Collaboration and Citation Analysis Within Social Sciences: A Comparative Analysis Between Two Fields

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Collaboration and Citation Analysis Within Social Sciences: A Comparative Analysis Between Two Fields

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Abstract

The present study focuses on a collaboration of a citation analysis of the JCR journals of the categories *Demography* and *Urban Studies* indexed in *Social Science Citation Index* from the period 2000–2016. A total of 64 journals were covered (26 for Demography and 38 for Urban Studies). We found that the percentages of multi-authored documents in both categories are very similar; moreover, the citation distribution is shown to be increasing in both but behaves slightly different in the two samples analysed. It seems to be a relation between the number of citations a document received and the number of authors. Regarding international collaboration, both categories present a similar type of network with densities of the kind of social science networks. Anglo-Saxon countries are the most prolific ones and the biggest collaborators in both networks. *Urban Studies* shows a relative importance to countries of emerging economies since it indexed more journals in the sample with a wider regional scope.

Keywords: bibliometrics, collaboration, citation, scientific production, social sciences

1. Introduction

Enquiries about science point to the existence of valid indicators to measure the level of scientific activity and scientific accomplishments from various perspectives: scientific fields, authors, institutions, faculties, departments, research groups and countries [1, 2]. The results of such studies are complemented with another set of indicators and are used at different governmental and organisational levels in, among other things, allocating economic and human resources [3]. It is increasingly evident given the development and consolidation of research

evaluation systems in almost every country. The situation represents a crucial shift in the nature of the behaviour of institutions and organisations that develop research programmes and projects [4, 5].

Van Raan [6] includes, as one of the objectives of bibliometric analysis, the ability to establish a set of standardised indicators that facilitate the evaluation of scientific production. The characteristics and indicators that are obtained from bibliometric studies are useful for planning, developing and organising the resources and services of the institutions in charge of the administration [7, 8].

Bibliometric studies are enormously relevant to the identification and characterisation of the scientific profile of countries, institutions for research and scientific fields themselves [9]. This statement is based on how they facilitate, among other things, the detection of research patterns or research strengths for each of the agents participating in the scientific process. Furthermore, evaluations with a basis on bibliometric indicators for citation have become commonplace in national processes for the evaluation of research at a university, faculty and even departmental levels [10].

1.1. What is scientific collaboration?

Scientific work is no longer an individual task having researchers work in isolation but a collaborative endeavour, instead. In this manner, collaboration is present in all the fields of knowledge and takes a wide range of forms. Scientific co-authorship is thought of as a reaction to the process of professionalisation of research, in terms of publication [11]. Katz and Martin [12] state that it can happen between individuals, groups, departments, institutions, sectors, regions or countries.

Many are the reasons that lead researchers to collaborate, from which the following stand:

1. Professionals seek opportunities to collaborate in order to increase their visibility within their field; it can be assumed that it applies to all fields of knowledge, since sciences generally share a common reward structure [13].

2. To gain access to equipment, resources or materials that may facilitate or improve research [12].

3. To improve the composition of research groups with a view to increase the chances of gaining financial support in open calls.

4. To know and share new methodological techniques.

5. To increase efficacy and efficiency, as well as quality of research [14].

6. To establish research networks with a greater social and scientific salience.

7. The chances of researching about interdisciplinary matters that touch on different areas of knowledge, due to which experts from each of them are necessary.

8. To interact with institutions of equal or higher prestige or to support the development of others of a less established research tradition.

9. To increase the scientific productivity of either research groups or their members.

10. To work with colleagues who share the same interests, ideas, theoretical frameworks or problems.

11. To increase citation and, hence, the impact and visibility of scientific production [15].

Occasionally, professionals who seek to add something new to their field may find that the reward is greater in doing so through the search of diverse ideas and remote collaborators than in collaborating with others from their own laboratory [16]. The increase in international collaboration in research may be regarded as a consequence of the mentioned rationales for establishing new links within science.

When remote collaborators have different points of view and experiences, they can be more easily prone to questioning—or perhaps complementing—the perspectives and capacities of the other participants [16]. For this reason, it is likely that these collaborations result in research studies of a more innovative kind and promote progress within the field of research itself. Nonetheless, collaboration between over-specialised scientists is in some cases necessary to tackle certain problems that are highly specific within a particular field of knowledge [17].

Glänzel [18] points out that the relation between collaboration and scientific productivity is a very important aspect of research. This has led to bibliometric analysis becoming highly recursive in the literature on informational sciences or social studies about science. There have been attempts to find collaboration patterns in countries or regions for a specific scientific field; for instance, clinical medicine in Taiwan [19] and epidemiology in Bulgaria [20]. Similarly, collaboration patterns at the global level of sciences have been studied in Eastern Europe [21, 22] and, in Spain, the production in Science Citation Index (SCI), Social Sciences Citation Index (SSCI) and Arts & Humanities [23, 24]. The field of Library Information Science itself (LIS) has been subject to various collaboration analyses [25–30].

Many of the studies reveal that collaboration raises not only participants' productivity but also the impact of their research [15]. However, Katz and Hicks [31] assert that the impact of an article in terms of citation is partially related with the number of participant authors, institutions and countries. In a study carried out by Narin and Whitlow [32] for the European Union, it was found that articles in which several institutions participated were more cited than those in which only one does. Likewise, articles are more cited when collaborators are foreign as compared with those that are signed by local or national collaborators.

Another aspect that attracts the attention of research on collaboration is the types of collaboration in terms of regions, determining if it is local, national or international [25, 33].

To measure collaboration, various indicators have been established, among which we highlight the following:

a) Collaboration Index (CI) defined by Lawani [34]: $IC = \dfrac{\sum_{j=1}^{A} j f_j}{N}$

b) Degree of Collaboration (DC) [35]: $DC = 1 - \dfrac{f_1}{N}$

c)   Collaborative Coefficient (CC) [36]: $CC = 1 - \dfrac{\sum_{j=1}^{A}\left(\dfrac{1}{j}\right) f_j}{N}$

fj = number of documents with j authors in collection *K*.

N = total number of documents in *K*.

A = total number of authors in collection *K*.

