‘Being good isn’t good enough’:

Gender discrimination in the Italian Academia

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(preliminary version)

The article analyses the effect of gender in professors’ career advancement in the Italian universities using data on the whole population of professors in the academia, data on the National Scientific Qualification (NSQ) and data on scientific productivity (SciVal) for bibliometric scientific sectors. The NSQ, as a precondition for career advancement in Italian universities, allows excluding low productivity and reluctance to apply for promotions as mechanisms to explain gender gap in academia. In fact, candidate professors have to apply for obtaining the qualification and to reach a minimum level of scientific productivity, as set by the commissions for the qualification. Among those who obtained the NSQ, the results show that gender differences in productivity do not fully explain women’s lower rate of career advancement. Gender gap remains also controlling for resources available and for the percentage of female full professors in the scientific sector.

Keywords: Academic career; Discrimination; Gender; Scientific productivity; Vertical segregation.

‘Being good isn’t good enough’ is the title of a Barbra Streisand’s song.

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Introduction

Even if, in the last decades, gender gap in education disappeared in advanced economies and women are often even more educated and obtain better academic results than men, they are still underrepresented in the universities and in the research centres in all countries (OECD, 2012; Stoet and Geary, 2015). In particular women are underrepresented in the highest positions of the academic ladder[1]. Italy is not an exception: in 2018 in the Italian universities only 23.7% of full professors were women, while the percentage increases to 38.4% among associate professors and to 46.7% among assistant professors. Certainly differences emerge in different disciplinary areas: literary studies, art history, pedagogy, psychology, biology are the scientific sectors with the highest presence of women.

In Italy gender discrimination is still a newsworthy fact. According to the last Global Gender Gap Report (World Economic Forum, 2018) Italy ranks 70th (out of 144) in gender equality, losing 29 positions with respect to the year 2015 and 20 positions with respect to 2016, and ranking similarly to ten years before. Notably, Italy is characterised by a low labour market participation of women with low and middle levels of education, but when we look at highly educated women female employment rate is similar to the other European countries (Del Boca *et al.*, 2012; Marino and Nunziata, 2017; Richardson *et al.*, 2018). However, even if more educated women work, they hardly reach the apical positions of the Italian companies and they are underrepresented in the political institutions (European Commission, 2013).

In our study, we focus on the career advancements of assistant and associate professors in the Italian universities over the period 2012-2016 using data downloaded from the Ministry of University (MIUR) web site. In Italy almost all universities are public and, in public universities, from 2010 career advancement is the result of a two stage procedure. In the first stage candidate professors have to apply for obtaining a National Scientific Qualification[2] (NSQ) for either associate or full professorship which is the pre-condition to participate to the second stage. The NSQ, therefore, sets a minimum level of scientific productivity that candidates must have to access to a higher position. Minima requirements are different among the 14 macro disciplinary areas and in the sub-sectors within the same area[3]. The second stage occurs at department level, where the scientific sector in which to open a competition is decided. Then, professors participate either to competitions open to all qualified applicants (Law 240/2010, art. 18) or to promotion procedures reserved for department members (Law 240/2010, art. 24)[4].

Several studies showed that female scientists are less productive than male ones[5] and this can explain the lower percentage of women among associate and full professors in the Italian universities. If this was the case, there would not be gender discrimination and policies should be promoted to sustain women's research activity. A second possible explanation of the gender gap in the Italian

[1] See Ooms *et al.* (2018) for Germany, Howe-Walsh and Turnball (2016) for the U.K, Winchester and Browning (2015) for Australia, Seierstad and Healy (2012) for Denmark, Norway and Sweden, van den Brink and Benschop (2012) for the Netherlands, Carvahlo and Santiago (2010) for Portugal.

[2] ASN (Abilitazione Scientifica Nazionale).

[3] See Section 2 for a detailed description of the Italian university system.

[4] At a single university level, the number of reserved promotion procedures cannot exceed the number of open competitions.

[5] Uhly *et al.* (2017), Nielsen (2016), Beaudry and Larivière (2016), Mairesse and Pezzoni (2015), Misra *et al.* (2012), Leahey (2006) and Stack (2004) showed gender differences in scientific productivity and discuss possible causes. For Italy the lower productivity of female scientists has been investigated by Jappelli *et al.* (2017), Abramo and D'Angelo (2015), Abramo *el al.* (Abramo *et al.*, 2009).

academia could be the relative reluctance of women to apply for promotions. Previous literature showed in fact that women are less self-confident than men and therefore are less likely to propose themselves for jobs with responsibilities and for career advancements[6]. If this was the case, again, we could not claim the existence of gender discrimination and policies to sustain female scientists through mentoring should be promoted.

However, previous studies also found pure discrimination in the academia mainly due to gender stereotypes that affect both the evaluation of the scientific production of male and female scientists and the different tasks assigned to men and women, often linked to gender roles[7]. Male, in fact, devote more time than women to research activities, while women are more in charge of student support and administrative tasks[8].

The article aims at investigating whether the gender gap in career advancements in the Italian universities is due to discrimination. Merging the MIUR data on the whole population of professors in the Italian universities with the data on the NSQ and with the data on individual productivity obtained from the SciVal web site (for bibliometric scientific sectors only), we are able to exclude negative auto-selection of female candidates to career advancement and to control for the level of scientific productivity, hence to measure pure gender discrimination in the Italian academia.

Our results show that in the Italian universities women are less likely to obtain career advancements even when we control for individual productivity. Moreover, gender discrimination is not mitigated by the resources available for recruitment and career advancement, proxied by university dimension, nor by having more women in the scientific sector in which the competition for career advancement has been done.

1. Gender inequality in the academia

Gender gap in academia has been widely investigated and the underrepresentation of women in the universities and research centres, especially in the higher positions, is a well-known and documented phenomenon. In the most recent years, women became the majority of graduates in all European countries (Eurostat 2015, 2016, 2017) and the proportion of female is almost at 50% also when we look at PhD graduates, with some variation between countries (European Commission, 2015). In 2012 in Italy, 53% of those who obtained a PhD were women, compared to the average value of 47% at European level. However, when we look at the data on female scientists in the European Union, women were only 33% of the researcher population in 2011 (European Commission, 2015, p.62). There are again significant variations across countries, but Italy is perfectly in line with the overall average, with women representing 35.5% of the population.

These data show remarkable gender inequalities in career advancement and participation in academic decision-making, with «a lower concentration of women than men in grade A positions [*i.e.* full professors] compared to lower levels of the academic career path» (European Commission 2015,

[6] See Kaiser (2014) and Islam (1997). Specifically, for academia see Howe-Walsh and Turnball (2016), De Paola *et al.* (2017), Pautasso (2015), Doherty and Manfredi (2006) and Chesterman and Smith (2006).
[7] Jappelli *et al*. (2017), Bagues *et al.* (2017), De Paola and Scoppa (2015), Budden *et al.* (2008), Howe-Walsh and Turnbull (2016), Krawczyk and Smyk (2016), Seierstad and Healy (2012), Winchester and Browning (2015), Mairesse and Pezzoni (2015), van den Brink and Benschop (2012) and van den Brink *et al.* (2010).
[8] Beaudry and Larivière (2016) and Misra *et al*. (2012).

p.131). Moreover, the proportion of women among the heads of higher education institutions is, on average, one out of five (European Commission, 2015) and Italy is again perfectly in line with the European average (22% in 2016 in our data).

