Analysis of Gender and Scientific Output of Researchers in the Spanish University

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ABSTRACT

Aim. Promoting gender equality and excellence are key policies in academia. Therefore, in this work, we investigated scientific output and potential gender disparities of researchers across different faculty positions in the Complutense University of Madrid (UCM), the largest academic institution in Spain.

Methods. Researchers' data was obtained from the UCM Scientific Production Portal. Full name, academic rank, affiliation, thesis defence year and SCOPUS Hirsch (*h*)-index was collected for each researcher. Sex (men/women) of researchers was assigned after their first names using Python programming. The *m*-index was computed by dividing the *h*-index between the length of the researcher´s career, taking in consideration the first publication. Statistical comparisons and analyses were carried out in RStudio.

Results. We found that women are clearly underrepresented in full professor positions despite being a majority in lower academic ranks. This gender disparity in full professor positions has however been narrowing down in recent years. The scientific output

of researches, as judged by the *h*-index, varied greatly between Faculties, but overall, correlated positively with the academic rank and no significant differences were detected between women and men, although exceptions were noted. Judging by the *m*-index, the scientific output of women and men in full professor positions were also alike.

Conclusion. There is effective equality between genders within UCM faculty ranks.
Keywords: Spanish university, faculty rank, gender equality, women, scientific productivity, *h*-index, *m*-index

Introduction

Historically, women have represented a minority in workplaces requiring a higher degree of education. However, societal changes have resulted in the expansion of opportunities for women into previously male-dominated workspaces (Barnett, 2004; Connell, 2005; Giuliano, 2015). The presence of women in academia and science represent a good example (Schiebinger, 1987). However, it has been noted that sex inequalities still persist in academia and science, which affect professional hiring, grant proposal success, and duration of employment, among other factors (Etzkowitz et al., 1992; Hechtman et al., 2018; Moss-Racusin et al., 2012; Roper, 2019). The reasons for such inequalities are multiple and do not fit all institutions alike (e.g. private *vs.* public, one country/region *vs.* another) (Ceci & Williams, 2011; Tomassini, 2021; Wieczorek-Szymańska, 2020). In western countries, most academic institutions count with policies to promote inclusive workforces and prevent sex inequalities, but there is room for improvement. In Spain, the number of female and male PhD candidates are approximately the same but yet women are still a minority in evaluation committees and chairs (Sánchez-Jiménez et al., 2023).

Universities must be an example to society, promoting not only gender inclusion but also merit and excellence. In this work, we focused on the University Complutense of Madrid (UCM) and study the scientific output of researchers with a gender perspective in the following academic ranks: assistant professor, associate professor, tenure associate professor and full professor. To that end, we used publicly available data from the UCM Scientific Production Portal (https://produccioncientifica.ucm.es/). The UCM Scientific Production Portal provides information regarding affiliation (Faculty and Department), academic rank, title of thesis and year of defence, as well as indicators of scientific impact and productivity, such as the Hirsch (*h*)-index, which we used as a measure of the scientific output (Hirsch, 2005). Since the *h*-index increases with time, we also evaluated the scientific output of researchers with regard to the *m*-index (Bornmann et al., 2008; von Bohlen und Halbach, 2011), which correct the *h*-index by the length of the research career. The sex/gender of researchers is not included in the data provided by the UCM Scientific Production Portal but it was inferred after the researchers' first names.

Overall, we found that there is a clear gender imbalance in the rank of full professors, with 34.60% women *vs.* 65.40% men. However, there are more women than men

in lower academic ranks, including associate professors, and parity is expected to occur in higher academic ranks. The scientific output of researches, as judged by the *h*-index, varied greatly depending between Faculties, but in general, was larger for researchers in higher academic ranks. Interesting exceptions were noted in specific Faculties that nonetheless did not reach statistical significance. Statistically significant differences were neither found between the scientific output of men and women in the different academic/faculty ranks, but exceptions were also noted in certain Faculties. Finally, we found that the scientific output of full professor generations as judged by the *m*-index has remained constant over the years with perhaps a trend towards increasing in younger full professors, both women and men. Carrying out these analyses is important to monitor and detect potential gender disparities in academic institutions.

