EVALUATING AUTHORSHIP VARIATION PATTERNS IN ENGLISH-MEDIUM ASTROPHYSICS RESEARCH PAPERS: AN ACROSS JOURNAL AND DIACHRONIC STUDY (1998-2012)[1]

David I. Méndez
University of Alicante

M. Ángeles Alcaraz
University of Alicante

Françoise Salager-Meyer
University of Los Andes, Mérida, Venezuela

Abstract

This paper explores authorship practices from a diachronic perspective in a corpus of 300 randomly selected research papers published in the most prestigious Astrophysics English-medium journals. Our main results show that 21 variants were recorded in the number of authors in the whole sample and that multi-authored research papers far outnumber single-authored ones. They also reveal a growth not only in the number of authors, but also in the number of multi-authored research papers over time, mainly in those contributed by more than seven authors. From a specific diachronic perspective, each journal has its own authorship variation patterns and variants, which are analysed and explained in relation to their specific scope and to the socio-economic and political situation in each geographic context (European countries and the USA).

Key words: astrophysics, authorship, research papers, English, diachronic, comparative.

Resumen

En este artículo hemos analizado las prácticas autoriales en una muestra seleccionada al azar compuesta por 300 artículos de investigación publicados en tres periodos diferentes (1998, 2004 y 2012) en las más prestigiosas revistas de Astrofísica publicadas en inglés en Europa y Estados Unidos de Norteamérica. Hemos hallado una gama de 21 variantes en el número de autores en toda la muestra analizada. También hemos apreciado que los artículos de investigación con autoría colectiva son muchos más numerosos que los de autoría individual. Asimismo, hemos observado que no sólo ha ido creciendo el número de autores, sino también el número de artículos con autoría colectiva, principalmente en aquellos redactados por más de siete autores. En términos diacrónicos específicos, hemos comprobado que cada revista posee sus propias variantes y patrones de variación autoriales,

que hemos explicado en relación a su ámbito específico y a la situación socio-económica y política en ambos contextos geográficos (países europeos y EE.UU.).

Palabras clave: astrofísica, autoría, artículos de investigación, inglés, diacrónico, comparativo.

1. INTRODUCTION

Science is an increasingly global enterprise occurring in more and more places than ever before. In Castells' parlance: "Scientific research in our time is either global or ceases to be scientific" (qtd. Cronin, *Hand* 18). As a consequence, the scientific world is becoming increasingly interconnected, and many areas of research are growing more multidisciplinary and team-oriented (Gordon; Gibbons et al.).

According to the Royal Society Report on scientific collaboration in the 21st century released in March 2011, today there are over seven million researchers around the world, drawing on a combined international research and development spending of over US$ 1.000 billion (a 45% increase since 2002), and reading and publishing in around 25,000 scholarly journals per year. These scholars, mostly drawn by their motivation to work with the very best people and facilities in the world, collaborate with each other in order to seek new knowledge, and to tackle and attempt to solve, *inter alia*, global problems, such as climate change, water, food supply, loss of biodiversity, health, economic growth, etc. Authorship in scientific papers has been extensively studied from the sociological and the bibliometric points of view, as well as by research in science policy and ethics (Beaver; Biagioli; Birnholtz; Chompalov et al.; Glänzel and Schubert; Wuchty et al., among others). Its growth has now been documented to the point that it was the topic of a conference held at the University of Valencia (Spain) in November 2013 (González Alcaide et al.). An international network the aim of which is to facilitate collaboration in scientometrics, infometrics and webometrics should also be mentioned here: it is the COLLNET network which, since 2000, organizes an international meeting on a yearly basis.[3]

Collaboration, understood as the specific scientific activities (research and observation, experimentation, data collection, and publication) conducted by scientists working together on a common research project, is the "staple food" of academic life (Shapin 359). There are various motivating factors that underpin collaboration. When scientific motives drive the research, shared interest in the research problem is the leading reason for collaboration, but scientists are likely to collaborate with their

---

[1] The authors are very grateful to the anonymous referees for their critical comments and valuable suggestions which helped improve the paper.

[2] Françoise Salager-Meyer was supported by Grant No. CDCHTA-M-1039-13-06 from the University of Los Andes Research Centre.