Collaborative research studies generally focus on a particular field in relation with itself or to a country or region. When studies in Social Sciences seek to compare collaboration indicators, it is usually done among subdisciplines within the same scientific field.

In this study, we aim to compare the collaboration between two different scientific fields of the Journal Citation Report (JCR), Social Sciences edition [37] with differences in the volume of scientific production indexed in the Web of Science (WOS) in the period 2000–2016.

2. Materials and methods

The 2016 JCR® Social Sciences Edition [37] was retrieved on June 1, 2017, to find out the name and number of the journals within the categories of *Demography* and *Urban Studies*. For the former, 26 journals were found, and 38 for the latter.

The time interval covered in this study is from 2000 to 2016. The procedure to obtain the data consisted in analysing the information contained in the SSCI, for which all the records were searched using the parameters: *Publication Name* [name of each journal in the chosen category] and *Year Published* [2000–2016]. In order to extract information only from citable documents, these were filtered once again by their categorisation as *Article* or *Review* (from now on, we are to refer them as documents). The category of *Demography* produced 11,361 documents whereas *Urban Studies* produced 24,010. Out of those documents, those in which the author was anonymous, or the author field was blank, were discarded. Lastly, 11,361 entries were considered for *Demography* and 23,998 for *Urban Studies*, all of which constitute the sample of this study.

All the information was uploaded to an *ad hoc* Microsoft® Access® 2016 relational database (version 1801) for the treatment and normalisation of data, as well as to produce the different graphs. The data were collected by year and collaboration was analysed into two levels. The first level was authorship, looking at collaboration in relation with the number of signatory authors; the number of authors in each document was full-counted, calculating a particular Collaboration Index (CI) and Degree of Collaboration (DC). The second level was established in relation with international collaboration, identifying the countries of each of the authors' institutions.

With a view to count the authors of each document, we opted for the complete counting system, as suggested by Cronin and Overfeld [38], attributing full authorship to each co-author,

considering them equally. The same procedure was applied in the case of countries. The documents were grouped according to collaboration by country, as has been done in other similar studies [39]. Given that documents can be signed by authors from different countries, the sum of the percentages is greater than 100%.

To analyse, treat and visualise collaborative networks, we have used the Pajek software [40].

3. Results and discussion

The category *Urban Studies* presents 28 indexed journals in the 2016 JCR [37], 12 more than *Demography*; this is 31.57% more. In the period between 2000 and 2016, the documents indexed within the category *Demography* mounted to less than half of those in *Urban Studies*, more precisely, only 47.36%. During those years, a total of 35,359 documents were indexed, considering both categories, in the SSCI.

3.1. Collaboration in the category demography

Concurrently with the increase of the production of documents along the period between 2000 and 2016, there was also an increase in the number of authors per article and, with it, collaboration in the category *Demography* (**Figure 1**). There is a correlation of 0.992 with a significance of 0.01, between the number of published documents and the number of documents with multiple authorships. Early in the set period of time, the difference between single and multiple authorship documents was of only 8.8%. Despite continuous ups and downs, such difference increased slowly by up to 20% in 2009. In 2010, the difference increased to 42% and remained ever since within an interval of a minimum of 30.3% to a maximum of 51.7%.

All this multiple authorship has an impact on collaboration indexes. In this line, the DC increased gradually from 0.52 in year 2000 to a top 0.67 in 2014 and 2015. Likewise, the CI ranges between an initial 1.87 and a maximum of 2.34 in 2014 (**Table 1**). The overall values for the time interval between years 2000 and 2016 are DC = 0.605 and CI = 2.14.

Figure 2 shows that the 70.4% of the documents from the *Demography* category are signed by one or two authors. A total of 39.5% of the papers have only one author, while articles with four or less authors only represented 13.07%.

The production of documents within the category *Demography* between 2000 and 2016 received a total of 147,024 citations. The average citation is of 12.9 cites per document (*SD* = 32.54), notwithstanding that 1840 received no citation at all, which represents 16.25 of total production.

Analysing citation in relation with author collaboration, it can be seen that multi-author documents receive 63.98% of the total citations while single-author documents receive 36.02%. In differentiating documents according to the number of authors, the highest citation is received by the documents signed by a single author, followed by those signed by two and three
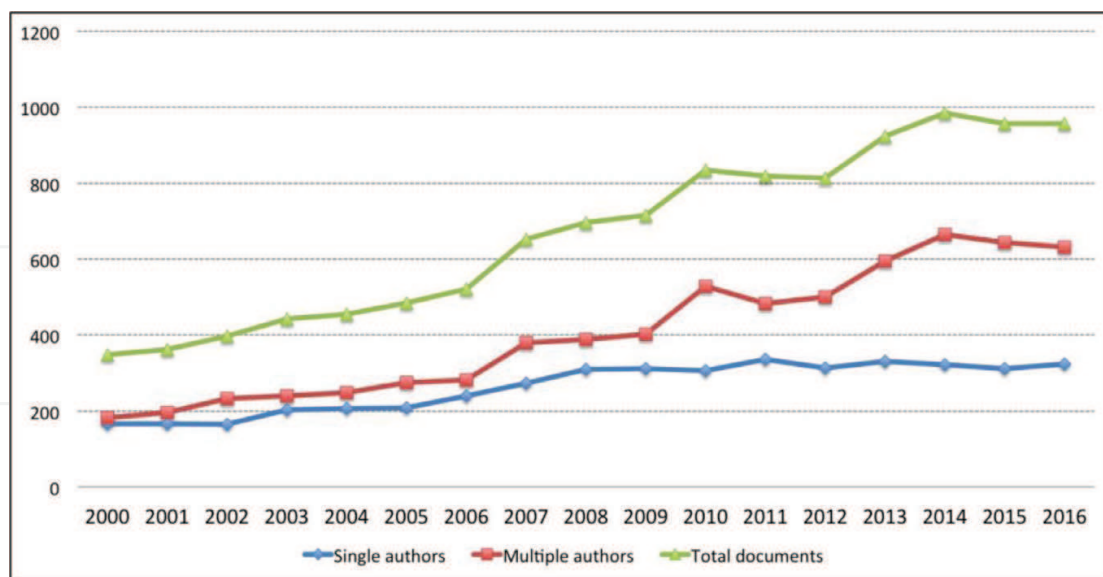
Figure 1. Diachronic type of authorship in the category demography.