Materials and Methods

Data Collection and Processing

Researchers' data are stored in the UCM Scientific Production Portal, under the researchers' section (https://produccioncientifica.ucm.es/investigadores). In this directory, each researcher has a unique identification number (RID) and associated data is found under six different subdirectories: (i) general information ("…/RID/detalle"), (ii) publications ("…/RID/publicaciones"), (iii) collaborations ("…/RID/colaboracion"), (iv) thesis (own and supervised) ("…/RID/tesis"), (v) projects ("…/RID/proyectos") and (vi) scientific production metrics ("…/RID/indicadores"). All these pages were downloaded in HTML format using WGET (https://www.gnu.org/software/wget/). The pages were then parsed using a Python script, obtaining for each UCM researcher the following fields: RID, full name, rank, affiliation, thesis defense year and SCOPUS Hirsch (*h*)-index. Sex (men/women) of researchers was guessed using a Python script that compared researchers' first names to those found in a large dataset of women and men first names. Python scripts to parse researcher data and guess sex can be obtained from corresponding author upon written request. All data collected in June 2023.

Computation of *m*-index

The *m*-index was used to compare the scientific output of researchers with different career length (Bornmann et al., 2008; von Bohlen und Halbach, 2011). The *m*-index of authors was computed using equation 1: $m\text{-}index = \Delta y/h$, where h is the *h*-index and Δy is the number of years elapsed between the first publication and 2023, which is the year in which the data was collected.

Statistical Methods

Pearson's Chi-squared test was used to test the independence of sex with regard to academic rank. Kruskal-Wallis rank sum test was applied identify statistical differences between quantitative variables in more than two groups (*e.g.* *h*-index in different academic ranks). Mann-Whitney U Test was performed in order to detect statistically significant differences between quantitative variables such as *h*-index and *m*-index, with regard to gender and academic rank. In multiple testing, *p*-values were corrected using Holm–Bonferroni method (Holm, 1979). Statistical analyses were carried out in RStudio. All plots were generated in RStudio with the help of the specific R package ggplot2 (Wickham, 2016).

Results And Discussion

Gender Bias in Faculty Positions

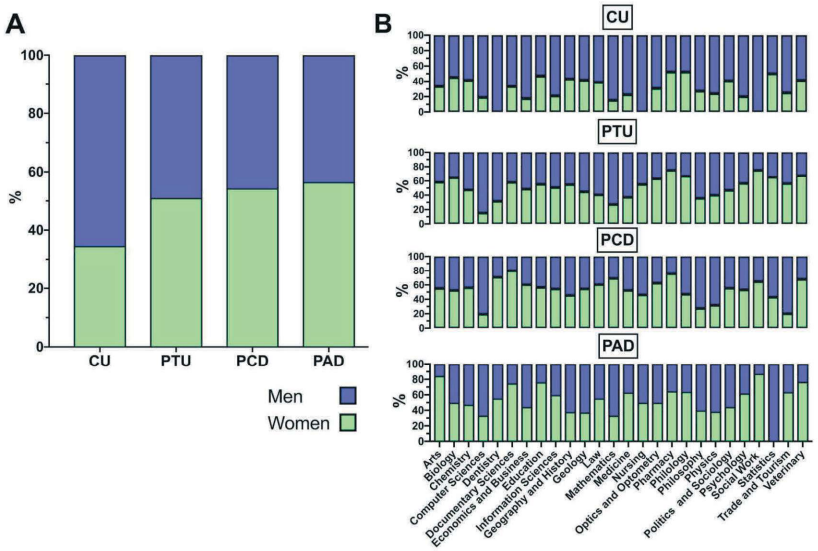
To study sex disparities within UCM faculty ranks, we resorted to data available at the UCM Scientific Production Portal (https://produccioncientifica.ucm.es). At the time of carrying out this work (June 2023), the UCM Scientific Production Portal included 6588 researchers and we put together a dataset including the following information for each of them: Full name, affiliation, position/faculty rank, year of thesis of defense, *h*-index, *m*-index and sex. Sex was not available at the portal and was assigned to each researcher after their first names as indicated in Material Methods. The *m*-index, which offers a time-adjusted evaluation of researches' output, is neither available at the portal and was computed as indicated in Material and Methods. To carry out the analysis, we selected 3250 UCM researchers among the following faculty positions: Full Professor (CU: "Catedrático de Universidad") (708), Tenure Associate Professor (PTU: "Profesor Titular de Universidad") (1332), Associate Professor (PCD: "Profesor Contratado Doctor") (762) or Assistant Professor (PAD: "Profesor Ayudante Doctor") (448). Data is provided in supplementary dataset.