This scenario confirms, on the one hand, the presence of the 'leaky pipeline' phenomenon, *i.e.* the larger number of female graduates does not lead to more women in academia and in the research centres (Blickenstaff, 2005) because women are more likely to leave the academic career path than men (Bozzon *et al.*, 2017). On the other hand, it indicates the presence of a 'glass ceiling' that makes more difficult for women to reach the highest position in the scientific research filed, as in most other sectors. The glass ceiling is a well-known and deeply studied phenomenon. Women face more difficulties than men to enter the labour market (Hassink and Russo, 2010), are more likely to be employed with temporary or (involuntary) part-time contracts, receive on average lower wages and have less career opportunities (OECD, 2018). The leaky pipeline and the glass ceiling are the result of gender gap in recruitment and promotion processes. Previous literature has dedicated considerable attention to study gender and discrimination in academic recruitment and promotion and this is a topic that still draws the researcher's interest (Bystydzienski *et al.*, 2017; Tiainen and Berki, 2019). In Germany, male scientists are more likely to obtain an early career position than female ones, but no differences emerge in the probability of becoming assistant professor. However, gender differences reappear in the transition to full professorship (Ooms, et al., 2018). In the Netherlands, transparency in the recruitment and selection processes seem to be not sufficient to guarantee gender equity in the outcomes (van den Brink, et al., 2010).

The lack of women in the highest positions of the academic ladder is not *per se* a sign of gender discrimination. According to the literature, two main factors can explain gender gap: the different scientific productivity of male and female scientists and women's reluctance to apply for promotions. Gender differences in productivity have been deeply investigated. Scientific productivity has been measured using mainly three indicators: number of publications (Abramo, et al., 2009; De Paola, et al., 2017; De Paola and Scoppa, 2015; Mairesse and Pezzoni, 2015; Nieddu and Pandolfi, 2018), number of citations (Nielsen, 2016) and citation indexes (Abramo, et al., 2009; De Paola, et al., 2017; De Paola and Scoppa, 2015). According to these measures, female scientists show lower scientific productivity than their male colleagues (Abramo and D'Angelo, 2015; Abramo, et al., 2009; Jappelli, et al., 2017; Mairesse and Pezzoni, 2015; Nielsen, 2016; Ooms, et al., 2018). This can be explained as the result of their family responsibilities, and this is especially true for women with children (Fox *et al.*, 2011; Mairesse and Pezzoni, 2015). In a country like Italy, where the role of principal caregiver in the household is mainly assigned to women and the welfare system is weak, making reconciliation of work and family difficult (Del Boca, et al., 2012), the negative effect of children on productivity can be relevant. In fact, as a consequence of their family responsibilities, female academics are less likely to participate in international networks and they have less collaborations (Beaudry and Larivière, 2016; Uhly, et al., 2017), with negative effects on the amount of research funds (Beaudry and Larivière, 2016) and therefore on the number of publications, number of citations and IF of the journal in which they publish (Nielsen, 2016). Moreover in Italy the connections with the selection committees members matters more than productivity for obtaining a position or a career advancement in academia (Abramo and D'Angelo, 2015; Checchi *et al.*, 2019; Checchi *et al.*, 2018; De Paola and Scoppa, 2015), smaller or weaker networks or a restricted number of collaborations might negatively affect women's career.

However, also after controlling for the presence of children gender gap in scientific productivity persists (Stack, 2004). Frequently, for Italian academics, articles authored by women received worst evaluations in the national research assessment and this might produce less citations and lower h-index values (Jappelli, et al., 2017).

Finally, the lower productivity of female scientists in the universities is also the consequence of more teaching and administrative tasks assigned to women: data, in fact, show that men are more devoted to research than women, while the opposite is true for mentoring activities and service hours (Beaudry and Larivière, 2016; Misra, et al., 2012).

Because female scientists have lower productivity, hiring or promoting a woman has a negative effect on the university's ranking and therefore on the ability of attracting public and private funds. In Italy, in the last decade, the amount of money the universities receive from the Ministry is partly determined by the evaluation of their scientific production (Abramo and D'Angelo, 2015) and therefore all universities have begun to closely monitor the productivity of their departments.

Lower productivity is not the only possible cause of gender gap in academia. A relative reluctance of women to apply for promotion, especially in male-dominated occupations (Antecol and Cobb-Clark, 2013), is well documented in research across a number of countries. This is explained by the women's lack of self-confidence, their higher risk aversion and their lower attitude to negotiation (Grund, 2015). Women often underestimate their abilities also because the gender discrimination they observe at the workplace makes them pessimistic about their career opportunities (Kaiser, 2014). The reported situation in the Italian academia seems to be not different: De Paola *et al.* (2015) found that, even after controlling for scientific productivity, Italian female assistant and associate professors are about 4 percentage points less likely to apply for the NSQ than their male colleagues.

In our analysis, we are able to exclude both these factors by considering only assistant and associate professors that obtained the qualification. In fact candidate professors have to apply for the qualification (no self-selection) and to reach a minimum level of scientific productivity as set by the commissions for the qualification (no low productivity). However, we cannot exclude that qualified female professors have applied less in competitions for promotion at department level, but we believe that having obtained the qualification, that is valid only for a limited period of time (six years), is a strong incentive to apply in the competitions for the advancement career.

Finally, gender composition in the scientific sector might play a role in the persistence of gender gap. Male-dominated workplaces might provide a context where women face stronger obstacles in being promoted. The mechanisms behind can be several: being a minority, female scientists might perceive social and intellectual exclusion, or might be less likely to apply for promotion in those fields in which promotions of females have been rare in the past, as they expect to be discriminated in competitions in which male committees members are predominant. However, the hypothesis of 'women helping woman' did not found strong support in the previous literature (Bagues, et al., 2017).

Also the resources available for recruitment and career advancement can be relevant in affecting the gender discrimination. In fact, previous studies found less gender discrimination in larger universities (*i.e.* where more resources are available).

3. The Italian university: career advancements and gender gap

In the Italian universities the academic staff is divided into four categories: full professors, associate professors, assistant professors with permanent contract and assistant professors with temporary contract. Before the year 2005 all assistant professors were hired with permanent contracts, while after 2010 only on a temporary contract basis[9]. Each professor is included in a macro scientific area that defines the general academic fields of his/her research, and in a scientific sub-sector that, within the macro area, better specifies the research fields[10].

Italian university experienced many reforms in the recruitment and career advancement rules over the last 20 years. The last reform, in 2010 (law 240/2010, known as Gelmini's reform, from the name of the Minister that promoted it), introduced a two-step system in the process for career advancement. The first step is the NSQ: assistant professors that want to be promoted associate professors and associate professors that aspire to become full professors apply for the qualification. In each academic sub-sector, a national committee of five scholars (four full professors from Italian universities and one full professor affiliated to a non-Italian academic institution in an OECD country randomly drawn from a list of eligibles) set the criteria for qualification and then evaluate the CVs of the applicants. Qualification is awarded to a candidate with the agreement of four out of five committee's members[11]. In the second step, professors that got the qualification can participate to open selections at departments level (Law 240/10, art. 18) or to promotion procedures reserved for department members (Law 240/10, art. 18).

The declared aim of introducing the NSQ as first step was to limit local favouritism (Nieddu and Pandolfi, 2018; Sala and Bosisio, 2017) and to improve the quality of the scientific production of the Italian university system by allowing only the most productive scientists to have career advancements. This should have been an incentive for all the academic staff to be more productive in their research activity and should have reduced discriminations, including gender biases. The Italian academia was, in fact, known for evaluating more personal connections and networks than actual scientific productivity for career advancements (Checchi, et al., 2019; De Paola and Scoppa, 2015).

