



Article

The Glass Door of Academia: Unveiling New Gendered Bias in Academic Recruitment

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Abstract: Gender statistics and studies on gendering mechanisms have been developing over recent years on two parallel tracks. This research reveals the need to rethink the standard indicators used in European comparative analyses to identify (1) gender-related mechanisms responsible for the production and reproduction processes of gender asymmetries, (2) their specificities in different local contexts, and (3) the profound transformations that have characterized the academies and the research system in Europe in recent years. The paper analyses the data on the composition of Italian academia provided by the Italian Ministry of Education, universities and research from a gender perspective. The introduction of the glass door index, specifically designed to measure gendering processes taking place in the recruitment stages in Italian academia, discloses new forms of gender segregation in Italian universities after the last academic reform (Law 240/2010), despite the emphasis placed on the neutral and meritocratic criteria of the new recruitment and career progression rules.

Keywords: academic recruitment; analysis of gender asymmetry; glass door index; glass ceiling index

1. Introduction

One of the trickier aspects of processes that produce gender inequality is the difficulty of making them recognizable. This is even harder in the scientific and academic context, institutionally conceived as universalistic and neutral fields with respect to gender. However, the conception of organizations and their institutional culture as neutral is one of the main causes of the persistence of gender inequalities, complicit in hiding some of the causes that produce gender differences.

Despite the significant and numerous programs promoted in the last two decades to encourage gender equality in science in several national and international scientific institutions, women are still significantly under-represented in science and academia. According to the last She Figures report ([European Commission 2019a](#)), in 2015 only one-third of the EU's researchers were women and, moving up the academic ladder, women represented 24% of full professor positions. The gap between women and men was wider in STEM (science, technology, engineering, and mathematics) fields, where women made up 39% of doctoral graduates and held only 15% of full professor positions.

In recent years, gender scholars have given several explanations of gender inequalities in academia: recent research focuses on excellence and scientific quality as a gendered social construction ([Bailyn 2003](#); [Benschop and Brouns 2003](#); [Deem 2007](#); [O'Connor and O'Hagan 2016](#); [Van den Brink and Benschop 2012b](#); [Nielsen 2015, 2017](#)) and shows the existence of gendered networking by gatekeepers, marginalizing women in academia ([Bagilhole and Goode 2001](#); [Benschop 2009](#); [Van den Brink and Benschop 2012a, 2014](#)).

Nevertheless, the relevance of the gender issue in science tends to be underestimated in many scientific environments, where it is frequently perceived as a past issue now outdated. Even in scientific institutions committed to gender equality, there is a relevant gap between the theoretical knowledge

and results of gender studies, on one hand, and the implementation of effective policies on the other (De Vries and Brink 2016).

In Italy, gender equality is no longer considered a priority in many academic contexts but rather a nearly achieved goal. This belief is supported by three kinds of data. The first concerns the gender balance registered in recent years in the composition of the student body in higher education. The second concerns the recent increase in the number of women researchers in Italian universities. The third concerns the decrease in the glass ceiling index, the most well-known index used to monitor the underrepresentation of women at the top levels of research and academia. These data may support the belief that gender differences in the research field, as represented by the career scissor diagrams for Italy, as well as for other European countries, are the result of gender segregation practices and of limitations in access to academic careers that women have experienced in the past, while the current conditions of the academic system are such that the equal development of careers is guaranteed.

The analysis of Italian academia in this paper disproves this thesis by quantifying the existence of differentiation processes between men and women in the current recruitment system. While in other works I have investigated the nature of gender practices and the mechanisms that produce gender asymmetries in academia and science (Picardi 2016, 2017, 2017), the focus of this research is a quantitative analysis that measures and compares, in different fields, the effects of gendered practices in two different phases of the academic career: the early stage, before the academic recruitment, and the reaching of apical academic positions.

Section 2 critically discusses the development of statistics on gender equality in research and academia and presents the theoretical perspective guiding this work. Section 3 briefly describes the current system of career development in Italian academia, analyzing the transformations in terms of recruitment and career progression recently introduced by the comprehensive reform of the university in 2010. Section 4 presents critical issues related to the glass ceiling index, one of the most well-known indexes used to measure and compare the underrepresentation of women in leadership positions. Section 5 introduces the glass door index, an index designed to measure the effect of gendered practices in the current Italian academic system. Section 6 is devoted to the analysis of the horizontal segregation across different fields of research and development (FORD). The final section discusses the main results and conclusions.

2. Unveiling New (and Old) Gender Inequalities in Academia

Since the 1990s, national governments and scientific institutions have started to develop initiatives aimed at addressing the underrepresentation of women in science and technology fields and in academia. Towards the end of the last millennium, gender equality has become one of the priorities of European policies on research and innovation, and, in the last two decades, the European Commission (EC) has launched several programs to promote gender equality in science. At this stage, intervention strategies in research and academia were mainly conditioned by the “equal opportunities” perspective to gender equality, and the emphasis was on the “fixing the women” approach (Calás and Smircich 2006; Meyerson and Kolb 2000). In this context, in 2003, the EC started to release, every three years, the She Figures report, which became the main source of pan-European, comparable statistics on the representation of women and men amongst researchers and academics across Europe (European Commission 2016, 2019a).

In the last decade, the academic discussion on gender equality in science has been growing, revealing critical issues in the “fixing the women” approach.

Feminist literature has focused on gender practices, as micro-level interactions between individuals, to understand the more complex and subtle means through which the gender order is structured in institutions and organizations (Acker 1990; Bird and Sokolofski 2005; Britton 2000; Butler 1990; Connell 1987; Martin 2001, 2003; Pyke and Johnson 2003; Schwalbe et al. 2000). Ely and Meyerson define gender as “a complex set of social relations enacted across a range of social practices that exist both within and outside formal organizations” (Ely and Meyerson 2000, p. 113). This perspective, stemming

from Acker (1990) gendered organizations theory, helped to focus European policies (also) towards new approaches and recommendations: the “fixing the institution” approach, which moves the focus from women to institutions (Helsinki Group 2009), and the “fixing the knowledge” approach, which highlights the relevance of gender analysis as a factor contributing to the development of new ideas and the fostering of innovation in research (European Commission 2013; Schiebinger and Schraudner 2011; Schiebinger et al. 2011).