Overall, the number of women and men with faculty appointments at the UCM is quite similar: 1658 men (51.02 %) and 1592 women (48.98 %). However, the proportions of men and women vary between different faculty ranks (Figure 1A). Among lower faculty ranks (PAD followed by PCD) there are more women than men: 56.47 % of PAD and 54.33 % of PCD are women. Among PTUs there also more women than men but the numbers are about the same (51.05 % women *vs.* 48.95 % men). By contrast, in the highest academic rank (CU), men are clearly overrepresented (65.40 % men *vs.* 34.60 % women). A chi-squared (X^2) test also indicated that gender and faculty rank are not independent ($X^2 = 79.631$, $p < .001$) with the major contribution to the X^2 statistics corresponding to CUs ($X^2 = 58.59$). In fact, without taking in consideration CUs, there is no statistical difference between the number of women and men in different academic ranks

(PAD, PCD and PTU) ($X^2 = 4.74$, $p = .093$). Therefore, the only statistically significant difference between the number of women and men is in CUs. A similar result was found when the analysis was stratified by Faculties. With a few exceptions, there are more men than women among CUs in all Faculties (Figure 1B). Moreover, in two Faculties, Faculty of Social Work and Faculty of Dentistry, there are no women within the CU rank, while they represent 87.50 % and 55.56 % of PADs, respectively. There are also Faculties displaying specific peculiarities. For example, in the Faculties of Mathematical Sciences and Computer Sciences, there are also more men than women among all lower academic ranks (PAD, PCD and PTU). In the faculties of Pharmacy and Philology the opposite occurs: there are more women than men among all academic ranks, including CUs.

Figure 1

Men and Women in Different Faculty Ranks



Note. A. Figure depicting the percentage of men and women (Y axis) in the different academic ranks (X-axis) for the entire UCM. The following ranks are considered: Full Professor (CU), Tenure Associate Professor (PTU), Associate Professor (PCD), and Assistant Professor (PAD). B. Percentage of women and men (Y axis) within the CU, PTU, PCD and PAD academic ranks in the different Faculties (X-axis).

Source. Supplementary dataset generated and provided in this study.

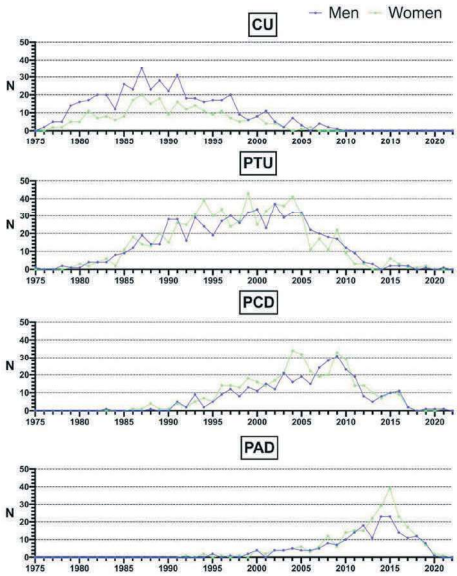
Longitudinal Gender Analysis in UCM Faculty Ranks

