 1.5. In Italy, this value was reported to 1.60 in 2015 and 1.71 in 2018: the value has increased since 2015, meaning that for women in 2018 was more difficult to advance in their career than in 2015. The rise is partly due to an increment in number of women at the lower levels of the academic career (grade C and B) that further reinforces the presence of bottlenecks while ascending to the senior roles.

3.3. Leadership And Rectors

The disparity persists when looking at the representation of women in leadership positions. The European Commission in its indicators distinguishes between Higher Education Sector (HES) and universities, where the former includes institutions were PHD's schools might not be provided. In 2019 at European level, the women heads of HES constituted the 23.6% of heads, with multiple countries with the highest proportion of women seeing the numbers in decrease; in particular only 18% of women were rectors of universities or assimilated institutions, with in Italy being constituting only the 9,2% of rectors (European Commission, 2021). In 2023 this data has risen slightly counting 12 women among 88 rectors (13,6% W)[11], with three of the rectors leading the largest Italian universities, and recently, for the first time ever a woman has been elected as president of the 60 years-old Council of the Rectors of the Italian Universities, CRUI [12].

3.4. Board Of Research Institutes

The European Commission (2021) notices an under – representation of women on boards affiliated to the R&I sector such as research institutes or scientific boards: in 2019 at European level women were part of the boards only for the 31.1% and leaders only for the 24.5%. According to the European Commission, improving the distribution and achieving gender balance is necessary in order to ensure the not perpetuating of gender disparity such as ensuring diversity in revising candidates for scholarships and fellowships, making decisions with a gender sensitive point of view and realizing equal access to subsidy for research (ibid.). In Italy in 2019, among 13 institutions, only 1 leader was female and only one-quarter of women accounted for the leaderboards (including the leaders) (ibid.). In 2023, within the 12 public research centers, only one institute was led by a woman[13], showing no improvements in representation since 2019.

3.5. Technical Administrative Staff

In Italy the situation with technical administrative (TA) staff suffered from a lack of the turn over in the previous decade. Specifically for public universities, after ten years of continuous staff reductions, the number of staff members only started to increase in 2022. At the end of the year, tenured staff numbered

[10] For more information regarding the indicator, please refer to the report's handbook: European Commission, Directorate-General for Research and Innovation, (2021). *She figures handbook 2021*, Publications Office. **https://data.europa.eu/doi/10.2777/003736**; p.116

[11] Data elaborated from CRUI: https://www.crui.it/atenei-e-rettori-crui.html, last accessed: 15/11/2023

[12] Source: https://www.ilsole24ore.com/art/iannantuoni-prima-donna-vertice-conferenza-rettori-universita-italiane-ecco-chi-e-AF3ceNkB?refresh_ce=1, last accessed: 25/11/2023

[13] Data elaborated from: https://www.mur.gov.it/it/aree-tematiche/ricerca/il-sistema-della-ricerca/enti-di-ricerca-pubblici

approximately 48,000, down from slightly over 52,000 in 2012—a decrease of approximately 4,000, or -8.1% (National Agency for the Evaluation of Universities and Research institutes, ANVUR, 2023). This data is further reinforced in a minor increase of the average age of the TA employees: from 48,7 years old in 2012 to 51, 9 in 2022 (ibid), and the average age for all the level of the career was over 50 years old (MUR, bilancio di genere personale amministrativo, 2023). For this reason the ANVUR (2023) is urging for growing the employed stuff, considering that it directly affects the good performance and ranking of the Italian universities among the international competitors. The ministry of education has found gender differences among the TA staff. In 2021 the 60,5% of the staff was composed by women. Although women were the majority, vertical and horizontal segregation were still found. In 2021 the administrative area was made up by women for the 74%, in the "socio-sanitaria" they constituted only the 66%, while they were present in the Technical area only for the 39%. Similarly, women constituted the minority in the "Dirigenza" (Directorate) area too, accounting only for the 42% of presence. Again this is a clear sign of the underpinning gender stereotypes that contributes to the horizontal segregation, that further sustains the vertical segregation, as figure 4 shows. In the Figure it is possible to see sign of improvement from 2005 in the area of "Dirigenza", but the horizontal segregation has become stronger, as the table Annex 3-7 illustrates too.

Figure 3-4: Figura 4 from MIUR, 2023, p.24

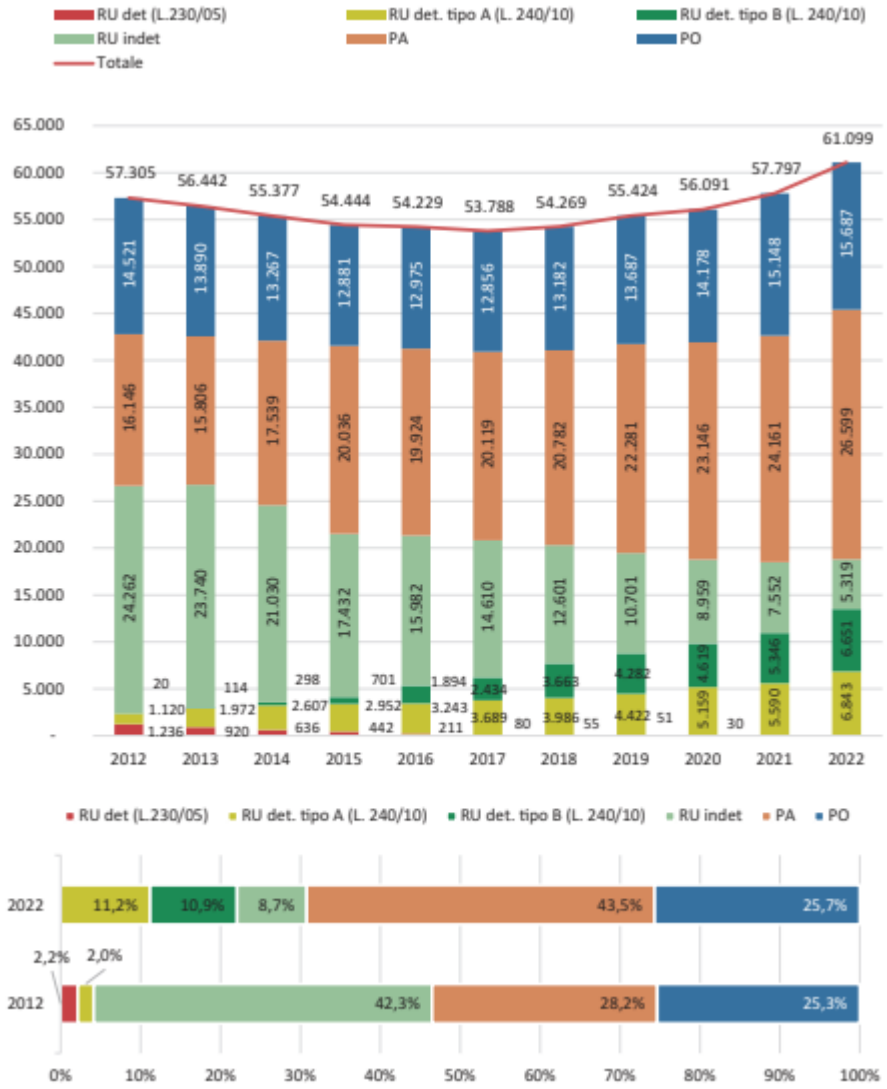
Figura 4: Tasso di femminilità secondo l'area funzionale di afferenza del Personale amministrativo - Anni 2005 e 2021

Area	2021	2005
Amministrativa	280	244
Socio sanitaria	193	131
Tecnica	64	54
Dirigenza	72	49
TOTALE	153	125

ELEVATA PREVALENZA MASCHILE
MODERATA PREVALENZA MASCHILE
SOSTANZIALE PARITÀ
MODERATA PREVALENZA FEMMINILE
ELEVATA PREVALENZA FEMMINILE

3.6. Annex Figures And Tables

Annex: 3-1 . Numero docenti universitari per qualifica (anni 2012-2022) from ANVUR, 2023, P.71



Annex: 3-2. Figura 1.5.2 from ANVUR, 2023, P.73

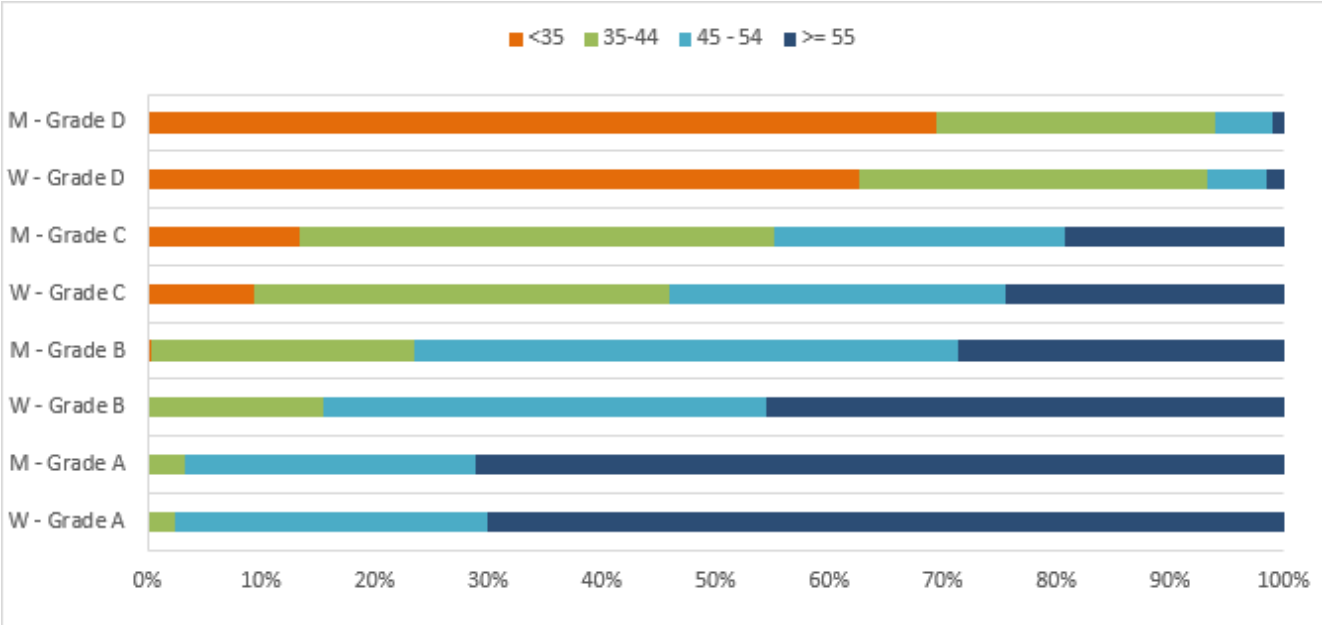
Tabella 1.5.2 – Età media dei docenti universitari per ruolo (anni 2022 e 2012) e distribuzione per classe d'età (anno 2022)

Ruolo	Età media 2022	Età media 2012
PO	58,2	58,9
PA	51,8	52,9
RU indet	56,3	45,4
RU b	41,0	37,5
RU L.230/05		38,0
RU a	37,5	36,5
Totale	**51,1**	**50,6**

Ruolo	< 30 anni	30-39 anni	40-49 anni	almeno 50 anni
PO	0,0%	0,3%	11,9%	87,9%
PA	0,0%	4,9%	38,0%	57,1%
RU indet	0,0%	0,0%	16,8%	83,2%
RU b	0,0%	46,3%	45,2%	8,4%
RU a	1,8%	69,2%	25,2%	3,8%
Totale	**0,2%**	**15,0%**	**28,8%**	**56,0%**

Fonte: elaborazioni su Banca dati MUR – Personale atenei

Annex: 3-3. Distribution of grades staff across age groups, by sex, 2021. Data elaborated from MUR database, serie personale accademico 2023.