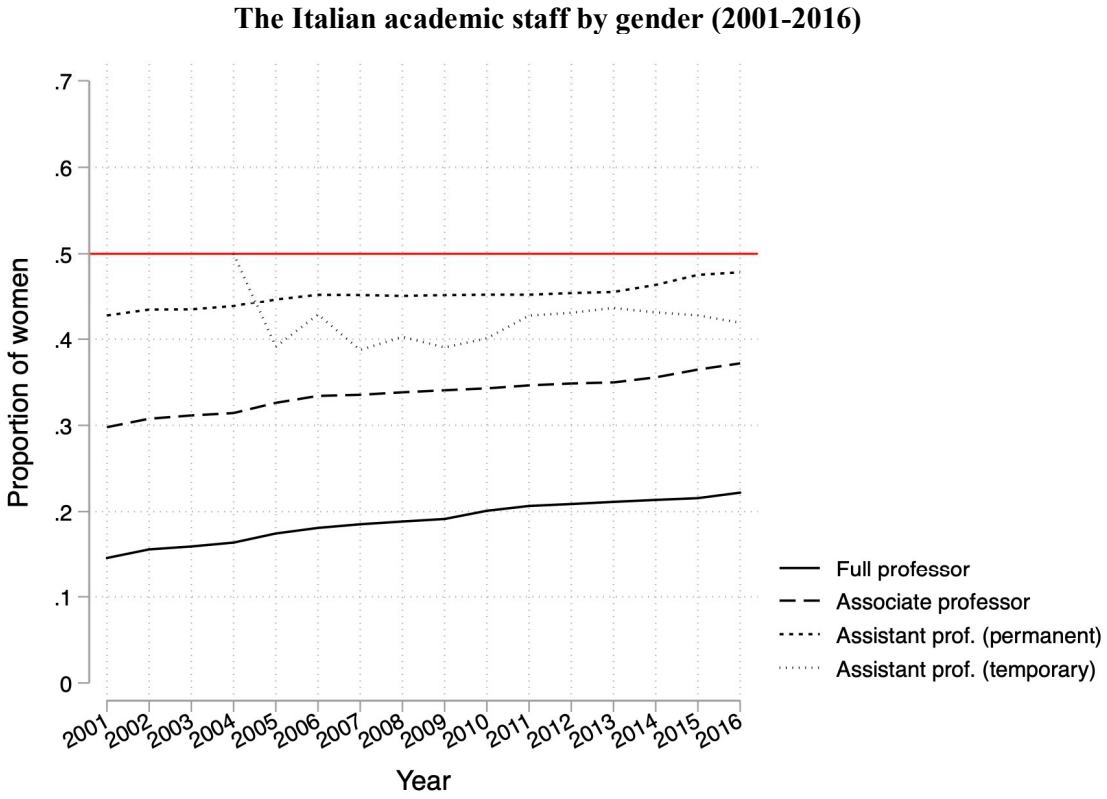
Figure 1 shows the gender composition of the Italian academic staff in the period 2001-2016. In none of the categories we observe gender balance, but the presence of women among full professors is extraordinarily low throughout the period, exceeding the value of 20% only after 2010.

[9] The Moratti reform (law n. 230/2005), in fact, introduced a flexibilisation in early career stages that has been confirmed and made even stronger by the subsequent reforms (Bozzon, et al., 2017).

[10] Mathematics and informatics (10 sub-sectors)s, Physics (8 sub-sectors), Chemistry (12 sub-sectors), Earth sciences (12 sub-sectors), Biology (19 sub-sectors), Medicine (50 sub-sectors), Agricultural and veterinary sciences (30 sub-sectors), Civil engineering and architecture (22 sub-sectors), Industrial and information engineering (42 sub-sectors), Antiquities, philology, literary studies, art history (67 sub-sectors), History, philosophy, pedagogy and psychology (34 sub-sectors), Law (21 sub-sectors), Economics and statistics (19 sub-sectors), Political and social sciences (14 sub-sectors).

[11] The composition of the commissions and the rules on the number of positive evaluations needed to obtain the National Scientific Qualification changed after the first two years of implementation. However, those reported in the text were the rules in force for the qualification process of the individuals in the dataset.

Figure 1



Source: MIUR data. Own elaborations

The picture of gender bias is not homogeneous across the fourteen different macro disciplinary areas, as shown in Table 1[12]. *Industrial and information engineering* is the disciplinary area with the lower percentage of women in all categories, particularly among full professors, followed by *Physics*. The macro disciplinary areas with the greater presence of women are *Antiquities, philology, literary studies, art history* followed by *History, philosophy, pedagogy and psychology*, and by *Biology*. In these areas the percentage of women among full professor is respectively 42%, 32% and 30%. In the *Medicine* sector, which is the most numerous area (17.5% of the whole academic staff) women are 40% of the assistant professors, but only 25% of associate professors and 13% of the full professors.

[12] Data refer to the initial year of our observational period.

Table 1

Gender gap in the different macro disciplinary areas

Macro disciplinary areas (code)	ERC group, bibliometric Y/N	Full professor	Associate professor	Assistant professor	N	% (N/Total)
		% of women (2012)			(2012)	
Mathematics and informatics (1)	PE, yes	17.9	39.9	39.4	3,171	5.5
Physics (2)	PE, yes	9.4	18.5	25.7	2,232	3.9
Chemistry (3)	PE, yes	20.3	41.8	57.2	2,919	5.1
Earth sciences (4)	PE, yes	18.0	31.0	33.2	1,055	1.8
Biology (5)	LS, yes	30.5	49.1	63.1	4,866	8.5
Medicine (6)	LS, yes	13.3	25.0	40.9	10,026	17.5
Agricultural and veterinary sciences (7)	LS, yes	15.4	36.9	47.5	3,046	5.3
Civil engineering and architecture (8)	PE, yes (not all*)	16.8	24.6	39.1	3,572	6.2
Industrial and information engineering (9)	PE, yes	6.6	16.0	21.0	5,292	9.2
Antiquities, philology, literary studies, art history (10)	SH, no	42.3	55.2	61.3	5,198	9.1
History, philosophy, pedagogy and psychology (11)	SH, yes (not all*)	32.1	46.3	52.2	4,618	8.1
Law (12)	SH, no	20.9	36.1	46.8	4,793	8.4
Economics and statistics (13)	SH, no	20.2	36.5	45.2	4,786	8.4
Political and social sciences (14)	SH, no	25.8	36.3	45.5	1,733	3.0

Source: MIUR data. Own elaborations

*Not all sub-sectors of the disciplinary areas are bibliometric

Our empirical analysis aims at testing if female professors with the NSQ are less likely to experience career advancements than their male colleagues, *i.e.* if there is gender discrimination in the Italian universities. For the bibliometric sub-sectors, we also investigate if the low presence of women in the highest ranks of the Italian academia can be explained by their lower scientific productivity. Furthermore, we investigate if a higher presence of female full professor in a scientific sector decrease gender discrimination in career advancements.

4. Data and method

For our empirical analysis we used data on the whole population of the academic staff in the Italian public universities downloaded from the MIUR web site[13]. Data are available from the year 2001 onward[14], and for each year it is possible to download the list of all assistant, associate and full professors with the information on gender, macro disciplinary area, scientific sub-sector they belong to and the university and department of affiliation.

[13] The web site is cercauniversita.cineca.it

[14] Data on the whole Italian academic population are available since the year 2000, but is it only from the year 2001 that they report also the information on the scientific sub-sector of each individual.