[3] For more information, see <http://www.collnet.de> and <http://www.tu-ilmenau.de/collnet2014/>.

international counterparts for reasons that go beyond mere scientific compatibility and complementarity. Geographic proximity (Sugimoto and Cronin), historical linkages (less influential in the 1990s than in the past, according to Wagner and Leydesdorff), a shared language, specific problems and issues, economic factors, expertise, productivity, and the presence of particular research equipment, databases and/or laboratories are factors that also encourage collaboration (Harsanyi; Wagner et al.; Royal Society Report).

As regards the benefits of joint authorship, these consist of both measurable (e.g. increased citation impact and access to new markets) and less easily quantifiable outputs, such as broadening research horizons. These benefits also depend on the type of collaboration (Leimu and Koricheva), whether it is domestic in-house, domestic institutional or international. However, collaboration benefits are discipline-dependent, as Cronin et al. demonstrated. For example, the effects of collaboration on scientific impact are stronger in the 'hard sciences' (e.g., Physics and Astronomy) than in the "soft sciences," such as Sociology or Social Sciences (Stack; Marshakova-Shaikevich).

The methods used by scientists to create new knowledge have changed over time. The frequency and ease of travel as well as the development of new information and communication technologies, for example, have been influential in increasing the dynamism of knowledge sharing, and this has led to more robust networks of scientists. When asked about the medium for exchanging information, the scientists Wagner et al. reported that the Internet has become the central mechanism for communication and information exchange, although they also stress its limitations. Indeed, in many cases, the Internet does not substitute for face-to-face interaction, a key element in many capacity building activities and in the building of trust and confidence.

All in all, then, the growth of collaboration in science and technology is reflected in an increasing number of authors per publication, which is generally justified by the development of a growing number of multicentre trials and the increasing complexity of scientific research, thus requiring greater interdisciplinary work (Vincent-Lancrin; Royal Society Report). Since the increase in the mean number of authors per article is well documented (Laband and Tollison; Glänzel and Schubert; Cronin, *Hand*, "Collaboration"; Cronin et al.; Burton; Salager-Meyer et al., among others), the "publish or perish" motto has given rise to a new concept "publish together or perish" (Baethge; Levsky et al.).

The abundant literature on scientific collaboration also showed that co-authorship intensity varies by discipline (Subramanyan; Cronin et al.; Cronin, *Hand*; Lewis et al.), the most dramatic rise in multi-authored papers being seen in, for example, High-Energy Physics and Biomedicine (Cronin, *Hand*), a phenomenon described by Cronin as "hyperauthorship" ("Hyperauthorship" 560).

The growth of scientific collaboration has also been analysed in the field of Astrophysics. For example, Burton presented a very interesting account of some statistics (number of papers published per year and number of pages and authors per paper) recorded between 1990 and 2006 regarding *The Astrophysical Journal* by drawing comparisons with other principal international journals in the field of Astrophysics.

This study, which is part of a larger project focused on research papers published in Astrophysics journals, complements and enriches a previous article on the linguistic analysis of titles in the same type of academic documents (Méndez et al. 2014).

2. CORPUS AND METHODOLOGY

2.1. Source Journal Selection

The source journals had to fulfill the following criteria: 1) be the most authoritative journals in the field of Astrophysics, 2) publish papers on observational data and/or theoretical analyses, and 3) be freely accessible on line.

Taking these three criteria into account, the following four journals were selected: *The Astrophysical Journal* (ApJ) and *The Astronomical Journal* (AJ), which are both US-based and published on behalf of the American Astronomical Society, and *Monthly Notices of the Royal Astronomical Society* (MNRAS) and *Astronomy and Astrophysics* (A&A), which are based in Europe. MNRAS is published on behalf of the Royal Astronomical Society and is often the journal of choice for astronomers from the United Kingdom and the Commonwealth.

ApJ (impact factor: 6.733) has a more theoretical trend and publishes papers in Astronomy and Astrophysics. MNRAS (impact factor: 5.521) covers research on Astronomy and Astrophysics. A&A (impact factor: 5.084) is a European journal that publishes papers on theoretical, observational, and instrumental Astronomy and Astrophysics. AJ (impact factor: 4.965) publishes papers on astronomical research. [4]

Since these four journals became freely accessible on-line in 1998, that year was chosen as our starting point for our analysis.