Annex: 3-4. Distribution of academic staff by gender and grade; 2012 and 2021. Data elaborated from MUR database, serie di genere personale accademico 2023.

Grade	F% - 2021	M%-2021	TOT - 2021	F% - 2012	M% - 2012	TOT - 2012
A	26,2%	73,8%	15.150,00	20,9%	79,1%	14.522,00
B	41,3%	58,7%	24.155,00	34,9%	65,1%	16.143,00
C	46,3%	53,7%	18.487,00	45,3%	54,7%	26.531,00
D	49,1%	50,9%	15.701,00	51,3%	48,7%	15.747,00
TOTAL	41,1%	58,9%	**73.493,00**	39,4%	60,6%	**72.943,00**

Annex: 3-5. Distribution of grade A (professore ordinario) academic staff by gender and field of study; 2012 and 2021. Data elaborated from MUR database, serie personale accademico 2023.

Field of Study	F% - 2021	M%- 2021	F% - 2012	M%- 2012
01 - Natural sciences (STEM)	26,9%	73,1%	21,2%	78,8%
02 - Engineering and technology (STEM)	16,4%	83,6%	10,4%	89,6%
03 - Medical and health sciences	19,6%	80,4%	13,1%	86,9%
04 - Agricultural and veterinary sciences	23,6%	76,4%	15,4%	84,6%
05 - Social Sciences	30,3%	69,7%	24,0%	76,0%
06 - Humanities and the arts	38,9%	61,1%	35,6%	64,4%
Total	26,2%	73,8%	20,9%	79,1%

Annex: 3-6. Distribution of women by STEM area of study and grades, 2021. Data elaborated from MUR database, serie personale accademico 2023.

Area of Study - STEM	Grade A	Grade B	Grade C	Total
01 - Scienze matematiche e informatiche	189,00	477,00	313,00	979,00
02 - Scienze fisiche	91,00	251,00	214,00	556,00
03 - Scienze chimiche	216,00	723,00	552,00	1.491,00
04 - Scienze della terra	48,00	151,00	120,00	319,00
05 - Scienze biologiche	377,00	1.166,00	1.157,00	**2.700,00**
08 - Ingegneria civile e Architettura	222,00	617,00	452,00	1.291,00
09 - Ingegneria industriale e dell'informazione	228,00	499,00	429,00	1.156,00
Total	**1.371,00**	**3.884,00**	**3.237,00**	**8.492,00**

Annex: 3-7 Distribution of gender per area of the TA staff, 2012 - 2021. Data elaborated from MUR, serie di genere personale TA 2023.

AREA	F% - 2021	M% - 2021	TOTAL - 2021	F% - 2012	M% - 2012	TOTAL - 2012
01-Dirigenza amministrativa	41,7%	**58,3%**	1040	36,8%	**63,2%**	990
02-Amministrativa ed Amministrativa-gestionale	**73,9%**	26,1%	56118	**72,7%**	27,3%	53724
03-Biblioteche	**71,3%**	28,7%	5446	**69,8%**	30,2%	7050
04-Servizi generali e tecnici	37,6%	**62,4%**	7124	40,0%	**60,0%**	9094
05-Socio sanitaria, Medico-odontoiatrica e Socio sanitaria	**65,9%**	34,1%	6154	**61,2%**	38,8%	10346
06-Tecnica, Tecnico-scientifica ed Elaborazione dati	39,3%	**60,7%**	31178	38,3%	**61,7%**	34128

4. Following the path of the young Italians: examining the pool of candidates for a doctoral program

4.1. Introduction: upper secondary education

In order to better understand the phenomenon, it is useful to look at trends in education for young Italians, to know whether gender disparities and differences appear earlier in the education stages. The specific trends observed for Italy follow a similar pattern as the ones found at European level, according to the *She Figures* 2021 report. In this chapter there will be investigated the disparities mentioned in the previous chapter, in particular it will be analyzed the gender distribution during the secondary school education, university education and finally during the phd's programs.

In Italy education is compulsory from the age of 6 up to the age of 16 years old, but young people must stay in education or training at least until 18 years old in order to complete 12 years of education. Given the obligation in school attendance, enrollment data for 2021 in public school show a substantial equality between genders and a high level of participation in education (MIUR, Ministero dell'istruzione e del Merito, 2023), (Annex 4.1).

The situation shifts when the compulsory education ceases. Indeed, the OECD reports that, in 2022, the 37% of Italians (25-64 years old) had not attained an upper secondary education. This data is dramatic compared to the OECD average of 13.8% (OECD, 2023).

When looking at a younger population, Figure 1 shows the percentage of the Italians aging from 18-24 years-old that are no longer in education or training, holding at most a lower secondary education. The data are still worrisome, illustrating a peak of early leavers of almost 13% in 2015. Interestingly, in the period from 2015 to 2020 the female percentage of early leavers is consistently lower than the male counterpart. Regardless the declining trend, early leavers pose a significant challenge to the Italian education system, considering the new EU target of reducing the quota to the 9% (European Commission, 2022).

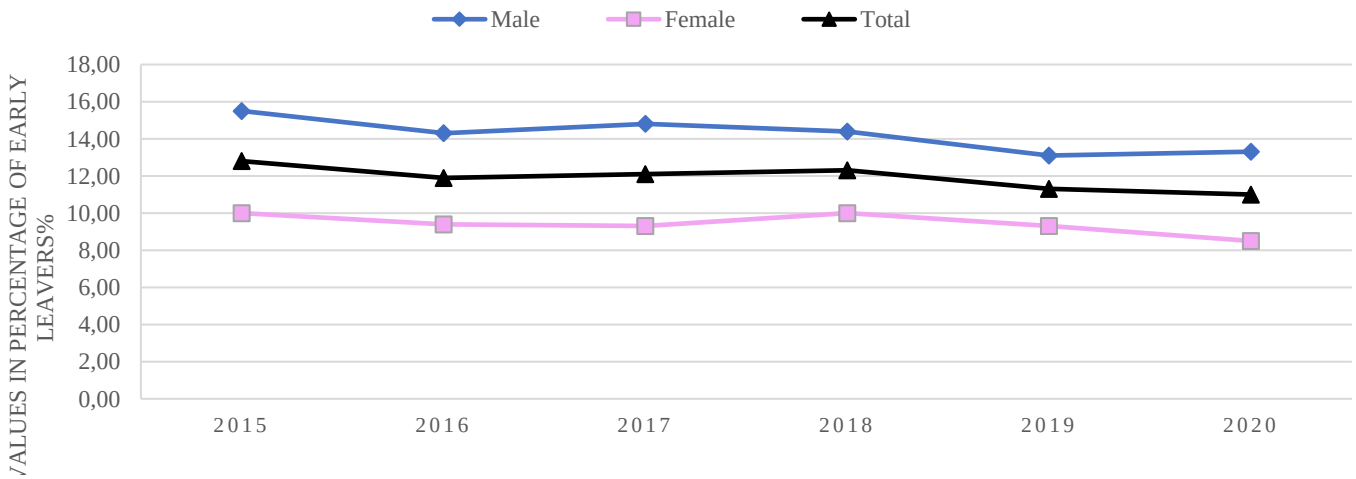


Figure 4-1 Young Italians (18-24 years- old) holding at max a lower secondary diploma. Data elaborated from ISTAT 2023, available until 2020.

The courses of study chosen by students during their secondary school years might have an impact on their total involvement in various professions, career choices, and possibilities. Stereotypes and expectations from society frequently impact the subjects and courses chosen for secondary education. Students may choose courses that are typically linked with their gender due to gender prejudices and expectations (European Commission, June 2021). For example, boys may be encouraged to pursue science or technology, while girls may be encouraged to select the humanities or the arts, impacting later choices in pursuing a STEM career. Stereotyping of this kind can exacerbate gender disparities in professional and academic domains (UNESCO, 2017), (European Commission, June 2021). Furthermore, education decisions influenced by gendered expectations have the potential to uphold social standards and traditional gender roles, restricting people's ability to follow their passions and goals regardless of their gender (UNESCO, 2017).

In Italy gender disparities are already evident while selecting the upper secondary curriculum (Annex 2). In general the majority of the students in public schools were enrolled in the General Education "Liceo"(1.296.605,00 students), followed by the Technical and Vocational education (Istituto Tecnico: 801.432,00; Istituto Professionale: 443.705,00 students). In 2021, women showed to prefer General education, making up the 61% of the students enrolled to the "Liceo". Within this category of school, women were over-represented in the fields of "Scienze Umane" (83% of students), followed by the "Liceo Linguistico" (79% of students) and "Liceo Artistico" (72% of students) while they represented the minority for the "Liceo Scientifico" (43% students). Women were underrepresented in the "Istituto Tecnico" and "Istituto Professionale", where they constituted the 32% and 43% of scholars respectively. In the "Istituto Tecnico" gender parity was reached for the Economic path of study while female students accounted only for the 18% of the one enrolled to the Technological path. Therefore, horizontal segregation appears already in the choice of the upper secondary education, and it can result in harmful effects for reaching the overall gender equality; this horizontal segregation clearly shows its results in the choice of the university education path.

