

# Productivity and Collaboration Networks in the Main Spanish Sociology Journals: A Gender-Based Analysis of the period 2001-2020

*Productividad y redes de colaboración en las principales revistas españolas de sociología: un análisis del período 2001-2020 desde la perspectiva de género*

**Agustín García-Ramos, Wilfrid Martínez-Sánchez and Francisco Javier Jiménez-Loaisa**

## Key words

Network Analysis

- Bibliometrics
- Scientific Collaboration
- Gender
- Scientific Productivity
- Sociology
- Sociology of Science

## Palabras clave

Análisis de redes

- Bibliometría
- Colaboración científica
- Género
- Productividad científica
- Sociología
- Sociología de la ciencia

## Abstract

The aim of this piece of research is to study productivity and scientific collaboration in the main Spanish sociology journals from a gender perspective. The authorship of 3171 documents published in these journals during the period 2001-2020 was analysed using bibliometric and social network analysis techniques. While there was an overwhelming male dominance at the start of the period, the results show a steady trend towards parity; however, this was only achieved during the 2016-2020 period, and not in all indicators. In conclusion, gender advances in sociology research have only partially come to fruition in Spain, but the scholarly monitoring system cannot be held accountable for this.

## Resumen

La presente investigación tiene como objetivo aplicar la perspectiva de género al estudio de la productividad y la colaboración científica en las principales revistas españolas de sociología. Para ello se ha analizado, mediante técnicas propias de la bibliometría y el análisis de redes sociales, la autoría de 3171 documentos publicados en dichas revistas durante el período 2001-2020. Partiendo de un afromador predominio masculino, los resultados muestran una tendencia constante hacia la paridad, aunque esta solo se alcanza durante el lustro 2016-2020, y no en todos los indicadores. En conclusión, los avances en materia de género en la sociología española son todavía parciales, si bien no cabe responsabilizar de ello al sistema de vigilancia de la ciencia.

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**Agustín García-Ramos:** Universidad de Alicante | agus.garciaramos@ua.es

**Wilfrid Martínez-Sánchez:** Instituto de Estudios Sociales Avanzados, CSIC. Unidad de Investigación Asociada «Innovación y Transferencia de Conocimiento», Universidad de Córdoba-CSIC. Universidad de Córdoba | wmartinez@iesa.csic.es

**Francisco Javier Jiménez-Loaisa:** Universidad de Alicante | jimenez.loaisa@ua.es



## INTRODUCTION

Since scientific journals emerged at the end of the 17th century, they have become established as a key element in the functioning of science, to the extent that it would be almost impossible to conceive of science without scholarly journals today. Scientific journals (hereafter referred to as *journals*) contribute to the validation of knowledge, thus providing science with a structure of authority and making it *reliable*. Journals also help the dissemination of this knowledge, which makes science *accessible*. From a different perspective, peer-reviewed publications are the mechanism that links the desire for recognition inherent in scientists' work to the reward system provided by science as a social institution (Merton, 1985). In short, journals represent an excellent means of access to the contents of science, but also to the processes of reflection on the production of certified knowledge.

In line with the latter question, this study is focused on gender differences in the authorship of publications featured in the main Spanish sociology journals. To this end, a research paper by González-Alcaide *et al.* (2009), which analysed female participation in five of these journals during the period 2001-2005, was taken as a starting point. However, the number of journals was extended to six and the period analysed to the years 2001-2020 in the analysis presented here. This accounts for an increase of 384.9 % in the number of documents examined. Techniques from bibliometrics and social network analysis were used, following in the steps of the research paper by Alcaide. Nevertheless, in light of the specific objectives of the proposal developed in this paper, two of the three types of indicators used by González-Alcaide *et al.* (2009) (relating to institutional and geographical indicators) were dispensed with, and only individual indicators were employed, which were expanded and refined.

The sub-sections of this introduction are structured as follows. Firstly, the theoretical parameters of the study will be established (the field of the sociology of science), more specifically, the patterns of social stratification of scientific life developed by Merton (1985) and his school. This will be followed by three sub-sections presenting the state of the art of the three dimensions used in the study: 1) scientific productivity; 2) collaboration between authors; and 3) co-authorship networks generated as a consequence of this collaboration. This will be followed by a brief examination of the behaviour of the three dimensions mentioned above in Spanish sociology scholarship, with special emphasis on the gender differences within them. The introduction will conclude with a sub-section that explains the rationale of the study and details its objectives at some length.

### The social stratification of scientific life

The classical sociology of science has undeniable Mertonian roots, and understands science to be a social institution governed by a set of technical and moral prescriptions. One of the pillars of science thus conceived is the *reward system*, whereby a scientist's contributions that are considered valuable and original are recognised as such by their peer group. During the early part of his long career, Merton (1985) attributed an unequivocally meritocratic nature to the reward system, largely based on the principle of universalism. This principle, which is part of a well-established set of norms known as CUDOS, involves establishing a standard of scientific validity based on pre-established impersonal guidelines. Therefore, the position of each individual in the structure of science should be solely determined by their contributions to knowledge (Torres-Albero, 2001).

Partly contradicting his initial approach, in the 1960s Merton (1985) identified a number of psychosocial mechanisms interfering with the reward system in science, including the well-known *Matthew Effect*. In the wake of these findings, other authors in the sociology of science programme at Columbia University succeeded in demonstrating the influence that seemingly neutral factors (such as the department that individuals belong to) can have on the development of their scientific career (Cole and Cole, 1973; Gaston, 1978; Zuckerman, 1970). The tension between universalism and particular conditioning factors would remain in the production of the Mertonian school for several decades. In general terms, most of the authors who undertook their study came to the conclusion that, although universalism socially structures scientific life, the recognition obtained by researchers may be mediated by aspects other than merit or individual ability (Lamo de Espinosa, González-García and Torres-Albero, 1994).

### Scientific productivity

The study of scientific productivity (hereafter, *productivity*) is one of the most useful tools for analysing social stratification patterns in scientific life. There is a general consensus that scientific productivity should be understood and operationalised as the output of research in the form of scientific publications (Abramo and D'Angelo, 2014). Consequently, the most common way of measuring this dimension is based on the number of papers published by each author in peer-reviewed journals. In this light, productivity studies have shown that, overall, productivity has increased gradually but steadily in all disciplines in recent years (Piro, Aksnes and Rørstad, 2013).

As far as gender differences in productivity are concerned, several analyses have

agreed that there is an overwhelming male predominance (Larivière *et al.*, 2013). Furthermore, according to Ross *et al.* (2022), the gender gap extends across all disciplines, all stages of scholars' career and all academic levels, and is even greater in high-impact publications. However, from a diachronic perspective, research such as that by West *et al.* (2013) has shown that the gender gap has been narrowing in recent decades.

### Scientific collaboration

As with productivity, the analysis of scientific collaboration (hereafter referred to as *collaboration*) provides a privileged approach to the dynamics that structure scientific life. One of the earliest and most commonly accepted definitions of collaboration equates collaboration with the publication of co-authored academic texts (Katz and Martin, 1997). It is therefore reasonable to measure this in terms of the number of signatories to scientific publications. Similar to what was noted regarding productivity, studies on scientific collaboration have unanimously highlighted a strong trend for it to become widespread and intensified in all disciplines (Cainelli *et al.*, 2014; West *et al.*, 2013), a phenomenon undoubtedly related to the emergence and general use of the Internet, together with the development of movements such as *Big Science* (Price, 1973), *Open Science* and *e-Science* (Fecher and Friesike, 2014).

On the other hand, the analysis of scientific collaboration according to gender has yielded inconsistent, and sometimes even contradictory, evidence (Larivière *et al.*, 2013). Some authors have shown that women face more difficulties than men in building collaborative networks (Gaughan and Bozeman, 2016), while others have found the opposite trend to be the case (Abramo, D'Angelo and Murgia, 2013).

## Co-authoring networks

Co-authorship networks (hereafter, *networks*) are those spontaneously and deliberately created as a consequence of collaborative processes between researchers (Gómez-Ferri and González-Alcaide, 2018). Network analysis is therefore used to represent the relationships and influences between researchers themselves, as well as the social structure in which they are embedded. As a consequence of increased scientific collaboration, most networks have become larger, denser and more complex in recent decades (González-Alcaide and Gómez-Ferri, 2014), not only at the individual level, but also at the disciplinary, geographical and organisational levels (Sonnenwald, 2007).