On the other hand, the conceptualization of gender as a complex and multi-dimensional concept made the measurement of gender equality in the academy more problematic.

Recent research has developed different statistical models for measuring gender equality in academia. A gender equality index for academic institutions was developed within the European project Gender Time, applying the EIGE model in academic institutions (Badaloni and Perini 2016), and the GEDII project defined the gender diversity index to provide a measure of gender diversity in organizational performance (Humbert and Guenther 2017, 2018). The gender diversity index is a composite index aggregating several gender diversity measures into a single coherent measure.

While gender is to be conceived as a set of social relations that cannot be subsumed under a strictly binary conceptual dichotomy, statistics—which may actually be based only on data records for which sex is a proxy for gender—are still relevant to monitor gender segregation in institutions and to give evidence-based support to oppose the claims of those who say gender inequality is merely residual of a no longer existent prejudice against women in science and academia and those who deny that gender equality is now the rule.

The glass ceiling index and the glass door index discussed in this paper analyze two different stages of the academic career (the precarious stage and full professorship) to detect the existence and specificities of practices of gender segregation within these stages. Moreover, the use of these tools of analysis is related to the need to understand how gender practices are changing as an effect of deep transformations that have been re-shaping academia and research environments in recent years.

Recent studies have shown the relevance of deep organizational changes that have reshaped scientific work and careers in academic and research institutions in the last decades. These transformations, both globally and locally, are characterized by new forms of governance in academic and research institutions, redesigned practices and research schedules in academic work, redefined competition mechanisms, and the relevant effects on scientific career paths (Felt 2009, 2016; Le Feuvre et al. 2018).

The analysis presented in this paper examines the impact that the implementation of the last reform of Italian universities and of neutral meritocratic criteria of assessments has had on gender practices in academic recruitment and career progression. While official statistics and their analysis seem to show that gender equality in Italian academia is increasing (thesis supported by the decrease of glass ceiling index), new inequalities are shown to impact the early career stages of academia, and the rhetoric of merit conceals them and may be instrumentally used to blame the victims.

3. A First Glimpse on the Actual Italian Academic Paths: The Open Data Analysis

This paper analyzes the data¹ concerning the composition of Italian academia provided by the Italian Ministry of Education, Universities and Research (Ministero dell’Istruzione, dell’Università e della Ricerca—MIUR) and examines from a gender perspective the transformation of scientific careers paths induced by the last university reform.

In December 2010, the institutional governance and the organizational structure of Italian academia were profoundly changed by a comprehensive reform, known as the “Gelmini reform” (Law 240/2010), introduced by the Education Minister Maria Stella Gelmini.

¹ Data are available at <http://ustat.miur.it/opensdata>.

In addition to modifying the Italian state university institutional governance system (Donina et al. 2015), Law 240/2010 has established new rules concerning recruitment and career progression in Italian university that have significantly changed academic career paths.

In the new academic path outlined by Law 240/2010, we can distinguish two main stages comprising temporary and permanent positions. One of the most distinctive effects of the Gelmini reform can be observed in the drastic modification of the former permanent researcher position (RU), which used to represent the first appointment on the academic career path. The former model has now been replaced by two different fixed-term positions (type A and type B) to be filled by researchers who have earned a PhD degree and are expected, by an employment contract, to do research work, undertake a variety of teaching and tutoring duties, and be available for office hours. These two types of research positions have replaced those formerly provided by Law 230/2005 (the so-called Law Moratti). More precisely, though, only one research position provided by Law 230/2005 has been implemented and, although nearing completion, is for now still in place.

Type A researchers have a three-year contract that, upon positive evaluation of their teaching and research duties, can be renewed for two years only. Type B researchers have a three-year contract, which is granted to researchers who had previously been hired as type A researchers, to grant holders, to post-doctoral research fellows hired for at least three years (consecutive or otherwise) or to researchers who hold similar positions abroad, and to scholars who have earned the National Scientific Qualification (Abilitazione Scientifica Nazionale—ASN).

Even if the duties of type A researcher are in many aspects similar to those of type B (both give lessons, take part in departmental councils, supervise students, etc.), from the point of view of the academic role and career, they are completely different. Whereas type B research contract can be described, to a certain extent, as a tenure-track position (Arienzo 2017), type A research positions are still precarious, in many aspects more similar to the post-doctoral research fellowship. Law 240/2010, therefore, has in fact indicated, once the PhD has been completed, an ideal temporary-position career path articulated in two steps:

- Post-doctoral research fellowship (Assegnista di ricercar—AR)/type A fixed-term assistant professors (Ricercatore a tempo determinato di tipo A—RTD A);
- Type B fixed-term assistant professors (Ricercatore a tempo determinato di tipo B—RTD B).

After the temporary position stage, the academic career path entails two more career steps:

- associate professor (Professore Associato—PA);
- full professor (Professore Ordinario—PO).

In accordance with Law 240/2010, recruitment and career progression procedures follow a two-step timing and a two-level deliberation process:

- first, at the national level, national committees (one for each research field) have to select candidates that deserve the ASN, a formal entitlement to cover a position either as associate professor or full professor;
- second, at the local level, each department opens job vacancies to recruit, through formalized competitive public procedures, associate professors and full professors in specific research fields.

National committees are composed of five members, extracted—every four years—from a list of all Italian full professors, who meet pre-defined scientific requirements (identified by bibliometric and/or other indicators) in their research field.

The data for gender analysis available on the website of open data of MIUR are aggregated in accordance with the MIUR decoding table of the successions of grades of academic career defined by the Frascati Manual (Table 1).

Table 1. Grades of academic career: (a) Definitions of academic grades provided by Frascati Manual (2015), (b) decoding the classification used by the MIUR (Source: MIUR definition²).

