Gender Disparity in Access to Academia in Italy. Are there barriers to women’s early career stages?

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Gender Disparity in Access to Academic Career in Italy.
Barriers to women's tenure track positions

1. *Introduction*

Despite the progress made in recent years, achieving gender equality in various workplaces and professions, *including research and academia*, remains a major challenge. Gender asymmetry is a persistent phenomenon all over the world and in every socio-economic domain (OECD 2017). In academia and research contexts, women are less likely than men to get promotions (European Commission 2019). These phenomena are known as «leaky pipeline» (women less likely to receive tenure and more likely to leave academic career) and as «glass ceiling» (women less likely to achieve full professorship).

To use a Branch's (2016) metaphor, academic career can be represented as a road with exits, pathways, and potholes: some people leave (the «leaky pipeline» phenomenon), some journey on, some get stuck (the «glass ceiling» phenomenon). While some are free to exercise their choice to leave science as a result of disinterest, career options, family preferences, others leave in response to conditions that are often unfavourable and influence «perceived choice», such as discrimination, gender harassment, hostile work environments, chilly climates, and isolation.

To test a few explanations behind the leaky pipeline phenomenon this paper examines the likelihood of entering the academic and public research job market after the PhD and the chances of getting a tenure track position within academia and public research institutes in Italy. The contribution of this article is twofold. First, it provides a description of gender gaps in access to scientific career both in STEM (Science, Technology, Engineering, Mathematics) and SSH (Social Sciences and Humanities) disciplines, focusing on early career stages using recent large-scale Istat data. Second, it offers an empirical assessment of how gender gaps are produced and reproduced, testing whether it is through gendered patterns in scientific productivity and other career-enhancing individual characteristics, or rather it should be attributed to other gendered processes influencing promotion located in the evaluation phase of young researchers.

2. *Gender Inequality in (early) researcher's career attainment*

There is a wide agreement upon the existence of gender inequality in academia. Within the international literature there is a general consensus on the persistence of the leaky pipeline phenomenon: the number of women leaving the scientific career path continues to be regularly higher than the number of men, and women in research career are less likely to receive tenure positions than their male counterparts. Furthermore, despite the efforts to recruit and to retain more women in research, gender disparity in career attainment are starker within STEM disciplines and particularly in those fields that are most mathematically intensive (Garforth and Kerr 2009; Moss-Racusin *et al.* 2012; Bevan and Gatrell 2017; Manzo 2017; Pozzi *et al.* 2017; Gaiaschi 2019).

The under-representation of women in academia and in research professions has triggered interest among scientists in understanding the underlying reasons. As underlined in the literature, gender inequalities in research organizations and academia should be seen as constructed at different career stages (recruitment, retention and career advancement) and at different analytical levels. Our starting point for accounting for women researchers' lower career attainment draws from an analytical approach which looks at «gender as social structure» integrated with a focus on the gendered processes within research organizations.

Following the notion of «gender as social structure» (Risman 2004) it can be argued that gender acts and may have consequences at least at three different levels: at individual level (with the individuals' personal orientations); at cultural level (when men and women act on the basis of different cultural expectations even when they fill identical structural positions); at institutional level (where explicit regulations regarding resource distribution and material goods are gender specific). Gender structure, and gender inequalities in academia should be seen from this standpoint as the combination and interaction of different factors which work at different levels (micro, meso and macro) and which produce different types of *gendered processes* at various career stages. As for understanding [research] organizations, that is, the processes at work especially at the meso level, it is useful to integrate Risman's approach with Joan Acker's (1990) analytical approach which is based on the idea of 'inequality regimes' within organizations. Inequality regimes are all those interrelated processes, practices, actions and meaning that result in and contribute to maintaining class, gender, and racial inequalities within particular organizations. Yet, according to Acker (2006) the degree and shape of gender inequalities, as well as the organizing processes that produce them (those inequalities), might be very different (i.e. organizing the general requirements of work, recruitment and hiring, wage setting and supervisory practices, informal interactions while 'doing the work' and so on). Despite these differences, what is important in Acker's theory is that the author stresses the need to identify the barriers that stand in the way of achieving gender equality within organizations. In turn, those barriers are seen as the main culprits for creating and maintaining gender inequalities in organizations (Acker 2006).

But which are the main approaches for explaining the production and reproduction of gender inequalities in research organization and in academia?

Although the underrepresentation of women in academia and research profession has triggered interests among scientists, the debate on the barriers to women's full participation, and on the main factors accounting for gender disparity, is still open. Scholars discuss whether it is due to overt gender discrimination, to unconscious gender bias, to gender gap in scientific productivity or whether it is due to other more or less visible or subtle factors. The mainstream literature provides two main approaches to account for the gender imbalance in the academic and research contexts: demand-side explanations and supply-side explanations.

Explanations grounded on *demand-side* are based on the idea of gender bias and discriminatory behavior of employers in recruitments and promotions. The origins of those gender bias can be quite different. Preconceptions and stereotypes on the definition of masculinity/femininity, recruitment and career promotions criteria based on an «ideal academic» (Lund 2015), the ideological beliefs about who is eligible for certain professions (Witz 1990), and the way in which scientific «excellence» is constructed (Addis and Villa 2003; Addis 2008; Van den Brink and Benschop 2012b; a) may play a crucial role. For instance, van den Brink and Benshop (2012a) have noted that «excellence» has become the «holy grail» within the emerging culture of managerialism in academia. Pollard (1999) claims instead that prejudiced outcomes are the result of an unconscious bias. Other interpretations show how male dominated workplaces might provide a context where women face higher obstacles to being recruited or promoted (Doherty *et al.* 2006) and explain the lower level of female production. In addition, gender bias appears to be at work in the perceived importance of the various components of academic work (Moss-Racusin *et al.* 2012). As a matter of the fact, women, compared to men, tend to be more involved in teaching and to devote more time to student support, yet in evaluation criteria 'excellence' in research (i.e. publications) takes precedence over teaching in all scientific fields (Garforth and Kerr 2009).