Regarding the analysis of co-authorship networks according to gender, the accumulated knowledge reveals two interrelated circumstances (Etzkowitz, Kemelgor and Uzzi, 2000; Kegen, 2013). First, women tend to be part of networks of lesser importance or lower prestige than men. Secondly, even when they join networks that are at the same level, the nodes they connect to within these networks (that is, the authors with whom they collaborate) generally bring them fewer benefits in terms of professional or academic development than those with whom their male colleagues engage in collaborative efforts.

## Productivity, collaborative networks and gender in Spanish Sociology

Research using bibliometric techniques on scientific production in Spanish sociology dates back to the early 1990s, and its main focus of study is the *Revista Española de Investigaciones Sociológicas* (Jiménez-Contreras and Ruiz-Pérez, 2022). Generally speaking, the analyses closest to the study presented here have shown patterns similar to the trends de-

scribed in previous sections at the international level. Particularly illustrative in this regard is the paper mentioned earlier by González-Alcaide *et al.* (2009), in which the authors noted a general increase in scientific productivity and collaboration, although this increase was offset by an evident gender gap, especially at the highest levels of productivity. From a diachronic perspective, despite covering a comparatively short period of time, the research also found a relative increase in female productivity, as well as a growing inclusion of women in the different collaborative networks analysed, as a consequence of their increasing presence in collaborative documents.

On the other hand, a study by Jiménez-Contreras and Ortega-Priego (2022) showed that Spanish sociology is still characterised by low collaboration rates and co-authorship networks, with few connections and many isolated components compared to the experimental sciences. In terms of gender patterns, the network analysis conducted revealed that the number of women is much lower than the number of men (just over a third of all authors), that women occupy peripheral positions (with some exceptions) and that there are no defined groups of female researchers.

## Rationale and objectives

The publications listed in the previous section and others of a similar nature have undoubtedly shed valuable light on sociological research production in Spain and on the role played by women in it. However, it seems clear that there are still some gaps in this field, mainly concerning the evolution of authorship in the main journals in the area and certain forms of collaboration between male and female authors. This research aims to partly bridge this gap and to update and enrich the existing knowledge

on the subject. Thus, its general objective is to contribute to a better diagnosis of gender inequalities in a significant part of Spanish sociology by means of simple descriptive statistics and visualisation.

There were three specific objectives: 1) to compare the differences between men and women in terms of productivity and collaboration to try to identify evolutionary patterns; 2) to identify and describe the networks generated from co-authorships, affording a cardinal role in the analysis to the gender variable; and 3) to reflect on the factors that determine the positions of Spanish sociology in the social structure by gender.

## METHODOLOGY

This study analyses productivity, collaboration and co-authorship networks in six of the main Spanish journals in the field of sociology from 2001 to 2020. The journals analysed (in alphabetical order) were; *Empiria*, *Papers*, *Política y Sociedad*, *Revista Española de Investigaciones Sociológicas*, *Revista Española de Sociología* and *Revista Internacional de Sociología*. It is worth highlighting two of the criteria for the selection of these journals. One was being the most well-established and highest rated in the different evaluation indexes of Spanish scientific journals in the category of “Sociology” or, failing that, “Social Sciences” throughout the entire period covered by the research. The other was the profile of publications on a general (i.e. not specialised) subject matter or methodology within the area of sociology.

With regard to the documents contained in the journals, it was decided to exclude from the analysis any papers that did not exceed six pages in length. This decision was taken after a thorough review of the shorter papers, which concluded that almost all of the shorter papers lacked scientific impor-

tance. Once this filter was applied, a total of 3171 documents were obtained, the vast majority of which scientific articles; a total of 3032 authors were identified, of whom all but two had individual profiles.

The information concerning the documents was extracted from the respective online archives of the journals analysed, as it was considered the most reliable source. This operation used *web scraping* procedures, which not only facilitated the workflow, but also allowed for bulk data processing. These were organised in a matrix containing several variables relating to each document: name of the journal in which it was published, journal number and volume, year of publication and name and surname(s) of the author(s). The data produced in this way were then checked one by one against the online archives of the journals and normalised as necessary. In parallel to this process, other variables of interest that could not be extracted automatically were manually included in the matrix, including the number of authors of each document or the sex of the authors, which was deduced from their name<sup>1</sup>.

As for the methods themselves, many of the usual bibliometric-descriptive indicators were used in the analysis of productivity and collaboration (including the number of documents published per author, or the distribution of documents according to the number of signatories); in almost all cases the data were disaggregated by sex.

On the other hand, the analysis of the co-authorship networks was carried out using the Gephi programme, version 0.9.7. The (weighted and undirected) egocentric networks of authors who had published two or more co-authored arti-

<sup>1</sup> When identifying the author's sex from their name was problematic, other methods were used, specifically, a search for the author's institutional profile on the website of the research institution of which they were a member.

cles (either in any of the four 5-year periods examined or in the total period) were examined and represented. Many of the usual indicators used in this type of analysis were used in order to statistically characterise the overall structure of the networks: the *number of nodes*, the *number of ties* and the *diameter*, to measure the network size; *density*; number of existing ties in relation to the maximum number of possible ties; and, *number of subnetworks* and the *average size of the subnetworks*, to discover the amount and distribution of the nodes that are connected to each other.

In order to compare the role played by men and women in co-authorship networks, the averages of male and female authors were compared on different measures of local and global centrality (Díaz-Guilera, 2012). Local centrality refers to the number of different ties connecting a node, regardless of its position and level of influence in the network, and is usually measured by an indicator called the *degree*. In weighted networks, such as those developed in this study, it is also common to use *weighted degree*, which takes into account not only the number of different ties, but also the frequency of interactions. Global centrality, on the other hand, considers the relationship not only with neighbouring nodes, but also with those of the rest of the network, and is therefore identified, in general terms, with the more or less central or peripheral position occupied in the network as a whole. Although there are different indicators to determine global centrality, two of the most common ones were adopted in the analysis phase, both with normalised values between zero and one: *closeness centrality*, which measures the distance of a node to all other nodes, and *eigenvector centrality*, which not only takes into account the number of neighbours of a node, but also the relative importance of these neighbours.

Finally, the OpenOrd and Fruchterman Reingold algorithms were applied successively to visualise the networks.

## RESULTS

This section is structured on the basis of three dimensions: (1) productivity, (2) collaboration and (3) co-authorship networks. A brief global analysis was carried out first for all the dimensions. This served to contextualise the findings and was followed by an analysis disaggregated by gender, which is the core of the study. In order to convey the evolution of the indicators that make up each of the three dimensions, they are presented first broken down by five-year periods, and then for the period of study as a whole. It should be noted that the identity of the different authors has been anonymised in order to ensure that the analysis is focused on the gender perspective and avoid diverting attention to individual cases.

### Productivity

#### *Overall analysis*

Table 1 shows the development over time and percentage increase of three variables: 1) the number of papers published in the journals analysed; 2) the number of authors appearing as signatories of these papers; and 3) the average number of papers published by each author. A positive trend could be seen across the board: an increasing number of papers were published over the period examined, a greater number of authors succeeded in publishing their research with an increasing number of iterations. The data therefore showed a clear growth in productivity, in line with what has been observed in the previous literature reviewed in previous sections, both at the international and national level.

**TABLE 1.** Overall productivity indicators and their percentage increase, by 5-year period

	No. of documents		No. of authors		Average documents/author	
	Total	Incr. (%)	Total	Incr. (%)	Total*	Incr. (%)
2001-2005	650	—	637**	—	1.31	—
2006-2010	751	15.5	808	26.8	1.44	9.9
2011-2015	837	11.5	1,101	36.3	1.67	16.0
2016-2020	933	11.5	1,359	23.4	1.85	10.8
Total***	3,171	43.5	3,030****	113.3	1.60	22.1

\* The average number of papers per author is the result of dividing the number of authors appearing on all papers in a given period by the number of papers published in the same period.

\*\* The number of authors may be lower than the number of documents analysed if two conditions are met, as is the case: first, the majority of the documents are signed by a single author, and second, several authors have had more than one paper published in the five-year period in question.

\*\*\* In all tables, total increments have been calculated by relating the data for the final 5-year period to the data for the initial 5-year period.

\*\*\*\* The total number of authors does not match the sum of authors broken down by 5-year period (which would be 3905) because some of them had papers published over more than one 5-year period.