(a)	
Grade	Description Grade
A	The single highest grade/post at which research is normally conducted. Example: “full professor”.
B	Researchers working in positions not as senior at the top position (A) but more senior than newly qualified doctoral graduates (ISCED level 8 ³ . Example: “associate professor” or “senior researcher”.
C	The first grade/post into which a newly qualified doctoral graduate would normally be recruited. Example: “assistant professor” or “post-doc fellow”.
D	Either doctoral students at the ISCED level 8 who are engaged as researchers, or researchers working in posts that do not normally require a doctoral degree. Example: “PhD student” or “junior researcher” (without a PhD).
(b)	
Grade	Qualification
A	Full professors (PO)
B	Associate professors (PA)
C	Full-time assistant professors (RU)
C	Fixed-time assistant professors (RTD B, RTD A)
D	Post-doctoral research fellowship positions (AR)

The analysis of 2010 and 2017 data provides the well-known “scissors diagram” of gendered patterns of career progression reported in Figure 1a. Even though this diagram presents striking evidence of vertical segregation in the Italian academy, it seems to show a slow reduction of gendered scissors and the achievement of an equality condition at the first stage of academic careers, with 51% of women and 49% of men holding research appointments in 2017 (50% and 50% in 2010) and with only three percentage points that remove academic recruitment positions (grade C) from gender equality (five points in 2010).

We obtain different results if grade C data are disaggregated in data concerning RTD A, RTD B, and RU positions, which, as explained above, have very different meanings in terms of academic role and career. If we compare the diagram obtained with this analysis shown in Figure 1b with the previous one in Figure 1a, the differences in the early career stages are immediately evident: In particular, the gap between women’s and men’s paths increases in correspondence with the approach to academic recruitment. In 2017, 41% of those in the role of RTD B were women, which, although it is a temporary position, after the Gelmini reform constitutes the academic recruitment phase, while in 2010, 45% of those recruited in their first permanent academic role were women.

The negative derivative that marks women’s career progression curve in Figure 1b, however, shows a slight turnaround at the stage of permanent research positions (RU). These figures have to be interpreted by taking into account that the permanent contract research position is currently no longer effective, and it represents an exhausted category. The presence of a larger number of women in this position depends on the higher transition rate of men to the role of associate professor.

³ Programmes at ISCED level 8, or the doctoral or equivalent level, are designed primarily to lead to an advanced research qualification. Programmes at this ISCED level are devoted to advanced study and original research and are typically offered only by research-oriented tertiary educational institutions, such as universities.

² MIUR decoding is available at <http://ustat.miur.it/opendata>.

This observation makes us consider it necessary to study academic careers and make a very clear distinction between what happens before recruitment and after recruitment.

To analyze the segregation processes taking place in the early career stages and to capture the gender impact of the transformations of university careers introduced by the recent university reform, we introduce the glass door index (Picardi 2019). To analyze the vertical segregation of the full-time positions in the academy, we review the use of the glass ceiling index, as shown in the next section.