Since women joined the academic work latter than men, we examined the number of men and women in the different faculty ranks with regard to the year of the defence

of the thesis (range between 1975 and 2022) (Figure 2). As expected, the results clearly reflect a relationship between higher faculty ranks and age, both for men and women. Thus, the majority of CUs defended their thesis between 1985 and 1991. Not a single CU has defended the thesis latter than 2010. The rank of PCDs is somewhat in between, with more than 50 % of them defending their thesis between 2005 and 2013. Interestingly, PTUs have a much wider span of years in which they defended their thesis, indicating that this group is age-wise more heterogeneous. With regard to gender (women *vs.* men) in the different ranks, there are more women than men regardless of the age of defence of the thesis in the ranks of PCD, PAD and PTU. The contrast to this ratio is again seen in the CU rank. Thus, there are more men than women in the CU rank at any of the years examined, independently of the year in which the defence of the thesis took place. However, the gap between the numbers of men and women in the CU rank appears to be narrowing down, especially for those who defended their doctoral thesis between 2005 and 2010. This analysis does not reflect when researchers took their appointment but nonetheless serves to assess gender imbalance in Faculty ranks longitudinally. In this sense, parity between men and women among PTUs, PCDs and PADs has long been reached in the UCM, but it is not the case for CUs.

Figure 2

Women and Men in Faculty Ranks per Year of Thesis Defences



Note. Figure shows the number (N) of women and men (Y-axis) in the different academic ranks (CU, PTU, PCD and PAD) in the period 1975–2022 attending to the year that defended their theses.

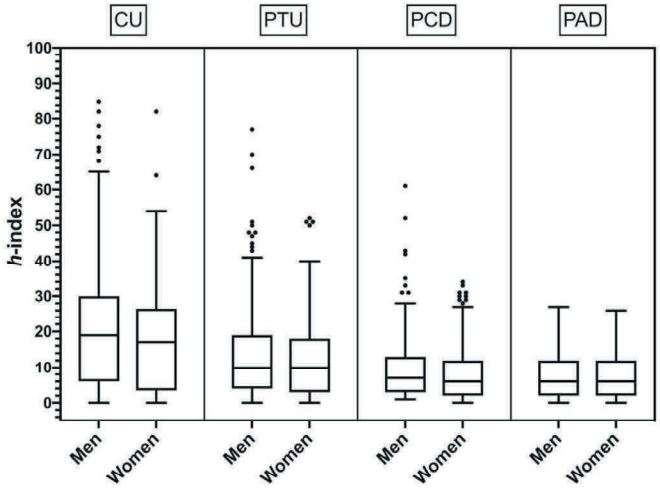
Source. Supplementary dataset generated and provided in this study.

Gender-Stratified Analysis of Scientific Output in UCM Faculty Members

We evaluated the scientific output of researchers in UCM faculty ranks, as judged by the SCOPUS *h*-index, for both women and men. We are aware that there is no single one-fits all metric to measure scientific output. However, the *h*-index is gaining recognition and acceptance since it is simple and it takes into account the volume of the scientific production (number of publications) and impact (citations) (Hirsch, 2005). We found no statistically significant differences between the scientific output of women and men in any of the faculty ranks, as judged by the *h*-index (Figure 3). However, the *h*-index of researchers, both, women and men, in higher academic ranks is significantly larger than that of researchers in lower academic ranks: *h*-index CUs > *h*-index PTUs > *h*-index PCDs ~ *h*-index PADs (Table 1). It is also worth noting that the *h*-index of researches, both women and men, vary largely in higher academic ranks, particularly among CUs. Since the *h*-index increases with age, this observation is likely related to the fact that CUs and PTUs have a wider range of ages than PCDs and PADs, which are generally younger. We also noted that the *h*-index of a significant fraction of CUs falls below the median *h*-index of researchers in lower academic ranks (PCD and PAD), perhaps pointing to limitations in SCOPUS *h*-index to evaluate research output for some academic disciplines.

Figure 3

Scientific Output of Men and Women within Different Faculty Ranks



Note. Boxplots representing the distribution of the h-index (Y-axis) for men and women (X-axis) in the different faculty ranks shown in the top of the figure. No statistically significant difference was detected between the scientific output of women and men in any of the Faculty Ranks.

Source. Supplementary dataset generated and provided in this study.