Source: Developed by the authors based on data from the journals analysed.

*Analysis disaggregated by sex*

Figure 1 depicts the productivity levels of men and women by examining the number of papers published by male and female authors, respectively. Two pieces of evidence stand out in the graph, both of which are consistent with the research discussed in previous sections. First, men had higher scores at all levels of productivity, although the differences were much greater for 3-4 or more published papers. Second, from a diachronic perspective, the gender gap narrowed over the entire period, and gender parity was reached<sup>2</sup> at the lowest levels of productivity during the 2016-2020 five-year period. Despite these advances, however, the highest levels of productivity remained almost exclusively male-dominated.

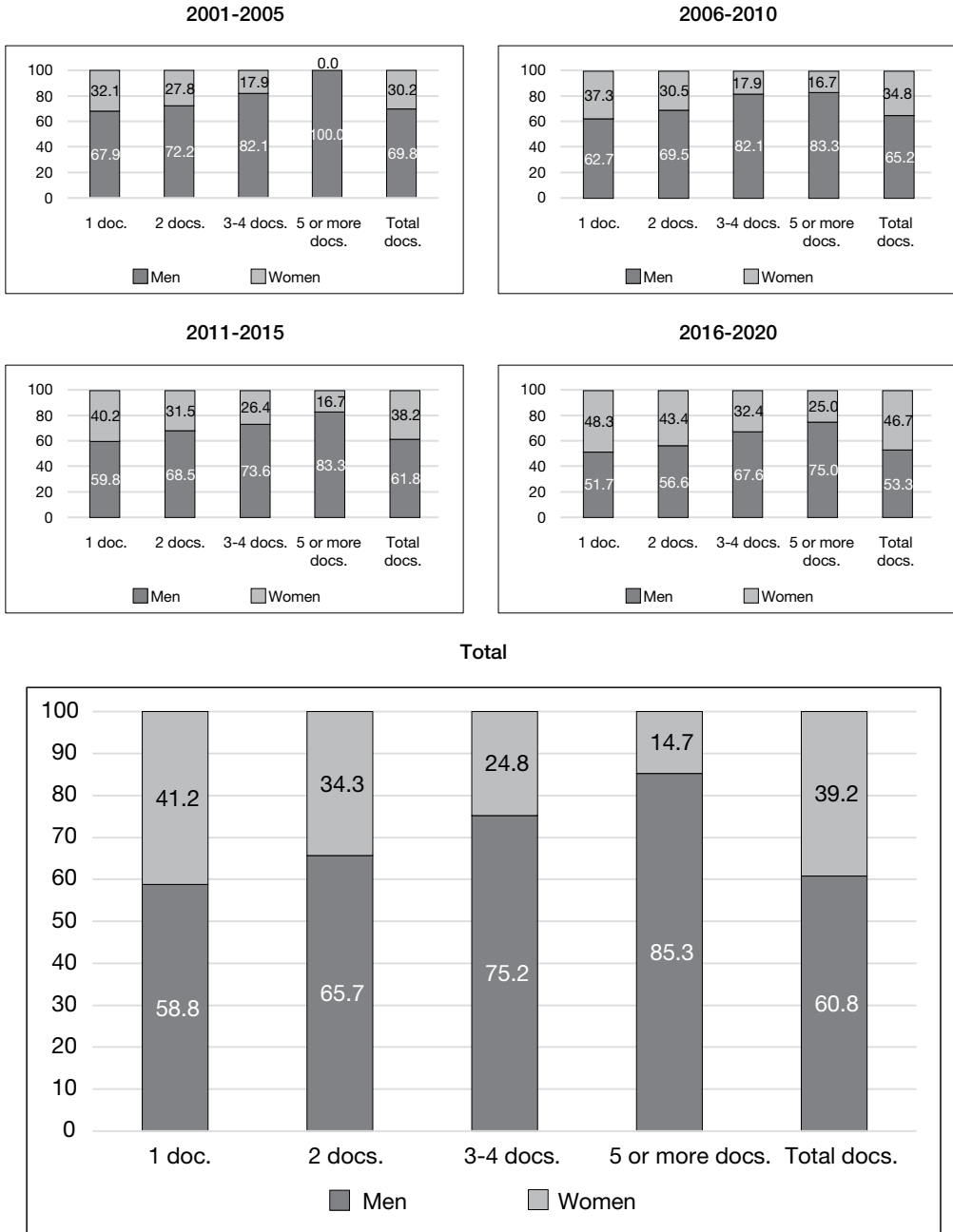
Figure 2 takes a closer look at the differences between the sexes at the highest lev-

els of productivity by dividing the total number of documents published per author into deciles<sup>3</sup>. From the outset, the figure shows an indisputable fact: the higher the productivity, the lower the presence of women. It is true that, from a diachronic perspective, their presence gradually increased across all deciles; however, in deciles 9 and 10 parity was not reached, except in decile 9 during the 2016-2020 five-year period, and only by 0.4 %. Specific details aside, these data on the overwhelming male dominance at higher levels of productivity are consistent with those found in various studies in different areas of knowledge (Abramo, Aksnes and D’Angelo, 2021; Huang *et al.*, 2020).

<sup>3</sup> In some cases (especially at the middle levels of productivity), the rigidity of the decile division meant that authors with the same number of published papers had to be placed in adjacent deciles. In such cases, criteria of proportionality according to sex were applied for placement in one decile or another, so that the division into deciles reflected as accurately as possible the number of men and women within each group of authors with the same number of published papers.

<sup>2</sup> As is well known, there is consensus (both within Spain and worldwide) that gender parity is defined as when neither of the two sexes is represented by less than 40 % or more than 60 % in the area in question.

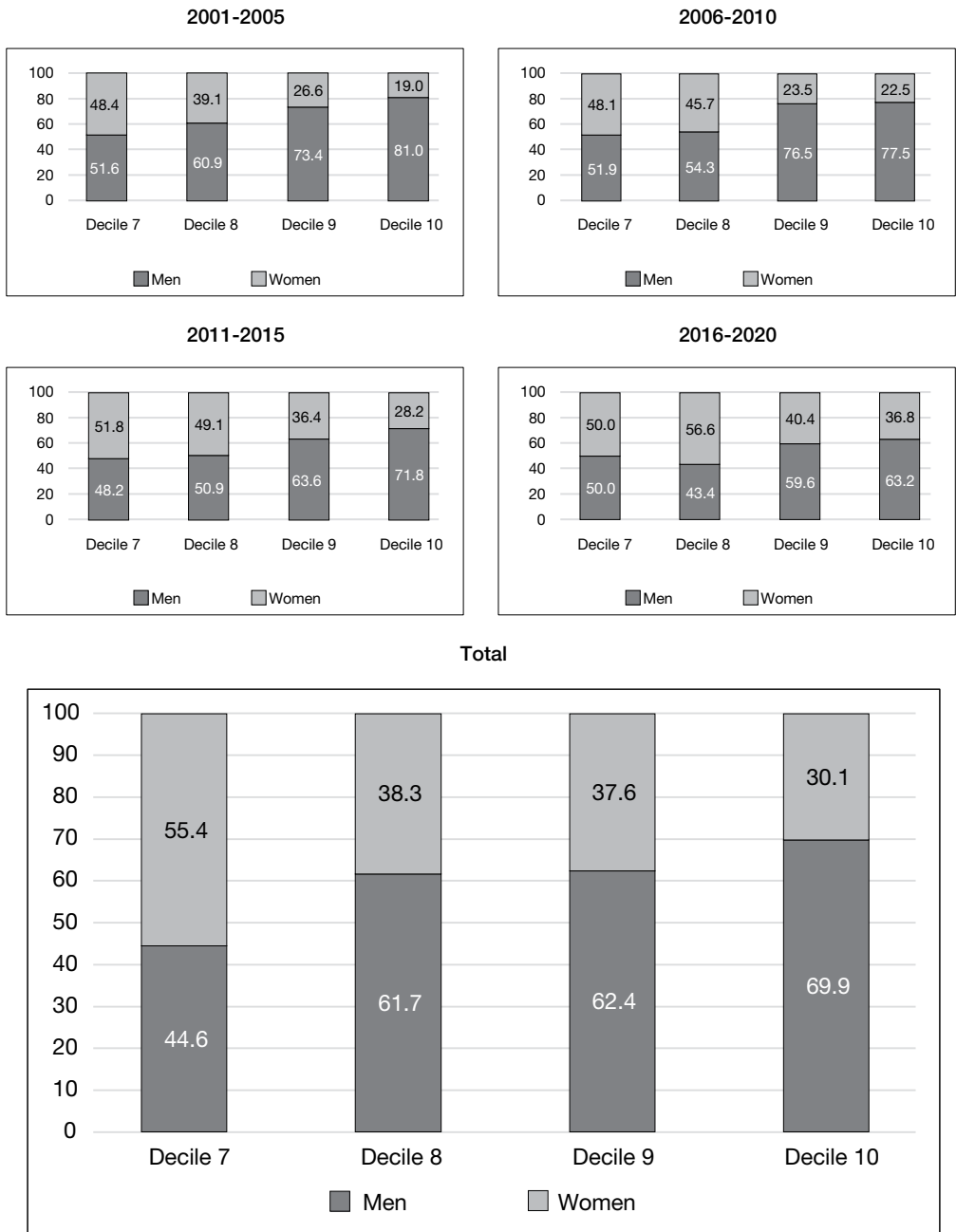
**FIGURE 1.** Distribution of authors according to number of documents published and sex, by five-year period and total (%)