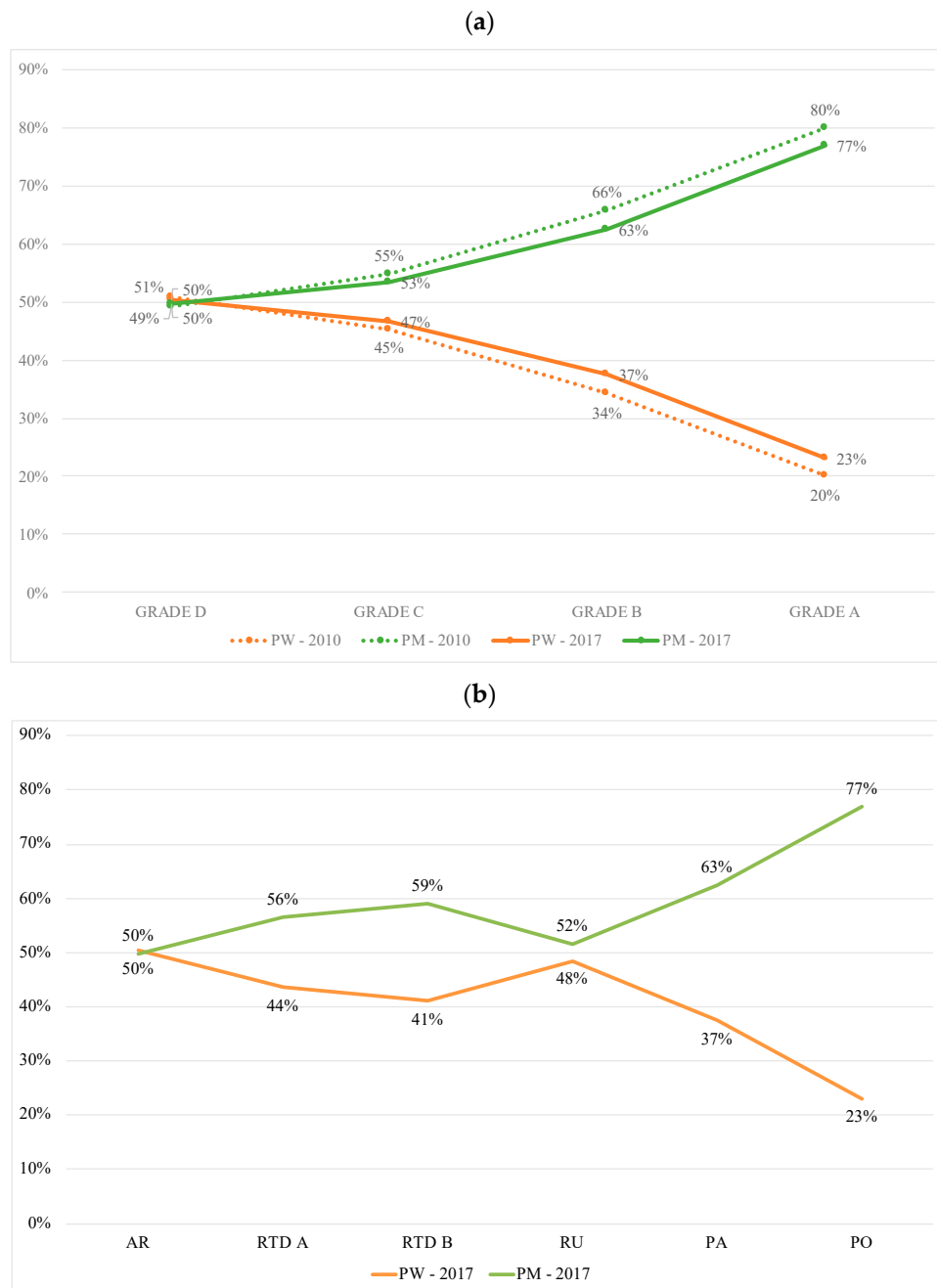


Figure 1. Scissors diagram of academic careers in Italy: (a) decoding grades of academic career by the Ministero dell’Istruzione, dell’Università e della Ricerca (MIUR); (b) disaggregated data (Picardi 2019).

4. The Glass Ceiling Index and the Paradox of Achilles and the Tortoise

According to the definition provided by the She Figures Handbook (European Commission 2019b), the glass ceiling index is a relative index comparing the proportion of women in the academic grades

A, B, and C in the year Y ($PW_{(A+B+C), Y}$) and the proportion of women in top academic positions (the grade A positions) in the year Y (PW_A, Y):

$$\text{Glass Ceiling Index} = \frac{PW_{(A+B+C), Y}}{PW_A, Y}.$$

As known, a glass ceiling index (*GCI*) of one indicates that there is no difference between women and men in terms of their chances of being promoted. A score of less than one means that women are more represented at the grade A level than in academia generally (grades A, B, and C) and a *GCI* score of more than one indicates the presence of a glass ceiling effect, meaning that women are less represented in grade A positions than in academia generally (grades A, B, and C). In other words, the higher the value of the *GCI*, the stronger the glass ceiling effect and the more difficult it is for women to move into the grade A level.

According to the latest She Figures, in recent years, the *GCI* values have decreased within the EU-28: 1.64 in 2016 compared to 1.68 in 2013 and to 1.80 in 2010 (European Commission 2016, 2019a). This decline in the *GCI* in recent years is also found in our analysis of Italian data, as shown in Table 2.

Table 2. The *GCI* of Italian academia (author's elaboration on MIUR data, 2010–2017).

Y	<i>GCI</i>
2010	1.89
2017	1.63

According to European Commission (2016, 2019a), this trend indicates progress towards reducing the glass ceiling effect and, although women continue to be less represented in grade A, suggests that women are encountering fewer difficulties in accessing higher positions. However, to correctly interpret these data, it is necessary to consider how the *GCI* is calculated and what the limits and critical points of this indicator are.

The changes in the *GCI*, therefore, indicate how the proportion of women in grade A varied compared to the proportion of women in grade A, B, and C. Table 3 shows that in 2017, compared to 2010, the proportion of women in grade A increased more than it increased in grades A, B, and C.

Table 3. Changes of indicator $PW_{(A+B+C)}$ (%) and PW_A (%) (author's elaboration on MIUR data 2010 and 2017).

Y	$PW_{(A+B+C)}$	PW_A
2010	35.12	20.07
2017	37.56	23.04
ΔPW	2.44	2.97

The changes in the indicators $PW_{(A+B+C)}$ and PW_A reported in Table 3, calculated over a period of seven years, are very small: less than 3% for grade A and 2.5% for the academic staff in positions A, B, and C. The decrease in the *GCI* recalls the paradox of Zeno, also known as the paradox of Achilles and the tortoise, according to which Achilles cannot reach the tortoise because, although it is slower, in the time necessary to advance, the turtle continues to maintain an advantage over Achilles. Similar to the progression of the turtle, the slow increase of the PW_A is not achieved by the increase in the proportion of women in academia, hence the paradox of the *GCI* resignation, despite the poor results in terms of gender equality in apical positions.

Moreover, the slow growth of $PW_{A+B+C, Y}$ is quite surprising because it seems to contradict the data showing the rapid increase in women found in the early years of their scientific career.

This anomaly has led us to analyze more closely the gender variations that are characterizing these early career stages. The analysis is shown below.

In this regard, it is needed to observe the relevance of the definition of grade C in *GCI* values. In fact, as well remarked in comments and critical issues in *GCI* used by the She Figures Handbook, the classification into positions of grades A, B, and C varies across countries, so it is necessary to be careful in comparing or aggregating statistics indicators and indexes that may point to different academic roles and career stages (European Commission 2019b). In a comparative analysis of *GCI*, the most critical position corresponds to grade C, which changes meaning across academic systems of different countries, but which can also be represented as the door of the academic system.

Similar considerations have to be made in a longitudinal analysis of the gender composition of academia, where indicators may assume different meanings in time. This is, for example, the case in the analysis of academic careers in Italy, where, as briefly reported in the previous paragraph, the Gelmini reform performed in 2010 has changed the researchers' role in academia. Indeed, the decoding operated by MIUR regarding the division in grade of academic career provided by the Frascati Manual includes in grade C a full-time assistant professor (RU), an assistant professor in tenured track (RTD B), and an assistant professor in temporary positions (RTD A), while the post-doc fellows are decoded as grade D. As stated in the previous paragraph, the interpretation of grade C operated by the MIUR is not appropriate for understanding the academic transformations related to early career stages and the current recruitment in academia.

Consistent with the need expressed in the previous paragraph to study academic careers in two different phases (before and after recruitment), this work suggests a third possible interpretation of grade C, which includes the positions of passage to permanent academic roles, i.e., positions of tenure track (RTD B) in full positions (RU). These different interpretations of grade C are summarized in Table 4, while Table 5 shows the different values found in *GCI* for the varying definitions of grade C.