Table 1

Statistical Comparisons between the Scientific Output of Researchers in Different Faculty Ranks for both, Women and Men

Gender	Rank	N	CU	PTU	PCD	PAD
Men	CU	398	NA	< .001	< .001	< .001
	PTU	493	< .001	NA	< .001	< .001
	PCD	273	< .001	< .001	NA	0.2
	PAD	149	< .001	< .001	.2	NA
Women	CU	205	NA	< .001	< .001	< .001
	PTU	510	< .001	NA	< .001	< .001
	PCD	309	< .001	< .001	NA	.84
	PAD	179	< .001	< .001	.84	NA

Note. The SCOPUS *h*-index was used a measure of scientific output and statistical comparisons were carried out using pairwise Mann-Whitney U Tests with Holm–Bonferroni corrections. Comparisons were carried out independently for women and men in different faculty ranks. NA: Not Applicable (self-comparisons).

Source. Supplementary dataset generated and provided in this study.

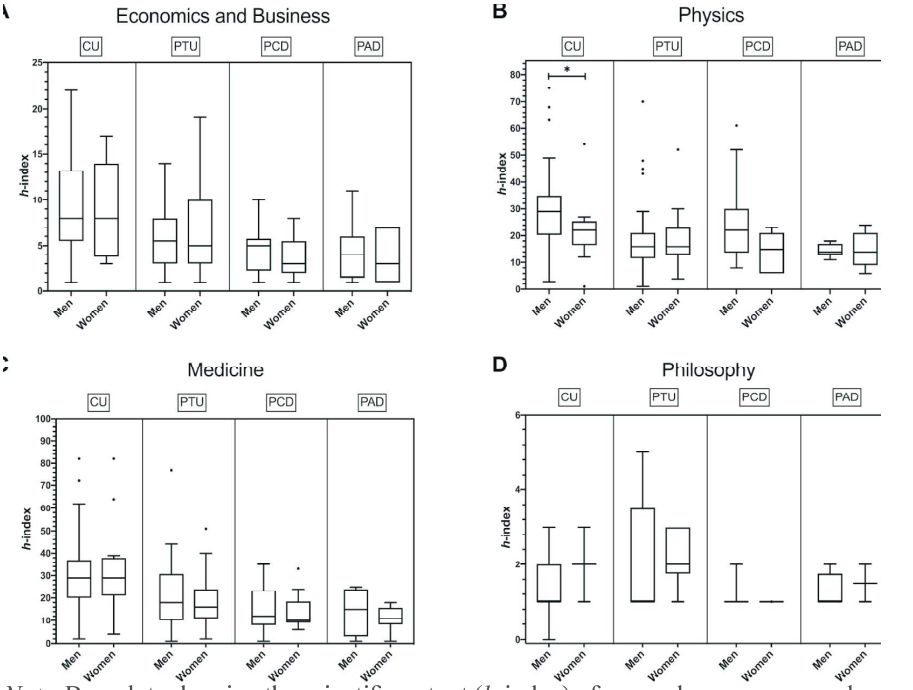
Since the *h*-index can vary between academic/scientific disciplines (Alonso et al., 2009), we stratified the *h*-index analysis by considering researchers belonging to four distinct UCM academic centres (Faculties): Economics and Business, Physics, Medicine and Philosophy. As noted for the entire UCM, we found no statistically significant difference between the scientific output of women and men in the different Faculties, with the exception of the Faculty of Physics in the rank of CUs, where the h-index of men is larger than that of women (Figure 4). This difference may be linked to that fact that women got into Physics more recently than in other disciplines, and it is likely that women CUs are younger than men CUs in this Faculty.

