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**Title:** The rise in co-authorship in the social sciences (1980-2013)

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### **Abstract**

This article examines the rise in co-authorship in the Social Sciences over a 34-year period. It investigates the development in co-authorship in different research fields and discusses how the methodological differences in these research fields together with changes in academia affect the tendency to co-author articles. The study is based on bibliographic data about 4.5 million peer review articles published in the period 1980-2013 and indexed in the 56 subject categories of the Web of Science's (WoS) Social Science Citation Index (SSCI). The results show a rise in the average number of authors, share of co-authored and international co-authored articles in the majority of the subject categories. However, the results also show that there are great disciplinary differences to the extent of the rises in co-authorship. The subject categories with a great share of international co-authored articles have generally experienced an increase in co-authorship, but increasing international collaboration is not the only factor influencing the rise in co-authorship. Hence, the most substantial rises have occurred in subject categories, where the research often is based on the use of experiments, large data set, statistical methods and/or team-production models.

**Keywords:** co-authorship; social sciences; research collaboration; bibliometrics

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## Introduction

Research collaborations are an essential part of academic life, and the lone scholar in the ivory tower is a rare phenomenon, even in the social sciences. In some scientific fields, such as high energy physics and biomedicine, research collaboration is a well-documented fact of life (Cronin 2004). The tendency to co-author is spreading, and the number of authors is not only increasing in the physical and life sciences (Cronin 2001; Wuchty et al. 2007), but also in the social sciences (Ossenblok et al. 2014). However, when the number of authors in the byline increases, it becomes difficult to identify the individual contribution.

This article explores the extent to which formal research collaboration has risen in the fields of social sciences by investigating the rises in the share of co-authorship and number of authors in the disciplines of the social sciences. The study is based on all the articles registered from 1980-2013 in the 56 subject categories of Web of Science's (WoS) Social Science Citation Index (SSCI).

Research collaboration is in this article understood as co-authorship. Thus, it is assumed that collaboration is visible by co-authorship and that the co-authors are in fact collaborators. This article uses the concept formal research collaboration to emphasize that we are focusing on the kinds of collaborations that are visible in the form of co-authorship, which is measurable using bibliometric methods in bibliographic databases. The study does not cover informal collaborations, which often consist of sharing ideas, discussions or comments of papers. These contributions are often invisible in the bibliographic databases, since they are not consummated in the form of co-authored publications. Thus, they are not measurable using bibliometric methods (Laband and Tollison 2000; Laudel 2002). Although co-authorship is only a partial indicator for research collaboration, it is still considered the best proxy for studying research collaboration quantitatively (Corley and Sabharwal 2010).

Authorship is an essential element in the scholarly communication system and fulfills multiple functions in academia. The scholarly communication system is linked to the reward system, and the publication process combines the elements reward, responsibility, and recognition (Cronin 1984; Whitley 1969). Authorship is an essential link, since it is in the publication process that researchers take ownership and responsibility of knowledge claims as well as demonstrating the originality and value of their work. The work is incorporated in the scholarly communication system by referencing and recognizing the preceding work of others. It is by authoring a publication the researchers attribute credit and enable the accrual of reputation in the reward system, and this reputation is influential in the considerations for employment, promotion, funding and increases in salary (Costa and Gatz 1992; Weingart 2005; Biagioli 2012).

The academic reward system is based on the academic norms that it is possible to identify and assign the individual intellectual responsibility of a piece of scientific work (Merton 1973). But with the increasing number of authors per publication it becomes more difficult to identify the contribution of the individual researcher, and it dilutes the intellectual responsibility and questions the idea that authorship is a measure of intellectual achievement (Cronin 1984; De Bellis 2009). Furthermore, if the contribution of the individual cannot be identified, it seriously challenges the use of publications and citations in research evaluations. If we do not know "who speaks", then who can claim the intellectual property over a published idea, as well as "who is awarded for what part of the work" of the cited document (De Bellis 2009). There have been multiple studies investigating the citing behavior and motives of researchers (Vinkler 1998; Wouters 1999; Bornmann and Daniel 2008), but because of the increases in average

number of author it is necessary to go one step further and discuss this in relation to “who is the author”. Particularly since the author is the point of departure of bibliometric studies, and therefore the giver and receiver of citations. Previous studies of publication, citation and authorship behavior reveals that the academic norms do not necessary fit the reality, especially when the number of authors increases (Birnholtz 2006; Vinkler 1993; Marusic et al. 2011). Hence, is the researcher included as a co-author because of the contribution to the research or is it a matter of honoring a senior researcher, repaying favors or validating the importance of the publication by adding a well-known name.

This is especially an important question with the rising tendency to measure and assess researchers on their quantitative research output instead of its’ content, which seems to affect researchers’ publishing behavior, including their definitions, perceptions and practices of authorship (e.g. Ossenblok et al. 2012). Thus, it creates incentives to “game” the system to improve one’s resume by co-producing publications. Especially when the performance-based research funding systems use whole counts instead of fractionalizing (Ossenblok et al. 2014; Butler 2003), so the reward for producing a publication does not have to be shared.

However, the rise in co-authorship is also affected by other factors that influence the research community. It can be because of an increasing tendency to collaborate in the social sciences. For example, research is to a greater extent performed in large scale research projects executed as team-production models (Laband and Tollison 2000). These projects require greater human and financial resources, a larger data collection effort, and often more advanced technical and statistical analyses. Hence, they lead to more specialization and division of labor in the research process (Birnholtz 2006; Fisher et al. 1998; Cronin et al. 2003; Beaver 2001). These types of projects are often associated with natural and life sciences, where there is a strong tradition for working in the team-production model. Nevertheless, the increasing tendency to work with large scale data sets, the rise in using quantitative methods and in some cases experiments have generated a similar team-production model in the social sciences (Moody 2004; Cronin et al. 2003). In addition, studies have found that researchers in the more quantitative research areas of social science are more likely to collaborate (Fisher et al. 1998; Pontille 2003).