We merged the data on the whole population (MIUR) with the data form the NSQ on the assistant and associated professors that got the qualification for associated and full professorship respectively in the first two years of implementation (2012 and 2013). Unfortunately, for each scientific sub-sector only the lists of qualified individuals are available since the lists of those who did not obtained the qualification have been removed from the web site for privacy reasons 120 days after their publication.

In order to include individual's seniority in our analysis, we selected only individuals who have been hired with a permanent contract between 2002 and 2011 (*i.e.* that were not present in the database in the first year, 2001, but that are present afterwards) and who were continuously employed in an Italian public university for the whole period we consider (2002-2016). We selected assistant and associated professors in 2012 that could therefore participate to the first two waves of the NSQ. Hence, we considered the career of those who entered in an Italian university between 2002 and 2011 and that are still in the Italian academia in 2016. We did not consider the years after 2016 since, in 2016, new waves of qualifications has been opened (first results where released in April 2017) and the observational window is too short in order to investigate career advancements.

The merge of the MIUR data on the Italian academic population with the data on NSQ has been done by individual's name and surname and by scientific macro area to which the individual belongs[15], with two possible sources of errors. First, we could have merged two homonyms, one employed in an Italian university and one outsider that applied for qualification in the same macro area. Therefore, we could have attributed the qualification of one outsider individual to a homonymous insider belonging to the same macro area. We were unable to correct for this error but, since the percentage of outsiders that obtained the qualification has been very low[16], we assumed that this error did not affect our results. Second, we could have considered as qualified two homonyms insider individuals in the same macro area as we cannot be sure which of them obtained the qualification. In order to avoid these second possible error, we excluded from our sample all homonyms within the same macro disciplinary area. We also excluded individuals that changed scientific macro area in the period we consider. The total number of dropped cases is 150. Our final sample consists of 16,216 assistant professors (45.4% of which are women) and 3,522 associate professors (32.3% women). Among these, the total number of assistant professors who obtained the qualification in our sample is 8,208 (40.8% of which are women), while for the associate professors is 1,817 (30.0% women).

We firstly showed the probabilities of men and women to obtain the NSQ in the different Macro disciplinary areas and then we estimated the probability of being promoted to the higher rank for assistant and associate professors that obtained the NSQ without controlling for scientific productivity and then we re-estimated the model also controlling for productivity on the subsample of individuals belonging to bibliometric sub-sectors. We estimate a logit model in which the dependent variable is the probability of having a career advancement in the period 2012-2016 for those professors that obtained the NSQ in 2012 or in 2013. The independent variable of interest is gender and we control for seniority, scientific macro areas (14 dummies with *Mathematics and informatics*, coded as Macroarea 1, used as reference category), a set of five dummy variables for the size of the university

[15] In some cases, individuals belonging to one scientific sub-sector obtained the qualification in a different sub-sector within the same macro area. For this reason, we used the macro area (and not the sub-sector) to merge the two databases.
[16] See for example https://www.lavoce.info/archives/18356/universita-professori-universitari-concorsi-abilitazione/ and https://www.roars.it/online/asn-2012-ecco-le-statistiche-finali-diverse-da-quelle-anvur/.

(as a proxy for resources available for recruitment and promotions) and a set of dummies variable one for each university. These last controls are crucial as recruitment and career advancements depend on merit, but also on the number of positions available.

Individuals that obtain the NSQ exceed a minimum threshold. However, the individual's actual productivity can affect the probability of career advancement. Therefore as far as scientific productivity is concerned, for each individual in the restricted sample of qualified individuals in the bibliometric sectors, we considered three different indicators of scientific productivity: the h-index[17], the number of citations and the number of publications until the year 2015. We downloaded these information from the SciVal web site[18]. Since there is still not a metric to measure scientific productivity in the non-bibliometric sectors, these indicators are clearly relevant for bibliometric scientific sectors only and they are commonly used for evaluating candidates in the procedures that take place at department level. Moreover these bibliometric measures are highly correlated[19], we first introduced them one at a time and then, to consider all of them simultaneously avoiding multicollinearity problems, we did a principal component analysis to obtain a comprehensive measure of individual productivity which captures as much as possible of the variation in the original variables. The principal component analysis allowed us to create a new set of variables as linear combinations of the original set of variables, but we considered only the first component (which we called *Productivity*) that is the combination of the original variables that explains the maximum amount of variation.

Finally, we introduced in our models a variable measuring the percentage of female full professors in the scientific sub-sectors. The gender composition of the sector is important as, we assume, a larger proportion of female full professors can result in a greater institutional attention to female assistant and associate professors and therefore in a greater promotion potential for female scientists.

Descriptive statistics of the variables used are reported in Table A1 in the Appendix.

5. Main results

As we discussed in Section 2, having the NSQ is the requirement to become associate or full professor. Figure 2 shows the percentage of assistant and associate professors that obtained the qualification over the population of all potential candidates (*i.e.* in the population of all assistant and associate professors). In almost all macro disciplinary areas (MDA), with the only exception of *Agricultural and veterinary sciences* (code 7) and *Civil engineering and architecture* (code 8), there are more men than women that got the qualification and this is true both in macro areas in which a high parentage of applicants obtained the qualification (more than 60%) and in the macro areas in which the percentage is low (less than 50%).

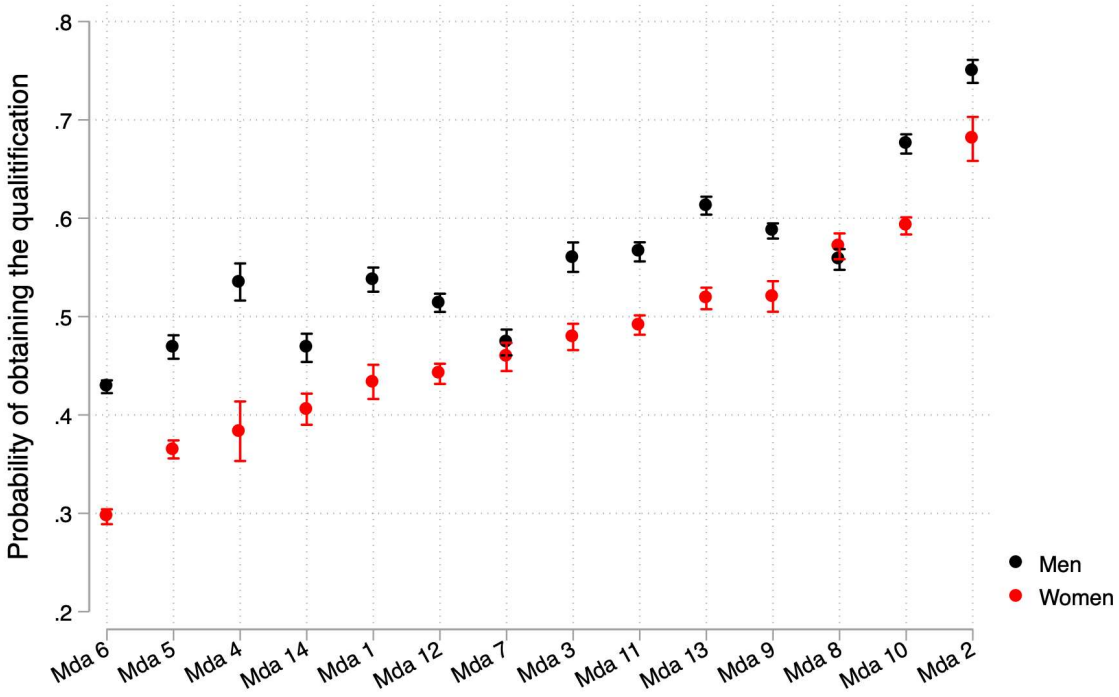
[17] The h-Index, proposed in 2005 by Jorge Hirsch, a physicist at the University of California, is a numerical indicator to measure a researcher productivity and how his/her research is influential. According to Hirsch definition, a scientist has index h if h of his/her N papers have at least h citations each, and the other (N−h) papers have no more than h citations each (Hirsh, 2005).