Year	DC	CI
2000	0.52	1.87
2001	0.54	1.90
2002	0.58	2.03
2003	0.54	2.01
2004	0.55	2.03
2005	0.57	2.09
2006	0.54	1.96
2007	0.58	2.02
2008	0.56	2.01
2009	0.56	2.05
2010	0.63	2.16
2011	0.59	2.11
2012	0.62	2.17
2013	0.64	2.28
2014	0.67	2.32
2015	0.67	2.34
2016	0.52	1.87

Table 1. Degree of collaboration and collaboration index in the category demography.
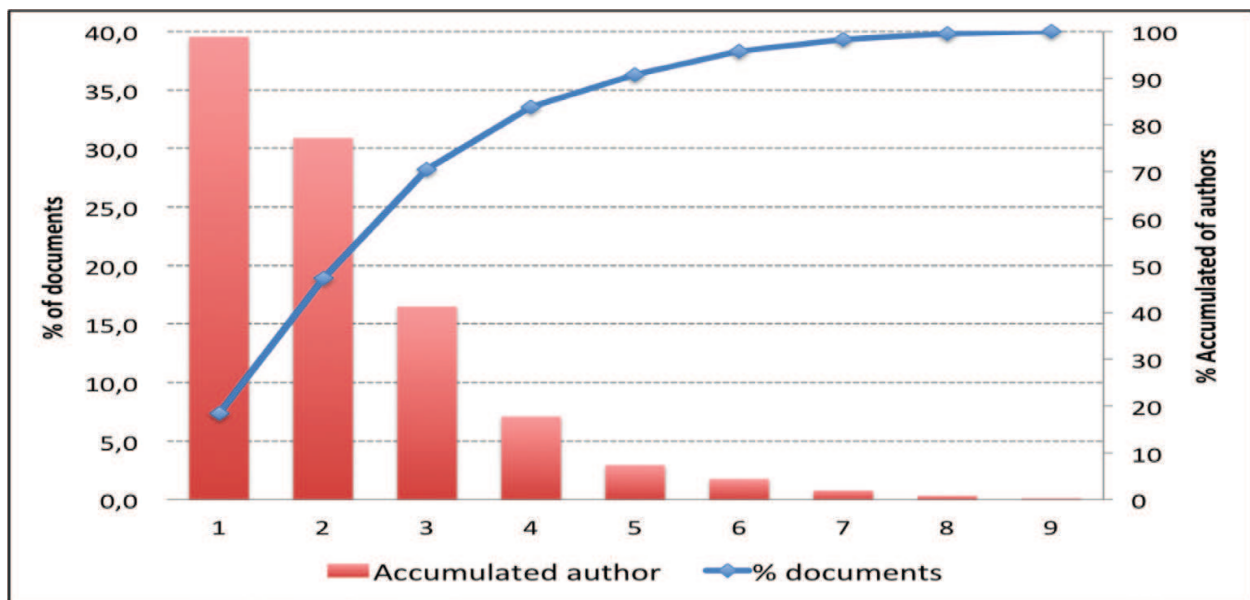
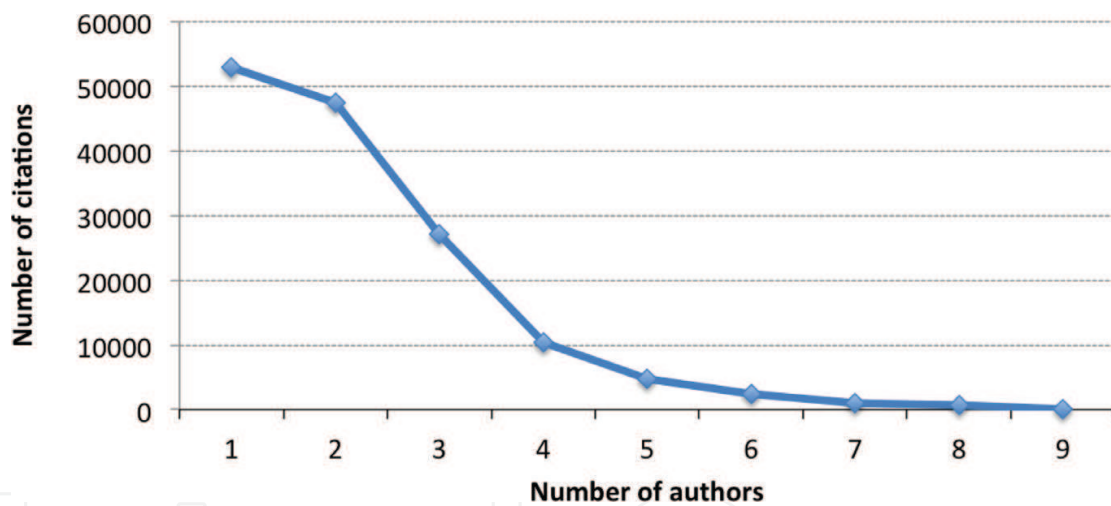**Figure 2.** Co-authored distribution in demography (2000–2016).

Figure 3. Citation by number of authors in demography 2000–2016.

authors, and decreases as the number of signatory authors increases (**Figure 3**). There is a moderated correlation between citation and number of signatory authors, with a Pearson's correlation coefficient of 0.709 (p = .001) for the category. In the same line, citation and DC present a correlation coefficient of 0.542 (p = .025). Eight articles received more than 300 citations; one article received 806 citations.

Regarding international collaboration, only 10,479 documents (out of 11,361) presented affiliation information. The documents of the category *Demography* were written by authors affiliated to institutions of 147 different countries. Most of the documents (77.6%) in the sample are written by authors from the same country regardless if they are written by multiple authors

or not. **Figure 4** shows a tendency in the increase of the international collaboration between authors which provide much better visibility and further citation to the work [13, 15].

There are only 11 countries (*Barbados, Bolivia, Cape Verde, Hong Kong, Malta, Oman, Solomon Islands, Syria, Trinidad and Tobago, Yemen, Yugoslavia*) that do not collaborate with other countries in the sample. The country with most co-authorship with other countries in the world is the *USA*, relating with 104 countries. A total of 50.34% of the countries (74) have relationships with a maximum of four other countries.