Others have pointed to the increasing mobility of researchers that has made it possible and desirable to expand inter-institutional collaborations (Melin 2000; White et al. 1982). Furthermore, the development of communication and information technology have enabled geographically disperse researchers to collaborate, by making it easier to communicate, analyze and exchange data (Fisher et al. 1998; Beaver 2001; Melin 2000), and the average collaboration distance per article have also increased in the social sciences during the last decade (Waltman et al. 2011).

Furthermore, the growing number of people working in academia has created more collaboration opportunities (Lee 2000; Melin 2000). Specially the increases in PhD students have created more opportunities for research advisors to collaborate and co-author with their students (Price et al. 2000). However, this tendency has led to issues regarding gift authorship in academia and some studies suggest that research advisors may inappropriately demand co-authorship with their students (Lissoni et al. 2013). This is disputed by Costa and Gatz (1992), who found that students willingly were giving their advisors inappropriate authorship credit even though the advisors do not fulfill the journal guidelines and requirements for co-authorship. However, they do suggest that the willingness

to offer co-authorship can be affected by a power imbalance between advisors and advisees, especially because more PhD students are subsidized by grants held by their advisors.

The examples of gift authorship illustrate how research collaboration and co-authorship are not necessarily synonymous, though these concepts are often treated this way in the literature. Some co-authored publications are created based on a peripheral collaboration between the researchers (Katz and Martin 1997), and the contributions of the authors of the publications are of various degrees, and one should be careful about treating them as an objective unit in bibliometric evaluations.

The rise in co-authorship has been documented in numerous social science research fields, such as economics (Laband and Tollison 2000), sociology (Pontille 2003; Leahey and Reikowsky 2008), political science (Fisher et al. 1998), psychology (Cronin et al. 2003), public administration (Corley and Sabharwal 2010), nursing (Norris 1993) and education (O'Neill 1998). Other studies investigate the rise in co-authorship in multiple research fields (Ossenblok et al. 2014; Wuchty et al. 2007; Lariviere et al. 2006). These bibliometric studies vary in design, but most of them can be categorized as being based on either bibliographic data from a national database (Lariviere et al. 2006; Ossenblok et al. 2014) or a selection of journals (Fisher et al. 1998; Cronin et al. 2003; Laband and Tollison 2000). Wuchty et al. (2007) is one of the few studies, that has examined the increase in co-authorship by using bibliographic data about research articles from multiple fields collected from the subject categories in WoS. However, Wuchty et al. (2007) do not specify the number of articles in their study that are indexed in either Science and Engineering, Social Sciences, and Arts and Humanities. Thus, the extent of the social science sample is unknown. Furthermore, the study does not reveal how much the number of authors per article has increased in the individual subject categories, but only at the major category level.

This article is the first study of the rise of co-authorship in the social sciences that uses a large sample of time series data based on all of the articles in the subject categories of SSCI. Thus, the study covers multiple research fields of the social sciences and the data set is not biased by national publication tendencies or selection of journals. The disadvantage of a data set restricted to articles from SSCI is that other publication types and a substantial share of journals are excluded (Piro et al. 2013; Ossenblok et al. 2014). Furthermore, the rise of co-authored book chapters have been found to be substantial smaller than the co-authored articles (Ossenblok et al. 2014). However, the larger data sample should to some degree compensate for these data limitations and it will be taken into consideration in the discussion of the results.

This article documents the evolution of co-authorship in the research fields of social science, and it is a substantial revised and expanded version of the study presented at and published in the proceeding of the 15<sup>th</sup> International conference on Scientometrics and Informetrics conference (Henriksen 2015). In this article, the extent of increase in the number of authors per article, share of co-authored and international co-authored articles will be examined for each of the 56 SSCI subject categories. The article will investigate which research fields have experienced the greatest increase in co-authorship, and it will conclude with a discussion of the factors that could influence these increases.

## Method and data collection

The bibliometric data used in this study were collected from the Centre for Science and Technology Studies (CWTS) enhanced version of Thomson Reuters' WoS database in December 2014. The data contained bibliographic information about 4,466,134 articles from 99,752 journal issues published in 1980 to 2013 and registered in WoS' SSCI 56 subject categories. The indexed journals can be registered in more than one of these subject categories. These 56 subject categories have in this analysis been grouped into 6 overall subject categories.

The grouping of the categories is based on the topics of each subject category described in the SSCI scope notes (SSCI 2012). Hence, there are differences in how many categories there has been group together, and the similarity of the research areas. The Social Sciences, Interdisciplinary group consist of a variety of subject categories and do not have the similar thematic relationship as the other groups. Table 1 presents the grouped categories and the number of articles in each category.

**Table 1 The group subject categories of SSCI**

Insert table 1

This study limits the relevant types of publications to journal articles, though we know that the publication pattern in the social sciences is more varied than the sciences (Lariviere et al. 2006; Ossenblok et al. 2014), thus letters, book chapters and books are an essential part of the scholarly communication in some fields of the social sciences. Unfortunately, the Thomson Reuters Book Citation Index (BCI), part of the WoS core collection, do not have as systematic and exhaustively bibliographic information about books compared to the SSCI's information about journal articles. The BCI do only cover the time period from 2006-present, while SSCI have bibliographic data from 1900 to present, so by choosing to only include journal articles we can set a larger time frame for this study.

In the following sections is presented the time series data showing the increase in the number of authors per articles, share of co-authorship and international co-authorship. For each group we will present two figures demonstrating the evolution in the share of co-authorship and the mean number of authors in the different subject categories. The share of co-authorship is calculated as the percentage of articles per year with 2 or more authors. The share of international co-authorship is calculated as the percentage of articles per year with 2 or more authors and with 2 or more countries in the address field. The mean number of authors is calculated by the dividing the number of articles per year by the number of authors per year. The median number of authors for each category will be mentioned in the results section and is represented in the Appendix A1. To enable a clear presentation of the evolution in co-authorship, the figures will only present data from the following publishing years: 1980, 1985, 1990, 1995, 2000, 2005, 2010 and 2013.