Although statistical comparisons were not made between Faculties, there are large variations in the *h*-index of researchers depending on their affiliation (Figure 4). The *h*-index of researchers affiliated to the Faculty of Medicine and the Faculty of Physics are comparable, but much smaller for researchers in the Faculty of Economics and Business, and seldom available for researchers in the Faculty of Philosophy. Since *h*-index metric does not appear to be an adequate metric to evaluate scientific output for humanistic disciplines, we will focus in the remaining disciplines. As seen in the non-stratified analysis, the scientific output of researchers correlates in general with their academic rank *(h-index* CU > *h-index* PTU > *h-index* PCD ~ *h-index* PAD), regardless of their gender (Table 2). An interesting exception is seen among researchers in the Faculty of Physics, where the median *h*-index of PCDs is comparable or higher than that of PTUs, particularly for men. It is also worth noting that the *h*-index of CUs and PTUs within the same Faculty vary widely, more than in other academic ranks, and can be notably low. In Spain, credentials for opting to the different academics ranks in public universities are required. These credentials are provided by the National Agency for Quality Assessment and Accreditation (ANECA)

and scientific output is not the only merit taking in consideration. Among others, merits related with the professional activity and formation of researchers are also important. Nonetheless, the ample variation of the *h*-index in CUs is striking.

Figure 4

Scientific Output of Researchers Stratified by Gender, Academic Rank and Faculty Affiliation



Note. Box plots showing the scientific output (*h*-index) of researchers, women and men, within different academic ranks affiliated in the Faculties of Economics and Business (A), Physics (B), Medicine (C) and Philosophy (D). Mann-Whitney U Tests were used to identify statistical differences between groups (* p-value < .05). No statistically significant difference was detected between the scientific output of women and men in the different Faculties, with the exception of the Faculty of Physics in the rank of CUs.

Source. Supplementary dataset generated and provided in this study.

Table 2

Statistical Comparisons between the Scientific Output of Researchers in Different Academic Ranks in Selected Faculties for both, Women and Men

Faculty	Gender	Rank	CU	PTU	PCD	PAD
Economics and Business	Men	CU	NA	.097	*.038*	.076
		PTU	.097	NA	.459	.416
		PCD	*.038*	.459	NA	.491

Faculty	Gender	Rank	CU	PTU	PCD	PAD
		PAD	.076	.416	.491	NA
	Women	CU	NA	.76	.12	.26
		PTU	.76	NA	.12	.49
		PCD	.12	.12	NA	.82
		PAD	0.26	.49	.82	NA
Physics	Men	CU	NA	*< .001*	.286	*.003*
		PTU	*< .001*	NA	.286	.656
		PCD	.286	.286	NA	.245
		PAD	*.003*	.656	.245	NA
	Women	-	Kruskal-Wallis: *p*-value = 0.21			
Medicine	Men	CU	NA	*.02*	.053	0.062
		PTU	*.02*	NA	.718	0.718
		PCD	.053	.718	NA	1
		PAD	.062	.718	1	NA
	Women	CU	NA	*.036*	.051	*.020*
		PTU	*.036*	NA	.333	.196
		PCD	.051	.333	NA	.885
		PAD	*.020*	.196	.885	NA
Philosophy	Men	-	Kruskal-Wallis: *p*-value = .95			
	Women	-	Kruskal-Wallis: *p*-value = .51			

Note. The SCOPUS h-index was used as a measure of scientific output and statistical comparisons were carried out using Kruskal-Wallis Rank Sum Tests. When Kruskal-Wallis Rank Sum Test p-value was significant, h-index were compared using pairwise Mann-Whitney U Tests with Holm–Bonferroni corrections. Statistically significant p-values were marked in bold. NA, Not Applicable (self-comparisons). Comparisons were carried out independently for women and men in different Faculty Ranks.
Source. Supplementary dataset generated and provided in this study.