France, Germany, England and the *USA* are the only four countries that co-write articles with more than 50 other countries.

The network depicted in **Figure 5** shows a general view over the country network for Demography considering all the period. Every vertex represents a country; the volume of a vertex is proportional to the number of documents written by authors of the country. The lines between vertices show that the linked countries co-write documents and the colour of the lines are proportional to the number of documents shared. International collaboration networks tend to be very dense. The density of the network in **Figure 5** is 0.06737933 which indicated that the network is dense for social sciences. The average degree of the countries is 9.9048, which means that each of the 147 countries in the network shares documents with almost 10 other countries.

There are 728 collaborations detected, most of them being anecdotal; 48.08% of these collaborations appear only once, which means that these two countries only co-write one document in the whole period. The most prolific relationships among countries are found to be between *England* and the *USA, Canada* and the *USA, Germany* and the *USA* with more than 100 documents shared by each.
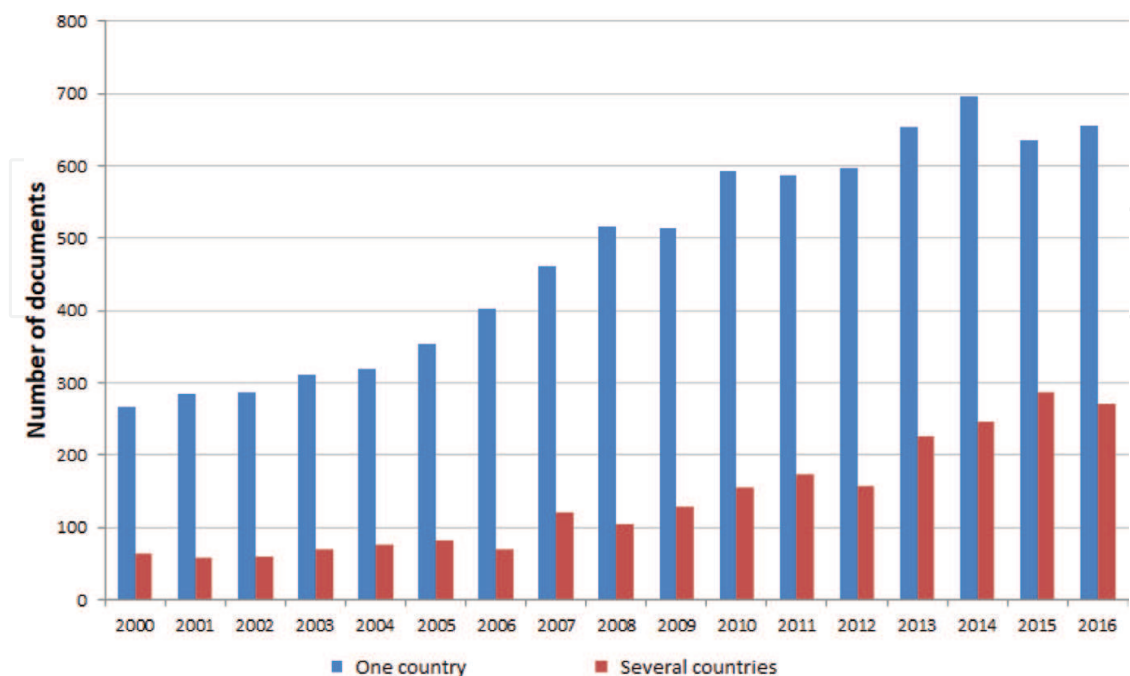

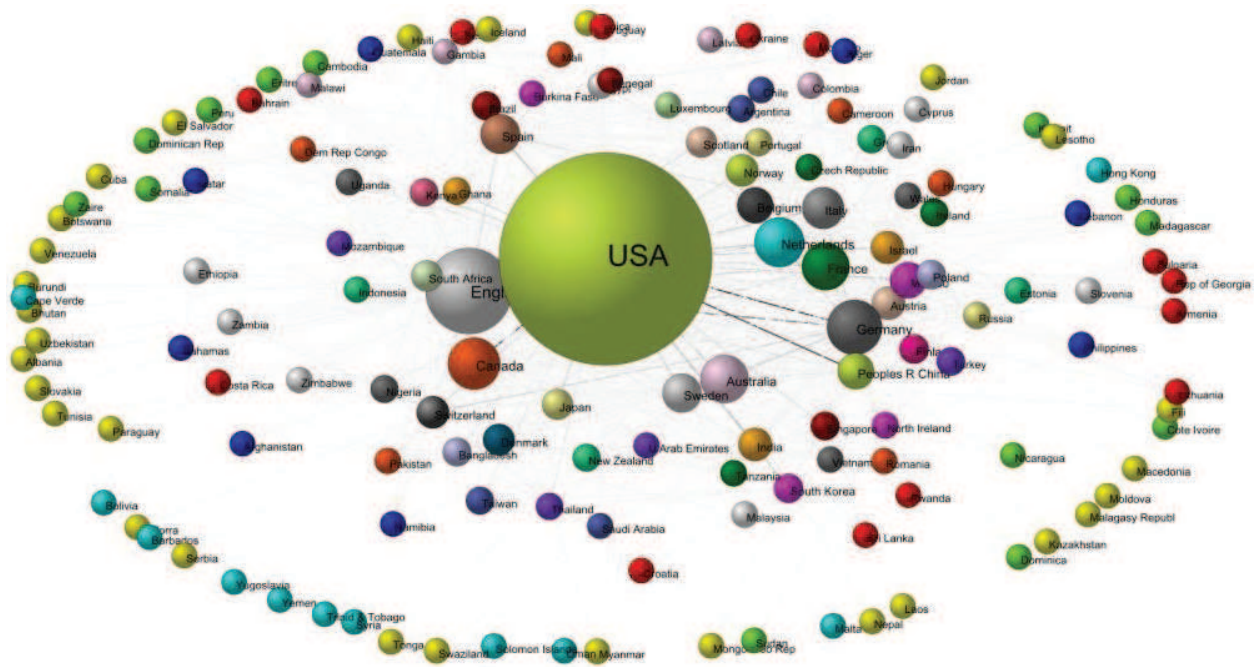**Figure 4.** Diachronic international collaboration in demography 2000–2016.