Table 4. Alternative glass ceiling index definitions.

Grade C	Italian Academic Position	Glass Ceiling Index
$GRADE D_{Frascati\ Manual}$	RU + RTD B + RTD A + AR	GCI_{FM}
$GRADE D_{MIUR}$	RU + RTD B + RTD A	GCI_{MIUR}
$GRADE D_{NEW}$	RU + RTD B	GCI_{PR}

Table 5. Different values for different definitions of glass ceiling index (author's elaboration on MIUR data 2017).

GCI_{FM}	GCI_{MIUR}	GCI_{PR}
1.75	1.63	1.61

Findings reported in Table 5 show that the value of the *GCI* is significantly sensitive to the definitions of grade C: the *GCI* values increase if the grade C is interpreted in an inclusive way towards the lower steps of the academic career (GCI_{FM}). On the other hand, if grade C is interpreted in a more restrictive sense, including those who have undertaken a stable academic career, the value of the *GCI* decreases (GCI_{NEW}). This result can be explained easily considering that the first stages of one's career (more precarious) are those in which there is greater feminization, while when moving towards more prestigious academic roles the presence of women decreases. Therefore, the value of $PW_{(A+B+C)}$ increases (and consequently the *GCI* increases) if grade C also includes the first female-dominated career stages.

The next section is devoted to analysis from a gender perspective of temporary positions in academia and recruitment processes in Italian academia.

5. The Gendered Glass Door of Academia

The glass ceiling phenomenon, and the difficulties of women in reaching top positions and top management positions in scientific institutions is much debated in the academic literature on gender studies in science, while gender practices responsible for gender segregation at early career stages have received less attention. However, in the last few years, the focus of research on the underrepresentation of women has also shifted towards many other forms assumed by gender disparity, in particular towards the processes of horizontal segregation that act on career paths and in the recruitment phases (Nielsen 2017; Murgia and Poggio 2018; Herschberg et al. 2018; Courtois and O’Keefe 2015; Nikunen 2012; Morgan and Wood 2017).

To investigate gender differences in the early stages of the academic career in quantitative terms and provide evidence of gendering processes in the academic recruitment, I have introduced the glass door index (*GDI*) to measure and highlight gender asymmetries in the academic entry phase (Picardi 2019).

In analogy with the *GCI*, the *GDI* is defined as the ratio between the percentage of women performing research in academia in fixed-term positions and in an early position of academic stabilization in the year *Y* ($PW_{\leq D, Y}$) and the percentage of women in a position of access to stabilization in an academic role (PW_D) in the year *Y*:

$$\text{Glass Door Index} = \frac{PW_{\leq D, Y}}{PW_D} .$$

Given the relative presence of women in fixed-term research positions and positions of academic access, the *GDI* measures the fraction of these women that has reached stabilization. In other words, while the *GCI* quantifies the relative difficulties of recruited women in academia in moving beyond the glass ceiling, the *GDI* measures the relative difficulties of women researchers in precarious academic roles in moving beyond the door of academic access.

Like the *GCI*, the *GDI* can vary from zero to infinity. A *GDI* lower than (or equal to) one indicates that, in the academic recruitment phase, the percentage of women grows (or remains stable) compared to the percentage of women in fixed-term positions, a *GDI* value above one indicates the presence of a glass (invisible) door that restricts the passage for women, or a selection process in academic recruitment that acts against women. The greater the value of the *GDI*, the greater the effect of the glass door in the entrance to academia.

To explain the meaning of this index, it is important to define the composition of fixed-term academic positions. In Italian academia, the types of post-doctoral contractual positions that precede stabilization in the first fixed-term academic position are multiple and do not necessarily define a progressive and linear career path. Furthermore, in diachronic analysis, it is necessary to consider how the fixed-term contractual positions have changed after the latest university reforms (Laws 230/2005 e 240/2010).

The precarious body in academia is composed of different components: alongside fixed-term researchers and research fellows, there are collaborators in research activities, linguistic collaborators, and contract professors. These latter categories, although they constitute a large component of academic precariousness, cannot be considered as a pre-university body in the strict sense, since they include external professionals who carry out teaching activities at the university and professionals who are not oriented towards an academic career⁴. Therefore, except when not explicitly declared, with the expression “fixed-term positions” in this article we refer to the positions of fixed-term researchers and research fellows and not to all figures in pre-academic roles.

⁴ An analysis of the age group of contracted professors for the year 2016–2017 shows that almost 60% are over 45 years old.

Table 6 compares values of the glass door index after the enactment of Law 240/2010—values calculated considering the first stable position in academia as an RTD B position—with values before the law was enacted (data for the year 2010), when the first position in the academy was the position of a fixed-term researcher. Since a certain time interval elapses from the enactment of a law to its effective administrative reception, the RTD data for the years 2011–2014, which followed the implementation of the reform, do not lend themselves to adequate statistical treatment. The comparison between values of the *GDI* before the reform (the average over three years: 2008–2010) and after the reform (average over three years: 2015–2017) shows, after the Gelmini reform, a systematic decrease in the women who have access to stable academic positions.

Table 6. A comparison of *GDI* before and after the implementation of Gelmini reform (MIUR data) (Picardi 2019).

<i>GDI</i> _{2008–2010}	<i>GDI</i> _{2015–2017}
1.04	1.22

It is possible to observe how the methodological choice to include in the calculation of $PW_{\leq D}$ only some components of the precarious and fixed-term positions imply an underestimation of the *GDI* values: If research collaboration (CR) contracts are included in the analysis of the percentage $PW_{\leq D}$, the *GDI* grows reaching a value of 1.30 in 2017 and 1.15 in 2010 (Table 7).

Table 7. *GDI* variation according to parameters that define the pre-academic role phase (MIUR data 2010, 2017, (Picardi 2019)).