## Results

### Management, Planning & Geography

Insert Fig 1a

**Fig 1a Mean number of authors per article Management, Planning & Geography**

Insert Fig 1b

### **Fig 1b Share of co-authorship Management, Planning & Geography**

Insert Fig 1c

### **Fig 1c Share of international co-authorship Management, Planning & Geography**

Figure 1a, 1b and 1c shows the rise in the mean number of authors, the share of co-authored articles and the share of international co-authored articles in the six categories group as Management, Planning & Geography (see Table 1 for details about the categories). Co-authorship has been increasing in all categories. The percentage of co-authored articles have in the categories of this group risen by 34.5%-49.8%, hence the majority of the articles are produced in collaboration in 2013 (62.6%-88.4%). The category Transportation has the highest increases in this group in the share of co-authored articles (from 38.6% to 88.4%) and in the mean number of authors (from 1.6 to 3.1 authors) during the 34 years. Generally, the mean number of authors has in all the categories increased by 0.8-1.6 authors (figure 1a.) during the 34 years, starting with the mean number of authors in 1980 being in the range of 1.3-1.6 authors per article and then increasing to 2.1-3.1 authors per article. The median number of authors is 1 in all categories in 1980 (see appendix A1). In 2013 the median number of authors has risen to 3 in the category Transportation, while the remaining categories have a median of 2. The share of international co-authored articles have risen from 2.7%-4.8% in 1980 to 18.6%-29.8% in 2013 (Figure 1c). Thus, a greater share of the articles are created in international collaborations, however the majority of the articles are still produced of co-authors from the same country.

The category Transportation does not cover civil engineering per se, but the close relation with the above mentioned research field can explain some of the increase in co-authorship in this category. The subject categories in this group have all similarities to research fields in science and technology, and are probably influenced by collaboration and publication tendencies dominating the sciences.

### **Political Sciences, Business and Law**

Insert Fig 2a

### **Fig 1a Mean number of authors per article Political Sciences, Business & Law**

Insert Fig 2b

### **Fig 2b Share of co-authorship Political Sciences, Business & Law**

Insert Fig 2c

### **Fig 2c Share of international co-authorship Political Sciences, Business & Law**

Figure 2a, 2b and 2c shows the rise in the mean number of authors, the share of co-authored articles and the share of international co-authored articles in the eight categories group as Political Sciences, Business and Law (see Table 1 for details about the categories). The percentage of articles being co-authored have increased in all categories (figure 2b.), though there are clearly differences in the amount of increases and the level of co-authored articles. The three categories Political science, Law and International Relations experience an increase in the share of co-authored articles from 9.9%-12.8% in 1980 to 32-37.6% in 2013, while in the remaining categories the share of co-authored articles in 1980 are between 21.7%-28.8%, and rises to 63.1%-78.5% in 2013.

The mean numbers of authors are between 1.1 - 1.4 in 1980 to 1.5 - 2.6 in 2013 (see figure 2a). The two categories Criminology & Penology and Business have both increased the mean number of authors by 1.2 authors, but the share of co-authorship is almost 10% higher in Business, indicating a greater tendency for co-authorship in Business. The median numbers of authors increases from 1 to 2 authors during the 34 years in the categories Business, Business, Finance, Economics, Criminology & Penology and Public Administration, while in the remaining three categories the median number of authors is constantly at 1 author (see appendix A1).

Figure 2c show the increase in international co-authored articles. The categories Law and Criminology & Penology have only 0.4%-0.6% international co-authored in 1980, and this increases to 8.2%-14.2% in 2013. The categories Business, Business, Finance, Economics, International Relations, Political Science and Public Administration have from 1.2%-5.9% in 1980 and this increases to 11.8%-30.7% in 2013.

The greater rise in mean number of authors in the categories Criminology & Penology, Business, Business, Finance, Economics, and Public Administration could be because of the greater use of statistics and register/survey data (Fisher et al. 1998; Hudson 1996). These categories have also the greatest share of international co-authored articles in this group. Political Science is the category in this group with the highest amount of articles (n = 172,625) and covers a broad range of research, thus the lower increase and mean number of authors is probably because areas of Political Science have similarities with research fields in the humanities. The same is the case for the category Law that draws on methods often associated with humanities, such as text analysis.

## **Psychology**

Insert Fig 3a

### **Fig 2a Mean number of authors per article Psychology**

Insert Fig 3b

### **Fig 3b share of co-authorship Psychology**

Insert Fig 3c

### **Fig 3c share of international co-authorship Psychology**

The figures 3a, 3b and 3c shows the rise in the mean number of authors, the share of co-authored articles and the share of international co-authored articles in the eleven categories grouped as Psychology (see table 1 for details). The percentage of co-authored articles is lowest in the category Psychoanalysis Psychology, where the share of co-authored articles are 20.5% in 1980 and rises to 32.7% in 2013. The percentage of co-authored articles in Psychoanalysis Psychology goes both up and down during the time period, but during the last 10 years the amount of co-authored articles stays between 25%-35%. In the remaining 10 categories the percentage of co-authored articles are between 47.5%-65.5% in 1980 and increases to 82.2%-92.1% in 2013.

Generally there is a great and still increasing tendency to co-author in the 10 categories. All the categories have experienced an increased in the mean number of authors (figure 3a.). The mean numbers of authors are between 1.4-2.3 authors in 1980, and have increased to 2-5.3 authors in 2013. Psychoanalysis is both the category with the lowest share of co-authorship and the lowest increase in mean number of authors (0.6 authors). Furthermore it is the only category in this group where the median remain constant at 1 author (appendix A1). In the



other end of the scale we have Psychiatry, where the mean number of authors in 1980 is 2.3 and increases to 5.3 authors in 2013, while the median increases from 2 to 5 authors. Mathematical Psychology have constantly had a median at 2, while Applied Psychology have had an increase in the median number of authors from 1 to 3 and Clinical Psychology have had an increase in the median number of authors from 2 to 4. Experimental Psychology, Social Psychology, Educational Psychology, Development Psychology, Biological Psychology, and Multidisciplinary Psychology have had an increase in the median number authors from 2 to 3 authors.