The second approach analyses the disadvantaged position suffered by women in academia by focusing on *supply-side explanations* namely «individual self-selection» mechanisms. In this *corpus* of literature, a set of different reasons are cited to explain the gender gap in scientific performance and the disadvantage position of women in career advancement. It is posited that women may have lower self-confidence, may be less competitive, so as they may have lower levels of risk appetite, of confidence and of competitiveness (Azmat and Petrongolo 2014). Women, it is posited, may have stronger preferences for family responsibilities than men (Hyde 2005; Croson and Gneezy 2009; Pautasso 2015). Bosak and Sczesny (2008), for instance, claim that women identify themselves as less suitable for higher ranks due to an inherent notion that associates masculine characteristics with leadership. Thus, women researchers are supposed to behave differently from men, self-selecting mechanisms produce different choices in terms of research field, time allocation between work and family, between teaching and research, but also in term of research and publishing strategies. As a result of these (individual) self-selection mechanisms, female researchers tend to show lower productivity than their male colleagues (Abramo *et al.* 2009; Misra *et al.* 2012; Abramo and D'Angelo 2015; Mairesse and Pezzoni 2015; Nielsen 2016; Jappelli *et al.* 2017; Uhly *et al.* 2017; Filandri and Pasqua 2019; Ooms *et al.* 2019). Scholarly productivity has mainly been measured using three indicators: number of publications (Abramo *et al.* 2009; De Paola and Scoppa 2015; Mairesse and Pezzoni 2015; De Paola *et al.* 2018; Nieddu and Pandolfi 2018), number of citations (Nielsen 2016) and citation indexes (Abramo *et al.* 2009; De Paola and Scoppa 2015; De Paola *et al.* 2018).

Table 1 shows a synthesis of the main analytical approaches and levels of analysis discussed so far. The disadvantaged position suffered by women in academia have been explained not only taking into account «individual self-selection» mechanisms and demand-based factors at micro level, but also focusing on more institutional and cultural factors. Shifting from the individual to meso and macro levels, the workplace gender composition and the institutional barriers may play a role to explain the lower level of female productivity. As matter of the fact, it is argued that women's disadvantages in academic careers are by and large related to prevailing gender roles in society, and in particular it is argued that they are due to career breaks over family formation (i.e. due to pregnancy and maternity leave) which indubitably have a role in reducing the time available to women for research and networking activities. Consequently, female researchers suffer from inequalities in the allocation of family responsibilities. These inequalities are further reinforced by weak and/or biased support for work-family reconciliation, which do not support women's double role as workers and carers, by poor availability of childcare facilities and working-time flexibility measures and by policies which emphasize mothers' roles rather than fathers' (Lewis 2006; Le Feuvre 2009; Solera 2009; Naldini and Saraceno 2011; Bozzon *et al.* 2017a).

TABLE 1. *Levels of analysis and explanatory approaches used to account for gender inequality in academia*

Explanatory approaches Levels of analysis	**Demand side**	**Supply side**
Micro	Stereotypes on definition of masculinity/femininity and employer's unconscious bias during recruitment and promotions processes	Individual characteristics (presence of children) and individual self-selection behaviors and attitudes which impact on recruitment and promotions: women's lower self-confidence and of competitiveness, lower levels of risk appetite
Meso	Workplace male dominated processes Gendered organizational practices and rewards and gender cultures related to practices of recruitments and promotion Evaluation of academic «excellence»	Involvement in high-status professional network, international mobility and research collaborations, Strength of network and recommendations: role of homosocial networks Gendered research areas
Macro	National legislation and local rules on university recruitment Masculine symbolic order dominant in Universities Stereotypical ideas about who is the ideal of good researcher and leader	Prevailing social norms related to gender roles and family formation. Welfare regime and social policies (or the lack of) which support a gendered division of care within the family and create different opportunities and constrains for male and female researchers

Explanations grounded on *demand-side* are mainly centered on the discriminatory behavior of employers. On the other hand, *supply side* explanations are mainly focused on gender differences in productivity. These types of explanations are illustrated in Table 1, where we see that gender disparity in academic access and advancement results from a complex interaction among three levels: micro (individual preferences, attitudes and decisions), meso (the level of culture prevailing in organizations and workplaces) and macro (the setting at national level). Furthermore, gender inequalities are constructed within organizational contexts and at different career stages (recruitment, retention and career advancement). Therefore, it is important to pay attention to the gendered processes in place in each stage and how they cumulate over time and during different stages.

According to Weisshaar (2017) three main *gendered processes* are seen as responsible for gender gap in early researchers' career attainment. The first type of gendered processes, influencing promotion outcome, is found in *placement* into workplaces – the stage during which men and women place themselves into jobs and this sorting can lead to gender compositional differences and inequalities across workplaces. These processes occur when men and women are unevenly distributed across type of occupations or disciplines (horizontal sex segregation) or when men are overrepresented in high-status roles within a specific occupation. The second type of processes that produces gendered patterns is found in *production.* These processes refer to women's lower productivity outputs, which might be caused by several factors: individual self-selection behaviours, women's less evaluations, or women's reduced opportunities for collaborative project, grants and media attention, also due to the unequal distribution of family obligations between mothers and fathers in society. Finally, *gendered processes in evaluation* can influence the promotion outcomes and create a persistent gender gap (i.e. women's work is devaluated or scrutinized by colleagues, presence of unconscious gender biases, overt discriminations, women's self-selection out of promotion review etc.). Within this framework gendered processes can be conceptualized as the remaining gender gap not explained by the first two (workplace differences and productivities). An overall gender gap in promotion rates is, therefore, an aggregate of many promotion decision outcomes and the result of several gendered processes. Weisshaar's work, which is based on a dataset drawing from a sample of US assistant professors in Sociology, Computer Science and English shows, for instance, that productivity differences by gender account for a portion – but not all – of gender gap in tenure rates, while gendered processes in placement, such as sex segregation across departments, or variation in organizational contexts do not explain the gender gap in tenure. A sizeable portion of the remaining gender gap in tenure is thus attributed «to *evaluation processes* which may consists of multiple gendered mechanisms (from explicit gender biases to women's self-selection out of promotion review, to types of recommendations) but what is clear is that it results in gender gap in women's promotion» (Weisshaar 2017).