Figure 5. General network for international collaboration in demography 2000–2016.

3.2. Collaboration in the category urban studies

In this category, the documents ranged from 1015 in the year 2000 to 2170 in 2016, so that production has doubled since the beginning of the period studied (**Figure 6**). Initially, the percentage of documents signed by only one author (54.58%) was slightly higher than the one for multi-authored documents (45.42%). These values have varied along the years, with the proportion being reversed in 2016, reaching 68.89% for multi-authorship and 31.11% for single authorship. Since 2005, the number of multi-authored documents prevails, showing a continued growth. The average of authors is 2.06 authors per document ($SD = 1.27$). There is a correlation between the total production of the documents and those of multi-authorship with a positive significance ($.926$, $p < .01$).

Indicators suggest that this collaboration has increased in the period. The DC increased from 0.45 to 0.69, while the CI varied from 1.67 in 2000 to 2.43 in 2016 (**Table 2**). Globally for the interval analysed, the value of DC = 0.813 and CI = 2.07.

Figure 7 shows that the 89.12% of the documents from the *Demography* category are signed by one, two or three authors. A total of 40.89% of the papers have only one author, while articles with four or less authors only represented 10.88%.

Between 2000 and 2016, the *Urban Studies* category received 377,473 citations. The average is that every document in the sample has been cited 15.6 times ($SD = 29.27$). A total of 11.14% of the documents have never been cited.

The multi-authored documents received 61.8% of the citations, while those written by a single author received 38.2%. According to the number of authors, the highest citation is received by papers signed by a single author, followed by those of two and three authors, all of whom
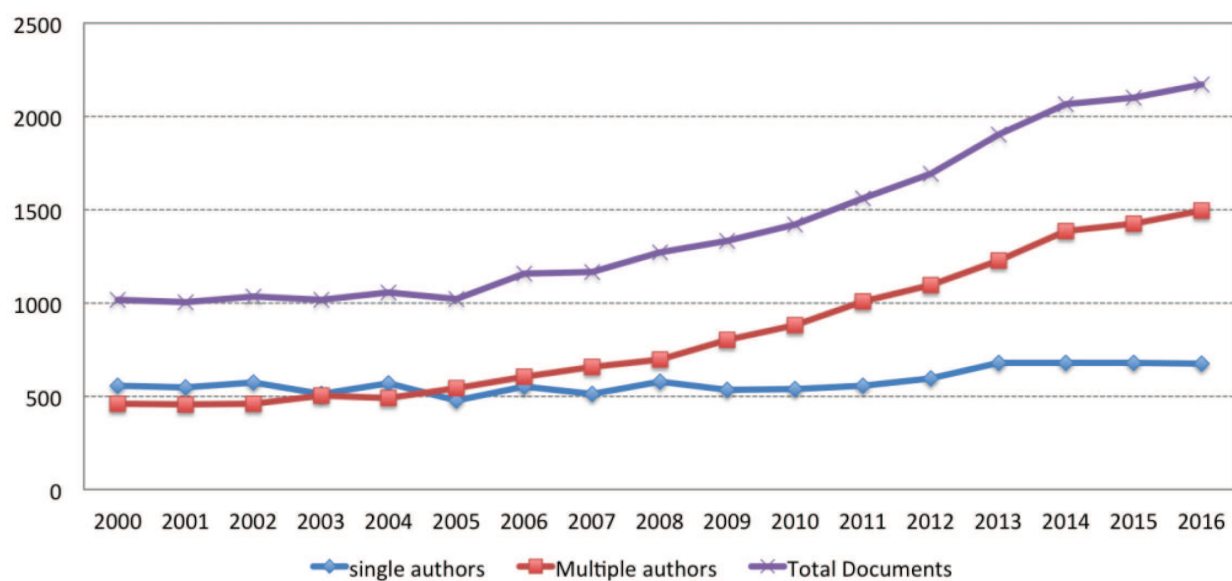
Figure 6. Diachronic type of authorship in the category urban studies.

Year	DC	CI
2000	0.45	1.67
2001	0.45	1.68
2002	0.44	1.69
2003	0.50	1.76
2004	0.46	1.75
2005	0.53	1.86
2006	0.52	1.86
2007	0.56	1.97
2008	0.55	1.91
2009	0.60	2.04
2010	0.62	2.09
2011	0.65	2.16
2012	0.65	2.19
2013	0.64	2.21
2014	0.67	2.31
2015	0.68	2.40
2016	0.69	2.43

Table 2. Degree of collaboration and collaboration index in the category urban studies.

received 88.31% of the citations (**Figure 8**). Data present a high correlation between citation and number of signatory authors, with a Pearson's correlation coefficient of 0.892 (p = .00) for the category *Urban Studies*. Citation-DC correlation coefficient was 0.878 (p = .00) which is an evidence of strong correlation between both variables. It is evident that for documents signed by more than four authors there is a decrease in the number of citations received. Seven articles received more than 500 citations.

The most cited document has 2004 citations and is signed by 2 authors.

For the international collaboration, only 23,577 registers were considered for being the only ones that incorporate information about authors' affiliation. The authors were affiliated to institutions of 133 countries.

The documents of the category *Urban Studies* were mostly written by authors affiliated to the same country, in fact only 16.12% of the documents were written in international collaboration. **Figure 9** shows these results analysing the international collaboration along the period. We can see an increase in this collaboration since 2010, resulting in this tendency being slightly lower than the one found for *Demography* sample. It is remarkable that the category *Urban Studies* involved less countries than *Demography* which led to a less collaboration among countries.