4.2. University Education

The European Institute for Gender Equality created the Gender Equality Index as a tool to track the advancement of gender equality in the EU. It ultimately helps policy makers create more successful gender equality policies by bringing greater attention to areas that require improvement[14], furthermore in an assessment conducted by the Joint Research Centre of the European Commission, the Gender Equality Index was recognized as a valid method for measuring gender parity in the EU. The index has a score out of 100: the closer the value to 100, the closer is the achievement of gender equality. In 2023 Italy reported a Gender Equality Index score of 68.2[15]. For this enquiry it is useful to look at the Index regarding the domain of knowledge: a score of 60.8 was reported for "Attainment and participation" and 60.7 in

[14] https://eige.europa.eu/gender-equality-index/about
[15] Italy | Knowledge | 2023 | Gender Equality Index | European Institute for Gender Equality (europa.eu)

"Segregation": it means that women are 17% times more likely to graduate from a tertiary education path and 47% times more likely to choose studies in **education, health and welfare, humanities and arts.** These differences will be further explored in this section at the tertiary education level.

Figure 2 shows the historical enrollment data to the Italian Universities[16]. Interestingly enough, it is possible to notice than in the last 22 years there have been changes in the enrollment, indeed the maximum number of enrollments has been achieved in 2003, with 338.036 enrollments. After that date, it is observable a decrease in the numbers, with a further increment starting from 2016 (274.486 enrollments) and a dramatic increase in 2020 (336.074 enrollments) almost at the 2003 level. Still, it is clear that the number of women enrolled to universities has been consistently higher than the male counterpart, with women constituting always more than 50% of enrollments.

From figure 2 therefore it can be concluded that women were and are still interested in continuing education by pursuing a university degree, and they do report slightly less abandonment rate compared to the male counterpart in the first year of education (on average, 6,49% M; 6,29% W)[17].

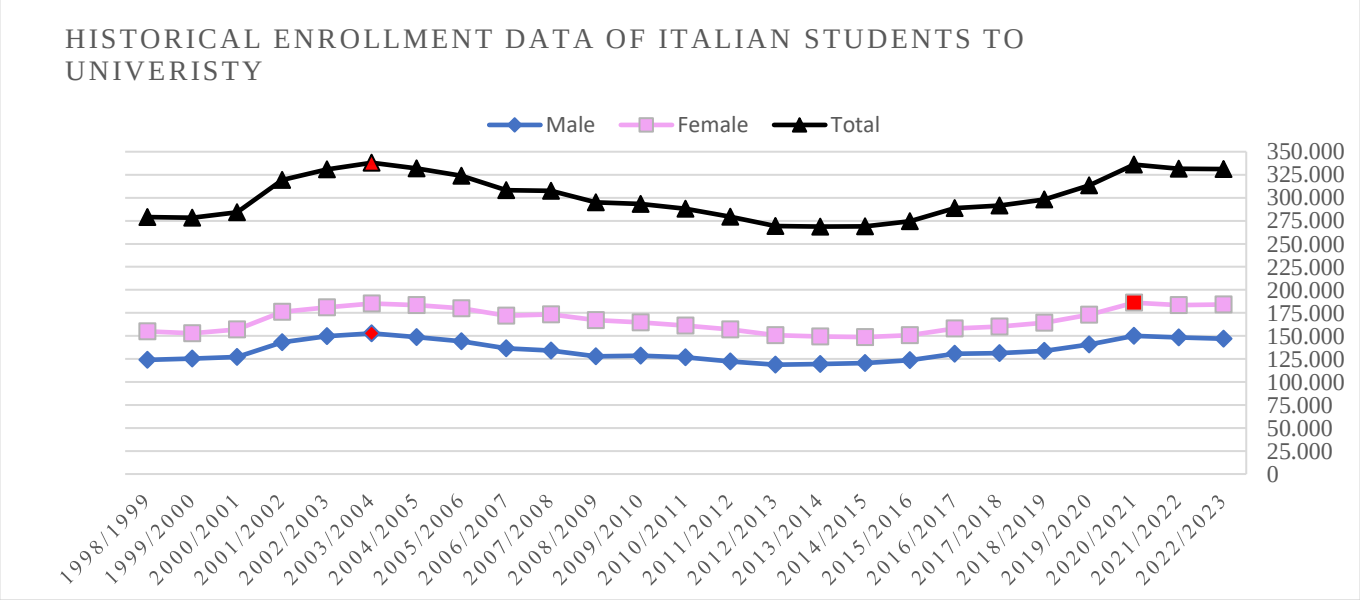


Figure 4-2 Historical enrollment data to Italians Universities by gender. Data from MUR Portale dei dati dell'istruzione superiore 2023.

This is further proved by figure 3. It is visible that in the last twenty years the number of women obtaining a degree title has always been higher than men, ranging from the 56% to 59%[18] of the total during this period. This trend is aligned to the rest of Europe, although the Italian gender gap is slightly wider (European Commission, 2022). Overall, there was an undeniable increase in numbers, with an increment

[16] The data elaborated refers to the "Immatricolati", that is to say, those people that for the first time ever are enrolling to the university.
[17] Data elaborated from MUR, Open data: tasso di abbandono. Accessed on 10/10/2023.
[18] Data elaborated from MUR, Portale dei dati dell'istruzione superiore, laureati per anno 2001 – 2022, 2023.

of 107% and 113% from 2001 for male and female respectively (MUR, Laureati per anno 2001 - 2022, 2023).

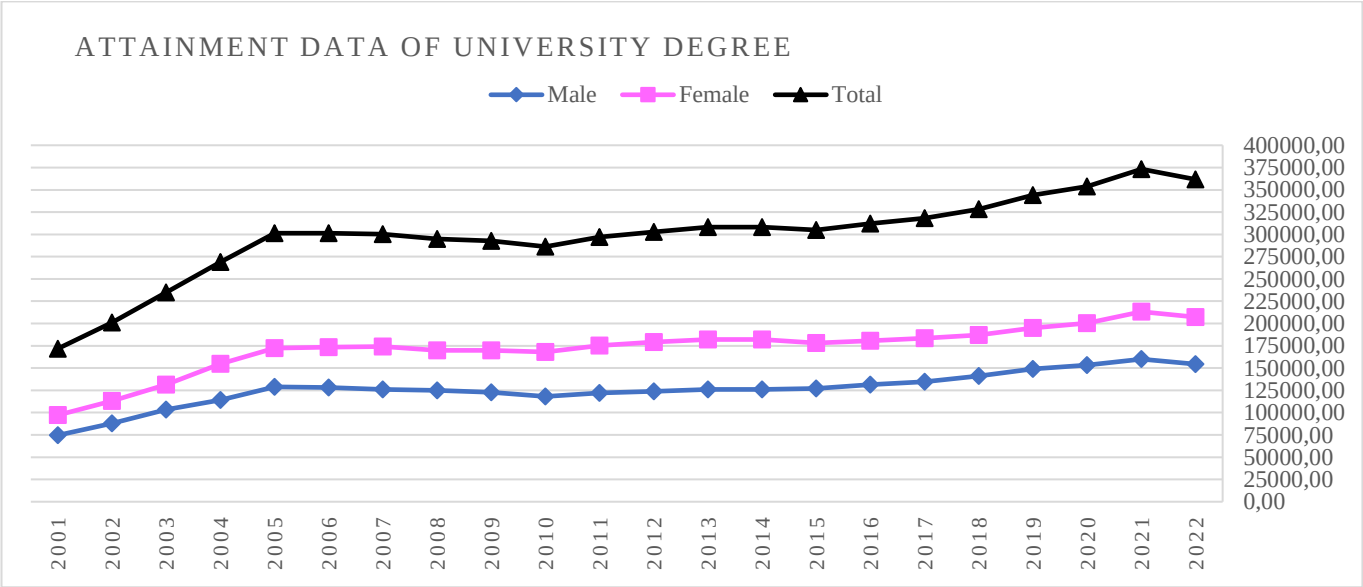


Figure 4-3 attainment data of university degrees. Data elaborated from MIUR, Laureati per anno 2001 - 2022, 2023

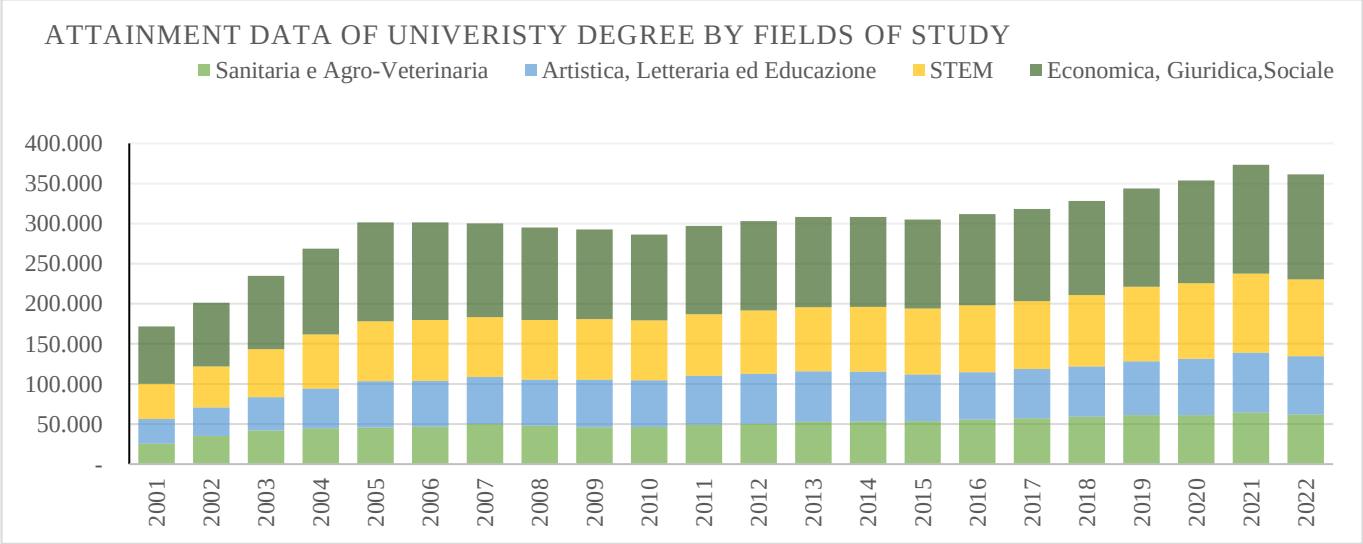


Figure 4-4 Attainment data of university degree by area of studies. Data elaborated from Italian Ministry of Education 2023 (MUR, Laureati per gruppo. 2001 - 2022, s.d.)[19].

According to the data, most degrees were earned in the fields of "Economics, Social and Judicial Sciences," with the fewest graduates coming from the "Health and Agricultural Sciences" field (figure 4; table 1). Within the STEM area, in 2022 The ICT sector reports lower number of graduates compares to the EU averege of 3.9% (European Commission, 2022).