[18] SciVal is a modular integrated platform offered by Elsevier for the analysis of research results based on scientific production data. In particular, it provides information on more than 12,400 research institutions and their associated researchers from 230 nations worldwide.

[19] The correlation between publications and citations is 0.87, while it is 0.65 between publications and h-index.

Figure 2

Probability by gender of obtaining the qualification for the population of assistant and associate professors (2012-2013)

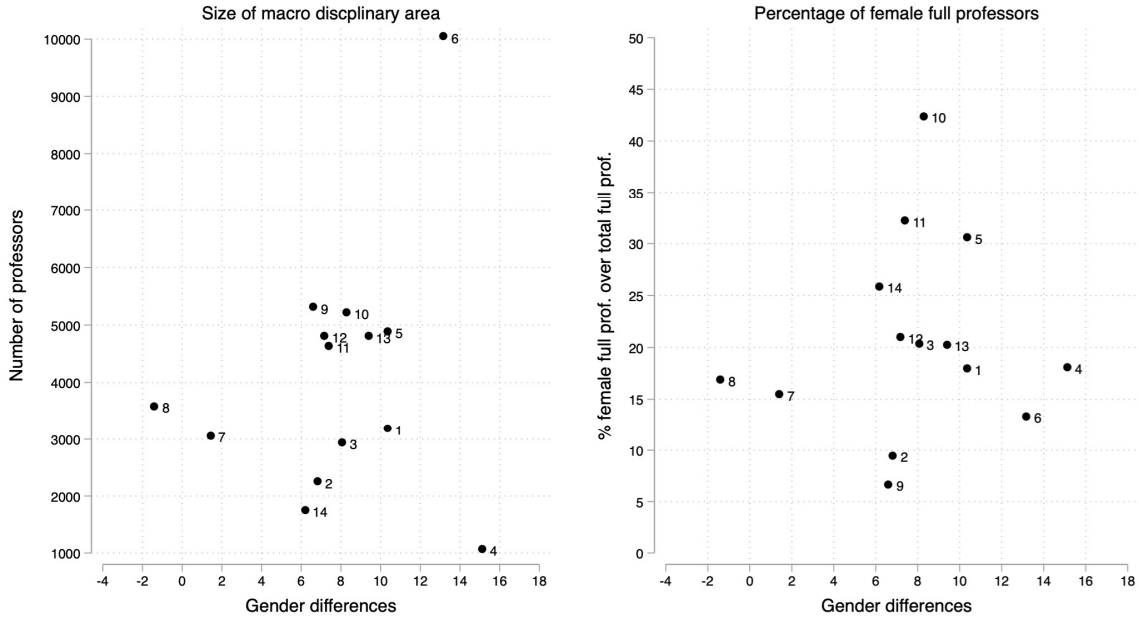


Source: Miur data. Own elaborations

The gender gap in the probability of obtaining the qualification could depend on factor related to the specific macro disciplinary area, such as the size of the macro area. Moreover, the percentage of female full professors in the macro area, as a measure of lower or higher masculinization of the area, might also have affected the gender gap in the qualification process. As showed in Figure 3, none of these contextual factors seem to have reduced the gender difference in the probability of obtaining the qualification. If we compare the difference in terms of percentage points between men and women who got the qualification with the size of the macro area (Figure 3, left graph) and with the percentage of female full professors in the same macro disciplinary area (Figure 3, right graph), we observe that there is not any apparent relationship.

Figure 3

Gender gap in National Scientific Qualification (2012-2013)
and size of macro area and % of female full professors in the macro area (in 2012)



Source: Miur data. Own elaborations

Descriptive statistics, however, are unable to show if the gender gap in qualification is due to lower scientific productivity of female scientists or to the lower number of application for qualification submitted by women or to the lower rate of qualification among female applicants, possibly due to a low share of women in the qualification committees (De Paola *et al*., 2017) or to the weaker ties between candidates and committees' members (Checchi *et al.*, 2018). We cannot test these hypotheses because data on individuals that did not get the qualification are not available. Therefore, we focused only on the population of qualified professors and we observe those who get a promotion and see if any gender discrimination emerges.

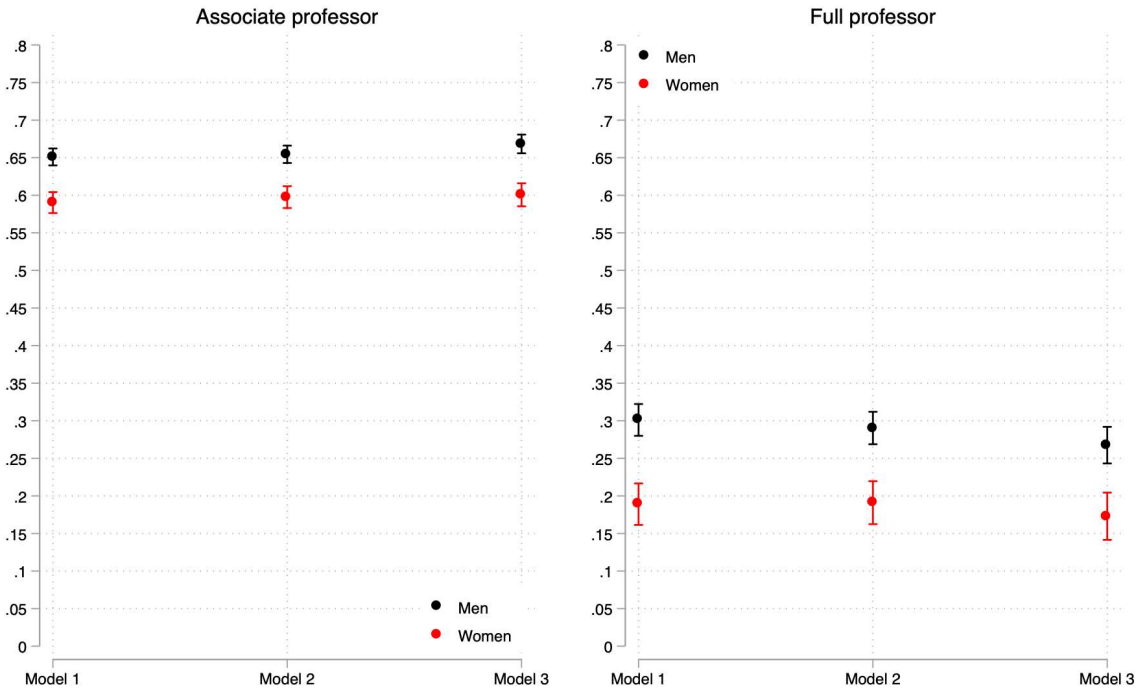
We used logit models to estimate the probability of becoming associate professor by 2016 for those who were assistant professors in 2012 and got the NSQ in 2012 or in 2013. Similarly, we estimated the probability of becoming full professor by 2016 for those who were associate professors in 2012 and got the NSQ in 2012 or in 2013.