Figure 3c shows that the share of international co-authored articles for the group psychology in 1980 is between 1%-3.5%. The lowest rise in international co-authored articles occurs in the category Psychoanalysis, where it rises to 7.1% during the 34 years. In the remaining categories it rises to be between 16.2%-27% in 2013.

The increases is greatest in the subject categories, where the research is mainly based on experiments, larger data set and quantitative methods, and where there is a lot of interdisciplinary collaboration opportunities with medical scientist. Furthermore, these categories also have the greatest rise in international collaboration. The subject categories with the lowest increase have more methodological similarities with the humanities, and for example Psychoanalysis has a very low share of international co-authored articles.

### **Social Health Sciences**

Insert Fig 4a

#### **Fig 4a Mean number of authors per article Social Health Sciences**

Insert Fig 4b

#### **Fig 4b Share of co-authorship Social Health Sciences**

Insert Fig 4c

#### **Fig 4c Share of international co-authorship Social Health Sciences**

The eight categories of the group Social Health Sciences (see table 1 for details) are presented in figure 4a, 4b and 4c, and show a rise in the mean number of author, the share of coauthored articles and share of international co-authored articles. The percentages of co-authored articles have risen from 28.9%-63.2% in 1980 to 83.7%-94.3% (figure 4b.). The degree the share of co-authored articles have risen within the categories varies a lot, and in some cases such as the categories Health Policy & Services and Nursing the share of co-authored articles have increased by more than 50%. Furthermore, the mean numbers of authors per article in the Social Health Sciences categories have risen between 104% to 176% or 2-2.6 authors. In 1980 the mean numbers of authors are between 1.4-2.5 authors and increases in 2013 to 3.5-5.1 authors (figure 4a.). Figure 4a shows how there have been substantial increases in all seven subject categories during the 34 years.

Figure 4c shows that the shares of international co-authored articles have risen from 0.6%-5.1% in 1980 to 16%-23.2% in 2013 for the categories Substance Abuse, Health Policy & Services, Public Environmental & Occupational Health, Rehabilitation, Gerontology, Ergonomics and Education, Special. The category Nursing has zero international co-authored articles in 1980, but in 1981 there is registered 0.3% international co-authored articles, and in 2013 the share has increased to 13.2%.

The median number of authors in 1980 is 1 in the categories Ergonomics, Health Policy & Services and Nursing and 2 in the categories Rehabilitation, Public Environmental & Occupational Health, Substance Abuse, Gerontology and Educational, Special. In 2013 the median numbers of authors have risen to 3 authors in Ergonomics, Nursing and Education, Special and to 4 in the remaining categories (Appendix A1). The average numbers of authors are general quite high in Social Health Sciences compared to other subject categories in the Social Sciences and the subject categories have a publication and collaboration pattern similar to the health and life sciences.

### **Sociology and Anthropology**

Insert Fig 5a

#### **Fig 5a Mean number of authors per article Sociology & Anthropology**

Insert Fig 5b

#### **Fig 5b Share of co-authorship Sociology & Anthropology**

Insert Fig 5c

#### **Fig 5c Share of co-authorship Sociology & Anthropology**

Figure 5a, 5b and 5c presents the evolution of the mean number of authors, share of co-authorship and share of international co-authorship in the ten categories of the group Sociology and Anthropology. The share of co-authored articles is in 1980 between 4.3%-42.6% and increases to 16.3%-74.4% in 2013. The categories Anthropology, Social Work, Education and Educational Research, Women's Studies, Demography and Sociology all increases the share of co-authored articles to more than half of the articles, while the two categories Social Issues and Ethnic Studies are just above 40%. The lowest share of co-authored articles in this group is in the remaining two categories Area Studies and Cultural Studies. The shares of international co-authored articles are in 1980 between 0.4%-7.2% and increases to 9%-24.6% in 2013. Especially Anthropology and Demography have a high share of international co-authored articles in the same range as can be found in the categories of the groups Social Health Sciences and Psychology.

The mean numbers of authors have in these last mention categories changed minimal from 1-1.1 in 1980 to 1.2-1.3 in 2013. The mean numbers of authors have in the categories Sociology, Social Issues and Ethnic Studies raised from 1.1-1.4 authors to 1.8-1.9 authors. In the remaining categories Education & Educational Research, Anthropology, Social Work, Women's Studies and Demography the mean number of authors have increased from 1.4-1.6 authors in 1980 to 2.2-2.9 authors in 2013. During the 34 years the median number of authors has risen from 1 to 2 authors for Education & Educational Research, Anthropology, Social Work, Sociology, Women's Studies and Demography, while it has stayed at one for the remaining four categories. (Appendix A1).

### **Social Sciences, Interdisciplinary**

Insert Fig 6a

#### **Fig 6a Mean number of authors per article Social Sciences, Interdisciplinary**

Insert Fig 6b

## Fig 6b Share of co-authorship Social Sciences, Interdisciplinary

Insert Fig 6c

## Fig 6c Share of international co-authorship Social Sciences, Interdisciplinary

Figure 6a, 6b and 6c presents the evolution of co-authorship in the thirteen categories in the group Social Sciences, Interdisciplinary (see table 1 for details about the subject categories). As mention in the methods section the categories in this last group do not have the similar thematic relationship as the other groups. History is the category with the lowest share of co-authorship with 6.3% articles in 1980 and 10.5% articles in 2013. The categories History & Philosophy of Science and History of Social Sciences have 8.4%-14.1% articles co-authored in 1980 which increases to 28.8%-29.9% in 2013. The category Ethics experiences a substantial increase from the lowest share of co-authored articles (5.3%) to almost half of the articles being co-authored (44.9%). The remaining categories have a share of co-authored articles from 18.3%-56% in 1980 that rises to 51.6%-82% in 2013.