3. *Gender Gap in Italian Academia*

Many studies investigated the gender gap in academia, documenting the underrepresentation of women in universities and research centers, especially at higher ranks (Garforth and Kerr 2009; Moss-Racusin *et al.* 2012; Van den Brink and Benschop 2012b; Morley 2014; Uhly *et al.* 2017). There are comparatively fewer studies that investigate gender gaps in the early stages of academic career (De Welde and Laursen 2011; Murgia and Poggio 2018; Ooms *et al.* 2019), and very few concern Italian academia (De Angelis and Grüning 2020; Gaiaschi and Musumeci 2020). Most of them are about STEM (Bozzon *et al.* 2017b; Murgia and Poggio 2018; Checchi *et al.* 2019), as women are usually underrepresented in those disciplines since graduate studies (though meaningful variations exist also within STEM). Thus, we focused our attention on the transition from the PhD to the first steps of the scientific career, spanning across all disciplines, both STEM and SSH. In what follows, we summarize the main features of the Italian academic context as concerns gender disparity and then present our research questions.

In general, the gender structure of the academic hierarchy has the classic scissor pattern illustrated for Europe as a whole by She-figures report (European Commission 2019) and for Italy by Picardi (2019). In the EU 28 as whole, female university students perform better than their male counterparts and are overrepresented in many fields of study, but not in engineering, manufacturing, construction, information and communication technology (OECD 2017; European Commission 2019; Eurostat 2020). Women's representation suddenly changes at the level of doctoral studies, where the majority of graduates are men (52,1%). The situation become worse for women throughout the subsequent stages of research careers all over Europe.

Eurostat 2016 data on tertiary education (European Commission 2019) show a few interesting differences regarding the Italian case. First of all, in Italy women account for 55.6% of all tertiary students and remain a narrow majority of doctoral students (50,5), while the EU28 averages are lower, 54% and 48% respectively. Italian female doctoral students have lower chances to get a PhD in STEM fields (De Vita and Giancola 2017), but again the share of women in typical male fields of study is higher than the EU average (European Commission 2019). Thus, women's representation at doctoral level in Italy is not worse and in some cases is even better than other EU countries.

Gender balance deteriorates when it comes to entry into academic jobs following PhD. The gender gap at various academic positions, though slightly declining, has remained substantial over time. In 2017 women accounted for 23% of full professors and 37% of associate professors, while ten years before the corresponding figures were 19% and 34% (Picardi 2019; ISTAT 2020). The underrepresentation of women among full professors is found in all disciplines, but is particularly strong in physics, industrial and information engineering and medicine (Filandri and Pasqua 2019), which partly mirrors what we already see at graduate study level.

As the above figures shows, in Italy the problem of gender inequality in academia becomes evident after PhD graduation, in the early stages of scientific career, and much more so in the later stages. That is why it is important to investigate the post-doc phase to understand the reasons underlying the leaky pipeline phenomenon. Looking at the institutional environment where such phenomenon takes place, evidence shows that the Italian context is characterized by an increase in the number of PhD graduates per year (which almost tripled between 1998 and 2013) and a large-scale process of precarization of the early stages of career (Bozzon *et al.* 2017a), largely as consequence of the latest university reforms inspired by the New Public Management paradigm (Krüger *et al.* 2018). Indeed, the most recent reform (law 240/2010, aka «Gelmini reform») reshaped the first stages of the academic career by replacing the previous permanent contract of the assistant professor with two new types of fixed-term contracts: A-type (junior assistant professor), and B-type (senior assistant professor). Of the two types of contracts, the B-type is a "quasi tenured" position because, once the contract is ended, it automatically turns into an associate professor position, conditional upon the candidate having earned the National Scientific Qualification (Abilitazione Scientifica Nazionale, ASN). The new recruitment rules, together with the increasing level of restrictions imposed on the university system in order to reduce public expenditure, have increased the level of job insecurity and decreased the number of PhD holders who undertake the academic career (Passaretta *et al.* 2019). Crucially, the claimed merit-based reforms have not reduced the disadvantages suffered by women in career advancement (Martucci 2011; Goastellec and Vaira 2017; Gaiaschi and Musumeci 2020). Moreover, the decline in the resources available for recruitment and career advancement can be another important circumstance shaping the leaky pipeline, as previous studies on Italy found less gender discrimination in larger universities, where more resources are available (Bianco 2002).
At the micro level, a critical factor affecting the chances of entry and career advancement in academia is scientific output. Evidence shows that Italian female researchers continue to suffer from a certain productivity gap and are less competitive than men, encountering – *ceteris paribus* – more difficulties when it comes to publishing and climbing the career ladder in all scientific disciplines (Abramo *et al.* 2009; Baccini *et al.* 2014; Jappelli *et al.* 2017). Thus, from the micro-level perspective, it is of utmost importance to assess the role of gender productivity differentials in producing women's disadvantage in their early post-doctoral steps. Productivity in terms of publications and research grants is only the most visible and measurable individual level characteristic that influences early career researchers' output, but involvement in high-status scientific networks and international mobility are also crucial determinants of their productivity (Zippel 2017).

Based on the theoretical and empirical background outlined above, we aim at answering two main research questions. The first one is more descriptive and it aims at understanding the extent to which gender disparity in access to research career varies across disciplines and career stages. Are there significant differences across academic fields? And in particular between STEM and SSH disciplines? As women are differently represented across scientific fields, and clearly under-represented in STEM sectors we expect that gender disparity in access to academia is also unevenly distributed and related to (horizontal) sex-segregation across disciplines. Moreover, regardless of disciplines, we hypothesize that gender gap in promotion rate is greater at the level of tenure rather than non-tenure track positions, as the former are scarcer, and competition is higher.

The second research question concerns the processes driving (or explaining) academic gender disparity: is women's and men's unequal access the result of gendered processes in production (individual scientific productivity and processes interfering with it)? Or is gender disparity not related to productivity, but rather to 'discrimination' and to evaluation processes (gender bias, women's work devaluated) (Weisshaar 2017)? And to what extent these driving forces are similar between STEM and SSH disciplines?