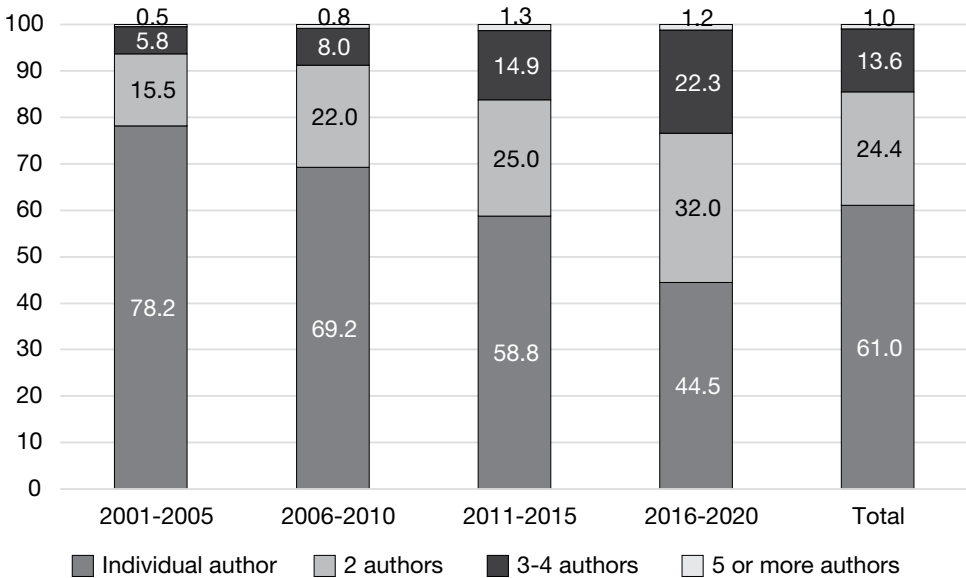
Source: Developed by the authors based on data from the journals analysed.



**FIGURE 2.** *Distribution of the top four deciles of productivity by sex, by 5-year period and total (%)*



Source: Developed by the authors based on data from the journals analysed.

**FIGURE 3.** Distribution of documents by number of authors, by five-year period and total (%)

Source: Developed by the authors based on data from the journals analysed.

## Collaboration

### Overall analysis

Undoubtedly, the key question in the overall analysis of collaboration is whether it increased in the journals analysed and, if this was the case, to what extent and in what way it did so. Figure 3 seeks to answer these questions by providing a classification of the documents according to the number of scholars who authored them. The most significant evidence in this respect points to a clear predominance of individual authorship in the initial phases, which, however, gradually declined, to the point that it ceased to be the prevailing pattern in the period 2016-2020, in favour of co-authorship.

Along with the increase in collaboration (which was to be expected, as it has been widely documented in previous literature), Figure 3 highlights the small size of research groups<sup>4</sup>, which in most cases

have only between two and four authors. This tendency to collaborate in small groups is typically found in the social sciences, in contrast to the experimental sciences, where research groups are generally much larger (Jiménez-Contreras and Ortega-Priego, 2022).

### Analysis disaggregated by sex

Having established that there was an increase in overall collaboration in the journals analysed, it is important to determine how this was distributed between men and women. Figure 4 shows the distribution of papers according to the number of authors and their gender. It highlights the greater inclination of men to publish either individually or in small groups (a behaviour previously reported by Hunter and Leahey, 2008), which contrasts with the diametrically opposite inclination of

<sup>4</sup> In this context, *research groups* (or, simply, *groups*) are understood as communities of authors formed as

a result of the publication of co-authored papers; they may have been formed either on a stable or an occasional basis.

women. Different types of reasons have been given for this divergence. For example, Bozeman and Corley (2004) noted that one of the most common strategies among women to enhance their academic career is to seek the sponsorship of a high-ranking male researcher, while Gómez-Ferri and González-Alcaide (2018) observed that women's motivations for collaboration are mainly oriented towards personal learning.

An major issue in the analysis of collaboration concerns the order in which the authors appear on research outputs published in journals. Although there are different practices depending on the area of knowledge and the status of the authors, in the social sciences, appearing as first author is usually associated with leadership positions and greater visibility (Brand *et al.*, 2015). Figure 5 aims to explore this question by dividing the co-authored documents according to the number of authors and the gender of the first author. Two important observations can be made about this.

Firstly, the figure shows that the percentage of male first authors was higher at all levels of co-authorship, with the sole exception of papers authored by 5 or more scholars published in the period 2006-2010, where the percentage was 50 %. However, when weighting these results, it is important to bear in mind that, as shown in Figure 1, men accounted for more than 60 % in each of the 5-year periods and in the overall period, the only exception being the 2016-2020 period. This imbalance could be merely due to the fact that as there were more male authors, it is logical that they appeared more often as first authors. Therefore, although data visualisation comparison does not seem to point to an excessive concentration of leadership and visibility in the hands of men due to their prevalence as first authors, a more detailed analysis applying proportionality

criteria would be required needed to accurately determine this.

Secondly, from a diachronic perspective, it is worth noting the overall decline in the percentage of men appearing as first authors across the board, although there were some unevenness in papers authored by 3-4 scholars and those with 5 or more authors. This trend towards a progressive narrowing of the gap between the sexes as first authors had already been reported in the literature by West *et al.* among others. (2013).