Figure 6c demonstrates how the shares of international co-authored articles also have risen in the 34 years. The categories Hospitality, Leisure, Sport & Tourism and Social Sciences Mathematical Methods have the highest share of international co-authored articles with over 7% in 1980 being results of an international collaboration, and this increases to 25.1% and 32.2% in 2013. In the remaining categories are there between 0.5%-4.2% being international co-authored in 1980, and this increases to 3.7%-22.7% in 2013. The category History has a very low degree of co-authored articles, both international and generally. However, international co-authorship has been increasing more since the year 2000.

The rises in the mean numbers of authors are between 6.8%-163%. The mean number of authors has a minimal change in the category History where the mean increases from 1.1 in 1980 to 1.2 authors in 2013 authors and the median remain constantly at 1 during the time period. The median also remains at 1 author in the categories History of Social Science, History & Philosophy of Science and Ethics, while the mean rises from 1.1-1.2 authors in 1980 to 1.4-1.9 authors in 2013. During the time period, the median increases from 1 to 2 authors in the categories Communication, Information Science & Library Science, Industrial Relations & Labor, Linguistics, Social Sciences, Interdisciplinary and Social Sciences, Mathematical Methods and the mean numbers of authors increases from 1.3-1.5 in 1980 authors to 2-2.5 authors in 2013.

The median is constant at 2 authors in Hospitality, Leisure, Sport & Tourism, where the mean number of authors rises from 1.8 authors in 1980 to 2.5 authors in 2013. The median increases from 1 author in 1980 to 3 authors in 2013 in the categories Family Studies and Social Sciences, Biomedical and the mean numbers of authors rises from 1.4-1.6 authors in 1980 to 3.2-3.7 authors in 2013. In this very mixed group we can see how the categories with research closest to the humanities such as History, History of Social Science, History & Philosophy of Science and Ethics have a lower rise in the number of mean authors, while the categories Family Studies and Social Sciences, Biomedical, that both are methodological close to the life and medical sciences have a substantial high rise in number of authors.

## Discussion and conclusion

This study documents the evolution in co-authorship in the social sciences over 30 years period. The results show that the majority of research fields have had substantial increases in the share of co-authored and international co-

authored articles and numbers of authors per article during the 34 years. However, there are great variations in the extent of these increases.

For example, the share of co-authored articles have increased by more than 50% in 4 out of 56 subject categories and in 20 subject categories the increase is more than 40%. In 44 out of the 56 subject categories are more than half of the articles co-authored and in 10 categories is more than 90% of the articles co-authored. Similar, the median number of authors has increased by 1 or more authors 42 out of the 56 subject categories and the mean number of authors has increased by approximately 1 author or more in 36 out of the 56 subject categories.

These results confirm the previous studies of research collaboration in the social sciences (e.g. Bebeau and Monson 2011; Ossenblok et al. 2014); there is an increasing greater tendency to collaborate, but the tendency decreases the more similar the collaboration and publication patterns in the research field is to the patterns of the fields of the humanities. An example in our data is the four subject categories History, Cultural Studies, Area Studies and History of Social Sciences where the evolution in number of authors could be categorized as status quo during the 34 years, since the increase in the mean number of authors are 0.1-0.2 and the majority of the articles are single authored. All of these four categories could also have been categorized as belonging to the humanities, since the research often are based on qualitative in-depth studies.

In the other end of the scale, we have the 10 categories Psychiatry, Health Policy & Services, Public, Environmental & Occupational Health, Substance Abuse, Gerontology, Rehabilitation, Biomedical Social Sciences, Nursing, Ergonomics and Special Education, where the increase in the mean numbers of authors are in the range of 2-3 authors and the mean number of authors is 3,8-5,3 authors. The research in all of these ten categories is related to the medical and life sciences, hence it is often based on experiments, large data set, statistical methods and/or team-production models (Norris 1993; Beaver 2001).

The results in the subject categories group Psychology show how the methodological differences can affect the collaboration patterns. The subject categories Psychology, Psychoanalysis and Mathematical are both examples of subdisciplines dominated by theory building and abstract concepts, and the methodological relationships to research fields can often be defined as belonging to the humanities. The opposite are Psychiatry and Developmental Psychology, where the research is more experimental and empirical. The research project is done in collaboration with other researchers in a team-production model, thus the different tasks of the research projects are allocated to different individuals. However, the results show that in all of the psychology categories the tendency were more collaboration and in larger groups.

During the nineties the use of new communication and information technologies increased, and as the results showed, the same did the frequency of international co-authorship. The figures in the results section show that around 1995 and 2000 there is a remarkable increase in the share of co-authored articles. This is in alignment with previous studies, that suggest that the evolution of communication technologies have influenced whether researchers co-author, because it has become easier to communicate, analyze and exchange data (Beaver 2001; Melin 2000; Fisher et al. 1998). However, the increases in international collaboration are smaller than the general increase in co-authorship.

Generally, the results show that the increases have occurred mostly in subject categories, where there is a tendency to employ quantitative research methods, experiments and labor division, which can lead to more specialization (Laband and Tollison 2000; Corley and Sabharwal 2010). For example, the subject categories Public Administration, Management, Economics, Anthropology, and Information Science & Library Science etc. Though, if these subject categories are explored on a subfield, method or topic level, the results will probably show great differences in the increase in co-authorship, and it will be possible to confirm or disconfirm if these factors influence the increases.