2.2. Research Paper Selection

We randomly selected 300 research papers (RPs) from three different time periods comprising 100 RPs each: Block A (1998), Block B (2004), and Block C (2012). In other words, the 100 RPs per Block comprise 25 RPs per journal, i.e. 75 RPs per journal.

[4] All impact factors refer to the year 2012. The information was obtained from each journal's home page.

2.3. Authorship Data Recording Analysis

The number of authors per RP was recorded manually in each RP, and the quantitative data obtained were compared with the Student's *t*-test. The alpha value was set at 0.05.

3. RESULTS

3.1. Number of Authors (Table 1 and Graph 1)

TABLE 1. NUMBER OF AUTHORS PER JOURNAL AND PERIOD.

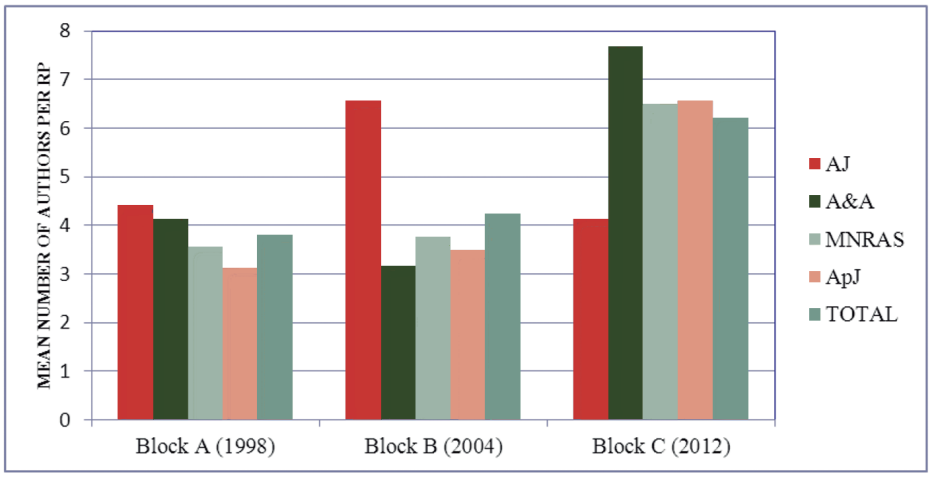
Journal	Block A (1998)	Block B (2004)	Block C (2012)	Total
AJ	110	164	103	377
A&A	103	79	192	374
MNRAS	89	94	162	345
ApJ	78	87	164	329
Total	380	424	621	1.425

As can be seen in Table 1, 1,425 authors were recorded in the RP bylines in the whole corpus. The mean number of authors per RP in the whole sample was 4.75. Table 1 also reveals that the number of authors varies from one journal to another, AJ and A&A containing the highest number of authors (26.5% and 26.2%, respectively) and MNRAS and ApJ the lowest ones (24.2% and 23.1%, respectively).

From a general diachronic standpoint, Table 1 also shows that the great majority of the number of authors (43.6%) appears in Block C, whereas the total number of authors recorded in Blocks A and B accounts for 26.7% and 29.8%, respectively (the sum of the three percentages is slightly greater than 100% because of rounding). This means that there is a large increase (1.63) in the total number of authors from Block A to Block C, and that the mean number of authors per RP rises from 3.8 in Block A to 6.2 in Block C (p=0.0002).

From a specific diachronic perspective, each journal has its own peculiarities. The number of authors rises steadily from Block A to Block C both in MNRAS and in ApJ, but in AJ it increases in Block B and decreases in Block C, and in A&A it falls in Block B and rises in Block C. Table 1 also shows that the greatest number of authors in Block C was recorded in A&A (30.9%), and the lowest in AJ (16.6%), MNRAS and ApJ accounting for 26.4% and 26.1%, respectively.

The behaviour patterns related to the mean number of authors per RP, journal and period are plotted in Graph 1. Both ApJ and MNRAS show an increase in the mean number of authors per RP from Block A to Block C: from 3.1 to 6.6 for ApJ (p=0.016) and from 3.56 to 6.5 for MNRAS (p=0.006). By contrast, the mean number of authors per RP in AJ increases from 4.4 in Block A to 6.6 in Block B



Graph 1. Mean number of authors per RP, journal and period.