4. *Data, variables and analytic strategy*

We use data collected by ISTAT for two editions (2018, 2014) of the survey on PhD holders' occupational outcomes[1]. These surveys are a census of four cohorts (2008, 2010, 2012, 2014) interviewed 4 or 6 years after PhD graduation. The response rate was over 70% and the total number of cases across all disciplines is about thirty-two thousand. Such large sample size allows us to make separate analyses for the following seven STEM(M) (including Medicine) and four SSH disciplinary groups: 1) mathematics/ informatics/ physics, 2) chemistry/ geology, 3) biology, 4) medicine, 5) agrarian/ veterinary, 6) engineering/ architecture, 7) industrial engineering, 8) arts & literatures, 9) history/ philosophy/ pedagogy/ psychology, 10) law, 11) social, economic and political sciences[2]. In this way we take horizontal gender segregation into account, as it is well-known that women are concentrated in certain disciplines and sub-disciplines, in both «hard» and «soft» sciences. Moreover, as we observe the academic position of *all* PhDs after 4 or 6 years, our analysis does not suffer from the typical self-selection bias that affect studies investigating junior academics' (e.g. post-doctoral researchers or assistant professors) outcomes.

Our dependent variables concern the chances of having a research job at interview time and the type of research position. For the first dependent variable we do not distinguish between tenure track (or permanent) and non-tenure track (short term) positions. This variable equals 1 if the subject has *any research job* (e.g.: professor, assistant professor, post-doc researcher, etc.) at university or at a public research center (CNR, INAF, ISTAT, ISFOL etc.) and 0 if the subject holds another type of job (not in research institutions) or is not employed[3]. The second dependent variable splits cases with a research job into two categories: tenure track and non-tenure track positions. The first category includes permanent professors as well as fixed-term A-type (junior) and B-type (senior) assistant professors. Unfortunately, the data do not allow to distinguish between these two types of tenure and non-tenure track positions. However, it is common knowledge that in most universities type-A assistant professors regularly get a B-type contract after three years and a positive evaluation from their departments. Moreover, from an economic and career prospect point of view, A-type contracts are more advantageous than other post-doc positions (e.g. «assegni di ricerca»). That is why we chose to merge A-type + B-type researcher positions with permanent professorship contracts. Thus, the second dependent variable has three categories: tenure track, non-tenure track, and other non-research position (or not employed)[4]. Notice that the analysis of this variable, rather than a simple dichotomy between tenure and non-tenure, allows to take account of self-selection into research career. As both dependent variables are categorical, we analyze them by means of binomial and multinomial logistic regressions respectively. All analyses are weighted with coefficients provided by ISTAT.

[1] ISTAT provides an earlier edition (2009) of the same survey which, however, is less comparable with latest ones. All editions are freely downloadable from the ISTAT website.
[2] This is a re-coding of the original 14 disciplinary groups (CUN areas).
[3] Those who do not work either in research or elsewhere at interview time account for 5.3% of men and 8.7% of women.
[4] We included fixed-term researchers in public research center among untenured. We excluded from the analysis 712 cases (2%) who already held a (quasi)-tenured research position *before* the PhD.

The aim of the regressions is to estimate gender gaps (female-male) in the probability of having a (specific type of) research position, net of several individual characteristics that may affect the outcome and may be also associated with gender (see variables' list and definition below). A few of these individual characteristics are time-varying variables that, because of data collection limitation, are not time-referenced. Rather they are measured at, and referred to, interview time. Four of them are of particular concern for our analysis because they are known predictors of academic career progression: total number of publications (from PhD graduation), involvement in collaborative projects with different types of institutions, marital status (married or partnered, unmarried, separated or divorced), and parenthood status (whether having at least one child or not). As we cannot disentangle their time ordering with respect to the DVs, their inclusion as controls in the regressions may bias the estimates of gender gaps. To circumvent this problem, we undertook two actions. First, we normalized the number of publication and the involvement in collaborative projects by dividing by individual's time spent in research. The latter is defined as years since PhD graduation, for those who hold a research position at interview time, and years from PhD graduation to the beginning of the current job, for those who hold a non-research position (assuming that this time was spent in a temporary post-doc research position). Doing this variable transformation should help to attenuate the bias arising from the fact that having a research job at interview time, by definition, increases the number of publications or involvement in collaborative projects. The second action consists of running several models, with and without «problematic» variables, and looking at changes in gender coefficients.

For each of the eleven disciplinary groups and for both dependent variables, we estimated three logistic regression models. The first one includes just gender, survey edition and time since PhD graduation. This model yields "gross" gender gaps in the likelihood of having a research job or having a tenure or non-tenure track position. The second model adds individual control variables that may be generically associated with career outcomes and whose time ordering with respect to the dependent variable is unambiguous (i.e. antecedents): age at PhD, citizenship (Italian or foreign), social origin (parents' education and class), master degree marks, time to complete PhD (within the established deadline or not), opportunity to teach during PhD, opportunity to receive some training abroad during PhD, mobility abroad (defined as change of residence from before starting PhD to present)[5], and geographical area of the PhD university. The third model adds measures of scientific production and engagement (defined and normalized as above), family and parenthood status, which, following Weisshaar (2017), we consider to be associated with gendered processes in the production phase. The variation in the gender gaps between models gives an indication of the weight of these processes.

Given the available data, it is not possible to directly assess the role of gendered processes in the evaluation phase because we are not able to observe evaluation processes. However, the (possible) reduction in gender gaps due to variables associated with production processes allows to gauge the weight of such processes. We assume that the remaining gender gap can be attributed to gendered processes during the evaluation phase like discriminatory practices or unconscious bias in hiring. Of course, we cannot rule out that the remaining gender gap is not due to unobserved individual characteristics such that, if they were taken into account, the remaining gender gap would be reduced.

[5] In this case we assume that propensity to move abroad influences the chances of getting a research job and hence the change of residence, rather than the other way around. We also measured propensity to mobility in a more general way (not only abroad) as change of residence from before starting the PhD to present. Results are remarkably similar.

The results of the 66 regression models are summarized through graphical representation of average marginal effects of gender and their confidence intervals. Full regression models are available upon request. Descriptive statistics of all variables used in the analyses are reported in Appendix.

6. *Results*

The distribution of PhD graduates across disciplines shows typical signs of horizontal gender segregation (Table 2). Although women account for 52.7% of the sample, they are underrepresented in a few STEM disciplinary groups: Mathematics/ Informatics/ Physics (31,8%) and Industrial and information engineering (26.4%). Conversely, they are *overrepresented* in other STEM fields like Biology (64.6%) and Medicine (64.4%), as well as in a few SSH groups like Arts and Literatures (63.8%), and History/ Philosophy/ Pedagogy/ Psychology (59.9%).