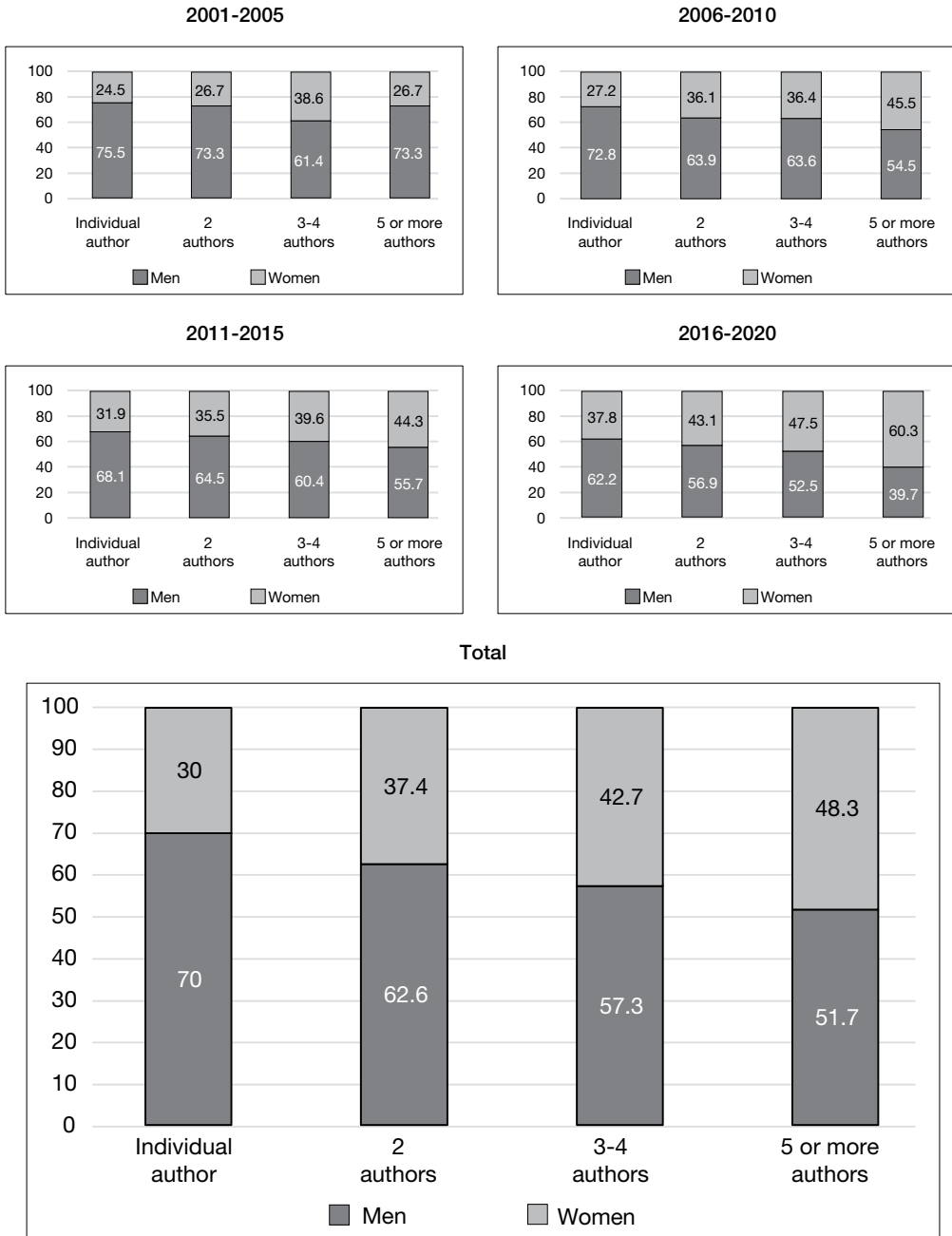
## Co-authoring networks

### *Overall analysis*

As described in the methodology section, the network analysis depicted below graphically and numerically represents the egocentric networks of authors who published two or more co-authored articles, either in one of the four five-year periods examined or over the whole period covered here. These authors will be hereafter referred to as *lead authors*, while those authors who contributed to a paper published by the main authors without fulfilling the aforementioned condition will be referred to as *contributors*. Table 2 shows the total number of authors included in the network analysis for each period, together with their percentage increase. The percentage of lead authors and contributors is shown in the two columns on the right.

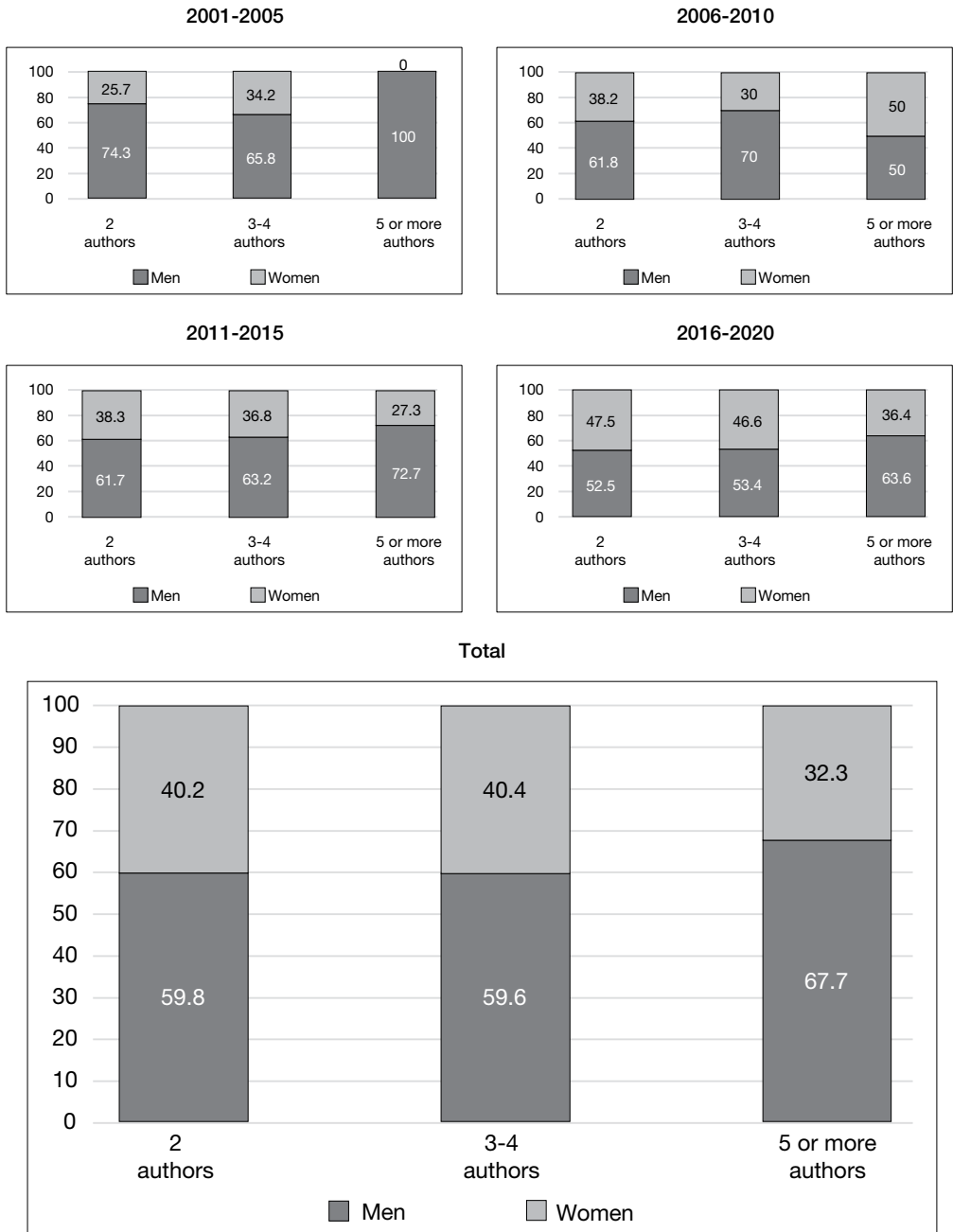
The first important information to be gleaned from the table is the increase in the total number of authors, especially in 2006-2010 and 2011-2015, which were precisely the periods in which there was the greatest increase in the number of overall authors (see Table 1). Unsurprisingly, the increase in the number of authors in this variable is largely correlated with the increase in collaboration, reflected in Figure 3.

**FIGURE 4.** Distribution of documents by number of authors and gender, by five-year period and total (%)



Source: Developed by the authors based on data from the journals analysed.

**FIGURE 5.** *Distribution of co-authored documents by number of signatories and sex of first signatory, by five-year period and total (%)*



Source: Developed by the authors based on data from the journals analysed.

Table 2 also provides a piece of information of great interest: the preponderance of contributors over lead authors. This preponderance suggests that lead authors are more inclined to interact with sporadic collaborators of a lower level than to establish sustained relationships with other lead authors of a similar level. It can therefore be stated that in the relations between the authors as a whole, disassortative mixing predominated over assortative mixing.

This behaviour, in addition to the absence of authors with a high degree of connection between them (as will be shown below), makes it possible to rule out the existence of *invisible colleges* (Price, 1973) or *social circles* (Crane, 1972) in Spanish sociology, both understood as groups of elite scientists who, despite being separated either geographically or institutionally, interact with each other and engage in joint publications.

**TABLE 2.** Author number and typology (lead author and contributors) included in the network analysis, by 5-year period and total

	Total authors	Increase (%)	Lead authors (%)	Contributors (%)
2001-2005	84	—	41.7	58.3
2006-2010	162	92.9	48.1	51.9
2011-2015	299	84.6	37.8	62.2
2016-2020	380	27.1	42.1	57.9
Total	1,110	352.4	43.7	56.3

Source: Developed by the authors based on data from the journals analysed.