(although this increase is not statistically significant) and decreases to 4.12 in Block C (p=0.029), whereas the mean number of authors per RP in A&A shows the opposite pattern: a fall from 4.1 in Block A to 3.2 in Block B (p=0.027) followed by a rise in Block C to 7.7 (p=0.002).

3.2. Number of Single- and Multi-authored RPs (Table 2 And Table 3)

TABLE 2. AUTHORSHIP VARIANTS PER JOURNAL.

No. of authors	AJ (15 variants)	A&A (14 variants)	MNRAS (13 variants)	ApJ (12 variants)	Total no. of RPs
1 author	11	5	10	4	30
2 authors	12	17	14	23	66
3 authors	11	11	16	18	56
4 authors	11	14	9	13	47
5 authors	8	8	5	5	26
6 authors	9	8	2	1	20
7 authors	3	4	7	3	17
8 authors	1	1	3	2	7
9 authors	-	-	5	-	5
10 authors	1	2	1	2	6
12 authors	1	-	-	-	1
13 authors	3	-	1	-	4

15 authors	-	1	-	-	1
16 authors	-	-	-	2	2
18 authors	1	-	-	-	1
19 authors	1	-	-	-	1
20 authors	1	1	-	-	2
21 authors	-	1	1	1	3
22 authors	-	1	-	-	1
24 authors	1	1	1	-	3
32 authors	-	-	-	1	1
Total	75	75	75	75	300

Table 2 shows that 21 variants were recorded in the number of authors, and that multi-authored RPs represent 90% of the whole sample, i.e. they far outnumber single-authored RPs, which account for only 10%. Two-, three- and four-authored RPs account for 56.4% (22%, 18.7% and 15.7%, respectively) of the whole sample, whereas the three variants from five- to seven-authored RPs account for 21.1% (8.7%, 6.7% and 5.7%, respectively) and the remaining 14 variants from eight to 32-authored RPs occurred much less frequently (12.7%).

Table 2 also illustrates that the highest number of single-authored RPs was recorded in AJ (36.7%) and in MNRAS (33.3%), and the lowest in A&A (16.7%) and in ApJ (13.3%). It also shows that that the highest number of two-authored RPs was found in ApJ (34.9%), followed by A&A (25.8%), MNRAS (21.2%) and AJ (18.2%). The sum of the three percentages is again slightly greater than 100% because of rounding. The greatest number of more than four-authored RPs was recorded in AJ (29.7%) and A&A (27.7%), followed by MNRAS (25.7%) and ApJ (16.8%). In this case, the sum of the three percentages is slightly lower than 100% because of rounding. The 24-authored variant is not found in ApJ which, by contrast, is the only journal that contains a 32-author RP.

Table 3 shows the evolution of the number of authors in our sample. A steady decrease in the number of single, three-, and four-authored papers can be observed from Block A to Block C. Conversely, the frequency of two- and six-authored RPs increases from Block A to Block B and decreases from Block B to Block C, and that of five- and seven-authored RPs decreases in Block B and increases in Block C.

TABLE 3. AUTHORSHIP VARIANTS PER PERIOD.

No. of authors	Block A (11 variants)	Block B (12 variants)	Block C (19 variants)	Total
1 author	14	9	7	30
2 authors	17	27	22	66
3 authors	26	18	12	56

4 authors	20	16	11	47
5 authors	8	6	12	26
6 authors	4	10	6	20
7 authors	5	4	8	17
8 authors	-	4	3	7
9 authors	2	-	3	5
10 authors	2	1	3	6
12 authors	-	-	1	1
13 authors	-	3	1	4
15 authors	-	-	1	1
16 authors	-	-	2	2
18 authors	1	-	-	1
19 authors	1	-	-	1
20 authors	-	1	1	2
21 authors			3	3
22 authors			1	1
24 authors	-	1	2	3
32 authors	-	-	1	1
Total	100	100	100	300

Worth pointing out is the steady increase in the number of author variants from Block A (11) to Block C (19) and in the total number of RPs signed by more than seven authors in the same time span (from 6% to 22%).