We estimated three different models. In Model 1 we included only the variable related to gender to estimate the overall effect of being women on the probability of having a career advancement. In Model 2 we added controls for the years of seniority, the scientific macro area and the size of the university of affiliation of the individual, while in Model 3 we substituted a set of dummy variables, one for each university, to the dummies for the size of the university. The estimated average probabilities are plotted in Figure 4 for an easy interpretation while the full set of results is in Table A2 in the Appendix). Results show that being female decreases the probability of career advancement in all specifications. The effect seems to be stronger for promotions of associate professors to full professors. Female assistant professors have a 6 percentage points lower probability of becoming

associate professor, but the difference between women and men increases to more than 10 percentage points when we consider the transition from associate to full professor. Gender differences remain unchanged when we add controls.

Figure 4

Probability of career advancement by gender

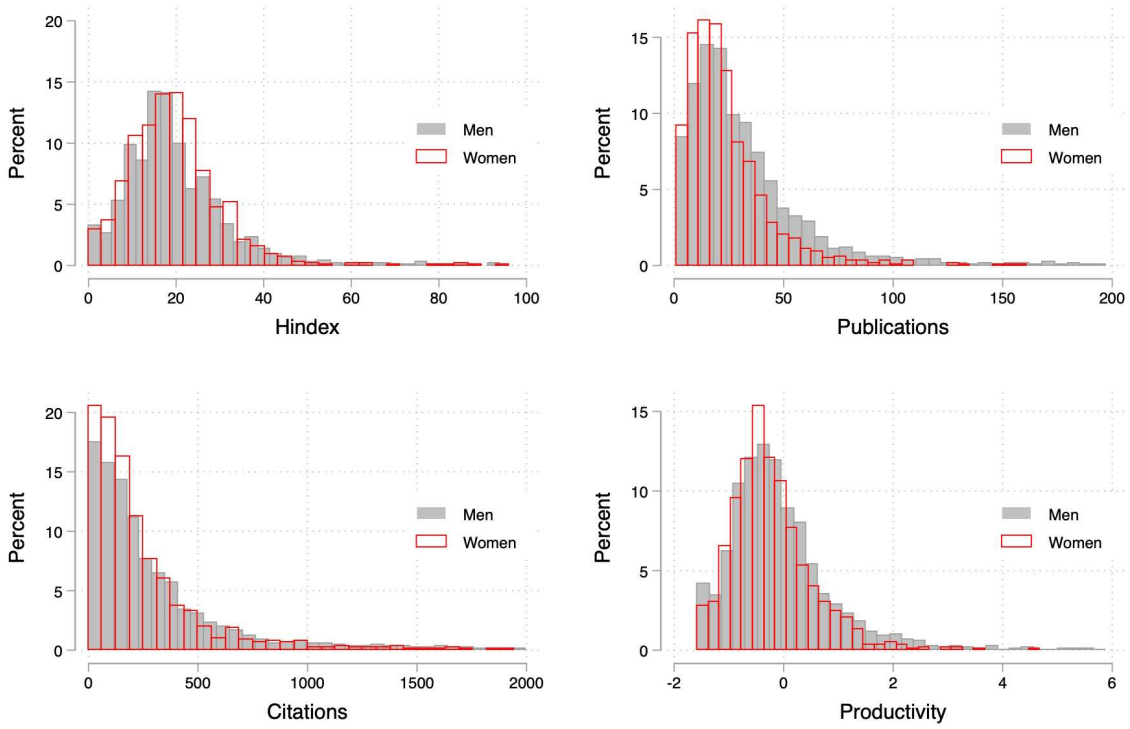


Note: Model 1 considers only sex. Model 2: control for seniority in the Italian academia, macro disciplinary area, and dimensions of the university of affiliation (2012). Model 3: control for seniority in the Italian academia, macro disciplinary area, and university of affiliation (2012).

To introduce individual's productivity in our model, we restricted our sample to professors in the bibliometric scientific sectors only. Our sample is reduced to 4,218 observations, 34.3% of which are women. Figure 5 show the distribution of our four measure of scientific productivity for male and female qualified professors in the sample. When we consider the h-index, female scientists seem to be slightly more productive, while if we look at number of publications and at the number of citations the opposite seems true. Thus, no significant gender differences emerge in our indicator of productivity.

Figure 5

Distribution by gender of measures of scientific productivity of qualified professors



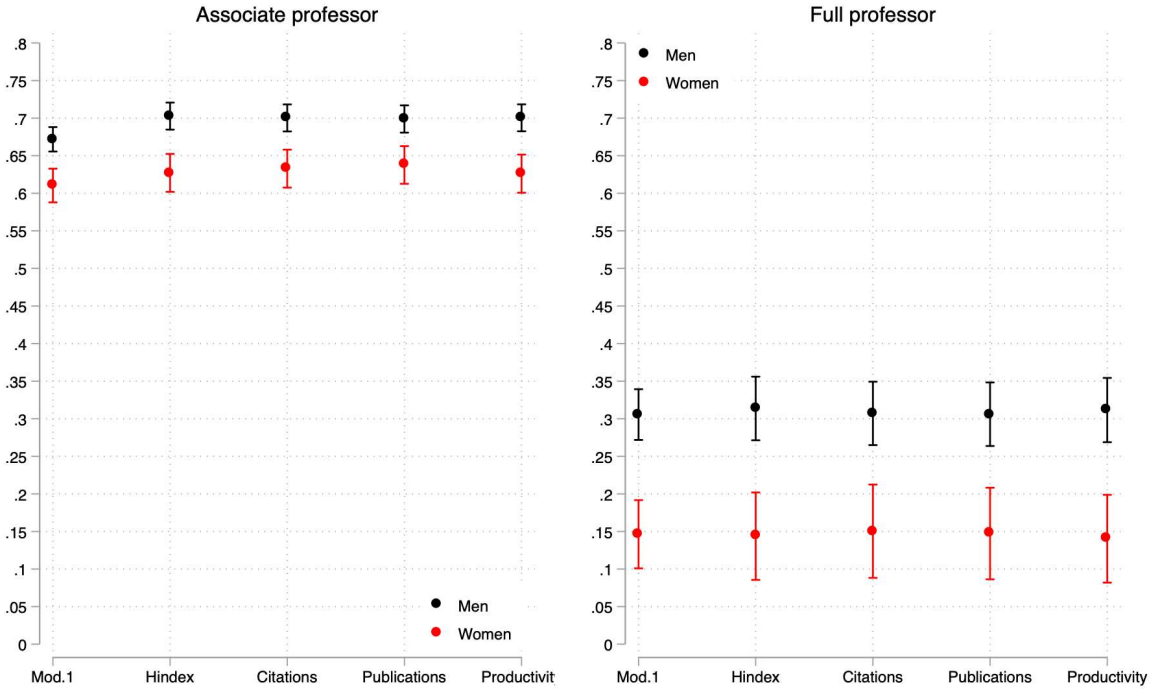
Source: *SciVal data. Own elaborations*

Figure 6 shows the the estimated average probabilities of career advancement to associate and full professor computed at the mean values of the logistic regressions in which we introduced our measures of productivity (results are reported in Table A3 in the Appendix). Model 1 is the overall effect of gender for the sub-sample of individual in bibliometric scientific sectors. The other four models are controlled for years of seniority, macro disciplinary area, university of affiliation and individual's scientific productivity measured using four different indicators: the standardized h-index (Model 2), the standardized number of citations (Model 3), the standardized number of publications (Model 4) and an overall measure of productivity (Model 5)[20]. No matter how scientific productivity is measured, gender gap in the probability of career advancement remains significant in all model specifications. On average female assistant professors have a probability of advancement to the position of associate professor which is 8 percentage points lower with respect to their male colleagues. This difference increases to 17 percentage points when we consider the probability of associate professors to become full professors. Therefore, at the same level of scientific productivity female professor have a lower probability of career advancement. We can define this gender discrimination.