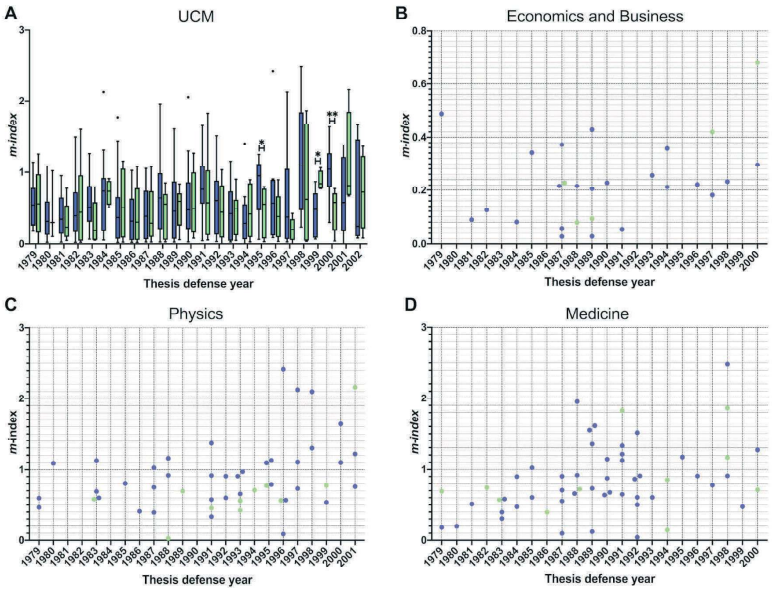
Longitudinal Analysis of the Scientific Output of CU Researchers

We conducted a longitudinal study to analyse the scientific output of researchers reaching the position of CU. Given that CUs are the group with more variable range of ages and the *h*-index increase over time, we used the *m*-index of researchers to compare the scientific output of CUs that defended their thesis in the same year, with those defending earlier or later (Figure 5). The *m*-index corrects the *h*-index to take in account the length of the researcher's career (details in Material and Methods). We carried out this analysis for entire UCM and for CUs affiliated to the following Faculties: Faculty of Economics and Business, Faculty of Physics and Faculty of Medicine. Considering the entire UCM (Figure 5A), the *m*-index of CUs is quite similar (median *m*-index < 1) regardless of the year of defence of their thesis (age). However, CUs that defended their thesis more recently (1998–2002) seems to have larger *m*-index values, although there is also more variability (Figure 5A).

With regard to gender, there are no significant differences between the *m*-index of men and women, regardless of the year that defended their thesis. Focusing on the selected Faculties, the *m*-index of CUs remains constant (Faculty of Economics and Business) (Figure 5B) or increases (Faculty of Physics and Faculty of Medicine) (Figure 5C and 5D) with regard to the year that they defended their thesis. In other words, the scientific output of CUs corrected by age is higher in younger CUs in the different Faculties. It is also worth noting that the *m*-index of CUs of the Faculty of Physics and the Faculty of Medicine is in general higher than that of CUs in the Faculty Economics and Business. This is expected as both, the *h*-index and *m*-index, are suitable to quantify scientific output in experimental sciences but not so much for other disciplines. As a rule of thumb, it has been suggested that an *m*-index of 1 is normal, 1–2 is above average, and > 2 is exceptional (Ndwandwe et al., 2021). In this sense, there are clearly more exceptional researchers among novel CUs. Although this rule has to be taking with caution, there seems to be more exceptional researchers among novel CUs. With regard to gender, the *m*-index of women and men in the CU rank are comparable, regardless of the year of the defence of the thesis. An exception is the Faculty of Physics, where men usually have larger *m*-index than women. As noted earlier, there are other important merits contributing to a researcher's promotion that cannot be accounted by their *h*-index, including transfer to industry and society, securing public and private funds and formation of researchers, among others.

Figure 5

Analysis of the m-index of CUs



Note. The m-index of researchers in the CU academic rank was obtained for both women and men, and plotted with regard to the year in which they defended their

thesis (1979–2002). The analysis was carried for the entire UCM (panel A) and researchers belonging to the following Faculties: Faculty of Economics and Business (panel B), Faculty of Physics (panel C) and Faculty of Medicine (panel D). In panel, A, the number of researchers is shown as box plots with women shown in green and men in blue. Groups with statistically significant differences as judged by Mann-Whitney U Tests are indicated (* p-value <.05, ** p-value < .01). In panels B, C and D each dot represents the m-index of a single researcher (women in green and men in blue). *Source.* Supplementary dataset generated and provided in this study.