Table 1 highlights the horizontal segregation present in the areas of studies: in the last 21 years, the degrees in the “Arts, Literature and Education” were mostly obtained by women with the preferred field of “Linguistic” (MUR, Laureati per gruppo. 2001 - 2022, s.d.), while the STEM area reports a minor presence

[19] The data were further elaborated by pairing each “gruppo disciplinare” with the corresponding “area disciplinare” as provided by the Italian Ministry of Education in: https://ustat.mur.gov.it/media/1253/monitoraggio_immatricolati_giu2023.pdf.

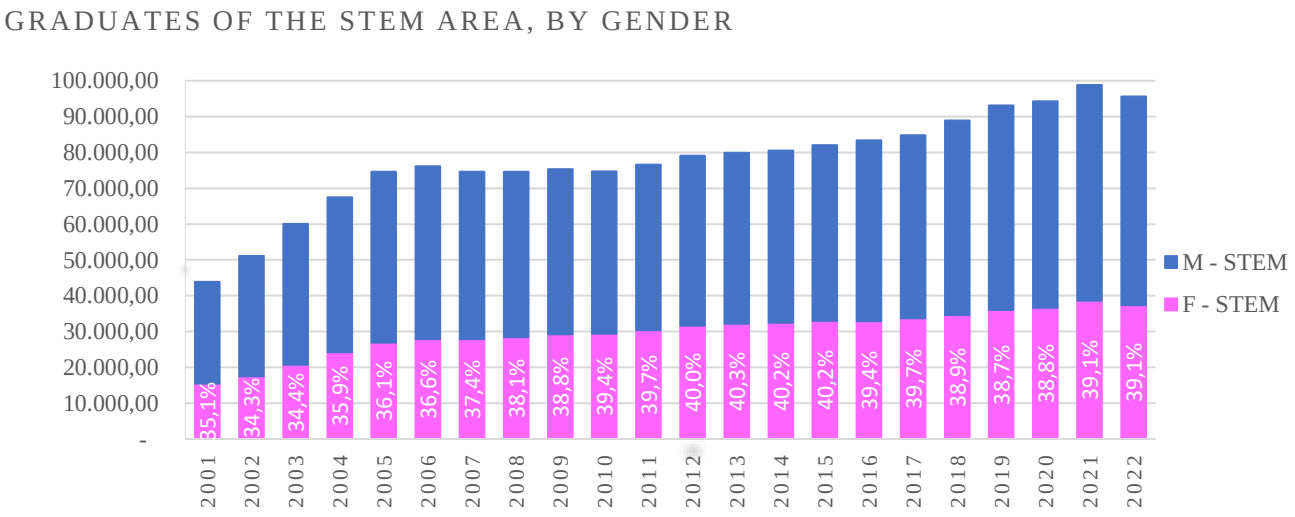
of women, in particular in the ICT field where they represented only the 15,3% (ibidem.). Annex 3 additionally deep dives into the distribution of graduates per field of study in 2021, where the horizontal segregation appears to be dramatic: women were over represented in the "Education" field where they made up the 92,5% of graduates, followed by the "Health and Welfare" field (75,4%) and "Arts and Humanities" (62,5%). Women were the minority in the ICT sector as mentioned before, but they were underrepresented too in the field of "Engineering, manufacturing and construction" (31,1% of graduates). For the STEM area of "Natural sciences, mathematics and statistics" was achieved gender balance (59% of female graduates).

Table 4-1: percentage of data attainment by area of studies and gender for the years 2001-2022. Data elaborated from: MUR, Laureati per anno 2001 - 2022, 2023.

Areas of Studies	Female	Male	Total
Sanitaria e Agro-Veterinaria	62,5%	37,5%	1.109.171,00
Artistica, Letteraria ed Educazione	80,1%	19,9%	1.280.600,00
STEM	38,4%	61,6%	1.709.448,00
Economica, Giuridica,Sociale	57,2%	42,8%	2.466.609,00

Figures 5 provide an extra in-depth look of STEM: Despite an overall increase in the number of graduates, there appears to have been a persistent underrepresentation of women in the gender distribution across the period under analysis. The distribution has not changed either in the field of study: Annex 4 shows that within the STEM field the gender disparities persists, with women prefering the Natural Sciences over the other area of STEM. Positively, compared to the EU average, there are more women graduating in STEM fields (European Commission, 2022).

Figure 4-5 : graduates of the STEM area by gender for the years 2001-2022. Data elaborated from: MIUR, Laureati per gruppo 2001 - 2022, 2023



Overall, the Italian performance in tertiary education remains below the EU average, considering that Italy in 2022 reported an obtainment of 28.3% for the 25-43 years old, while the EU average was of 41.2% (European Commission, 2022). The percentage was one of the of the lowest among the OECD countries too (OECD, 2023).

In conclusion, despite the low performance of Italy in the tertiary education, it is noticeable that women outnumbered men both in the overall data of enrollment and attainment for the last 21 years, with clear horizontal segregation regarding the study choice. Remarkably: in 2021, 57% of female students obtained a university degree while 55% of new enrolled to the university were females.

4.3. Doctoral Program

The data for the doctoral program show different patterns throughout the years. In the overall numbers of enrollment there is an increase in numbers up until the 2008 with 15.440 students. After that point, a considerable decrease in numbers arriving to the 2021 with an all-time high of 17.576, thanks to the injection funds from the European Union. Indeed, different factors have to be taken into account for this decrease, for instance the decrease in number of scholarships for the program, with the pivotal point of the National Recovery and Resilience Plan funds (PNRR) (National Agency for the Evaluation of Universities and Research institutes, ANVUR, 2023). Regarding the gender distribution, the data shows an overall steady trend of equality, with the latest data attesting a percentage of 47% of females enrolled in a doctoral program.

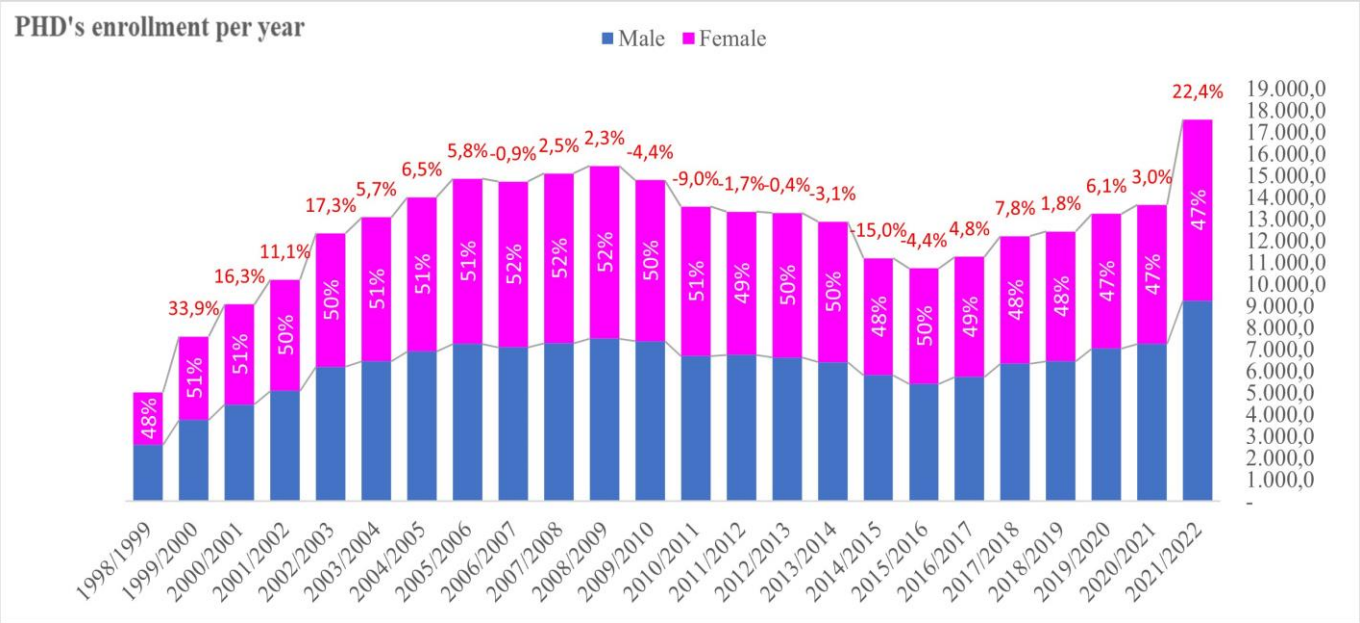


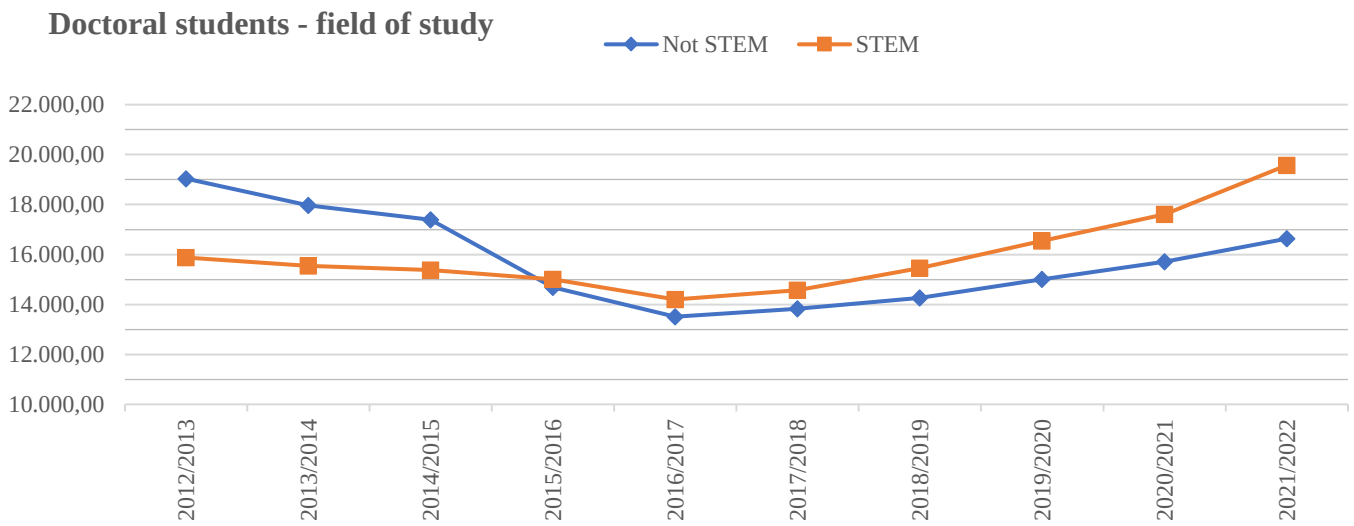
Figure 4-6 historical enrollment data for the doctoral program, first access[20]. Data elaborated from MIUR, Dottorati di ricerca - accessi per ciclo, 2023

The decrease in the first access enrollment contributed to an overall reduction of the enrollment. In 2021, 36.210 students were pursuing a doctoral program: considering the data from 2012, there was an increase of only 5,3%.