[20] Controlling in the same model for the three indicators (h-index, number of publications, number of citations) simultaneously results remain unchanged.

Figure 6

Probability of career advancement by gender considering scientific productivity

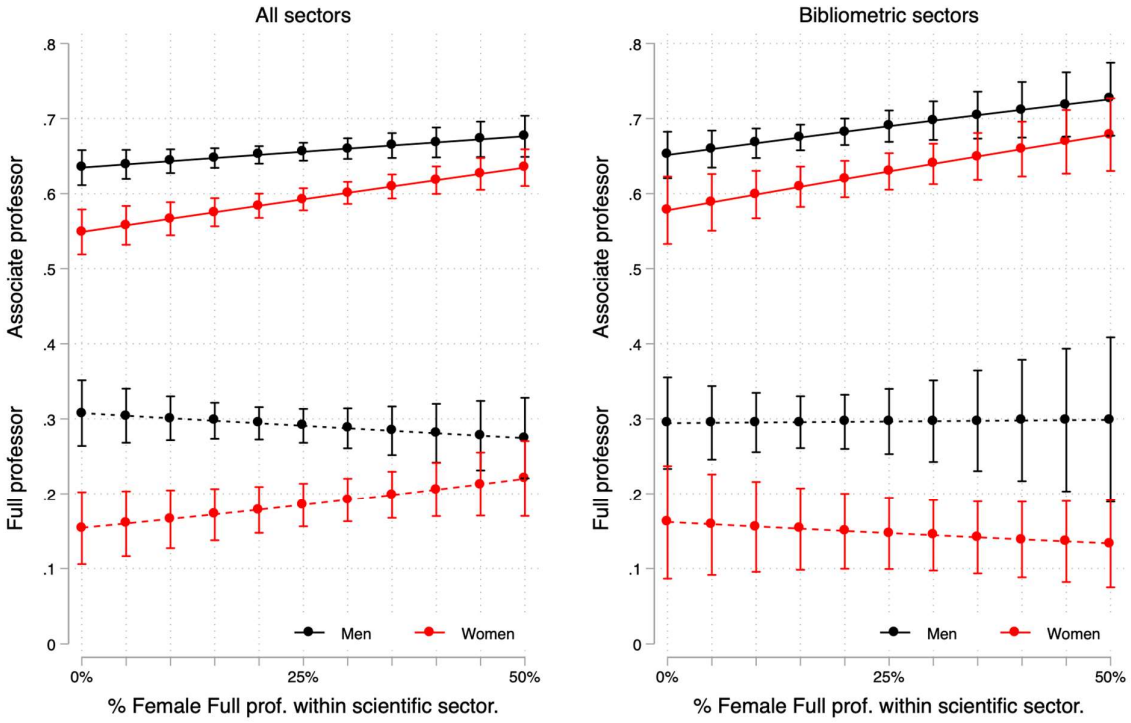


Note: Model 1 considers only sex in the subsample of bibliometric scientific sectors. Model 2: control for seniority in the Italian academia, macro disciplinary area, university of affiliation (2012), and h-index. Model 3: control for seniority in the Italian academia, macro disciplinary area, university of affiliation (2012), and citations. Model 4: control for seniority in the Italian academia, macro disciplinary area, university of affiliation (2012), and publications. Model 5: control for seniority in the Italian academia, macro disciplinary area, university of affiliation (2012), and productivity index.

Finally, gender discrimination can be more or less pronounced depending on the gender composition of the specific scientific sub-sector. Less male-dominant sectors, in fact, might entail more chances for women's careers. Figure 7 shows the estimated average probabilities of career advancement to associate and full professor considering the percentage of female full professors in the sub-sector. We run logit models both on the full sample and on the sub-sample of individuals in the bibliometric sectors (results are reported in Table A4 of the Appendix). Given the low share of female full professor in the Italian academia, we consider the variable *percentage of female full professors* only in the range of 0-50%, that includes 95% of the values observed. Our results show that although the discrimination between men and women always persists, in the scientific sectors where there are more female full professors the gap is not statistically significant anymore.

Figure 7

Probability of career advancement by gender considering the level of female full professors in the scientific sub-sectors (in 2012)



Note: Models 1 and Models 2 consider all sample. Models 3 and Models 4 refer to the subsample of bibliometric scientific sectors. All models are controlled for seniority in the Italian academia, macro disciplinary area, and university of affiliation (2012). Models 2 are also controlled for the productivity index.

Conclusions

The article investigates the gender discrimination in the Italian academia in recent years using administrative data and data on researchers' productivity. The underrepresentation of woman in the Italian university could be related to several factors, already deeply investigated in the literature, such as the low productivity or the reluctance in apply for open positions. Obtaining the NSQ, in order to be promoted, imply having a certain level of productivity and having apply for it. However there are still different chances for men and women of being promoted. Our results indicate that the observed lower promotion of women among associate and full professors in the Italian universities cannot be explained by the lower scientific productivity of female scientists, nor by a negative self-selection of women that apply less for career advancement. The type of data we used and the mechanism for career advancement in the Italian academia allow us to exclude these as causes of the gender gap.

The existence of discrimination in the Italian universities leads to questioning about possible solution to give men and women equal opportunities of career. It is still not clear which mechanism can effectively counter gender discrimination. Some scholars pointed out the necessity of clear guidelines and specificity in promotion and tenure documentation, together with senior colleagues to

help the junior scientists unravel objective expectations about success by talking more about their own personal goals and how they reconciled those with the institution's expectations (Sutherland, 2017). Consistently with this, our results show that gender gap is lower when the percentage of female full professors in the sub-sector is high. The other well known and discussed mechanism to face female underrepresentation is the introductions of quotas. Gender quotas can be introduces on selection committees but previous evidence showed no guarantee of a positive impact of female careers (Bagues, et al., 2017). Gender quotas can be introduced more effectively reserving a percentage of full professor positions to female scientists alone. However this comes at a cost in terms of equity and efficiency, as anti-quota arguments state.

Certainly without any specific policy intervention, the way to reach this results is a long one. The process toward gender equality needs to be forced and more research has been done to better understand all the possible mechanisms behind the gender gap in the Italian Universities. In this regards, the results of the study need to be considered within the context of possible limitations. Considering the productivity of female scientists in the bibliometric sectors provide a relevant insights for more then half of the Italian academic population. The selection of women in there sectors precludes generalizability of the findings to the all macro disciplinary areas. In the bibliometric sector the research evaluation is definitely more quantitative then qualitative. In the non-bibliometric sectors we can expect to find greater discrimination due to the more discretionality of the committee in the open position competition. We suggest future research incorporates a measure to quantify the productivity of the non bibliometric scientists. In addition, further investigation is required to explore the impact of individual factors on career advancement for women. A study of the influence of familiar conditions may prove a fruitful avenue of research.