#### *Analysis disaggregated by sex*

Table 3 shows the percentage distribution of men and women in the networks analysed, both for the total number of authors and for the two types of authors (lead authors and contributors). The table shows that men were in the majority in all variables, in each five-year period and in the period as a whole. However, before drawing any hasty

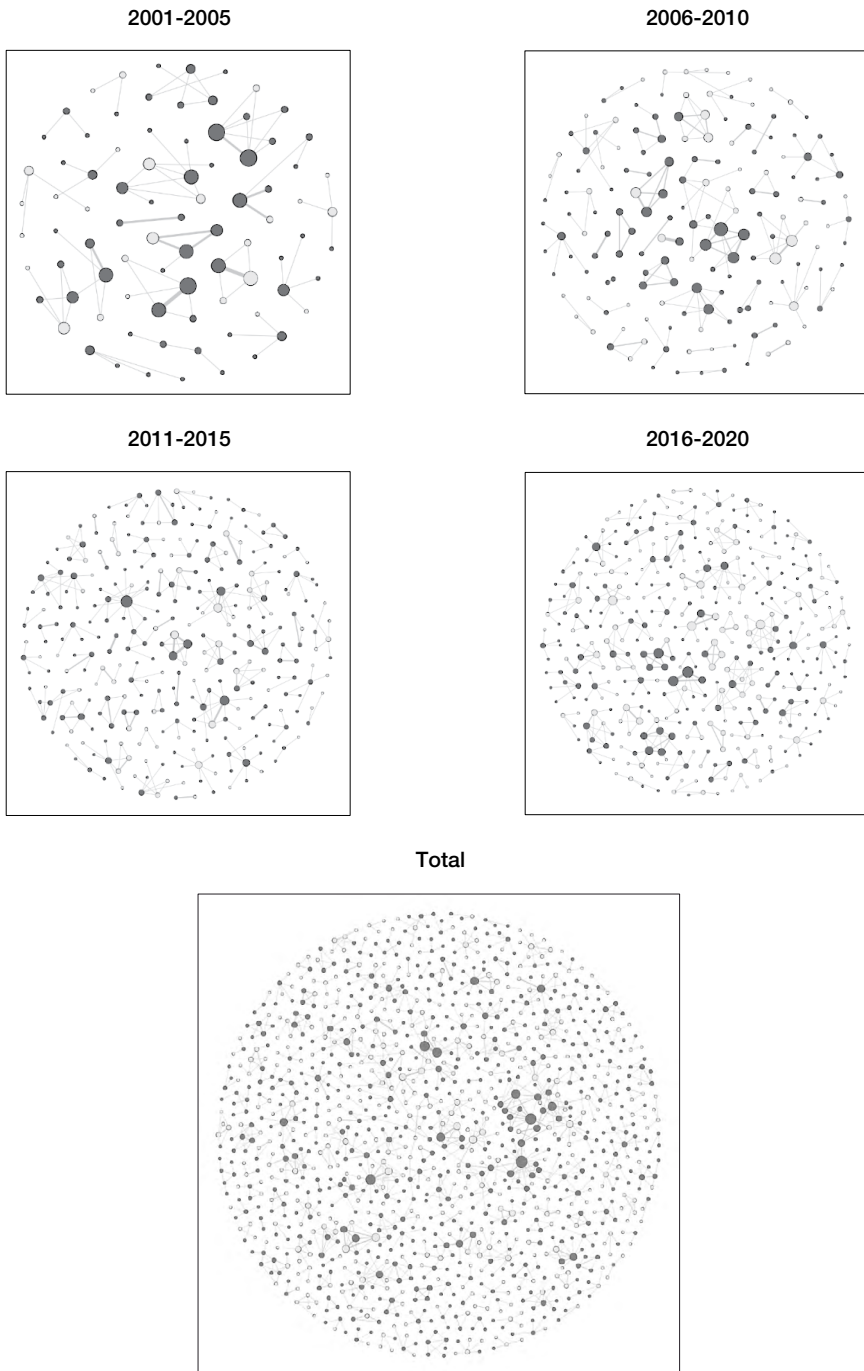
conclusions, it is worth looking again at the baseline data. Focusing on the columns of the total number of papers in Figure 1, it can be seen that the percentages of men and women were almost the same as the total number of authors depicted in Table 3. In other words, the gender ratio in networks correlated almost perfectly with the gender ratio in journal authorship.

**TABLE 3.** Distribution by sex and type of authors (lead author or contributors), by 5-year period and total (%)

	Total authors		Lead authors		Contributors	
	Men	Women	Men	Women	Men	Women
2001-2005	69.0	31.0	77.1	22.9	63.3	36.7
2006-2010	63.0	37.0	69.2	30.8	57.1	42.9
2011-2015	65.6	34.4	73.5	26.5	60.8	39.2
2016-2020	54.2	45.8	56.9	43.1	52.3	47.7
Total	60.0	40.0	64.1	35.9	56.8	43.2

Source: Developed by the authors based on data from the journals analysed.

**FIGURE 1.** Co-authorship networks by sex of authors, by five-year period and total



Note: Males: dark grey; females: light grey.

Source: Developed by the authors based on data from the journals analysed.

However, while men were not over-represented quantitatively in the networks in proportional terms, they were qualitatively over-represented. This is demonstrated by the fact that women were disproportionately far ahead of men as lead authors, even when taking into account the numerical superiority of men at the outset. Given that greater collaborative activity tends to result in greater academic success (Hunter and Leahey, 2008), it is easy to deduce that men's advantage on this indicator will, more often than not, be correlated with higher status. Even so, from a diachronic perspective, it is worth noting that the differences between men and women as lead authors decreased considerably during the 2016-2020 period.

Figure 1 graphically represents the networks of all the authors included in the analysis, their gender being distinguished by the colour of the nodes: dark grey for men and light grey for women<sup>5</sup>. From a structural point of view, Figure 1 shows how the networks grew in number of nodes and subnetworks, although the size of the networks remained stable, partly because they were hardly ever connected to each other. In terms of gender distribution, the largest nodes generally coincide with male authors, revealing a slightly higher *popularity* of men. This popularity is not only to be understood as the ability to attract and engage with more researchers and more repeatedly, but also in terms of *social capital* (Bourdieu, 2000).

Tables 4 and 5 present the statistical correlation of what was seen in Figure 1, the former from a structural point of view, and

the latter from the point of view of gender distribution. Two issues stand out in Table 4, both related to types of uneven growth. One of these issues has to do with the increase in the number of nodes (consistently with what was seen in the total authors column in Table 2), and the number of ties. The key point in this respect is that when the number of nodes in a network increases, the number of ties increases to a much greater extent, which is not the case in the networks analysed. This is the reason why the density of networks, instead of growing, decreased in each five-year period. The other issue related to uneven growth patterns has to do with subnetworks. As can be seen in the last two rows of Table 4, these rows increased by a factor of 3.5 over the four five-year periods analysed, but the number of nodes they contained grew irregularly and to a much lesser extent. In short, the data confirmed the findings shown in Figure 1: the number of nodes and subnetworks increased in the networks analysed, but the subnetworks increased very little in size or in connections to each other, resulting in a disjointed structure, consistent with that observed by Jiménez-Contreras and Ortega-Priego (2022).

With regard to the gender distribution in the networks, Table 5 contains the most outstanding finding of the study, given its novelty. This finding consists of higher local centrality scores among men (not very pronounced, but maintained over time), which contrasts with the relative balance in the indicators of global centrality. As noted in the methodological section, local centrality relates to the number and frequency of relationships established by an actor, while global centrality relates to the place occupied in the network as a whole. Based on these premises, higher local centrality scores among male scholars should be interpreted as higher popularity of men and lower popularity of women. According to previous literature, this dissimilarity has at

<sup>5</sup> In the networks shown, the size of the nodes is proportional to the weighted degree, and the thickness of the ties is proportional to their number. However, due to the characteristics of the logarithms applied for the visualisation and the graphical adjustments that had to be made for the joint visualisation of the networks, it should be noted that proportionality in the size of the nodes and ties varies from one network to another.



least two implications. Firstly, higher popularity is often the prelude to higher productivity (and vice versa), as productivity is influenced by the quantity and quality of contacts, among other factors (Cainelli *et al.*, 2014). Secondly, there is a mechanism known as *preferential attachment* (Barabási and Albert, 1999), commonly found in social networks, according to which actors joining a network for the first time tend to do so through its most popular nodes. Since in this study the most popular nodes mostly corresponded to men, they might see their popularity increase even

more, giving rise to a network variation of the Matthew Effect (Merton, 1985). Nevertheless, the data in Table 5 reflect stable differences between men and women, rather than a growing asymmetry. Consequently, it seems logical to think that other psychosocial mechanisms may be at work regarding the greater popularity of men in the networks, such as the *ratchet effect* (Merton, 1985), *labelling* (Cole and Cole, 1973), some kind of *cumulative advantage* (Allison and Stewart, 1974; Gaston, 1978; Merton, 1985) or even the *Matilda effect* (Rossiter, 1993).