Only 9 countries out of 133 contributed with documents without international collaboration (*Algeria, Azerbaijan, Bolivia, Hong Kong, Morocco, Sudan, Tunisia, Uruguay, Yugoslavia*) that do
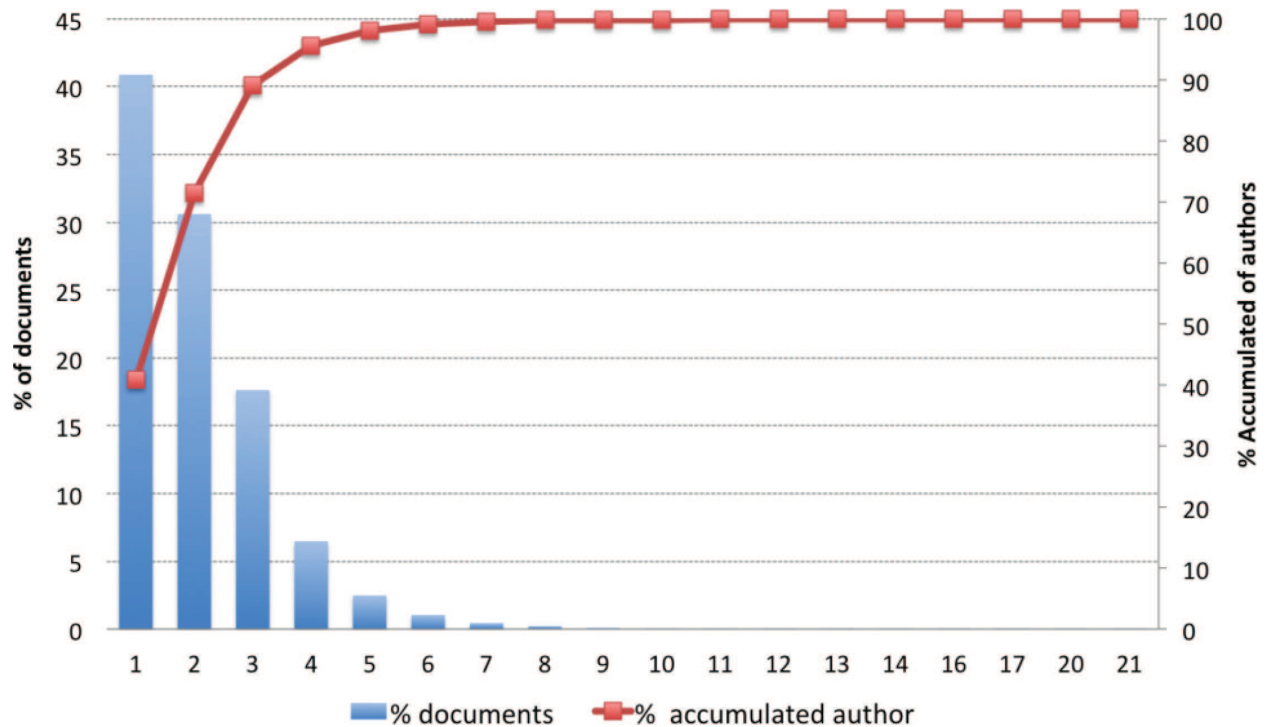

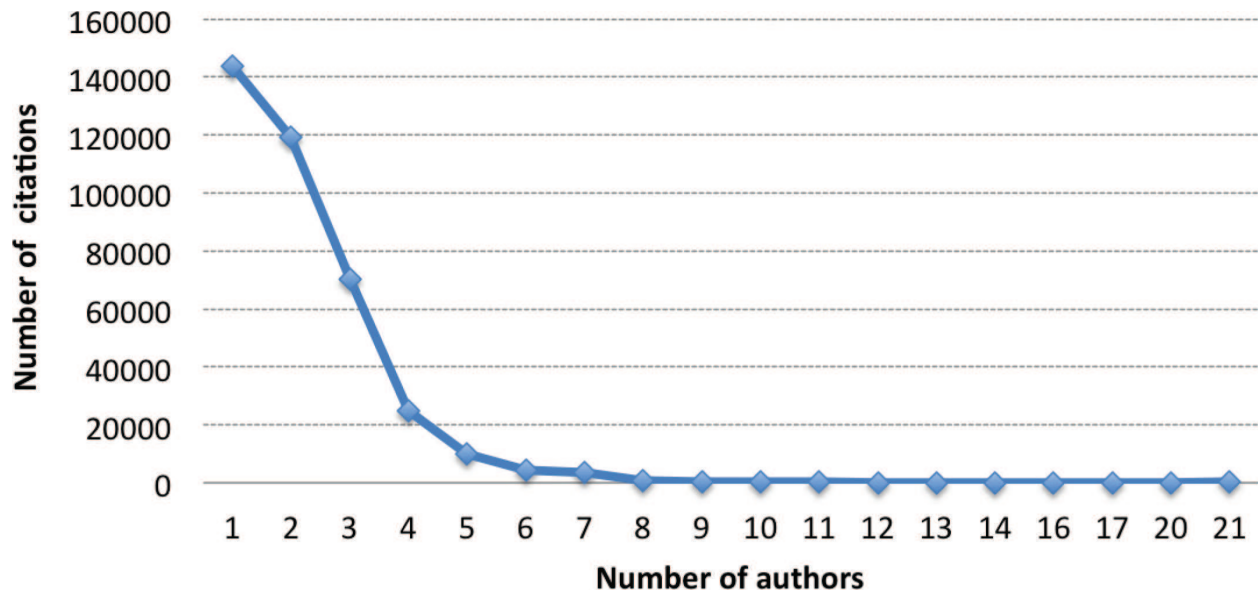**Figure 7.** Co-authored distribution in urban studies (2000–2016).