TABLE 2. *Distribution of PhD graduates by gender, within disciplinary groups*

Disciplinary group	% Men	% Women	N
Mathematics/ Informatics/ Physics	68.2	31.8	2473
Chemistry/ Geology	46.2	53.8	2415
Biology	35.4	64.6	3096
Medicine	35.6	64.4	4744
Agrarian/ Veterinary	44.2	55.8	1936
Architecture/ Civil engineering	51.6	48.4	2347
Industrial and Information Engineering	73.5	26.6	3785
Arts and Literatures	36.2	63.8	2923
History/ Philosophy/ Pedagogy/ Psychology	40.1	59.9	2841
Law	47.5	52.5	2296
Social, economic and political sciences	46.1	53.9	2811
Total	47.3	52.7	31667

After four or six years after their PhD, 30.2% of men and 25.0% of women have a research job (see Table 3). This five percentage point gender gap is not equally distributed across disciplinary groups. It is higher in the “hardest” and “softest” sciences, i.e. in mathematics, informatics and physics group (-10.2) and in arts and literatures group (-7.3). Conversely, the gender gap is much lower (or even reversed) in biology (-2.4), medicine (+1.1), agrarian/ veterinary (-1.3), law (-1.6), social, economic and political sciences (-1.5). When it comes to the type of research position, the percentage of PhD graduates with a tenure track position is 11.4% among men and 6.1% among women, yielding again a five percentage point gender gap. It is found in roughly similar size in all disciplinary groups, except for biology (-2.5), architecture/ civil engineering (-2.4), arts and literatures (-2.9). As for the non-tenure track positions, men are on average as likely to be found in them as women, although positive and negative gender gaps are found across disciplines.

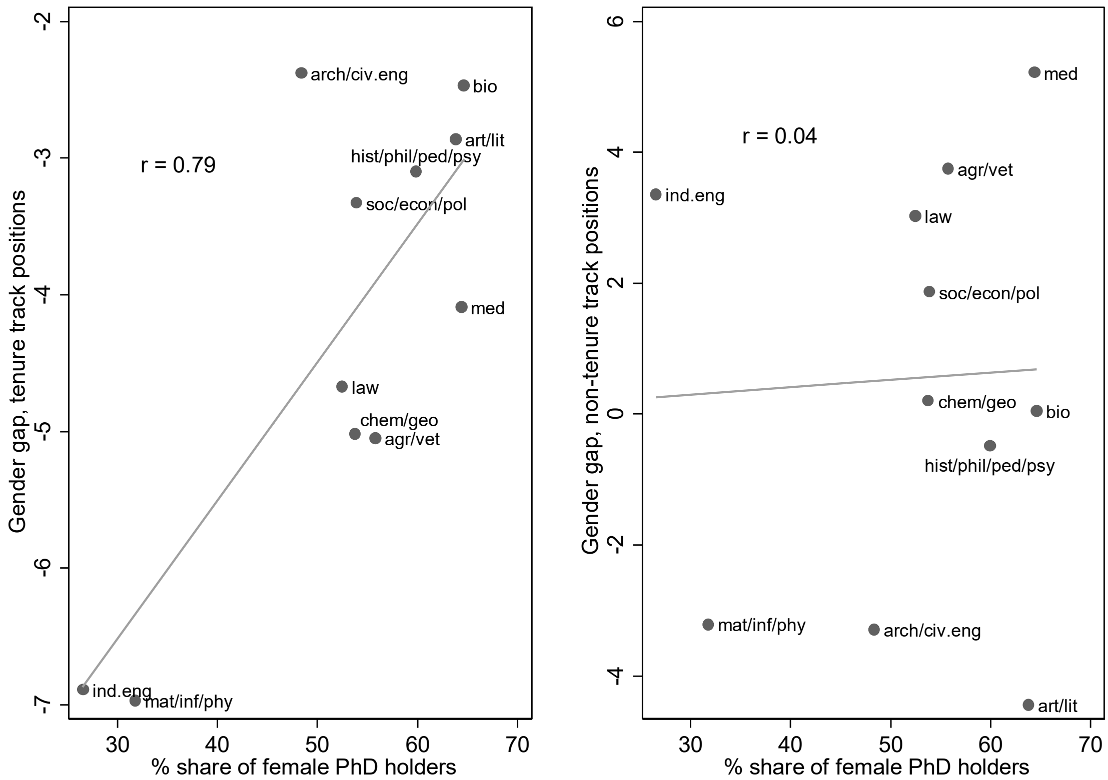
TABLE 3. *PhD graduates by type of research position, gender, and disciplinary group*

Disciplinary group	Has a research job			Tenure track			Non-tenure track		
	Men	Women	Gap W-M	Men	Women	Gap W-M	Men	Women	Gap W-M
Mathematics/ Informatics/ Physics	47.2%	37.0%	-10.2%	15.9%	8.9%	-7.0%	31.3%	28.1%	-3.2%
Chemistry/ Geology	34.4%	29.6%	-4.8%	9.6%	4.6%	-5.0%	24.8%	25.0%	0.2%
Biology	34.6%	32.2%	-2.4%	7.6%	5.1%	-2.5%	27.0%	27.0%	0.1%
Medicine	23.2%	24.3%	1.1%	8.2%	4.2%	-4.1%	15.0%	20.2%	5.2%
Agrarian/ Veterinary	26.6%	25.3%	-1.3%	8.8%	3.8%	-5.0%	17.8%	21.5%	3.8%
Architecture/ Civil engineering	26.7%	21.0%	-5.7%	9.0%	6.7%	-2.4%	17.6%	14.4%	-3.3%
Industrial and Information Engineering	33.7%	30.1%	-3.5%	15.1%	8.2%	-6.9%	18.5%	21.9%	3.4%
Arts and Literatures	23.5%	16.2%	-7.3%	8.1%	5.3%	-2.9%	15.4%	10.9%	-4.4%
History/ Philosophy/ Pedagogy/ Psychology	24.2%	20.6%	-3.6%	9.3%	6.2%	-3.1%	14.9%	14.4%	-0.5%
Law	17.5%	15.9%	-1.6%	10.5%	5.8%	-4.7%	7.1%	10.1%	3.0%
Social, economic and political sciences	31.3%	29.8%	-1.5%	16.1%	12.8%	-3.3%	15.2%	17.1%	1.9%
Total	30.2%	25.0%	-5.1%	11.4%	6.1%	-5.3%	18.8%	18.9%	0.1%

Note: percentages calculated on all PhD holders.