An additional hypothesis for the rise in co-authorship in the majority of the subject categories is the increasing tendency for supervisors to co-author with students (Fisher et al. 1998; Price et al. 2000; Costa and Gatz 1992). Perhaps, combined with changes in the conditions and practices of co-authorship, so what before were considered informal collaboration now is considered formal collaboration, and the supervisor now expects to be co-author for a contribution that earlier would have given an acknowledgement or perhaps nothing. Generally, an important factor in the rise in co-authorship can be a shift from informal collaborations to formal collaboration, where researchers affected by the mantra “publish or perish” are making sure their contributions are accounted for and visible.

However, all of these possible hypotheses need to be explored further, as well as an examination of other possible factors influencing the collaborative behavior of social scientists. Few of the studies mentioned in the introduction have undertaken a deeper investigation of the rise of co-authorship and research collaboration (Fisher et al. 1998; Costa and Gatz 1992), thus the hypotheses presented in these studies are often speculative and anecdotal or borrowed from the “hard” sciences. The next step should be a thorough investigation on why the average number of authors has increased. How much is it the increasing mobility of researchers, the development in communication technologies, the tendency to perform research in a team-production model, the increase in researchers and PhD students? And, how much is it the changing condition and practices in assigning authorship in collaborative research?

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Fig 1a Mean number of authors per article Management, Planning & Geography