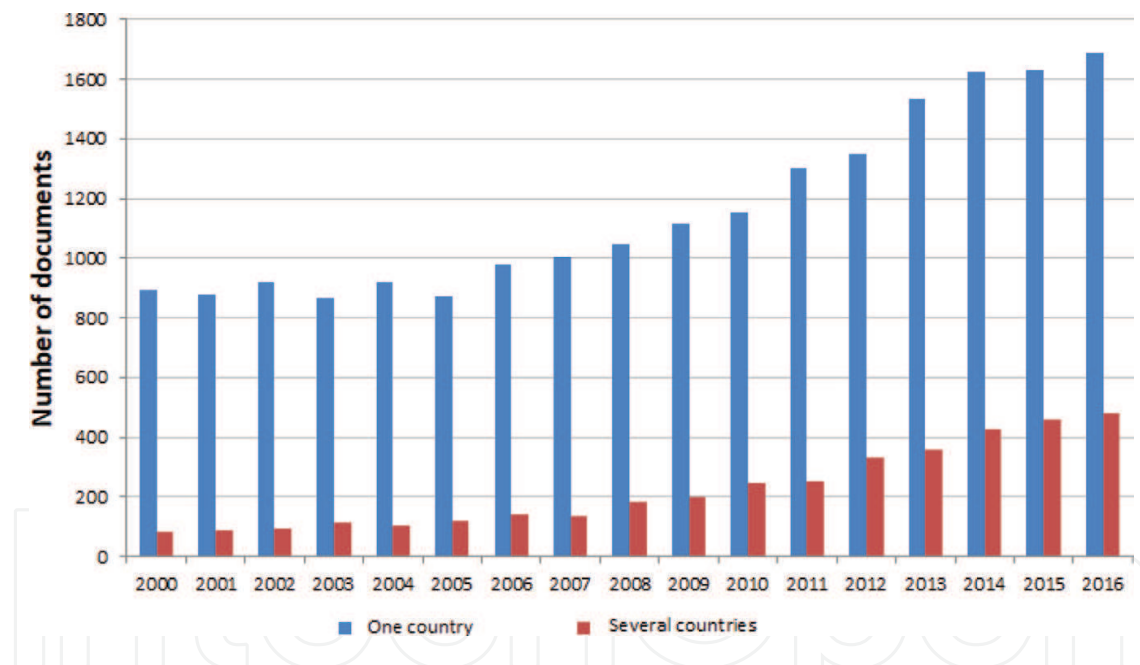**Figure 8.** Citation by number of authors in urban studies 2000–2016.

Figure 9. Diachronic international collaboration in urban studies 2000–2016.

not collaborate with other countries in the sample. The country with most co-authorship with other countries in the world is the *USA*, collaborating with 81 countries. A total of 49.62% of the countries (66) have relationships with a maximum of 5 other countries.

France, Canada, the Netherlands, England and the *USA* are the countries collaborating with more than 50 other countries in the category.

The network depicted in **Figure 10** shows a general view over the country network for *Urban Studies* considering all the period. The density of the network is 0.09808612, higher than the one found for *Demography* which also indicated that the network is dense for social sciences. The average degree of the countries is 12.9473.

There are 861 collaborations detected, most of them being anecdotal; 44.83% of these collaborations appear only once which means that these 2 countries only co-write 1 document in the whole period. The most prolific relationships among countries are found to be between *People's Republic of China* and the *USA, Canada* and the *USA* and *England* and the *USA* with more than 100 documents shared by each.

3.3. Comparison between the categories demography and urban studies

Comparing the number of journals indexed in JCR for the two categories analysed, it can be seen that *Demography* accounts for 68.4% of the number of journals for *Urban Studies* and its production only represents 47.36% of the second. In both categories, the percentages of multi-authored documents have very similar values with minor differences around l% (**Table 3**).

Throughout 2000 and 2016, the citation in *Urban Studies* has been increasing with an exponential behaviour ($R^2 = 0.9712$) as well as the number of multi-authored articles ($R^2 = 0.8214$). However, the category *Demography* behaves differently, the increase in citations has a logarithmic behaviour ($R^2 = 0577$) and the number of articles written in collaboration represents a linear model ($R^2 = 0.9557$) (**Figure 11**). This relationship between the citations received and the number of multi-authored documents in the two categories (*Urban studies: Pearson's coeff.* 0.892, $p = .00$; *Demography: Pearson's coeff.* = 0.709, $p = .001$) is in agreement with that found in other studies in which it has been shown that co-authorship has a tangible effect on the impact of the citations [41, 42].

It is remarkable that, for *Demography*, DC values have always been higher than 0.5; in addition, DC values are similar to those obtained for some other research fields of social sciences such as *basic psychology* between 1926 and 2005 [43]. There is a linear dependency between
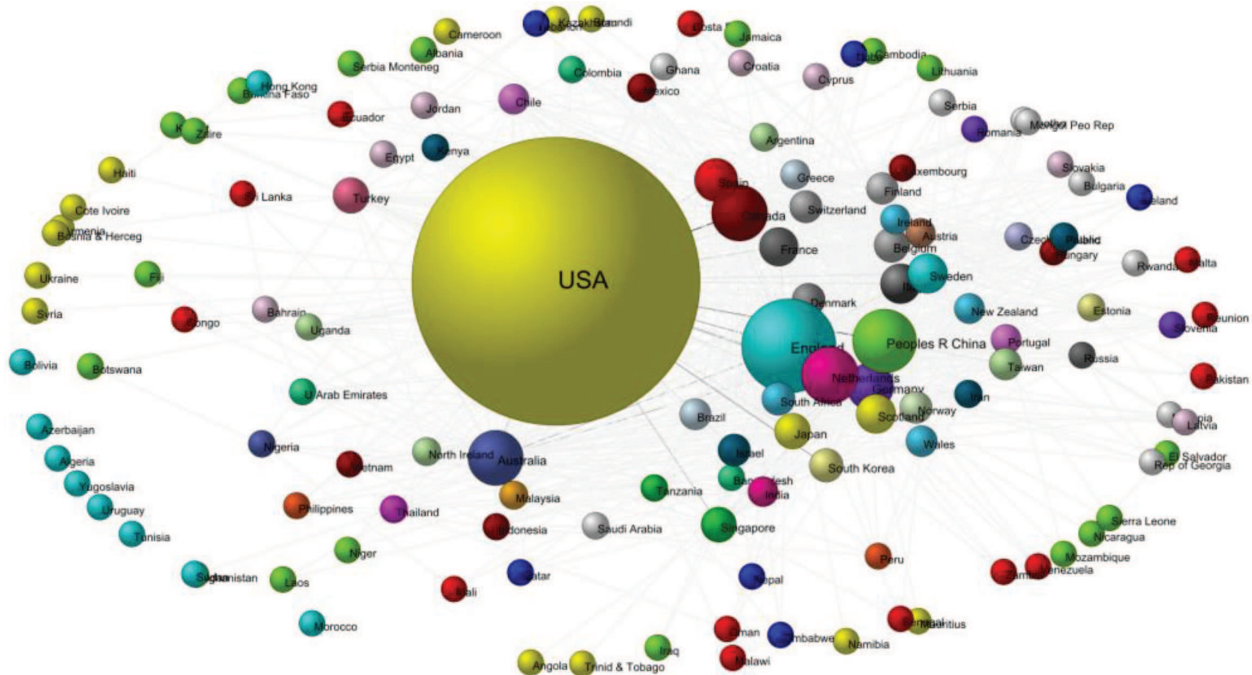

Figure 10. General network for international collaboration in urban studies 2000–2016.