4. DISCUSSION

4.1. Number of Authors

Our findings (Table 1 and Graph 1) reveal a growth in the number of authors from Block A to Block C. In this sense, our results are in line with previous studies not only in Astrophysics, but also in many other fields (see Introduction section). Furthermore, the scope of each journal may be responsible for the differences observed in the mean number of authors per RP. The highest mean number of authors per RP in AJ may be attributed to the fact that this journal focuses primarily on observational research (the most experimental part of Astrophysics) that requires complex instrumentation (telescopes, detection devices, space missions, etc.) and multidisciplinary teams.

Although the numbers of authors per RP have increased from Block A to Block C, the authorship variation patterns differ from one journal to another since

each of them has its own peculiarities. In MNRAS and ApJ, the number of authors increased steadily from Block A to Block C. Conversely, AJ and A&A are characterized by an erratic pattern of increases and decreases. The fall in the number of authors in Block C in AJ may be accounted for, in our opinion, by the worldwide economic crisis that started in the USA in 2006. The substantial funding allocated for astronomical research, which had been steadily increasing, was reduced as a consequence of the crisis to the point that less money was devoted to research. This meant that new projects were smaller and fewer scientists were needed, hence the lower number of authors in Block C. Due to its more general scope, i.e. not so observationally-oriented, authorship at ApJ may not have reflected the economic crisis to the same extent as AJ.

As for A&A, another economic crisis should also be mentioned, i.e. the crisis that started at the beginning of the year 2000, mainly in Germany. After German reunification, the country had to face an excessive deficit and huge economic problems to the point that it was known as "the sick man of Europe" until the year 2005, when its economy began to recover. This may explain why research was very scarce during the period 2000-2004 and why only small projects involving few researchers were carried out, as reflected in the decrease in the mean number of authors per RP in Block B in A&A. Once the crisis was over, so-called "Big Science" returned, which involved team work requiring more personnel and financial support for research. This resulted in the increase observed in Block C. Contrary to what happened in Germany, the research published in MNRAS was not affected by this economic crisis, hence the mean number of authors per RP in this journal does not differ significantly between Block A and Block B.

Finally, it is also worth pointing out that an identical pattern of variation in the mean number of authors and the average title length (see Méndez et al. 2014) is found both in AJ and MNRAS. In ApJ and A&A, the pattern is also similar except in Block B. Multiple authorship in scientific papers has also been associated with title length (Yitzhaki, "Relation of Title"), and paper length (Yitzhaki, "Relation of the Title"). This should come as no surprise because when a greater variety of specialties and of authors is involved in research, RP titles tend to be longer as do the RPs themselves in terms of number of pages.

Apart from the varying expertise—a cause that may be considered intrinsic to the science being performed—another reason why more authors are mentioned in the RP bylines may also be of a more sociological nature, namely that names of scientists who might have been previously included in the acknowledgement sections are now more likely to appear as authors (Burton).

4.2. Number of Single- and Multi-authored RPs

If we consider that the field of Astrophysics usually involves teams of researchers working together, the high frequency of multi-authored RPs found in our sample (Table 2) is quite predictable. This result does not mean that single-authored RPs have become extinct since some are still found, mainly in AJ and MNRAS.

In this respect, our results do not appear to corroborate de Solla Price's prediction (1963) that if the proportion of multi-authored papers continued to accelerate at the same rate, by 1980 single-authored papers would have become extinct. Indeed, our results are more in line with Gordon (1980), who found that the numbers of single-authored papers had not declined so dramatically.

Focusing on each journal, although AJ RPs have the highest mean number of authors, this journal also has the highest number of single-authored RPs (Table 2). This apparent contradiction disappears if we consider that AJ also has the highest number of more than four-authored RPs. ApJ, on the other hand, publishes the highest number of two-authored RPs and the lowest number of more than four-authored RPs, which may be due to its tendency to publish RPs that are closer to popularized science texts.[5] A similar publishing policy characterizes MNRAS, in which the number of more than four-authored RPs is lower than in AJ. The number of more than four-authored RPs is also greater in A&A than in MNRAS and ApJ, a fact which may be explained in light of its combined (both observational and theoretical) aims and scope.

When examined diachronically (Table 3), multi-authored RPs are a distinctive feature of Block C. With time, not only has the number of authors increased, but also the number of multi-authored RPs. These changes can be attributed to the universal tendencies of globalization, the birth and development of "Big Science", the degree of progress in particular disciplines (Gordon 1980), and the professionalization and growing specialization of science. A consequence of this last process is that researchers less frequently work on their own and more frequently participate in diverse teams of specialists and travel to research centres all over the world. These effects together are likely influencing collaboration practices.