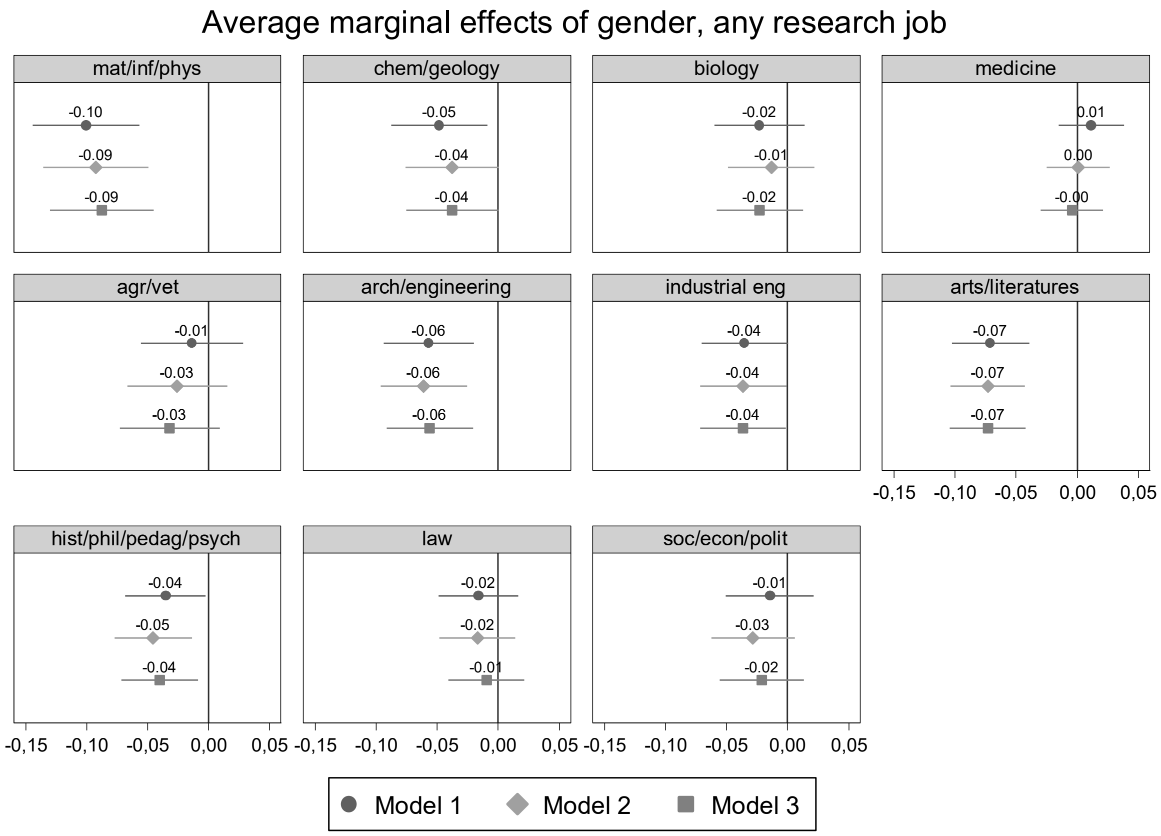
Exploring the relationship between the share of female PhD holders and gender gaps, we found a strong association between sex-segregation across disciplines and gender gaps in tenure track, but not in non-tenure track positions (see Figure 1). This finding gives credit to our initial hypothesis that the two things are related.

FIGURE 1. *Scatterplots of sex segregation and gender gaps across disciplinary groups*



We now turn to estimated gender gaps using average marginal effects from regression analyses. In general, the results closely mirror the raw data presented in Table 2 above. This means that the gender gaps in percentage points (interpreted as differences in probability) are about equal to the estimated marginal effects of gender.

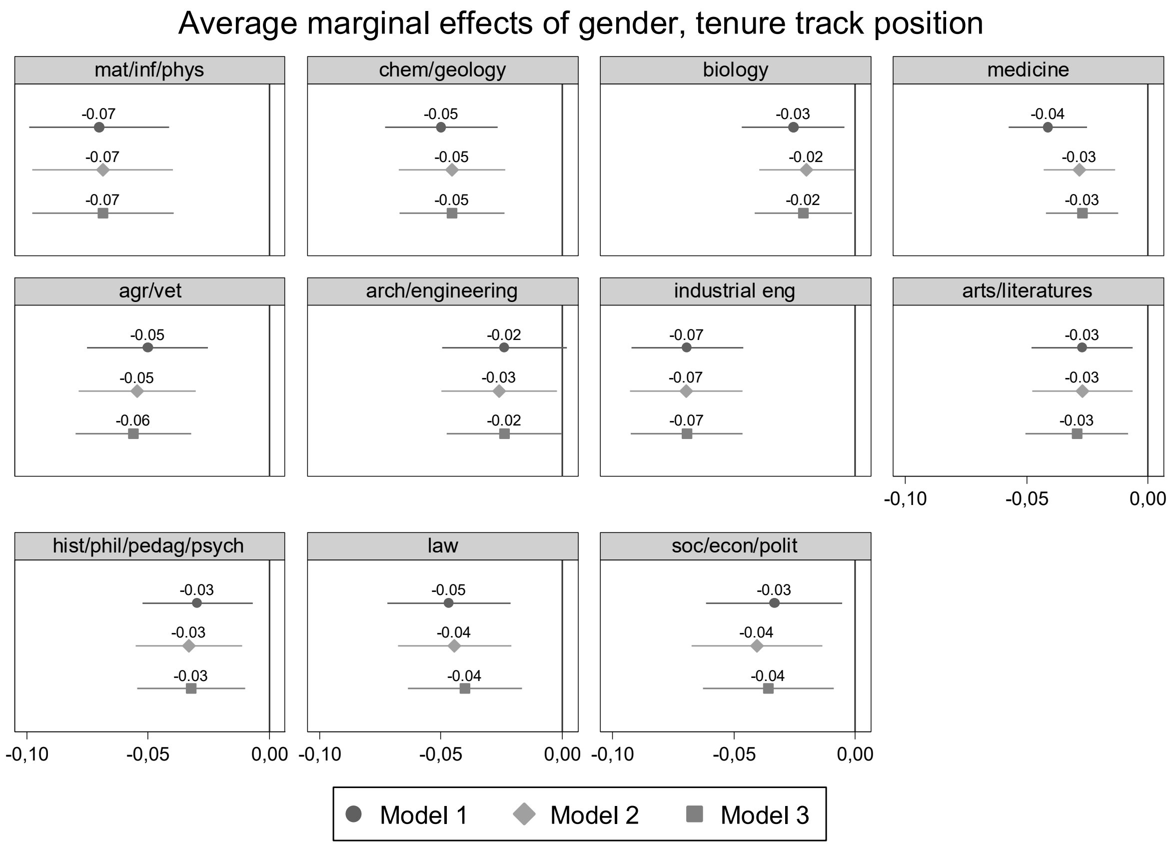
FIGURE 2. *Estimated gender gaps and 95% confidence intervals in the probability of having a research job*