$PW_{\leq D}$	<i>GDI</i> ₂₀₁₀	<i>GDI</i> ₂₀₁₇
CR excluded	1.04	1.17
CR included	1.15	1.30

The meaning of this result can be understood by analyzing the proportion of women in fixed-term positions. The diagram in Figure 2 shows how, in fixed-term positions, as the role assumes greater academic relevance, the weight of the male component increases to the detriment of the female component. This horizontal segregation effect in fixed-term roles can be interpreted as the prelude to vertical segregation that occurs in permanent positions.

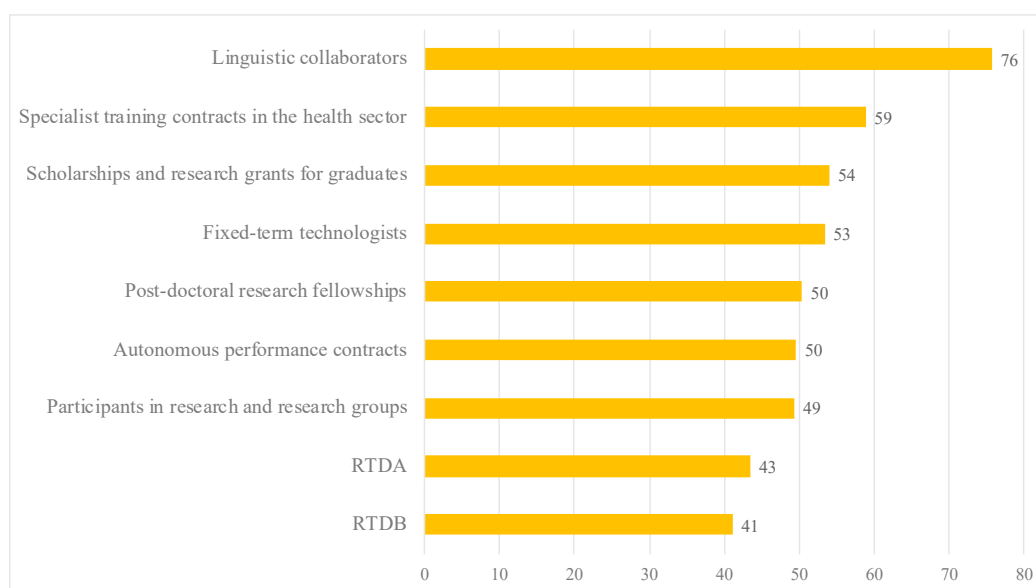


Figure 2. Proportion (%) of women in fixed-term positions (author’s elaboration on MIUR data, 2017).

The glass door index values of the Italian university system reveal the operation, after the application of the Gelmini reform, of gendering processes that act in the phases of academic stabilization, determining a systematic disadvantage for women in almost all disciplines, including those attracting a high percentage of women in the early stages of the academic career.

6. Horizontal Segregation in Scientific Fields

A more detailed analysis shows different gender patterns of scientific careers in different disciplines. Table 8 shows the correspondence between the main fields of research and development (FORDs) defined by the Frascati Manual (OECD 2002, 2015) and Italian scientific areas defined by The Italian National University Council (CUN).

Table 8. The association between the main fields of research and development (FORDs) defined by the Frascati Manual (OECD 2002) and Italian scientific areas defined by The Italian National University Council (CUN).

FORD	CUN Areas
Natural sciences	Mathematics and Computer Science Physics Chemistry Earth Sciences Biological Sciences
Engineering and technology	Civil Engineering and Architecture Industrial Engineering and Information Systems
Medical and health sciences	Medical Sciences
Agricultural and veterinary sciences	Agriculture and Veterinary Sciences
Social sciences	Law Economics and Statistics Political and social sciences
Humanities and the arts	Classical studies, Philology and Literature, History and Art History, Philosophy, Education and Psychology

Table 9 reports the proportion of women by academic role (AR, RTD A, RTD B, RU, PA, and PO) in 2017 by the six main FORDs.

A color code was used in the table: white is assigned to cells characterized by positions in which there is an equal number of male and female components ($45\% \leq PW \leq 55\%$), different shades of green indicate male-dominated positions ($0\% \leq PW \leq 45\%$) (the shade of green is of greater intensity as the number of men increases), and different shades of orange indicate positions occupied predominantly by women ($55\% \leq PW \leq 100\%$) (the shade of orange is of greater intensity as the number of women increases).

In Table 9, the green shift of the proportion of women in apical positions confirms the vertical segregation⁵, while different *PW* values characterize the scientific field. In the comparison between the different disciplines, we note that the fields of science and technology are characterized by a significantly low percentage of women throughout the entire career path (32% in the early stages of career, 13% in top positions). A very different trend is found instead in the disciplines that make up the medical and health sciences and the agricultural and veterinary sciences, where in the initial phases of the academic course there is a preponderant presence of women (respectively 72% and 58%), but with

⁵ Even in this case, the increase of *PW* in RU positions is explained by taking into account that this is an exhausted category. The presence of a larger number of women in this position depends on the higher transition rate of men to the role of associate professor.

career advancement the gender gap progressively increases until the proportion of women in full professor positions reaches values equal to 15% and 18%, respectively.

Figure 3 compares the values of the proportion of *PW* women in fixed-term positions and in the academic entry position in the different FORDs, while Figure 4 compares the values of the proportion of *PW* women in permanent academic positions and in top-level academic positions in the different FORDs. Table 10 also shows the values of the GDI and the GCI_{PR} in the different FORDs.

Table 9. Proportion (%) of women by an academic role in the main FORDs defined by the Frascati Manual (OECD 2002) (author’s elaboration on MIUR data, 2017).

FORD	PW_{AR}	PW_{RTDA}	PW_{RTDB}	PW_{RU}	PW_{PA}	PW_{PO}	PW_{TOT}
Natural Science	50	43	38	54	40	24	43
Engineering and technology	32	27	28	31	23	13	26
Medical and health sciences	72	50	44	44	28	15	41
Agricultural and veterinary sciences	58	51	47	48	41	18	43
Social sciences	53	48	43	49	40	24	40
Humanities and the arts	61	53	52	59	51	40	52

PW_{MIN}	PW	PW_{MAX}
0	-	15
15	-	25
25	-	35
35	-	45
45	-	55
55	-	65
65	-	75
75	-	85
85	-	100

Legend color code of Table 9 (author’s definition).