5. CONCLUSION

In this diachronic study of different journals, we have explored authorship in English-written RPs published in the principal scholarly journals in Astrophysics.

Our main results show that 21 variants were recorded in the number of authors in the whole sample, and that multi-authored RPs far outnumber single-authored RPs. They also reveal growth not only in the number of authors, but also in the number of multi-authored RPs with time, mainly in RPs with more than seven authors. From a specific diachronic perspective, each journal has its own authorship variation patterns and variants. The peculiar behaviour observed in each journal has been related to their specific scope and to the socio-economic and political situation in two geographic contexts (European countries and the USA). In terms of global evolution, and for all four journals studied, the distribution of the mean number

[5] This kind of texts are usually characterized by short titles (Méndez et al.) that make them look like editorials and/or oral communications.

of authors is identical to the distribution of the average title length reported in a previous study of the same corpus.

A special case worth pointing out is AJ, a US-based journal which can be considered the most experimentally-oriented one in our sample. From a diachronic perspective, AJ shows an identical pattern of variation in the mean number of authors per RP and in the average title length. Furthermore, it is the journal with the highest number of authors, of single-authored RPs, and of more than four-authored RPs. Conversely, it is the journal with the lowest number of two-authored RPs.

The results obtained in this study should be completed with a further analysis of the different collaboration and mobility practices of authors of RPs published in the field of Astrophysics. Such research would likely provide deeper insight into a more comprehensive understanding of the changes and transformation of science in general and Astrophysics in particular.

Reviews sent to author: 27 September 2014; Revised paper accepted for publication: 6 October 2014

WORKS CITED

Baethge, Christopher. "Publish Together or Perish." *Dtsch Arztebl International* 105.20 (2008): 380-383. Print.

Biagioli, Mario. "Aporias of Scientific Authorship: Credit and Responsibility in Contemporary Biomedicine." *The Sciences Studies Reader*. Ed. Mario Bagioli. New York: Routledge, 1999. 12-31. Print.

Beaver, Donald deB. "Reflections on Scientific Collaboration (and Its Study): Past, Present, and Future." *Scientometrics* 52.3 (2001): 365-377. Print.

Birnholtz, Jeremy. "What Does It Mean to Be an Author? The Instersection of Credit, Contribution and Collaboration in Science." *Journal of the American Society for Information Science and Technology* 57 (2006): 1758-1770. Print.

Burton, William Butler. "Some Statistics Regarding the *Astrophysical Journal* as Published between 1990 and 2006, Including Comparisons with Sister Journals." *Future Professional Communication in Astronomy*. Ed. André Heck and Leo Houziaux. Brussels: Mémoires de l'Académie Royale de Belgique, 2007. 31-59. Print.

Chompalov, Ivan, Joel Genuth, and Wesley Sschrum. "The Organization of Scientific Collaboration." *Research Policy* 31 (2002): 749-767. Print.

Cronin, Blaise. "Collaboration in Art and in Science: Approaches to Attribution, Authorship and Acknowledgment." *Information and Culture* 47.1 (2012): 18-37. Print.

——.*The Hand of Science: Academic Writing and Its Reward*. Lanham: The Scarecrow, 2005. Print.

——."Hyperauthorship: A Postmodern Perversion or Evidence of a Structural Shift in Scholarly Communication Practices." *Journal of the American Society for Information Science and Technology* 57.2 (2001): 558-569. Print.

Cronin, Blaise, Debora Shaw, and Kathryn La Barre. "A Cast of Thousands: Co-authorship and Sub-authorship Collaboration in the 20th century as Manifested in the Scholarly Journal Literature of Psychology and Philosophy." *Journal of the American Society for Information Science and Technology* 54.9 (2003): 855-871. Print.

Gibbons, Michael, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, and Martin Trow. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage, 1994. Print.

Glänzel, Wolfgang and András Schubert. "Analyzing Scientific Networks through Co-authorship." *Handbook of Quantitative Science and Technology Research: The Use of Publication and Patent Statistics in Studies of S&T Systems*. Ed. Henk F. Moed, Wolfgang Glänzel, and Ulrich Smoch. Dordrecht: Kluwer Academic, 2004. 257-276. Print.