Note: see section 4 for the list of control variables included in the models

As can be seen in Figure 2, there are four disciplinary group, two STEM and two SSH, where estimated gender gaps are clearly statistically significant, net of control variables: mathematics/ informatics/ physics (-0.09), architecture/ civil engineering (-0.06), arts and literatures (-0.07), history/ philosophy/ pedagogy/ psychology (-0.04). In other two STEM groups (chemistry/ geology, industrial and information engineering) the gap is marginally significant and negative (-0.04), while in the remaining five groups there are no significant gender gaps in the probability of having a research position.

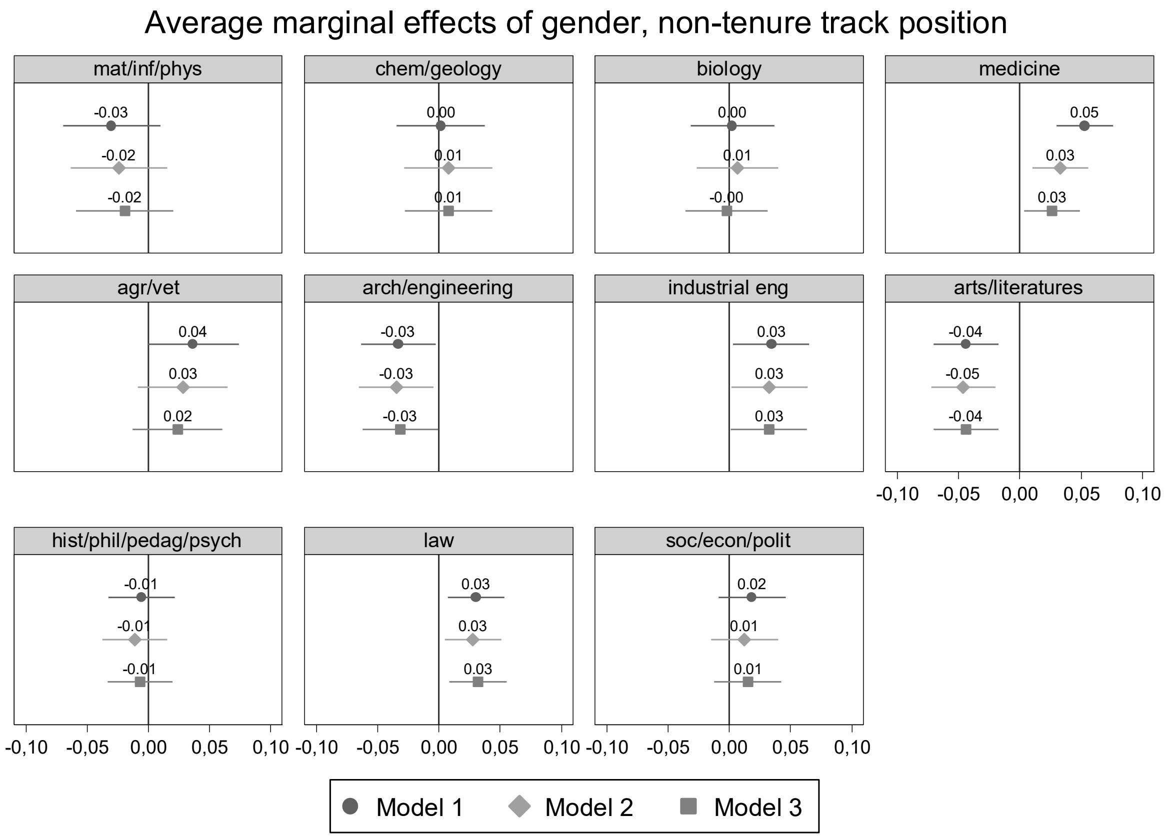
FIGURE 3. *Estimated gender gaps and 95% confidence intervals in the probability of having a tenure track position*



Note: see section 4 for the list of control variables included in the models

Looking at the types of research position, as regards the chances of having a tenure track position (Figure 3), we found that gender gaps are negative and significant in all but one disciplinary group (architecture and civil engineering). In two STEM groups (mathematics/ informatics/ physics and industrial and information engineering), where the percentage of female PhD holders is also lowest, the gap is substantial (-0.07). Conversely, as regards the chances of having a non-tenure track position, we found few statistically significant gender gaps (Figure 4). For women, the probability of getting a non-tenure position is *higher* (+0.03) than men in medicine, industrial and information engineering, and law; while it is lower in architecture and civil engineering (-0.03) and arts and literature (-0.04). The findings of positive gender gaps should be read in conjunction with those about tenure track position. For instance, in medicine, women are on a par with men as regards the chances of staying in a research job after the PhD, but when it comes to obtaining a more secure work position they are disadvantaged compared with men. Hence, women appear to be advantaged as regards the less secure jobs. The same holds true for female PhD holders in industrial and information engineering and law.