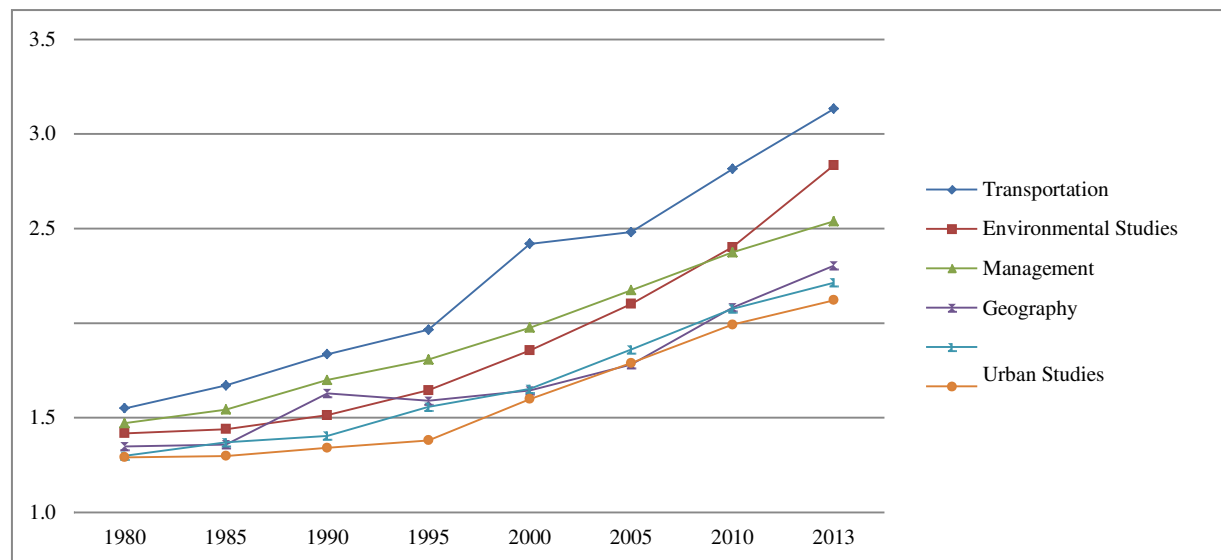


Fig 1b Share of co-authorship Management, Planning & Geography

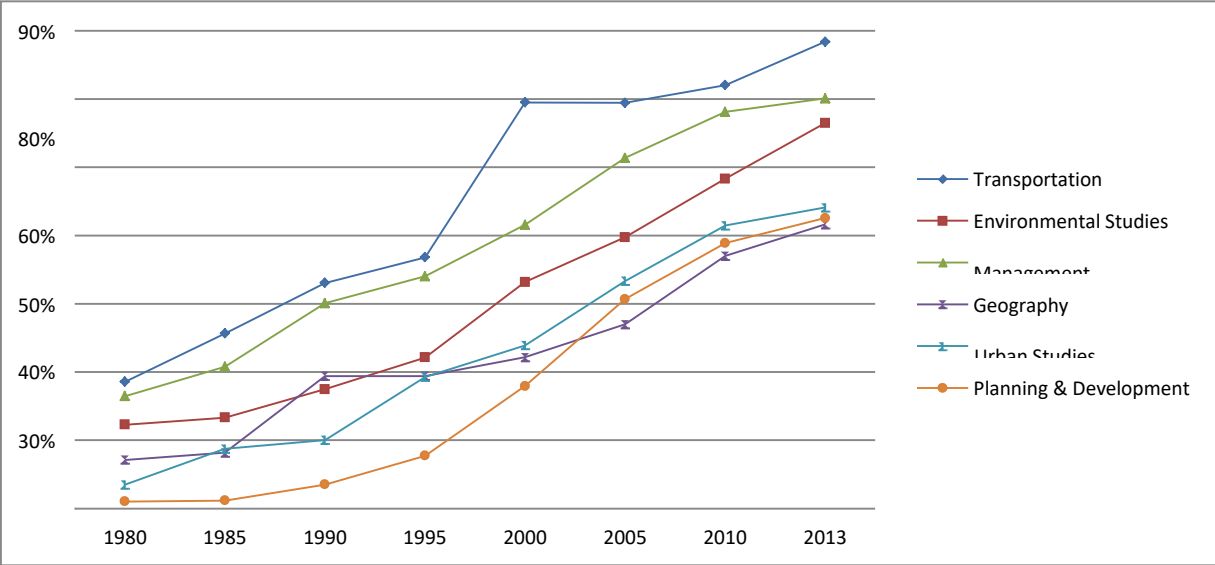




Fig 1c Share of international co-authorship Management, Planning & Geography

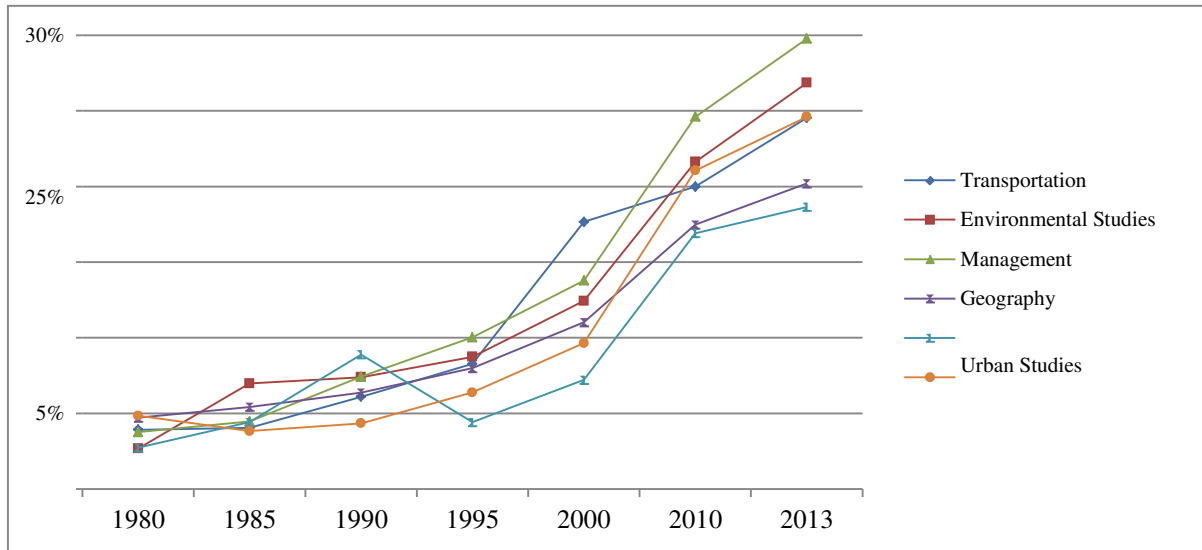


Fig 2a Mean number of authors per article Political Sciences, Business & Law

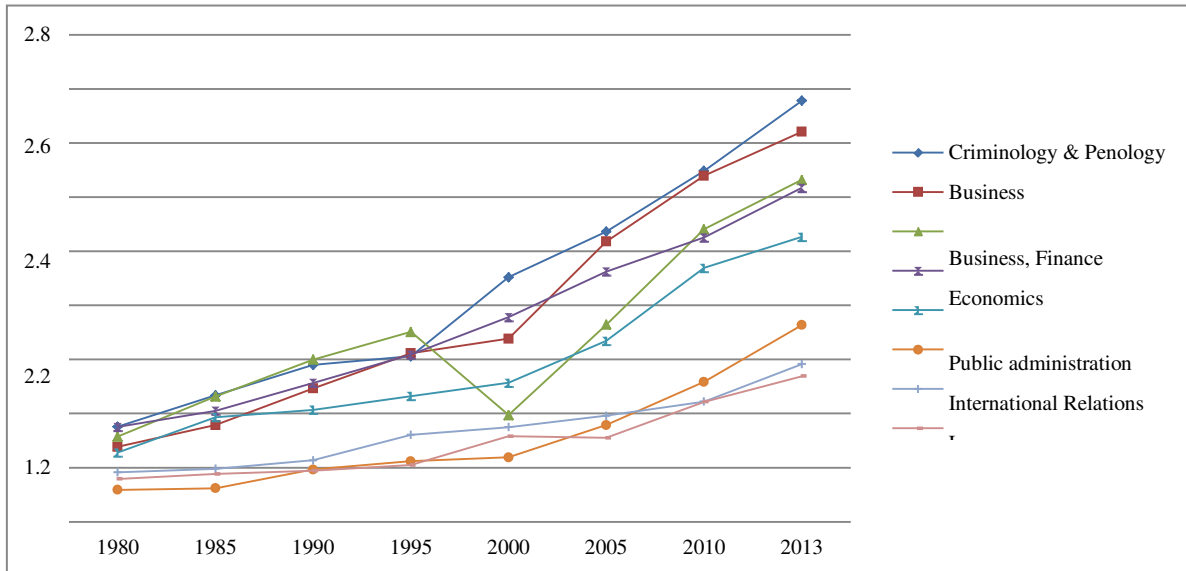


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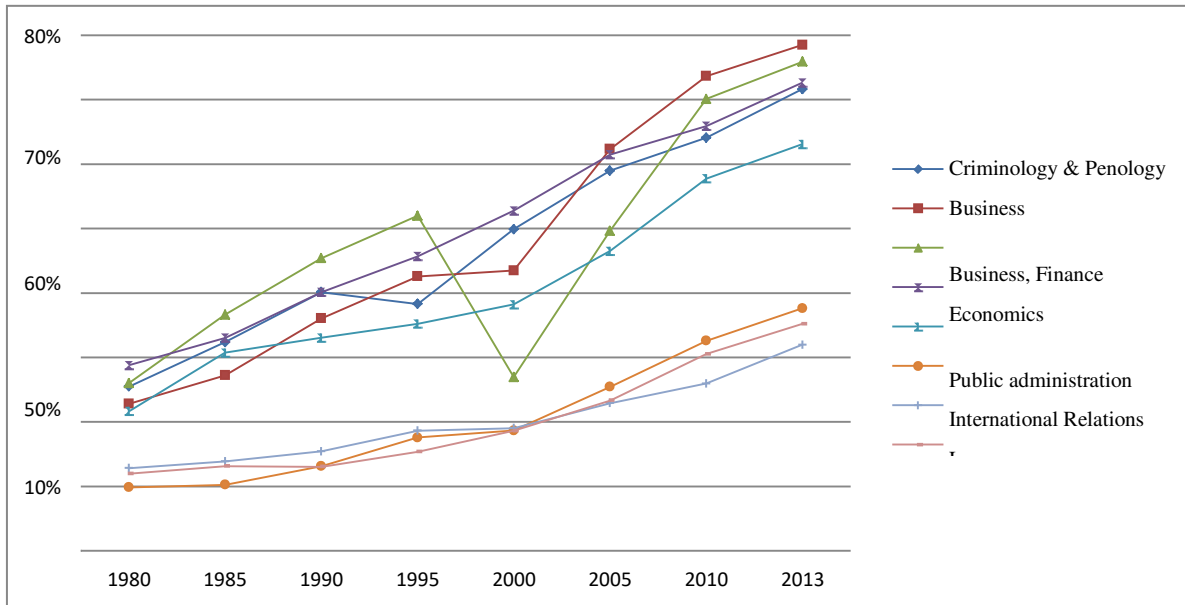