Category	Demography	%	Urban Studies	%	Total
Journals	26	40.62	38	59.38	64
Documents	11,361	32.13	23,988	67.87	35,349
Multi-authored documents	6869	32.62	14,188	67.38	21,057
Single-authored documents	4492	31.40	9810	68.60	14,302
Authors per document	2.15		2.06		
DC	0.605		0.591		
CI	0.591		2068		
Citations	147,024	28.03	377,473	71.97	524,497
Citations/paper	12.94	87.25	15.73	14.83	14.83

Table 3. Demography versus urban studies multi-authorship (2000–2016).
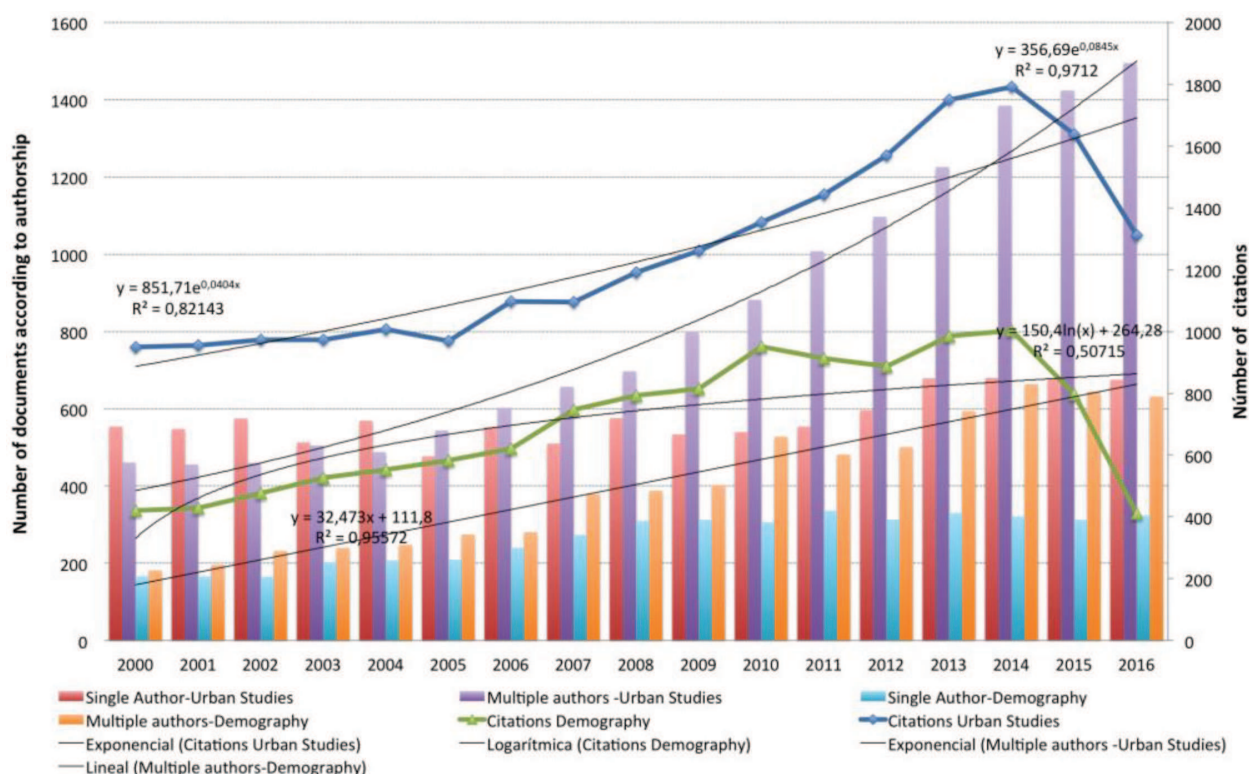

Figure 11. Citations and number of documents according to authorship.

DC values and citations which is found to be high for *Urban studies* category (*Pearson's coeff.* = 0.878, *p* = .00) and moderated for *Demography* category (*Pearson's coeff.* = 0.542, *p* = .025).

Focusing on the international collaboration, it is shown that both categories have similarities such as a high percentage of documents assigned to a single country. Moreover almost the half of the collaboration produced are no kept across time and frequently end in sporadic

connection between countries. The category *Urban Studies* present less countries despite the fact that it involved more documents than *Demography*.

Analysing DC values and citation in relation with international collaboration, it is found that the linear dependency between them is higher when international collaboration is involved, being the correlation coefficients 0.922 (p = .00) for *Urban studies* and 0.933 (p = .00) for *Demography*.

The USA is the most prolific country in both categories, whereas minority countries or countries of emerging economies are residual in *Demography* but relative important in the category *Urban Studies*. This could be explained by the fact that *Urban Studies* it indexed more journal in the sample with a wider regional scope.

The ranking of the most productive and collaborating countries is clearly dominated by English countries in both categories.

4. Conclusions

It has been verified that, in the period 2000–2016, there is a predominance of documents written in multi-authorship in the categories *Demography* and *Urban Studies*. Likewise, the number of documents in collaboration has been increasing proportionally to the total production. The highest values in the collaboration indicators, DC, CI have been reached in the most recent years, showing a tendency to continue increasing. This increase in the number of citations in relation to the increase in the number of authors per article shows a similar pattern to those found for other branches of knowledge closer to the hard sciences.

Despite these results, the international collaboration is not so high, compared to author collaboration, which means that a great portion of the multi-authored documents are written by authors affiliated to institutions of the same country.

The analysis of the scientific production of these two scientific categories in social sciences, *Urban studies* and *Demography*, has confirmed the findings of previous studies [44, 45] stating international collaboration in science is growing rapidly. This international collaboration has a correlation with the increase in the citation of multi-authored publications. The internationalisation of science in these two categories is largely due to the collaboration of researchers from the USA, England and Canada.

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