Conclusions

We found that in the University Complutense of Madrid there are more women than men in all academic ranks, but in the full professor (CU) rank where there are many more men than women. However, the gap between women and men in CU positions is narrowing down. Overall, there are not significant differences between the scientific output of women and men, but there are significant differences between academic ranks and Faculties. CUs usually have larger scientific output since they have longer trajectories. Interestingly, the scientific output of novel generations of CU is similar or larger than that of previous generations. Monitoring scientific production and gender in higher academic institutions is of paramount importance in order to safeguard equality, diversity and excellence. Currently, our results and findings are limited to the University Complutense of Madrid. However, since the Scientific Production Portal, used as source of data, has been adopted by most universities in Spain, we plan to carry out this same analysis to other Spanish universities for comparative purposes.

REFERENCES

Alonso, S., Cabrerizo, F. J., Herrera-Viedma, E., & Herrera, F. (2009). h-Index: A review focused in its variants, computation and standardization for different scientific fields. *Journal of Informetrics*, *3*(4), 273–289. https://doi.org/10.1016/j.joi.2009.04.001

Barnett, R. C. (2004). Preface: Women and work: Where are we, where did we come from, and where are we going? *Journal of Social Issues*, *60*(4), 667–674. https://doi.org/10.1111/j.0022–4537.2004.00378.x

Bornmann, L., Mutz, R., & Daniel, H.-D. (2008). Are there better indices for evaluation purposes than the h index? A comparison of nine different variants of the h index using data from biomedicine. *Journal of the American Society for Information Science and Technology*, *59*(5), 830–837. https://doi.org/10.1002/asi.20806

Ceci, S. J., & Williams, W. M. (2011). Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences*, *108*(8), 3157–3162.

Connell, R. W. (2005). Work/life balance, gender equity and social change. *Australian Journal of Social Issues*, *40*(3), 369–383. https://doi.org/10.1002/j.1839–4655.2005.tb00978.x

Etzkowitz, H., Kemelgor, C., Neuschatz, M., & Uzzi, B. (1992). Athena unbound: Barriers to women in academic science and engineering. *Science and Public Policy*, *19*(3), 157–179. https://doi.org/10.1093/spp/19.3.157

Giuliano, P. (2015). The role of women in society: From preindustrial to modern times. *CESifo Economic Studies*, *61*(1), 33–52. https://doi.org/10.1093/cesifo/ifu019

Hechtman, L. A., Moore, N. P., Schulkey, C. E., Miklos, A. C., Calcagno, A. M., Aragon, R., & Greenberg, J. H. (2018). NIH funding longevity by gender. *Proceedings of the National Academy of Sciences*, *115*(31), 7943–7948.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences*, *102*(46), 16569–16572.

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*, *6*(2), 65–70. http://www.jstor.org/stable/4615733

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences*, *109*(41), 16474–16479.

Ndwandwe, M., Bishop, D. G., Wise, R., & Rodseth, R. (2021). Bibliometrics to assess the productivity and impact of medical research. *South African Journal of Higher Education*, *35*(4), 224–236.

Roper, R. L. (2019). Does gender bias still affect women in science? *Microbiology and Molecular Biology Reviews*, *83*(3), Article e00018–19.

Sánchez-Jiménez, R., Botezan, I., Barrasa-Rodríguez, J., Suárez-Figueroa, M. C., & Blázquez-Ochando, M. (2023). Gender imbalance in doctoral education: an analysis of the Spanish university system (1977–2021). *Scientometrics*, *128*(4), 2577–2599.

Schiebinger, L. (1987). The history and philosophy of women in science: A review essay. *Signs*, *12*(2), 305–332. http://www.jstor.org/stable/3173988

Tomassini, C. (2021). Gender gaps in science: systematic review of the main explanations and research agenda. *Education in the Knowledge Society (EKS)*, *22*(SE-Artículos). https://doi.org/10.14201/eks.25437

von Bohlen und Halbach, O. (2011). How to judge a book by its cover? How useful are bibliometric indices for the evaluation of "scientific quality" or "scientific productivity"? *Annals of Anatomy—Anatomischer Anzeiger*, *193*(3), 191–196. https://doi.org/10.1016/j.aanat.2011.03.011

Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis*. Springer-Verlag New York.

Wieczorek-Szymańska, A. (2020). Gender diversity in academic sector—Case study. *Administrative Sciences*, *10*(3), Article 41.