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Appendix

Table A1

Sample descriptive statistics

		All	Qualified	Bibliometric sector
Role				
	Assistant professor	17.8	18.1	15.8
	Associate professor	82.2	81.9	84.2
Sex				
	Male	56.9	65.7	65.7
	Female	43.1	34.3	34.3
Macro disciplinary area				
	Mathematics and informatics (1)	4.4	4.4	8.6
	Physics (2)	3.3	4.7	8.6
	Chemistry (3)	4.5	4.5	7.5
	Earth sciences (4)	1.7	1.7	3.1
	Biology (5)	8.0	6.4	12.5
	Medicine (6)	16.1	12.2	22.2
	Agricultural and veterinary sciences (7)	4.6	4.3	8.4
	Civil engineering and architecture (8)	6.6	7.2	4.6
	Industrial and information engineering (9)	9.2	10.3	19.3
	Antiquities, philology, literary studies, art history (10)	9.8	12.1	-
	History, philosophy, pedagogy and psychology (11)	9.3	9.7	5.2
	Law (12)	9.4	8.9	-
	Economics and statistics (13)	9.0	10.2	-
	Political and social sciences (14)	4.0	3.4	-
Years of tenure				
	Seniority in the Italian academia	10.9	10.9	10.9
Size of university				
	I quintile	21.9	20.9	16.4
	II quintile	20.3	20.9	20.9
	III quintile	21.6	20.6	20.7
	IV quintile	18.0	17.5	18.7
	V quintile	18.2	20.1	23.3
Productivity				
	Hindex	-	-	19.8
	Citations	-	-	31.5
	Pubblications	-	-	414.4
	Productivity index	-	-	0
% of Female Full professor within scientific sector (2012)				
	Median	20.6	20.6	20.6
N		19,738	10,025	4,218

Table A2

Logistic regression models for the likelihood of being promoted

	Associate professor			Full professor		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Sex						
Male	-	-	-	-	-	-
Female	-0.258***	-0.244***	-0.292***	-0.615***	-0.550***	-0.558***
Macro disciplinary area						
Mathematics and informatics (1)		-	-		-	-
Physics (2)		-0.456**	-0.470**		-0.414	-0.677
Chemistry (3)		-0.185	-0.184		-0.695	-0.441
Earth sciences (4)		-0.717***	-0.702**		-0.026	0.388
Biology (5)		-0.498***	-0.460**		-0.283	-0.068
Medicine (6)		-0.672***	-0.554***		-0.386	-0.261
Agricultural and veterinary sciences (7)		-0.724***	-0.654***		-0.659	-0.634
Civil engineering and architecture (8)		-0.261	-0.457**		-0.118	-0.062
Industrial and information engineering (9)		-0.125	-0.358*		-0.46	-0.779*
Antiquities, philology, literary studies, art history (10)		-0.681***	-0.630***		-0.958**	-0.65
History, philosophy, pedagogy and psychology (11)		-0.350*	-0.299*		-0.37	-0.273
Law (12)		-0.507***	-0.439**		-0.18	-0.024
Economics and statistics (13)		-0.332*	-0.224		-0.211	-0.103
Political and social sciences (14)		-0.301	-0.311		0.144	0.161
Seniority in the Italian academia		0.117***	0.151***		-0.013	0.002
Size of university						
I quintile		-			-	
II quintile		0.261***			-0.524**	
III quintile		-0.210**			-0.115	
IV quintile		0.088			-0.295	
V quintile		-0.197**			-0.629***	
University of affiliation (dummy vars)			Yes			Yes
Constant	0.624***	-0.159	-0.361	-0.842***	-0.065	-1.05
N	8,208	8,208	8,105	1,817	1,817	1,702

* p<0.05, ** p<0.01, ***p<0.001

Table A3

Logistic regression models for the likelihood of being promoted (only bibliometric sectors)

	Associate professor					Full professor				
	Model 1	Hindex	Citations	Publications	Productivity	Model 1	Hindex	Citations	Publications	Producivity
Sex										
Male	-	-	-	-	-	-	-	-	-	-
Female	-0.268***	-0.340***	-0.304***	-0.276**	-0.334***	-0.943***	-1.001**	-0.918**	-0.937**	-1.019**
Macro disciplinary area										
Mathematics and informatics (1)		-	-	-	-		-	-	-	-
Physics (2)		-0.519**	-0.478*	-0.465*	-0.768***		-1.294*	-1.271*	-1.189*	-1.873**
Chemistry (3)		0.143	0.100	0.062	0.005		-1.276	-1.369	-1.356	-1.507
Earth sciences (4)		-0.724**	-0.727**	-0.733**	-0.776**		0.201	0.081	-0.098	0.097
Biology (5)		-0.580***	-0.586***	-0.597***	-0.672***		-0.075	-0.008	-0.032	-0.189
Medicine (6)		-0.611***	-0.631***	-0.641***	-0.777***		-0.34	-0.395	-0.355	-0.629
Agricultural and veterinary sciences (7)		-0.779***	-0.785***	-0.818***	-0.820***		-0.66	-0.804	-0.596	-0.64
Civil engineering and architecture (8)		-0.329	-0.580*	-0.678**	-0.347		0.711	0.318	0.306	0.649
Industrial and information engineering (9)		-0.405*	-0.381*	-0.404*	-0.475**		-0.998*	-0.952	-0.992*	-1.089*
History, philosophy, pedagogy and psychology (11)		-0.108	-0.405	-0.578*	-0.144		-0.166	-0.5	-0.565	-0.095
Seniority in the Italian academia		0.146***	0.155***	0.158***	0.149***		-0.042	-0.046	-0.044	-0.046
University of affiliation (dummy vars)		yes	yes	yes	yes		yes	yes	yes	yes
Productivity										
Hindex		0.354***					0.235**			
Citations			0.318***					0.337***		
Pubblications				0.382***					0.399***	
Productivity index					0.164**					0.215**
Constant	0.716***	0.208	0.06	-0.052	0.359	-0.821***	-1.398	-1.311	-1.506	-1.640
N	3,550	3,527	3,527	3,527	3,527	668	547	547	547	547

* p<0.05, ** p<0.01, ***p<0.001

Table A4

Logistic regression models for the likelihood of being promoted

	Associate professor		Full professor	
	Model 1	Model 2	Model 1	Model 2
Sex				
Male	-	-	-	-
Female	-0.356***	-0.312*	-0.893***	-0.771*
% of Female full professor				
% over full professor *within scientific sector*	0.370	0.695	-0.323	0.043
Sex % of Female full professor*				
Female*High level	0.342	0.171	1.201	-0.498
Macro disciplinary area				
Mathematics and informatics (1)	-	-	-	-
Physics (2)	-0.446**	-0.715***	-0.403	-0.886
Chemistry (3)	-0.230	-0.070	-0.621	-1.355
Earth sciences (4)	-0.693***	-0.761***	-0.060	-0.104
Biology (5)	-0.566***	-0.842***	-0,193	-0.061
Medicine (6)	-0.695***	-0.923***	-0.340	-0.474
Agricultural and veterinary sciences (7)	-0.749***	-0.871***	-0.539	-0.570
Civil engineering and architecture (8)	-0.345*	-0.202	-0.016	0.760
Industrial and information engineering (9)	-0.28	-0.213	-0.432	-0.514
Antiquities, philology, literary studies, art history (10)	-0.813***		-0.878**	
History, philosophy, pedagogy and psychology (11)	-0.445**	-0.514*	-0.304	-0.272
Law (12)	-0.542***		-0.028	
Economics and statistics (13)	-0.344*		-0.069	
Political and social sciences (14)	-0.343*		0.216	
Seniority in the Italian academia	0.120***	0.112***	-0.021	-0.070
Productivity				
Productivity index		0.157*		0.169*
Constant	-0.242	-0.011	-0.263	0.321
N	8,208	3,550	1,817	668

* p<0.05, ** p<0.01, ***p<0.001