FIGURE 4. *Estimated gender gaps and 95% confidence intervals in the probability of having a non-tenure track position*



Note: see section 4 for the list of control variables included in the models

Finally, we notice that in all analyses introducing control variables does not affect the gender coefficient substantially, even if most control variables are associated with the outcome. This is particularly evident in model 3 that adds variables associated with the production process (normalized number of publications, normalized involvement in collaborative research projects, family and parenthood status)[6]. We interpret this finding according to what we assumed above. Gender gaps in access to academic career are unlikely to be due to differences in productivity or in family circumstances. The observed remaining gender gaps are more likely attributable to gendered processes in the evaluation phase, such as discrimination, unconscious gender bias, or even self-exclusion out of promotion review by women themselves.

7. *Discussion and conclusions*

Gender disparities in research and academic contexts are a highly debated topic. This article aims to shed light on the gender gap in access to academic and scientific career and on the mechanisms behind gender disparity. The study focused on gender disparity in the Italian academy context both in STEM and SSH disciplines. Over the last decade the Italian academic and research context have been

[6] The gender coefficients would change substantially if we introduced the number of publications and involvement in collaborative projects *without* the normalization explained in section 5. This confirms that potentially endogenous variables must be handled with care, even if they are treated as controls, because their biasing impact on the coefficients of interest (i.e. gender in this case) may be quite important.

characterized on the one hand, by a steady increase of PhD graduates per year, on the other, by a general reduction of public expenditure, and by a precarization of early-stage academic careers, that translate in a wide use of non-tenure track positions. These disadvantageous job market conditions of Italian PhD graduates, combined with a general lack of social supports for family with children and of policies intended to promote gender equality are likely to worsen the opportunity job for women, because they are at higher risk of remaining trapped in unstable and underqualified job (Bozzon et al. 2015).

The empirical analysis presented here yielded three main findings. First, while the gender gap is almost absent in non-tenure track positions, it re-appears quite evidently in tenure-track positions, where competition for scarce resources is stronger. Thus, women early researchers' disadvantage does not reside in post-doctoral access to academia as such, but in the chances of getting a more secure position that allows to strengthen their scientific career. This in turns might discourage women's efforts – especially around motherhood – and as consequence some may leave in response to unfavorable conditions.

Second, the gender gap in tenure track positions is stronger in some, but not all, STEM disciplinary groups, while it is weaker, although still detectable, in all SSH groups. The reasons of such difference could not be investigated in detail in this article and future empirical research should engage in systematic comparisons of likely factors and mechanisms in both disciplinary areas. However, we hypothesized (and found some evidence) that the difference is linked with differential representation of women in STEM and SSH, both at both lower and higher academic ranks. Further research is needed to investigate the link between women's representation in full professorship in various disciplines and female young researchers' chances to getting a tenure track position. But this would require more detailed data at the meso (organizational) level (see below).

Third, estimated gender gaps are not dramatically different from «gross» gender gaps (i.e. without individual control variables) and, crucially so, are not due to gender differentials in productivity. We interpreted this finding as the consequence of gendered processes acting in the evaluation phase. Even if we cannot rule out other explanations dealing with individuals' unobserved characteristics, we find it worrisome that some key indicators of scientific productivity like those employed in our analysis did not contribute to (statistically) explain the gender gap in access to early academic positions.

A few limitations of our empirical analysis must be acknowledged. The data do not provide precise time reference for some crucial variables (publications, marital and parenthood status), which would allow to disentangle family and work career trajectories (i.e. having children and publications, moving to other university and career attainment). The data also lack any organizational level information (e.g. size of department, name of university, etc.) that would be extremely useful in order to take account of workplace differences. While adding time reference to some variables would require improvement of data collection tools, adding organizational level variables (or simply identifiers) would require overcoming privacy law restrictions.

Appendix

TABLE A1. *Descriptive statistics of variables used in the analyses*

Variable	MEN (N = 14995) % or Mean	SD	WOMEN (N = 16672) % or Mean	SD	ALL (N = 31667) % or Mean	SD
Has research job	30.2%		25.0%		27.5%	
Type of position						
Other non-research	69.8%		75.0%		72.5%	
(quasi)-tenured	11.4%		6.1%		8.6%	
Untenured	18.8%		18.9%		18.8%	
Years since PhD						
4 years	49.2%		49.0%		49.1%	
6 Years	50.8%		51.0%		50.9%	
Survey						
2014 Edition	50.7%		49.8%		50.2%	
2018 Edition	49.3%		50.2%		49.8%	
MA graduation marks						
< 104	18.0%		12.9%		15.3%	
104-108	14.0%		12.3%		13.1%	
109-110	68.0%		74.7%		71.5%	
Opportunity to teach						
Regularly	36.1%		34.2%		35.1%	
Occasionally	36.8%		35.6%		36.2%	
Never	27.2%		30.2%		28.8%	
Had some PhD training abroad	43.9%		38.7%		41.2%	
Finished PhD on time	82.4%		83.3%		82.9%	
Mobility abroad	13.2%		10.0%		11.5%	
Age at PhD						
25-29 years	36.6%		37.9%		37.3%	
30-34 years	38.9%		38.8%		38.8%	
35+ years	24.6%		23.2%		23.9%	
Parents' education						
Less than tertiary	61.5%		62.4%		62.0%	
Tertiary (at least one)	38.5%		37.6%		38.0%	
Parents' social class						
Lower	45.0%		45.9%		45.4%	
Higher (at least one)	55.0%		54.1%		54.6%	
Has Italian citizenship	92.4%		94.1%		93.3%	
University geographical area						
North West	27.2%		25.6%		26.3%	
North Est	15.8%		15.5%		15.7%	
Center	28.5%		27.9%		28.2%	
South	18.3%		20.7%		19.5%	
Islands	10.3%		10.3%		10.3%	
Publications (normalized)	5.3	8.7	4.0	6.9	4.6	7.9

Collaborative projects (normalized)	0.5	0.7	0.4	0.6	0.5	0.7
Family status						
Unmarried	52.6%		47.0%		49.7%	
Married or partnered	44.0%		48.7%		46.4%	
Sepated/divorced/widow	3.4%		4.3%		3.9%	
Has children	35.1%		40.9%		38.2%	

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