The historical trends (figure 7) show an increasing preference for the STEM area starting from 2015.

Figure 4-7: enrollment of doctoral students per field of study. Data elaborated from MIUR, Serie dottorandi, 2023.

[20] The data refers to the "first access", that is to say, new students enrolled in a doctoral program.



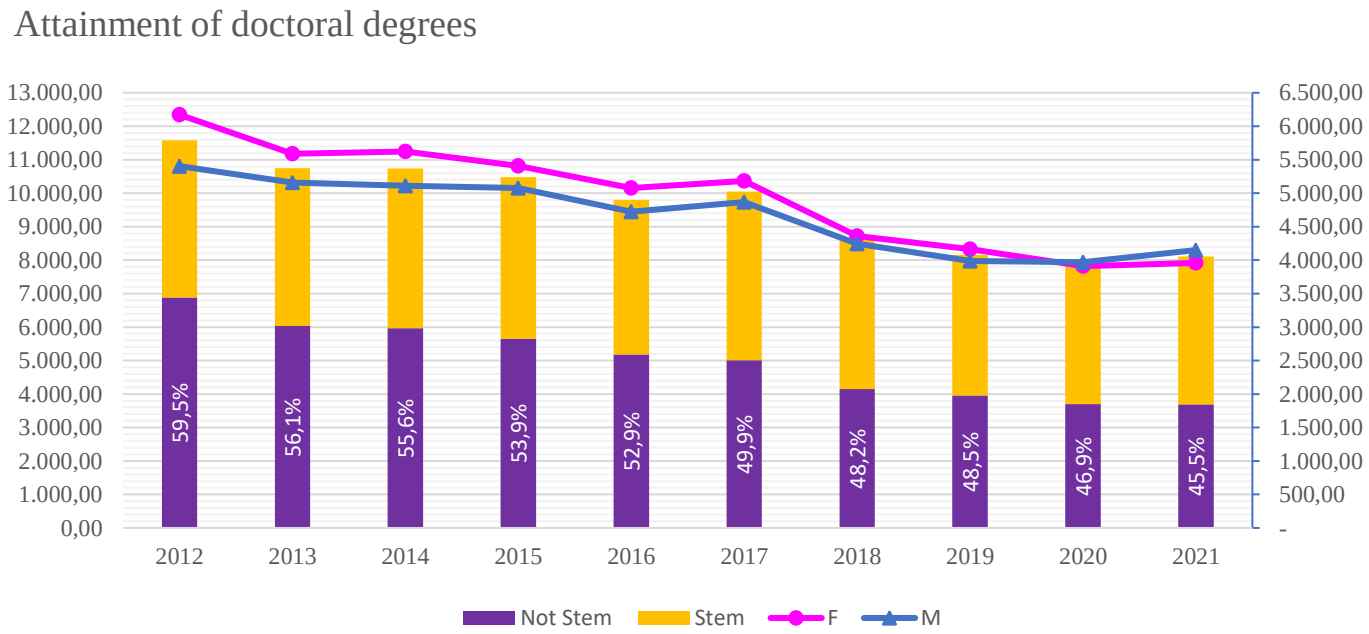
In particular, in 2021 enrolled doctoral students in the STEM area constituted the 57% overall, with the field of "Natural Sciences, Mathematics and Statistics" being the most populated on total (27,2%), reporting the highest number of female students among the STEM courses (4.667 students). Even in this instance, gender disparities in higher education are still evident: female students have historically made up the majority in non-STEM fields, but they have represented the minority in STEM fields, accounting for 40,7% and 56,3% of all students in 2021, respectively. However, it's noteworthy to note that the proportion of female students in the latter increased at a faster rate: in 2021 there was an increase of the 11,8% of the female students enrolled compared to the 5,9% of the Not Stem area; in particular in the field of "Engineering, manufacturing and construction" (+16,1%) and, as stated before, most female students were enrolled in the "Natural Sciences, Mathematics and Statistics" field. These numbers describe a situation of gender balance although underrepresentation of over representation of women persist in certain fields (Annex 5)

The data for the attainment of a doctoral diploma are unfortunately not encouraging according to the OECD: in 2022 the percentage of Italians ranging 25-64 years olds obtaining a doctoral title was only of the 0,6%; for the same age group, the percentage in the OECD and EU was 1,3%. The same low percentage can be attested for the women, with a percentage of attainment of the 0,5% compared to the averages of 1,2%.

Clearly the reduction in number of attainments reflect the fall in numbers as seen in Figure 6, therefore it might be expected an increase in doctoral diplomas in the next five years. As showed in figure 7, from 2015 there was a preference for pursuing doctoral courses in the STEM field, with enrollments in the Not STEM sector being the minority. This is further reinforced by figure 8 that shows a progressive reduction of obtained diplomas in the Not STEM fields. Regarding the gender distribution, women outnumbered the male peers up until 2020: in 2021 they represented only the 48,8% of doctorates and they preferred the Not STEM field over the STEM one, outnumbering men in the "Education" field (78,7%). The presence of female doctors in the STEM fields is registered at 42,3% in 2021 with the majority of presence in the "Natural Sciences, Mathematics and Statistics" field while they represented the minority in the "ICT's" one

(26,5%). On the other hand, the majority of male students obtained a diploma in the "Engineering, manufacturing and construction" field.

Figure 4-8: attainment data of doctoral degree by sex and field of study. Data elaborated from MIUR, Serie dottori bilancio di genere, 2023



In conclusion, is it possible to state that there is gender balance in the doctoral programs' levels of enrollment and attainment, although horizontal segregation is still found in regard to the subject of study as shown in table 2. This horizontal segregation is aligned to the trends reported in Europe (European Commission, 2021).

Table 4-2: Distribution (%) of doctoral graduates across broad fields of study, by sex, 2019-2021. Data elaborated from MIUR, Serie dottori bilancio di genere, 2023

Education fields	F%-2019	M%-2019	F% - 2020	M% - 2020	F%- 2021	M% - 2021
Agriculture, forestry, fisheries and veterinary	**63,34%**	36,66%	58,33%	41,67%	58,35%	41,65%
Arts and humanities	**61,45%**	38,55%	57,93%	42,07%	53,93%	46,07%
Business, administration and law	51,06%	48,94%	49,88%	50,13%	49,33%	50,67%
Education	**75,32%**	24,68%	**69,15%**	30,85%	**78,67%**	21,33%
Engineering, manufacturing and construction	35,03%	64,97%	35,33%	**64,67%**	35,52%	**64,48%**
Health and welfare	**65,21%**	34,79%	**63,56%**	36,44%	**62,57%**	37,43%
Information and Communication Technologies (ICTs)	20,53%	**79,47%**	19,72%	**80,28%**	26,45%	**73,55%**

Natural sciences, mathematics and statistics	50,28%	49,72%	49,64%	50,36%	48,78%	51,22%
Services	37,50%	**62,50%**	50,00%	50,00%	31,25%	**68,75%**
Social sciences, journalism and information	56,40%	43,60%	56,89%	43,11%	55,77%	44,23%
Total	**51,07%**	**48,93%**	**49,63%**	**50,37%**	**48,83%**	**51,17%**

4.4. Annex Figures and Tables

Annex: 4-1. Distribution of students enrolled to school by education grade and gender in 2021/2022. Data from MIUR database, portale unico dei dati della scuola 2023.

School grades	Men	Women	TOTAL	%W
PRIMARY SCHOOL (ISCED 1)	1.191.303,00	1.119.703,00	2.311.006,00	48,5%
LOWER SECONDARY (ISCED 2)	817.909,00	765.756,00	1.583.665,00	48,4%
UPPER SECONDARY (ISCED 3)	1.300.554,00	1.241.188,00	2.541.742,00	48,8%
Total	**3.309.766,00**	**3.126.647,00**	**6.436.413,00**	**48,6%**

Annex: 4-2. Distribution of students enrolled to upper secondary school by school type and gender in 2021/2022. Data from MIUR database, portale unico dei dati della scuola 2023.

School type	MEN	WOMEN	TOTAL	W%
LICEO	**499.921,00**	**796.684,00**	**1.296.605,00**	**61%**
EUROPEO	1.219,00	2.848,00	4.067,00	70%
INTERNAZIONALE	2.039,00	4.148,00	6.187,00	67%
MUSICALE E COREUTICO	8.784,00	10.513,00	19.297,00	54%
ARTISTICO	33.435,00	85.492,00	118.927,00	72%
CLASSICO	44.416,00	105.552,00	149.968,00	70%
LINGUISTICO	43.113,00	163.302,00	206.415,00	79%
SCIENZE UMANE	37.216,00	176.369,00	213.585,00	83%
SCIENTIFICO	329.699,00	248.460,00	578.159,00	43%
PROFESSIONALE	**244.448,00**	**186.067,00**	**430.515,00**	**43%**
INDUSTRIA E ARTIGIANATO	19.667,00	5.980,00	25.647,00	23%
SERVIZI	40.534,00	44.216,00	84.750,00	52%
NUOVI PROFESSIONALI	184.247,00	135.871,00	320.118,00	42%
PROFESSIONALE IeFP	**8.091,00**	**5.099,00**	**13.190,00**	**39%**
IeFP	8.091,00	5.099,00	13.190,00	39%
TECNICO	**548.094,00**	**253.338,00**	**801.432,00**	**32%**
ECONOMICO	142.612,00	163.255,00	305.867,00	53%
TECNOLOGICO	405.482,00	90.083,00	495.565,00	18%
Total	**1.300.554,00**	**1.241.188,00**	**2.541.742,00**	**49%**

Annex: 4-3: Distribution of graduates by field of study and gender in 2021. Data from MUR database, portale dei dati dell'istruzione superiore.