González Alcaide, Gregorio, Javier Gómez Ferri, and Victor Agulló Calatayud, eds. *La colaboración científica: una aproximación multidisciplinaria*. Valencia: Nau Llibres/Edicions Culturals Valencianes, 2013. Print.

Gordon, Michael D. "A Critical Reassessment of Inferred Relations between Multiple Authorship, Scientific Collaboration: The Production of Papers and Their Acceptance for Publication." *Scientometrics* 2.3 (1980): 193-201. Print.

Harsanyi, Martha A. "Multiple Authors, Multiple Problems, Bibliometrics and the Study of Scholarly Collaboration: A Literature Review." *Library and Information Science Research* 15.4 (1993): 325-354. Print.

Laband, David N. and Robert D. Tollison. "Intellectual Collaboration." *Journal of Political Economy* 108.3 (2000): 632-662. Print.

Leimu, Roosa and Julia Koricheva. "Does Scientific Collaboration Increase the Impact of Ecological Articles?" *Bio Science* 55 (2005): 438-443. Print.

Levsky M., A. Rosin, T. Coon, W. Enslow, and M. Miller. "Descriptive Analysis of Authorship within Medical Journals, 1995-2005." *South Medical Journal* 100.4 (2007): 371-375. Print.

Lewis, Jenny, Sandy Ross, and Thomas Holden. "The How and Why of Academic Collaboration: Disciplinary Differences and Policy Implications." *Higher Education* 64 (2012): 693-708. Print.

Marshakova-Shaikevich, Irina. "Scientific Collaboration of New 10 EU Countries in the Field of Social Sciences." *Information Processing and Management* 42 (2006): 1592–1598. Print.

Méndez, David I., M. Ángeles Alcaraz, and Françoise Salager-Meyer. "Titles in English-medium Astrophysics Research Articles." *Scientometrics* 98.3 (2014): 2331-2351. Print.

Price, Derek J. De Solla. *Little Science, Big Science*. New York: Columbia UP, 1963. Print.

Royal Society Report. *Knowledge, Networks and Nations: Global Scientific Collaboration in the 21st Century*. London: The Royal Society, 2011. Print.

Salager-Meyer, Françoise, M. Ángeles Alcaraz Ariza, and Marianela Luzardo Briceño. "Titling and Authorship Practices in Medical Case Reports: A Diachronic Approach." *Communication and Medicine* 10.1 (2013): 63-80. Print.

Shapin, Steven. *A Social History of Truth: Civility and Science in Seventeenth-Century England*. Chicago: U of Chicago P, 1995. Print.

Stack, Steven. "Gender and Scholarly Productivity: The Case of Criminal Justice." *Journal of Criminal Justice* 30.3 (2002): 175-182. Print.

Subramanyam, Karthigeyan. "Bibliometric Studies of Research Collaboration: A Review." *Journal of Information Science* 6 (1983): 33-38. Print.

Sugimoto, Cassidy R. and Blaise Cronin. "Bio-bibliometric Profiling: An Examination of Multifaceted Approaches to Scholarship." *Journal of the American Society for Information Science and Technology* 63.3 (2012): 450-468. Print.

Vincent-Lancrin, Stephan. "What Is Changing in Academic Research? Trends and Future Scenarios." *European Journal of Education* 41.2 (2006): 169-202. Print.

Wagner, Caroline, Irene Brahmakulam, Brian Jackson, Anny Wong, and Yoda Tatsuro. *Science and Technology Collaboration: Building Capacity in Developing Countries*. Santa Monica: RAND, 2001. Print.

Wagner, Caroline and Loet Leydesdorff. "Mapping Global Science Using International Co-authorships: A Comparison of 1990 and 2000." *International Journal of Technology and Globalization* 1 (2005): 185-208. Print.

Wuchty, Stefan, Benjamin F. Jones, and Brian Uzzi. "The Increasing Dominance of Teams in Production of Knowledge." *Science* 316.5827 (2007): 1036-1039. Print.

Yitzhaki, Moshe. "Relation of Title Length of Journal Articles to Number of Authors." *Scientometrics* 30 (1994): 321-332. Print.

——."Relation of the Title Length of a Journal Article to the Length of the Article." *Scientometrics* 54.3 (2002): 435-447. Print.