**TABLE 4.** *Structural measures of co-authorship networks, by 5-year period and total*

	2001-2005	2006-2010	2011-2015	2016-2020	Total
Nodes	84	162	299	380	1,110
Ties	82	159	306	401	1,321
Diameter	4	6	6	12	24
Density	.024	.012	.007	.006	.002
Subnetworks	18	40	57	63	134
Average size of subnetworks (no. of nodes)	4.67	4.05	5.25	6.03	8.28

Source: Developed by the authors based on data from the journals analysed.

**TABLE 5.** *Average of different measures of local and global centrality of authors according to sex, by 5-year period and total*

		2001-2005		2006-2010		2011-2015		2016-2020		Total	
		M	W	M	W	M	W	M	W	M	W
Local C.	Degree	2.02	1.81	2.00	1.90	2.15	1.84	2.21	1.99	2.48	2.22
	Weighted degree	2.34	2.00	2.70	2.25	2.43	2.11	2.59	2.34	3.08	2.70
Overall C.	Closeness c.	.67	.67	.74	.73	.67	.62	.57	.59	.45	.45
	Eigenvector c.	.21	.19	.13	.12	.10	.08	.12	.10	.07	.05

Note: M: men; W: women.

Source: Developed by the authors based on data from the journals analysed.

## DISCUSSION

The study has confirmed that the journals analysed showed very similar patterns in terms of productivity, collaboration and

co-authorship networks to those found in other fields and other areas, both in aggregate and disaggregated by gender. In addition to this confirmatory value, in fulfilment of the third specific objective set, the study

has also prompted some reflections on gender-based social stratification in sociological research production in Spain. It is imperative to ask why there were fewer female than male authors of the papers published in the journals analysed.

The reasons why women researchers are less productive than men are so complex that it is common in the literature to use the apt expression *productivity puzzle* coined by Cole and Zuckerman (1984) to describe the obstacles in explaining this imbalance. While many different explanations have been given, including that by Fox (1983), for example, who distinguished between individual, environmental and social factors, in this particular case it is worth shifting the focus to the intrinsic characteristics of Spanish sociology in order to understand, at least partially, this particular productivity puzzle.

As Finkel and Arroyo (2022) pointed out, women have traditionally been in the majority in sociology studies in Spain. However, a *bottleneck* in gaining access to research and a professional career emerged when the discipline became institutionalised (González-Alcaide *et al.*, 2009). To make matters worse, the initial inequalities were amplified as the individual moved up the academic ladder, so that female researchers became both quantitatively and qualitatively underrepresented. A good example of this is the fact that, in the 1998-1999 academic year (that is, shortly before the start of the period covered by this study), women represented only 33 % of all sociology teaching staff, with an added twist: they only accounted for 8.1 % of university professors and 17.6 % of college professors. Two decades later, in 2018 (almost at the end of the period covered by this study) the figures had ostensibly improved: women accounted for 44 % of the teaching staff, 25.8 % of whom held university professorships and 36.4 % in college professorships (Pérez-Yruela, 2022).

Bearing in mind that university teaching and research staff (hereinafter, *UTRS*, known in Spanish as PDI) make up the majority –and almost exclusive– group among the authors who published in the journals analysed (González-Alcaide *et al.*, 2009), the data presented above suggest that there is a gender gap *prior* to the submission of manuscripts to journals and, therefore, *outside* the evaluation processes carried out by journals. In fact, the second most striking finding of this study is the strong correlation between the gender distribution among UTRS and the gender distribution of authorship in journals. Indeed, at the beginning of the period analysed, the proportion of women among UTRS was, as noted above, 33 %, while the proportion of women who authored journal papers was 30.2 %; at the end of the period analysed, these percentages stood at 44 % and 46.7 % respectively (see percentages of the total number of documents for the 2001-2005 and 2016-2020 periods in Figure 1).

On the other hand, the correlation between the figures for gender stratification in academic life and in journals also suggests that journals, as *guardians of science* (Merton, 1985), have not played any significant role in the creation or amplification of the gender gap in Spanish sociology. Along these lines, recent studies such as that by Squazzoni *et al.* (2021) have confirmed that the blind peer review system (used by all the journals analysed and by the majority of prestigious publications) is a tool that prevents gender discrimination in the refereeing process.

Of course, the relatively good general functioning of the science monitoring system (Merton, 1985) and of the referee system in particular does not mean that referees are free from bias or conditioning (Crane, 1967; Merton, 1985, with Zuckerman). Similarly, other factors involved in the social structure of scientific

life should not be overlooked. In the case of Spain, for instance, in addition to the higher number of men among the teaching and research staff, there are relevant factors such as evident ageing and unequal socio-occupational conditions (Climent-Sanjuán and Simó-Solsona, 2022). With this background situation, it is fairly likely that some authors either have had or have access to certain privileges by virtue of their gender, age or academic status. However having power does not necessarily mean using it for one's own benefit, as Merton (1985, with Zuckerman) warned in his article on age structure in science.

## CONCLUSIONS

In the light of the above, the conclusions of the study are necessarily ambivalent. It is undeniable that the gender gap in authorship in the journals analysed has been gradually closing, particularly in the 2016-2020 period. However, a detailed analysis of indicators such as high productivity, collaborative density and local centrality suggests that progress in this area is still limited. Thus, it remains to be seen whether the presence of female authors in Spanish sociology journals has hit a *glass ceiling* or whether, on the contrary, there is room for growth.

On the other hand, the evolution of the gender gap in journals has been shown to be strongly dependent on the gender gap among Teaching and Research staff in Spain. This dependence seems to support the thesis that journals are not responsible for the unequal publication rates of men and women (Squazzoni *et al.*, 2021). Nevertheless, it is worth noting that many journals are increasingly adopting active policies in favour of gender equality. The authors of this paper feel the need to perform a reflexive somersault and humbly call for these policies to be extended further.

## BIBLIOGRAPHY

- Abramo, Giovanni; D'Angelo, Ciriaco A. and Murgia, Gianluca (2013). "Gender Differences in Research Collaboration". *Journal of Informetrics*, 7(4): 811-822. doi: 10.1016/j.joi.2013.07.002
- Abramo, Giovanni and D'Angelo, Ciriaco A. (2014). "How Do You Define and Measure Research Productivity?". *Scientometrics*, 101(2): 1129-1144. doi: 10.1007/s11192-014-1269-8
- Abramo, Giovanni; Aksnes, Dag W. and D'Angelo, Ciriaco A. (2021). "Gender Differences in Research Performance within and between Countries: Italy vs Norway". *Journal of Informetrics*, 15(2): 101144. doi: 10.1016/j.joi.2021.101144
- Allison, Paul D. and Stewart, John A. (1974). "Productivity Differences Among Scientists: Evidence for Accumulative Advantage". *American Sociological Review*, 39(4): 596-606. doi: 10.2307/2094424
- Barabási, Albert-László and Albert, Réka (1999). "Emergence of Scaling in Random Networks". *Science*, 286(5439): 509-512. doi: 10.1126/science.286.5439.509
- Bourdieu, Pierre (2000). *Poder, derecho y clases sociales*. Bilbao: Desclée de Brouwer.
- Bozeman, Barry and Corley, Elizabeth (2004). "Scientists' Collaboration Strategies: Implications for Scientific and Technical Human Capital". *Research Policy*, 33(4): 599-616. doi: 10.1016/j.respol.2004.01.008
- Brand, Amy; Allen, Liz; Altman, Micah; Hlava, Marjorie and Scott, Jo (2015). "Beyond Authorship: Attribution, Contribution, Collaboration, and Credit". *Learned Publishing*, 28(2): 151-155. doi: 10.1087/20150211
- Cainelli, Giulio; Maggioni, Mario A.; Uberti, T. Erika and de Felice, Annunziata (2014). "The Strength of Strong Ties: How Co-authorship Affect Productivity of Academic Economists?". *Scientometrics*, 102: 673-699. doi: 10.1007/s11192-014-1421-5
- Climent-Sanjuán, Víctor and Simó-Solsona, Montserrat (2022). Las dinámicas del mercado de trabajo académico de la sociología española: pautas de contratación y estabilidad. In: M. Fernández Esquinas and M. Domínguez Amorós (eds.). *La sociología en España: diagnóstico y perspectivas de futuro* (pp. 291-309). Madrid: Marcial Pons, Ediciones Jurídicas y Sociales.
- Cole, Jonathan R. and Cole, Steve (1973). *Social Stratification in Science*. Chicago: The Chicago University Press.