Field of study	Women	Men	Total	W%	Stem Area
Information and Communication Technologies (ICTs)	771,00	4.263,00	5.034,00	**15,3%**	STEM

Agriculture, forestry, fisheries and veterinary	4.279,00	4.482,00	8.761,00	48,8%	Not Stem
Services	5.833,00	9.168,00	15.001,00	**38,9%**	Not Stem
Natural sciences, mathematics and statistics	18.468,00	12.836,00	31.304,00	**59,0%**	STEM
Engineering, manufacturing and construction	19.182,00	42.520,00	61.702,00	**31,1%**	STEM
Education	21.236,00	1.726,00	22.962,00	**92,5%**	Not Stem
Health and welfare	29.405,00	13.540,00	42.945,00	**68,5%**	Not Stem
Business, administration and law	33.882,00	32.881,00	66.763,00	50,7%	Not Stem
Arts and humanities	38.493,00	12.572,00	51.065,00	75,4%	Not Stem
Social sciences, journalism and information	39.520,00	23.726,00	63.246,00	**62,5%**	Not Stem
Total	**211.069,00**	**157.714,00**	**368.783,00**	57,2%	-

Annex: 4-4: Distribution of graduates in the STEM field per gender, year 2012 and 2021

STEM field	W-2012	W-2021	M-2012	M-2021	W%-2012	W% - 2021
Engineering, manufacturing and construction	16.015,00	19.182,00	34.735,00	42.520,00	31,6%	31,1%
Information and Communication Technologies (ICTs)	524,00	771,00	2.626,00	4.263,00	16,6%	15,3%
Natural sciences, mathematics and statistics	15.115,00	18.468,00	10.078,00	12.836,00	60,0%	59,0%
Total	31.654,00	38.421,00	47.439,00	59.619,00	40,0%	39,2%

Annex: 4-5: Distribution of doctoral students per field of study and gender. Data elaborated from MUR database, 2023.

Field of Study	Women	Men	Total	W%	M%
Not STEM Courses	**9.372,00**	**7.265,00**	**16.637,00**	**56,3%**	**43,7%**
Agriculture, forestry, fisheries and veterinary	973,00	789,00	1.762,00	55,2%	44,8%
Arts and humanities	1.967,00	1.484,00	3.451,00	57,0%	43,0%
Business, administration and law	1.625,00	1.557,00	3.182,00	51,1%	48,9%
Education	477,00	236,00	713,00	66,9%	33,1%
Health and welfare	2.784,00	1.807,00	4.591,00	60,6%	39,4%
Services	37,00	37,00	74,00	50,0%	50,0%
Social sciences, journalism and information	1.509,00	1.355,00	2.864,00	52,7%	47,3%

STEM Courses	**7.963,00**	**11.610,00**	**19.573,00**	**40,7%**	**59,3%**
Engineering, manufacturing and construction	3.145,00	5.881,00	9.026,00	34,8%	65,2%
Information and Communication Technologies (ICTs)	151,00	534,00	685,00	22,0%	78,0%
Natural sciences, mathematics and statistics	4.667,00	5.195,00	9.862,00	47,3%	52,7%
Total	**17.335,00**	**18.875,00**	**36.210,00**	**47,9%**	**52,1%**

5. Research and innovation output

Throughout the previous chapters, the quantitative exploration of gender differences within the academic sphere has been the main focus of analysis. A thorough framework has been established by providing an overview of the current distribution of academic staff members and their preferences across a range of subjects and fields of study. This framework not only sheds light on the current state of academia but also serves as a foundation for understanding the origins of gender disparities within academic careers. One crucial area that the analysis shed light on is the rise of gender disparities during fundamental life moments, specifically when students are called to make decisions regarding their high school education: this early stage of decision-making has proved to be determinant for the future gender asymmetries that rise in the academic career. Eventually the struggle of scholars to ascend to the highest levels of their careers becomes evident, giving rise to the well-documented phenomena of the "leaky pipeline" and the "glass ceiling", that capture the difficulties and impediments that prevent women from moving up the academic ladder effectively. To sum up, the analysis provided in the earlier chapters presents a clear picture of gender disparities in academic careers, revealing a path that starts with early educational decisions and ends with the difficult obstacles represented by the glass ceiling and leaky pipeline.

In the following chapter, it will be explored the dimension of productivity; the aim is to understand whether there are significant gender disparities that might contribute and "justify" the different academic treatment of women staff and their struggles to reach the highest point of the career. Indeed, some studies hints that the gap in productivity and self-selection might be two of the biggest reasons according to which the gender gap in academia exist (Filandri & Pasqua, 2019). The conclusion are drawn based on existing works on the subject.

The production and accomplishments of academics in their professional work, such as research, publications, teaching, and other intellectual endeavors, are referred to as academic productivity. The number and caliber of publications, grants obtained, conference presentations, and other services to the academic community are frequently used for assessing it (Filandri & Pasqua, 2019). As Abramo (2021) describes it, measuring productivity aligns with microeconomic theory of production because "productivity is the quintessential indicator of efficiency in any production system". Regarding academic productivity, it exists a wide range of literature that focuses on different aspects of this phenomenon that enriches its understanding and that provides different explanations and points of view regarding gender differences. Still for the scope of this analysis and its limitations, the productivity output that is going to be assessed is the publications output and their impact, measured as the number of papers published by an author and the citations received by the author up to 2023. Two are the reasons that led to this choice: 1. because there are already databases that gather information in this area, it is simpler to measure productivity in terms of the quantity of publications and citations obtained; the existence of these database usually guarantees an higher level of trustworthiness of the data, despite intrinsic limitations[21] ; 2. for the exact reason mentioned above,

[21] For the data collecting process see chapter 2.

there are numerous studies and publications on the topic that can be compared and that can provide a solid theoretical foundation for this study, one of which is the one provided by the European Commission[22].

It is still important to notice that results on the same topic can vary according to the data sources used, considering that several bibliometric databases exist.

5.1 Productivity pattern in Europe and Italy

In alignment with the prior chapters, the European Union report serves as a crucial reference point, emphasizing significant data and key indicators. In this case, its best importance lies in the insights it provides to interpret the data analysis conducted on the dataset of Italian professors. The wealth of information and metrics offered by the report, particularly on individual countries, proves invaluable in comprehending and quantifying the intricacies of a complex and at times elusive phenomenon. For this type of research, the Commission has used the SCOPUS dataset.

The first aspect on which the report sheds a light is the difference between the authors and the active authors. Are considered active authors those who have published at least 10 papers in the last 20 years. Furthermore, for the sake of a clearer and coherent data analysis, the authors have been divided according to their level of seniority [23].

At the European Union level, the gender ratio among authors is nearly equal for “early-stage” authors and steadily decreases with higher seniority levels (European Commission, 2021, Figure 7.2, p. 222). Notably, in the Italian context, gender parity is observed among authors with recent publications and those in the “middle-stage” of their careers. However, prominent Italian authors fall short of gender parity but maintain a balanced ratio of 0.7 (ibid.).

In terms of active writing, the European Commission's data for 2021 show that men are more active than women. In general, “early-stage” authors are closer to parity than senior authors on the European level. However, in Italy, “middle-stage” authors are closer to parity, followed by “early-stage” and “senior” authors. **This suggests that senior female authors in Italy produce less publications than their male counterparts** (European Commission, 2021, Figure 7.1, p. 220). This is a recurring finding in the research that has been seen in a wide range of nations, disciplines, and historical periods (Abramo, Aksnes, & D'Angelo, Gender differences in research performance within and between countries: Italy vs. Norway, 2021).

[22] European Commission, She Figures, 2021

[23] The length of time since an author's first publication in a Scopus-indexed journal is used to evaluate their seniority level, which is divided into three categories: the term "early-stage" refers to authors whose first publication in Scopus was published within the years 2015–2019 (< 5 years span); "middle-stage" refers to authors whose first publication in Scopus was published between 2010–2014 (5 to 10 years span); and "senior" refers to authors whose first publication in Scopus was published in 2009 or earlier (> 10 years span) (European Commission, 2021).

The diminishing data between authors and active authors exhibit that more women than men are left out of the active author calculation compared to the all-author calculation, which shows that **women were not releasing papers sufficiently to achieve the productivity threshold used to define active authorship**.

The previous paragraphs emphasized the pervasive horizontal segregation within the academic sector across all levels. Similar segregation can be found in active authorship too. Examining the European context, it becomes evident that men exhibit greater activity than women in the field of Engineering and Technology across all levels of seniority. A similar imbalance is observed in the Natural Science field. However, in fields such as Medical and Health Sciences, Agricultural and Veterinary Sciences, Social Sciences, Humanities, and the Arts, parity is achieved between male and female active authors. Despite advances toward equity in several sectors, discrepancies exist at the senior level (European Commission, 2021, table 7.1, p.221). Although some research claim that in some sector, women might surpass men (Abramo, Aksnes, & D'Angelo, Gender differences in research performance within and between countries: Italy vs. Norway, 2021).

In the Italian context, a more balanced scenario exists across the Research and Innovation (R&I) disciplines. Male active authors outweigh women in Engineering and Technology, whereas female active author outnumber men in Medical and Health Sciences (ibid.). Overall, this data reflects that, despite the unbalanced gender composition in the various fields of study, **Italian women authors are still more active than the European average, with some exceptions for authors considered senior.**

The average number of publications supports these findings, demonstrating that **women publish fewer works than males as their seniority grows**. This is consistent with the general European trend, in which **women's parity in publishing output falls with increasing seniority**. Italian writers follow this pattern, as evidenced by data from the European Commission in 2021 (Figure 7.3, p. 225).

Despite this declining tendency, women's publications seems to be as relevant as the men's counterpart. Indeed, according to the FWCI index[24] estimated by the European Commission, both genders appears to have the same level of publications' influence in terms of citations across all seniority level, with no disparity exhibited in the different fields either (ibidem., figure 7.4 and table 7.3, pp.227-228).This finding of the European Union account for Italy too. This latest finding however is debated in literature, with discoveries suggesting even diverging results (Abramo, Aksnes, & D'Angelo, Gender differences in research performance within and between countries: Italy vs. Norway, 2021). In order to explore the performance and impact arriving to a satisfactory conclusion, in the most recent paper on the subject Abramo (2021) propose and indicator that takes into account multiple factors: these aspects include not only researchers'output, but also their position in the auhtor's list (when available) and the input of the

[24] Field-weighted citation impact (FWCI) measures the citation impact of a publication: "Field-weighted citation impact (FWCI) is an indicator of citation impact of a publication based on the actual number of citations received by an article compared to the expected number of citations for articles of the same document type (article, review or conference proceeding paper), publication year and subject field. A score above 1.0 indicates that women produced publications that, on average, had a higher impact than men's publications whereas a score below 1.0 means the opposite." (European Commission, 2021, p. 224)

research, that is to say, the economic contribution that the authors received, along with several other factors. The research analyzed papers from the years 2011-2015, concluding that in that time window examined Italian men were more performative than women; they particularly outperformed women in the number of papers published per year. Similarly, the performance gap increased as the rank of the professors incresed, suggesting that tangible gender discrepancies are found only among the top performing groups.