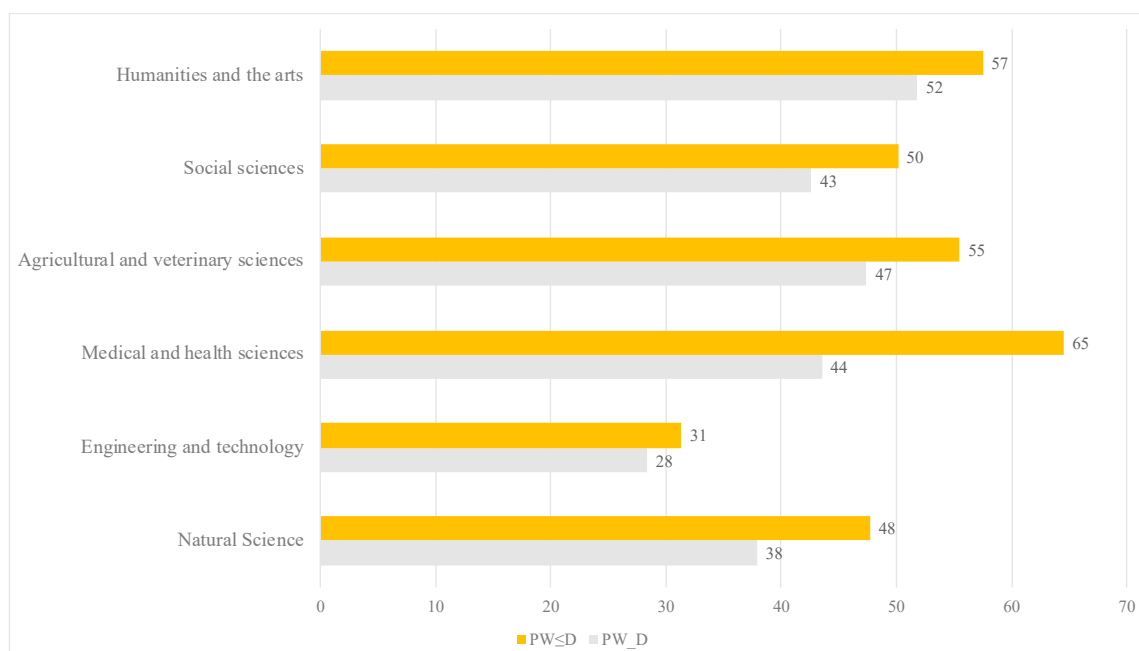


Figure 3. Proportions (%) of women in fixed-term positions and at the recruitment stage by main field of science (the author’s elaboration on MIUR data, 2017).

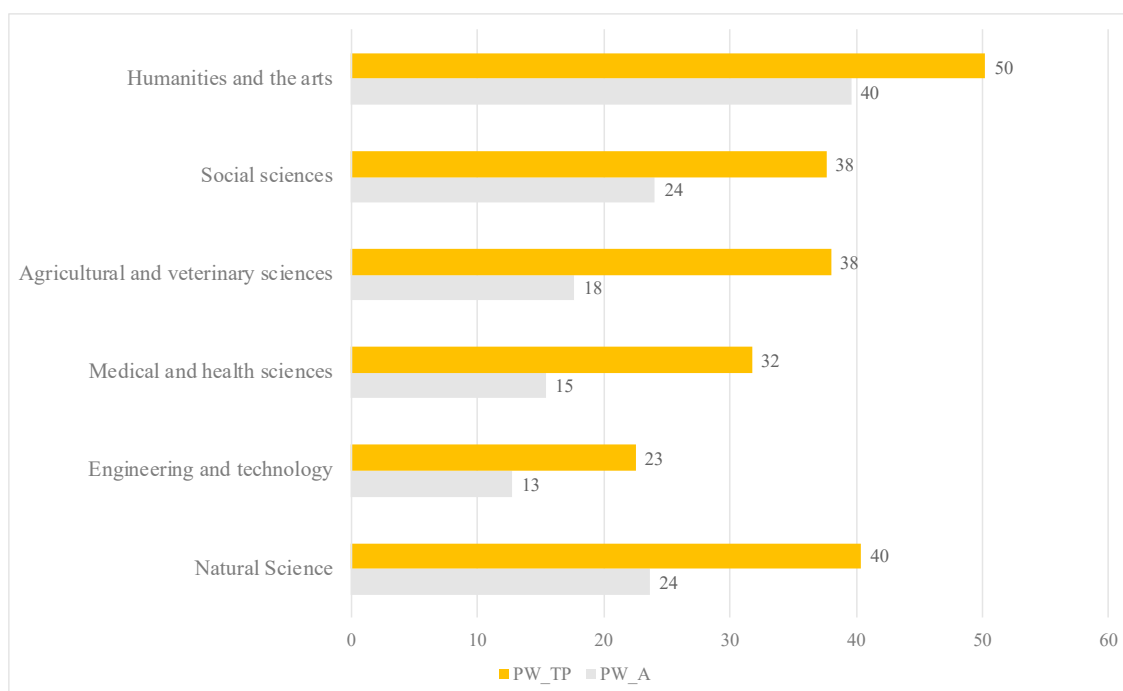


Figure 4. Proportions (%) of women in permanent positions and in grade A by main field of science.

Table 10. *GDI* e *GCI* by main field of science (author’s elaboration of MIUR data, 2017).