- Cole, Jonathan R. and Zuckerman, Harriet (1984). "The Productivity Puzzle: Persistence and Changes in Patterns of Publication of Men and Women Scientists". *Advances in Motivation and Achievements*, 2: 17-256.
- Crane, Diana (1967). "The Gatekeepers of Science: Some Factors Affecting the Selection of Articles for Scientific Journals". *The American Sociologist*, 2(4): 195-201. Available at: <https://www.jstor.org/stable/27701277>, access September 2, 2023.
- Crane, Diana (1972). *Invisible Colleges: Diffusion of Knowledge in Scientific Communities*. Chicago: University of Chicago Press.
- Díaz-Guilera, Albert (2012). Introducción a las redes. In: A. Canals, A. Díaz-Guilera, J. L. Molina and B. Pataca (eds.). *Redes sociales* (pp. 11-68). Barcelona: Editorial UOC.
- Etzkowitz, Henry; Kemelgor, Carol and Uzzi, Brian (2000). *Athena Unbound: The Advancement of Women in Science and Technology*. Cambridge: Cambridge University Press.
- Fecher, Benedikt and Friesike, Sascha (2014). Open Science: One Term, Five Schools of Thought. In: S. Bartling and S. Friesike (eds.). *Opening Science: The Evolving Guide on How the Internet is Changing Research, Collaboration and Scholarly Publishing* (pp. 17-49). Heidelberg: Springer. doi: 10.1007/978-3-319-00026-8
- Finkel, Lucila and Arroyo, Millán (2022). Estudiantes y titulados de sociología en el sistema universitario español. In: M. Fernández Esquinas and M. Domínguez Amorós (eds.). *La sociología en España: diagnóstico y perspectivas de futuro* (pp. 235-278). Madrid: Marcial Pons, Ediciones Jurídicas y Sociales.
- Fox, Mary F. (1983). "Publication Productivity among Scientists: A Critical Review". *Social Studies of Science*, 13(2): 285-305. doi: 10.1177/030631283013002005
- Gaston, Jerry (1978). *The Reward System in British and American Science*. New York: Wiley and Sons.
- Gaughan, Monica and Bozeman, Barry (2016). "Using the Prisms of Gender and Rank to Interpret Research Collaboration Power Dynamics". *Social Studies of Science*, 46(4): 536-558. doi: 10.1177/0306312716652249
- Gómez-Ferri, Javier and González-Alcaide, Gregorio (2018). "Patrones y estrategias en la colaboración científica: la percepción de los investigadores". *Revista Española de Documentación Científica*, 41(1): e199. doi: 10.3989/redc.2018.1.1458
- González-Alcaide, Gregorio; Agulló-Calatayud, Víctor; Valderrama Zurián, Juan C. and Aleixandre Benavent, Rafael (2009). "Participación de la mujer y redes de coautoría en las revistas españolas de Sociología". *Revista Española de Investigaciones Sociológicas*, 126: 153-166.
- González-Alcaide, Gregorio and Gómez-Ferri, Javier (2014). "La colaboración científica: principales líneas de investigación y retos de futuro". *Revista Española de Documentación Científica*, 37(4): e062. doi: 10.3989/redc.2014.4.1186
- Huang, Junming; Gates, Alexander J.; Sinatra, Roberta and Barabási, Albert-László (2020). "Historical Comparison of Gender Inequality in Scientific Careers Across Countries and Disciplines". *Proceedings of the National Academy of Sciences*, 117(9): 4609-4616. doi: 10.1073/pnas.1914221117
- Hunter, Laura and Leahey, Erin (2008). "Collaborative Research in Sociology: Trends and Contributing Factors". *The American Sociologist*, 39: 290-306. doi: 10.1007/s12108-008-9042-1
- Jiménez-Contreras, Evaristo and Ortega-Priego, José L. (2022). Análisis de la colaboración científica en la sociología académica española. In: M. Fernández Esquinas and M. Domínguez Amorós (eds.). *La sociología en España: diagnóstico y perspectivas de futuro* (pp. 491-511). Madrid: Marcial Pons, Ediciones Jurídicas y Sociales.
- Jiménez-Contreras, Evaristo and Ruiz-Pérez, Rafael (2022). La internacionalización de la investigación sociológica española (2000-2018). In: M. Fernández Esquinas and M. Domínguez Amorós (eds.). *La sociología en España: diagnóstico y perspectivas de futuro* (pp. 435-469). Madrid: Marcial Pons, Ediciones Jurídicas y Sociales.
- Katz, J. Sylvan and Martin, Ben R. (1997). "What is Research Collaboration?". *Research Policy*, 26(1): 1-18. doi: 10.1016/S0048-7333(96)00917-1
- Kegen, Nadine V. (2013). "Science Networks in Cutting-edge Research Institutions: Gender Homophily and Embeddedness in Formal and Informal Networks". *Procedia-Social and Behavioral Sciences*, 79: 62-81. doi: 10.1016/j.sbspro.2013.05.057
- Lamo de Espinosa, Emilio; González-García, José M. and Torres-Albero, Cristóbal (1994). *La sociología del conocimiento y de la ciencia*. Madrid: Alianza Editorial.
- Larivière, Vincent; Ni, Chaoqun; Gingras, Yves; Cronin, Blaise and Sugimoto, Cassidy R. (2013). «Bibliometrics: Global Gender Dispar-

- ities in Science». *Nature*, 504(7479): 211-213. doi: 10.1038/504211a
- Merton, Robert K. (1985). *La sociología de la ciencia: investigaciones teóricas y empíricas*. Madrid: Alianza Editorial.
- Pérez-Yruela, Manuel (2022). Sobre la institucionalización y normalización de la sociología en España. In: M. Fernández Esquinas and M. Domínguez Amorós (eds.). *La sociología en España: diagnóstico y perspectivas de futuro* (pp. 29-68). Madrid: Marcial Pons, Ediciones Jurídicas y Sociales.
- Piro, Fredrik N.; Aksnes, Dag W. and Rørstad, Kristoffer (2013). "A Macro Analysis of Productivity Differences across Fields: Challenges in the Measurement of Scientific Publishing". *Journal of the American Society for Information Science and Technology*, 64(2): 307-320. doi: 10.1002/asi.22746
- Price, Derek J. de Solla (1973). *Hacia una ciencia de la ciencia*. Barcelona: Ariel.
- Ross, Matthew B.; Glennon, Britta M.; Murciano-Goroff, Raviv; Berkes, Enrico G.; Weinberg, Bruce A. and Lane, Julia I. (2022). "Women are Credited Less in Science than Men". *Nature*, 608: 135-145. doi: 10.1038/s41586-022-04966-w
- Rossiter, Margaret W. (1993). "The Matthew Matilda Effect in Science". *Social Studies of Science*, 23(2): 325-341. doi: 10.1177/030631293023002004
- Sonnenwald, Diane H. (2007). "Scientific Collaboration". *Annual Review of Information, Science and Technology*, 41(1): 643-681. doi: 10.1002/aris.2007.1440410121
- Squazzoni, Flaminio; Bravo, Giangiacomo; Farjam, Mike; Marusic, Ana; Mehmani, Bahar; Willis, Michael; Birukou, Aliaksandr; Dondio, Pierpaolo and Grimaldo, Francisco (2021). "Peer Review and Gender Bias: A Study on 145 Scholarly Journals". *Science Advances*, 7(2): eabd0299. doi: 10.1126/sciadv.abd0299
- Torres-Albero, Cristóbal (2001). *Sociología política de la ciencia*. Madrid: Centro de Investigaciones Sociológicas.
- West, Jevin D.; Jacquet, Jennifer; King, Molly M.; Correll, Shelley J. and Bergstrom, Carl T. (2013). "The Role of Gender in Scholarly Authorship". *PLoS ONE*, 8(7): e66212. doi: 10.1371/journal.pone.0066212
- Zuckerman, Harriet (1970). "Stratification in American Science". *Sociological Inquiry*, 40(2): 235-257. doi: 10.1111/j.1475-682X.1970.tb01010.x

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