5.2 Data analysis on Italian paper

Building on the upon literature and findings from the previous studies highlighted in the previous paragraph, the following paragraph will provide a detailed analysis of Italian author's productivity in order to examine whether gender differences emerge in the productivity output.

5.2.1 The dataset

The data analyzed have been obtained from Semantic Scholar API. A thorough explanation of the techniques and reasoning behind the dataset construction can be found in Chapter 1. The dataset is a selection of Italian academic writers due to the API restrictions. The writers are active Italian teachers as per 2023, according to the Italian Database for university staff[25].

The dataset is comprised of 8.079 authors, with 4.275 women and 3.614 men. Associate academics (1.951 writers), researchers (1.558 authors), and full professors (759 authors) account for 46%, 18%, and 36% of the total number of female authors. The male authors, instead, are comprised of the following percentages: associates (40%, 1.443 authors), full professors (31%; 1.104 authors), and researchers (29%; 1.054 authors). Given the unequal gender distribution of Italian full professors as highlighted in chapter 4, it is evident that while male authors in this sample constitute the minority group, the number of male full professors actually outnumbers the female counterpart, representing those asymmetries underlined before.

Table 5-1 Distribution of authors by gender and academic rank; 2023

Tenurship Grade	Male authors	Female authors
Full professor	1.104	759
Associate professor	1.443	1.951
Researcher	1.054	1.558
'Professore straordinario'	13	7
Total	**3.614**	**4.275**

Among the asymmetries and disparities, the dataset reflects the horizontal segregation highlighted in the previous chapters too. 61% of female authors are affiliated in Non-Stem fields of study, while male writers are more balanced in the field distribution: 55% of the male authors contributed to the Not Stem Fields. Again, regarding the Humanities and the Arts field, women authors are more prevalent than men (650 authors). For the STEM fields, it appears to be a prevalence of women in the Natural Science field (1.140 authors) while men outnumber women in the Engineering and technology subjects (755 male authors).

[25] https://cercauniversita.cineca.it/php5/docenti/cerca.php

Table 5-2 Distribution of authors by gender and field of study; 2023.

Field of study	Male authors	Female authors
Not STEM	**1.970,00**	**2.612,00**
05 - Social Sciences	809,00	1.101,00
03 - Medical and health sciences	639,00	611,00
06 - Humanities and the arts	309,00	650,00
04 - Agricultural and veterinary sciences	213,00	250,00
STEM	**1.644,00**	**1.647,00**
01 - Natural sciences	889,00	1.140,00
02 - Engineering and technology	755,00	507,00
Total	**3.614,00**	**4.275,00**

5.2.2 The sample

Considering the different limitations and bias that might be included in the dataset, in order to improve the quality of the data and having meaningful results, the author decided to work on a subset of the dataset in order to embark the study of the scholarly productivity patterns by gender.

The data from the Full professors in the Social Science field will be included in the sample. The rationale behind selecting Full Professors lies in their elevated academic rank, which implies longer production times. This longer trajectory allows for the publication of a more extensive body of work over an extended period. Additionally, the choice of a specific field was necessitated by the need to consider variations in legislations across different fields of study. Different legislations set varying criteria, including the number of papers and publications required for individuals to be appointed as university teachers. Therefore, the productivity output of different fields of study cannot be comparable. In this case, the Social Science field was chosen because the gender distribution in this field was more balanced (annex, table 5-6).

To ensure consistency, authors who looked to have published fewer than ten papers were removed from the subset. This criterion is consistent with Italian legislation, which establishes a minimum number of publications required for an individual to be designated as full professor. Furthermore, to verify the dataset's integrity, only papers with a unique ID were examined, reducing the possibility of duplicates influencing the analysis. This careful approach to data refining is intended to give a more accurate and nuanced examination of scholarly productivity patterns within the defined subset.

5.2.3 The analysis

The following metrics and indicators have been computed in order to analyze the sample:

- **Publishing period**: this measure was calculated as the time between the first and last date of publication, in years;
- **Activity period**: it refers to the period between the author's first publication year and the year 2023, taking into account the fact that they are still listed as active teachers in the Ministry of Italian Education dataset for the year considered.

- **Inactive years**: it signifies the number of years that the author has not made any publications; they are determined as the blank years within the activity period;
- **Inactive publishing years:** it highlights the number of years that the author has not made any publications; they are determined as the blank years within the publishing period;
- **Continuity:** Boolean value that considers whether an author has been continuous or discontinuous in its publication; it derives from the inactive publishing years. If the inactive publishing years are equal to zero, the author is considered continuous.
- **Index of inactivity**: percentage measure of the inactive years among the length of the activity periods. It determines, in percentage, the amount of time the author has been inactive (i.e. without publishing).

The analysis reveals that, within the sample of female authors, a substantial number, precisely 223 individuals, actively contribute to the analyzed scholarly publications. Upon meticulous data cleaning and manipulation, an interesting pattern emerges regarding the average length of the publishing period. These authors exhibit an average publishing span of 26 years (spanning 1979 onwards), highlighting a sustained commitment to academic contributions over an extended period, as per their academic rank. The total number of papers produced by them consists of 15.635 papers, with an average of 70 numbers of publications per authors. Examining the temporal dynamics of their careers, it is revealed that, on average, the authors have experienced periods of inactivity lasting 8 years. This prompts a closer inspection of the temporal distribution of their active and inactive phases. Approximately 30% of their active time is spent in periods of non-publishing, shedding light on a nuanced aspect of their academic trajectories. The seniority-based author segmentation provides insightful information on the contribution of experience to productivity. The division of publishers into three categories (10 years, 20 years, and >20 years) [26] offers a more complex viewpoint. Unfortunately, the sample for the 10 years publishers is too small to be considered significant (only two authors). The most important conclusion is that authors with over 20 years of experience predominate, constituting the 85% of the sample. Almost 90% of all articles written are the result of the latter, publishing on average almost 75 papers each. It's interesting to note that the analysis and the indicators might suggest also a link between inactive times and seniority. As authors accumulate more experience, there is a discernible increase in the duration of inactive years. This implies that although senior authors are quite productive, they also deal with extended periods of less academic engagement.

Table 5-3 Productivity indicators for female authors, 2023

Type of publishers	N° of **authors**	N° of **papers** (avg.)	N° of papers (sum)	**Inactive publishing year** (avg.)	**Index of inactivity% (avg.)**	**Inactive years (avg.)**
> 20 years publishers	187,00	74,48	13.927,00	8,11	0,31	9,47

[26] The categories have been determined in the following way: if the date of the first publications was 2013 or later, the author is described as '10 years publisher'; if the date falls within 2003 and 2013, the label assigned is '20 years publisher'; if the date traces back 2003, the author is considered ' >20 years publisher'.

20 years publisher	34,00	49,56	1.685,00	2,82	0,25	4,15
Total	**221,00**	**70,64**	**15.612,00**	**7,32**	**0,30**	**8,65**

A specular analysis has been conducted for the male authors that falls in the category of Full professor within the Social Sciences, the same logic of data cleaning and manipulation have been applied. The total number of authors amounts to 250. The average span of publishing time amounts to 32 years (spanning 1955 onwards). Although the number of male authors in the sample is slightly higher than the female counterpart, the authors that populates the 20 years publishers group appears to be less than the female counterpart. Male authors produced more papers than the female writers, accounting for 23.496 published papers, resulting in almost 50% of more publications. What is interesting to notice is that, although the male 20 years publishers are less than the women, constituting only the 11% of the male samples, they still produced more papers than the female counterparts with a difference of almost 300 publications, and an average number of paper per author that results more than doubled (71 papers each vs. 50 papers each). As expected, the number of papers written per men is higher, accounting for 94 publications each, with the senior authors making up most of the publications (92%): a pattern consistent with the observed trend among female authors. Examining the temporal aspect, the average number of inactive years for male authors totals 12, surpassing the corresponding figure for female authors. This discrepancy may be influenced by the average publishing year length, which stands at 26 years for women and 32 years for men. To facilitate a more meaningful comparison between the two genders, a relative measure is considered. A closer inspection of the index of inactivity reveals a similar pattern across both genders. On average, both male and female authors experience periods of inactivity during approximately 30% of their active periods. Furthermore, when considering specific seniority categories, 20 years publishers exhibit a quarter (0.25) inactivity rate, while senior authors reach a 30% inactivity rate. This finding suggests a shared trend of intermittent periods of inactivity, possibly influenced by broader factors such as academic demands and career trajectories.

Table 5-4 productivity indicators for male authors, 2023

Type of publishers	N° of authors	N° of papers (avg.)	N° of papers (sum)	Inactive publishing year (avg.)	Index of inactivity% (avg.)	Inactive years (avg.)
>20 years publishers	222,00	96,91	21.514,00	11,63	0,34	13,20
20 years publisher	28,00	70,79	1.982,00	3	0,23	4,00
Total	**250,00**	**93,98**	**23.496,00**	**10,672**	**0,33**	**12,17**

The examination of the timeline reveals distinct trends over the years. However, an in-depth analysis of the total sum of papers per year brings to light certain limitations, primarily stemming from the disparity in the number of authors contributing to the dataset. A noteworthy observation emerges as the male output consistently surpasses that of their female counterparts over the years. This discrepancy underscores a consistent higher level of scholarly productivity among male authors within the examined period. Looking at the post-2019 era, both genders exhibit a similar downward trend. This pattern raises the possibility that the global pandemic might had an impact on writers of both genders. Interestingly, women's scholarly output has decreased more significantly and noticeably during this era than men's, despite men showing some prominent peaks that may indicate variations or strategic moves. Lastly, overall, only the 6% of female authors showed continuity in their publications, versus the 5% of the male counterpart, according to the "author continuity" value. In order to understand the productivity pattern, it has also been calculated for each author the average number of papers produced in their activity period. In this case, the average has the advantage of limiting fluctuations among productivity patterns. Despite women being more consistent in their publications, on average, **women published three papers per year, compared to men that published four papers per year;** the median value for both genders was three papers per year .