	FORD	<i>GDI</i>	<i>GCI_{PR}</i>
1. Natural Science		1.26	1.71
2. Engineering and technology		1.11	1.76
3. Medical and health sciences		1.48	2.06
4. Agricultural and veterinary sciences		1.17	2.15
5. Social sciences		1.18	1.56
6. Humanities and the arts		1.11	1.27

The analysis by disciplinary areas of the *GDI* reported in Table 10 confirms the existence of a glass door that discriminates academic access based on gender, showing a systematic relative decrease in women who have access to stable academic positions in all the main research fields⁶. However, the glass door does not act in the same way in different areas. The 2017 data illustrate how the “glass door” effect is greater in the disciplinary areas related to the medical and health sciences macro-sector, where the proportion of women in early career stages is particularly high. In these disciplinary sectors, there is also one of the highest values of the glass ceiling index ($GCI_{PR} = 2.06$).

A special case is provided by the disciplinary area of engineering and technology, characterized by the lowest values of women’s presence in early career phases and by the lowest *GDI* value. This data indicates that the few women present in the engineering and technological disciplines, predominantly male, are subject to fewer obstacles in the academic stabilization in this sector⁷, even though the

⁶ Additionally, in this case the *GDI* values have been calculated without including all the types of research and teaching contracts in the temporary research positions. If we include all the precarious positions in the calculation of the *GDI* we would have again a growth in the *GDI* values.

⁷ To correctly interpret this datum, it would be necessary to identify possible career opportunities in non-academic paths, also assessing the prestige socially attributed to these professions.

analysis of career progression in these sectors shows high difficulties for women in achieving top positions ($GCI_{PR} = 1.76$).

The disciplinary area where there are fewer difficulties for women both in academic recruitment and in reaching top positions (although these difficulties exist anyway) is the humanities and the arts: $GDI = 1.1$ e $GCI_{PR} = 1.27$.

Finally, we note that the field of natural science, including multiple subject areas, includes academic sectors characterized by very different gender compositions and practices in recruitment and career progression. As an example, in Tables 11 and 12, respectively, we show the proportion of women by career steps and the values of GDI and GCI_{PR} in the fields of physics, biological sciences, mathematics and computer science, chemistry, and earth sciences.

Table 11. Proportion (%) of women by academic role in physics, biological sciences, mathematics and computer science, chemistry, and earth sciences (author's elaboration on MIUR data, 2017).

CUN Areas	PW_{AR}	PW_{RTDA}	PW_{RTDB}	PW_{RU}	PW_{PA}	PW_{PO}	PW_{TOT}
Physics	32	23	20	26	22	12	23
Biological Sciences	67	60	50	66	53	33	57
Mathematics and Computer Science	23	26	32	44	35	20	31
Chemistry	57	60	45	63	47	26	50
Earth Sciences	42	26	29	35	31	18	32

Table 12. GDI e GCI by in physics, biological sciences, mathematics and computer science, chemistry, and earth sciences (author's elaboration of MIUR data, 2017).

CUN Areas	GDI	GCI_{PR}
Physics	1.46	1.66
Biological Sciences	1.27	1.60
Mathematics and Computer Science	0.79	1.65
Chemistry	1.24	1.85
Earth Sciences	1.32	1.61

As in the case of engineering and technology, even in mathematics and computer science fields characterized by the lowest proportion of women in the first career stages, we obtain a low GDI , confirming that the few women present in male-dominated fields succeed in recruitment but encounter obstacles in achieving top positions ($GCI_{PR} = 1.65$).

7. Conclusions

The analysis of the data provided by the MIUR on the staff of the Italian academic system reveals the strengthening of gender practices in recruitment after the implementation of the last reform in Italian universities.

Qualitative studies show the relevance of invisible barriers that hinder the scientific and academic path of women from the earliest career stages (Murgia and Poggio 2018). The introduction of the glass door index has made it possible to quantify the effect of these invisible "glass doors" that women face when entering university. At the same time, the GDI allows us to carry out a differential analysis of the effect of this sort of gendered filter in academic recruitment across scientific disciplines. The results obtained show that the selection effect, to the disadvantage of women, has been strengthened after the last university reform was applied and is greater precisely in sectors where there is a greater presence of women in the early career stages. The glass door of academia is the metaphor chosen to unveil the presence of mechanisms that operate as if there were a threshold beyond which women

(the underprivileged gender) cannot be represented in tenured roles (gender saturation of academic organizations).

The accentuation of the gender asymmetry recorded in academic recruitment after the implementation of the reform underlines how the research evaluation criteria, strengthened in a meritocratic sense by Law 240/2010, do not correct the phenomena that determine gender segregations in these institutions. Therefore, these results support the need to focus on the construction of scientific excellence and meritocracy in the academy and to highlight its non-neutral character (Van den Brink and Benschop 2012a; Picardi 2016; Nielsen 2015, 2017). Recent literature has highlighted some of the mechanisms responsible for the reproduction of gender inequalities in academic and scientific institutions, indicating institutional, organizational, and cultural structures that impact scientific career paths (Van den Brink 2010; O'Connor 2014; Van den Brink and Benschop 2014; Picardi 2017, 2017; Poggio 2018).

Limits of current comparative analyses between different national systems that use standard indicators have also been stressed in this paper. Such limits are found in the difficulty of highlighting differences across regulatory systems that produce gender inequality mechanisms and in the inadequacy to detect new forms of gender inequalities in scientific institutions.

The analysis shows that uncritical adaptation to standardized indicators across Europe has determined a spreading of misinterpretations about the evolution of the gender composition of the academic staff. The belief that both a growing number of women researchers in the Italian academy and decreasing values of the glass ceiling index together point to the achievement of gender equality as only a “problem of timing” is an example of these misunderstandings.

This work suggests that the increase in the feminization of research personnel in the most precarious positions, since more women researchers are being employed in roles that are not included in index counts, explains the decrease in glass ceiling index values in recent years.

In conclusion, further investigations should be undertaken to understand what kind of gender practices and mechanisms are at work in academic recruitment and to determine a gender reversal in the recruitment to tenured positions in scientific areas marked by a prevalence of women in early career stages. A sort of rebalancing mechanism seems to be at work in the academic system, reflecting a peculiar gender order.

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