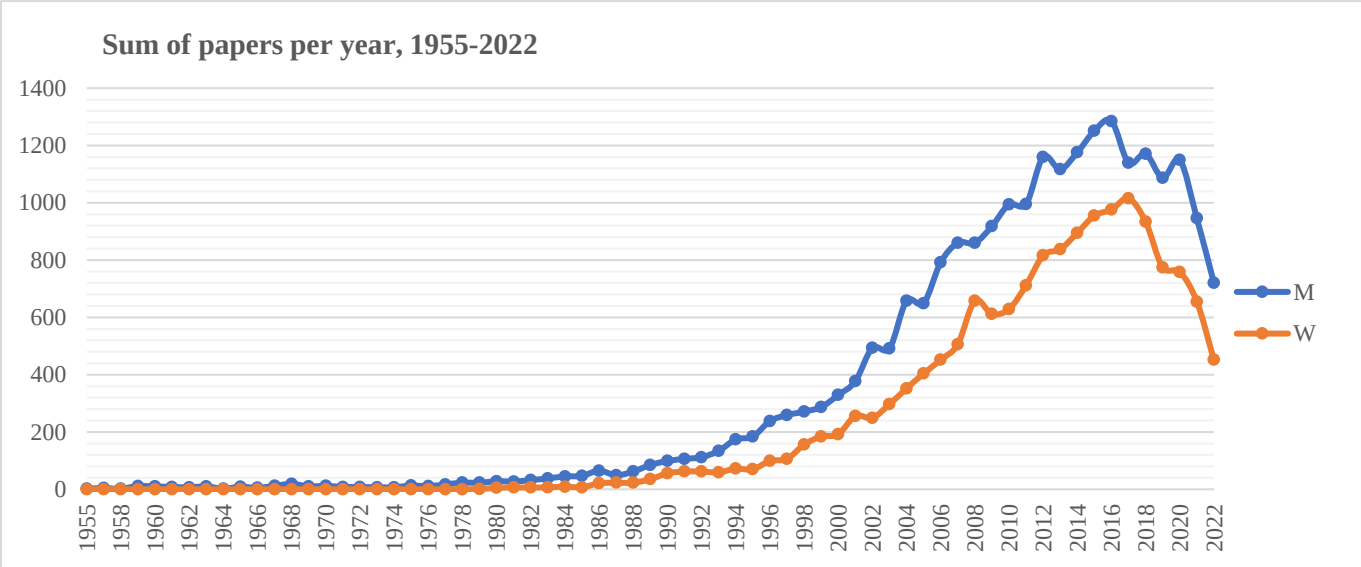


Figure 5-1: sum of papers per years and gender, 2023.

One of the most influential factors for a researcher is the impact of its publications. From the dataset, it is possible to retrieve the number of citations a paper has received, the total number of citations received by the author and data relative to their H-Index. Given the higher output in terms of publications and the difference in numbers, men resulted to have higher number of citations compared to women (346.849,00 citations compared to 167.524,00 citations), resulting in a difference of +107%. For a comparative measure, it has been calculated the average number of citations per paper[27], that should account for the discrepancies in number of authors and papers and fluctuation in productivity. As it appears from the table, on average women received 11 citations per paper, compared to male writers that received a slightly higher number

[27] Normalized Citations per Author: Total citations divided by the total number of papers.

(15). Regarding the H-Index, although the Semantic Scholar highlight the limitations of the measure[28], it is still worth to notice that the median value for the H-index for women was 6 and for the men 8, signaling that the 50% of the respective distributions attested over these values.

Table 5-5 Indicators of productivity for authors: citations. 2023.

	N° citations (avg.)	N° citations (sum)	N° citations per paper (avg.)
Women			
> 20 years publishers	825	154.261,00	11
20 years publisher	390	13.263,00	8
Total	**758**	**167.524,00**	**11**
Men			
>20 years publishers	1.419	315.034,00	15
20 years publisher	1.136	31.815,00	16
Total	**1.387**	**346.849,00**	**15**

In conclusion, the data analysis highlights a significant difference in the amount of scholarly work that men and women produce, with men consistently generating more papers—roughly four per year on average. The ongoing significance and impact of female researchers in the academic landscape must be acknowledged, regardless of this appearing productivity disparity. In particular, women researchers follow their male counterparts by only three points in the citation per paper metric, which supports this observation. A nuanced view of the contributions of each gender is offered by the contrast between the higher productivity of male researchers and the comparatively lower but significant output of female researchers. Comparable citation metrics indicate that women researchers contribute significantly and have an impact, despite a gender gap in the number of papers published. These findings are aligned to the ones discovered by the European Commission (per above) and the research that were presented on the matter. The consistency of female researchers' research, in spite of possible fluctuations in productivity, indicates a long-term dedication to academic pursuits. It suggests that women have a more steady and constant research trajectory over time, despite the fact that men may show higher output peaks. Moreover, the data highlights a trait that both genders have in common: about 30% of their active time is spent not publishing papers. This similarity points to a parallel trend in periods of inactivity, highlighting the fact that during a large portion of their active academic careers, both male and female researchers face comparable obstacles or partake in non-publishing activities. Indeed, many studies roots the disparity in productivity in the gender roles that Italian women play in the society as the primary caregiver in the families or at work, where women invest more time than men in mentoring activities, teaching and taking care of administrative tasks (Filandri & Pasqua, 2019). Therefore, our final finding regarding time of non-publishing may require

[28] https://www.semanticscholar.org/faq/h-index#:~:text=Semantic%20Scholar's%20h%2Dindex%20is,when%20comparing%20against%20other%20websites.

confirmation and additional investigation through the analysis of additional author samples or combination of the research with additional methodologies, such as qualitative methods (interviews, surveys), in order to measure and capture those aspects that are beyond the scope of simple statistics (e.g., the activities and duration of non-publication time) and having stronger conclusions.

Some might say that using a quantitative evaluation method when deciding on the career advancements of individual academics might yield benefits if such indicators accounted for inherent gender differences (Abramo, Aksnes, & D'Angelo, Gender differences in research performance within and between countries: Italy vs. Norway, 2021). This is also the reason why some authors have suggested to build "gender-sensitive" bibliometrics indicators that take into account the gender of the author (Abramo, D'Angelo, & Rosati, Selection committees for academic recruitment: does gender matter?, 2015) or even modifying traditional bibliometrics indicators such as the H-index in order to remove the possible gender bias they might carry (Cameron, White, & Gray, 2016).

The analysis concludes that there is a complicated relationship between the production, influence, and consistency of research conducted by male and female researchers. It is essential to recognize the many features of their contributions in order to advance fairness in scholarly judgments and to get a deeper understanding of the academic environment. Productivity, therefore, might contribute to gender disparities but one cannot forget that the same disparities might contribute to different pattern in research and productivity. Therefore, other confounding factors have to be taken into account while investigating gender disparities in the academic sector, for instance women's reticence in applying for higher positions due to lack of self-confidence or fear of being discriminated, or the feeling of social and intellectual marginalization coming from being a minority in certain context (Filandri & Pasqua, 2019). Sometimes, the resources invested for recruiting and support the staff in advancing their career can be a factor of discrimination (ibid.). Although, according to some researchers, the possibility that gender differences in the Italian academia result from women's low productivity or self-selection has to be ruled out, as it cannot explain the gender disparities acceptably (ibid.).

5.3 Annex Figures and Tables

Table 5-6 number of authors per academic rank, field of study and gender. 2023

	N° male authors	N° female authors
Full professor	**1.104,00**	**759,00**
01 - natural sciences	239,00	185,00
02 - engineering and technology	221,00	90,00
03 - medical and health sciences	200,00	82,00
04 - agricultural and veterinary sciences	65,00	33,00
05 - social sciences	272,00	237,00
06 - humanities and the arts	107,00	132,00
Associate professor	**1.443,00**	**1.951,00**
01 - natural sciences	378,00	545,00
02 - engineering and technology	303,00	225,00
03 - medical and health sciences	225,00	240,00

04 - agricultural and veterinary sciences	93,00	126,00
05 - social sciences	336,00	495,00
06 - humanities and the arts	108,00	320,00
Researchers	**1.054,00**	**1.559,00**
01 - natural sciences	271,00	416,00
02 - engineering and technology	230,00	192,00
03 - medical and health sciences	208,00	291,00
04 - agricultural and veterinary sciences	55,00	91,00
05 - social sciences	196,00	368,00
06 - humanities and the arts	94,00	201,00
‘professore straordinario’	**13,00**	**6,00**
01 - natural sciences	1,00	1,00
02 - engineering and technology	1,00	2,00
03 - medical and health sciences	6,00	1,00
05 - social sciences	5,00	2,00
Total	**3.614,00**	**4.275,00**

Conclusions

The research has elucidated the presence of gender discrepancies in Italian academia across all tiers and facets; specifically, it has illustrated that these inequities can start as early as high school address selection. Clear bottlenecks emerge from the data: although women have a higher percentage of educational attainment than men, few of them choose to pursue a doctoral degree and even fewer to pursue an academic career. For those who have already embarked on this path, however, the road is uphill, and several (often invisible) obstacles arise in the career climb. The enduring gender preconceptions and biases regarding women's abilities and social roles are among the many factors contributing to this effect, which cause both direct and indirect discrimination against women in the workplace (European Commission, 2021). Similarly, a lack of arrangements that are compatible with family responsibilities, instances of sexual harassment, bullying, and gender-based violence, as well as gender differences in personal choices and behavior, are additional obstacles to career advancement in workplace cultures that are not yet sensitive to gender (ibid.). Lastly, in some universities it might be displayed a "gatekeeper" effect, in which leaders—typically men—may unintentionally advance the careers of people who are like them (Van den Brink, 2010; ENLEFGE, 2012; NPWDPE, 2012 in European Commission 2021). So, it is no longer possible to impute the presence of these obstacles to reasons such as the narrow candidate pool or lower academic productivity, as we attempted to refute earlier in the research.

The data have also illustrated an improved situation for Italian women in comparison to the past, and some authors claim that the positive score of the index actually hides the reality of the majority of Italian women being employed in the most precarious roles, due to recent policy intervention (Picardi, 2019). Therefore, policy intervention is needed in order to correct these asymmetries, as long as the policy is able to be gender sensitive (Filandri & Pasqua, 2019). Similarly the European Union is advocating for diversity in research: for instance, starting 2022 bodies interested in participating to the Horizon program, and therefore to access funding, need to present a Gender Equality Plan (European Commission, 2021). The Commission claims that reaching equality in the R&I sector will have several beneficial spillovers in society and economy; indeed, the lack of women and diversity results in less than optimal outputs because targeted only to a small proportion of society (European Institute for Gender Equality, EIGE, 2022). Furthermore, it is also aimed to increase the number of patents made by women inventors (European Institute for Gender Equality, EIGE, 2022) and similarly the number of female leaders in research, in order to introduce fresh concepts and innovative techniques within the European Union (ibid.).

The research presented so far displayed interesting themes and insights that can be further expanded in future research through the utilization of different research methods too, given the importance and the urgence of the matter.

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