Fig 2c Share of international co-authorship Political Sciences, Business & Law

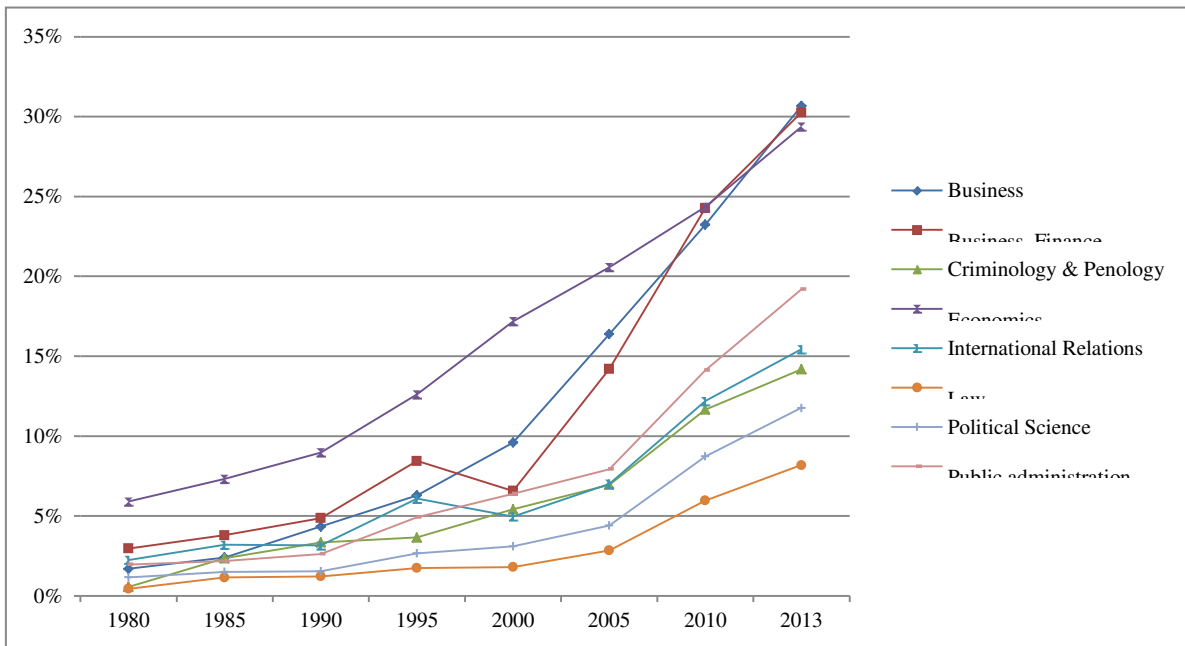


Fig 3a Mean number of authors per article Psychology

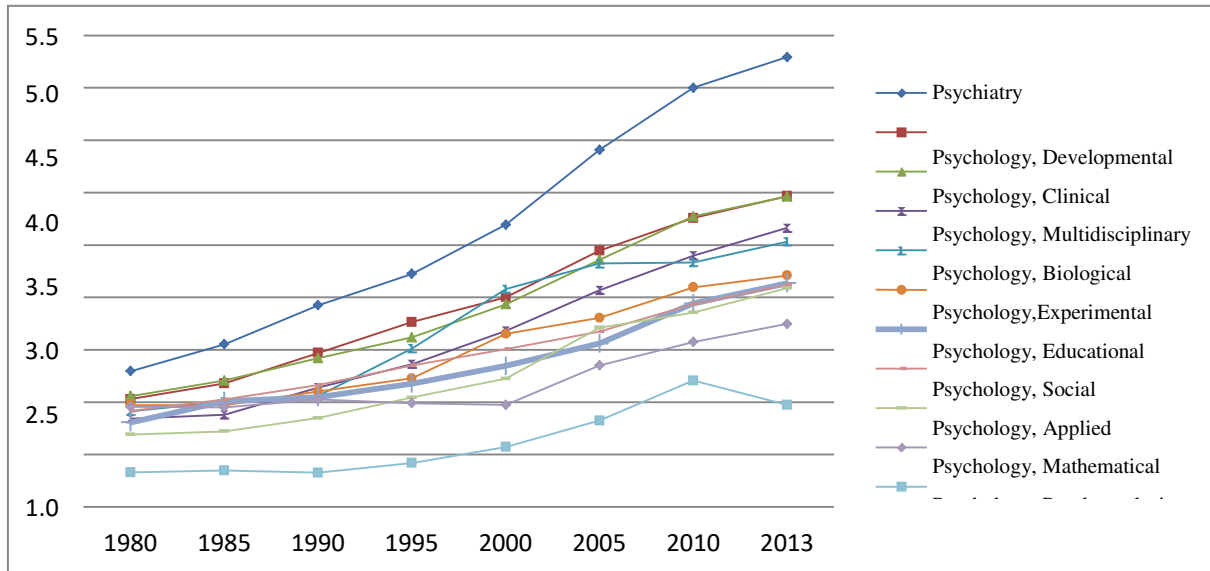


Fig 3b share of co-authorship Psychology

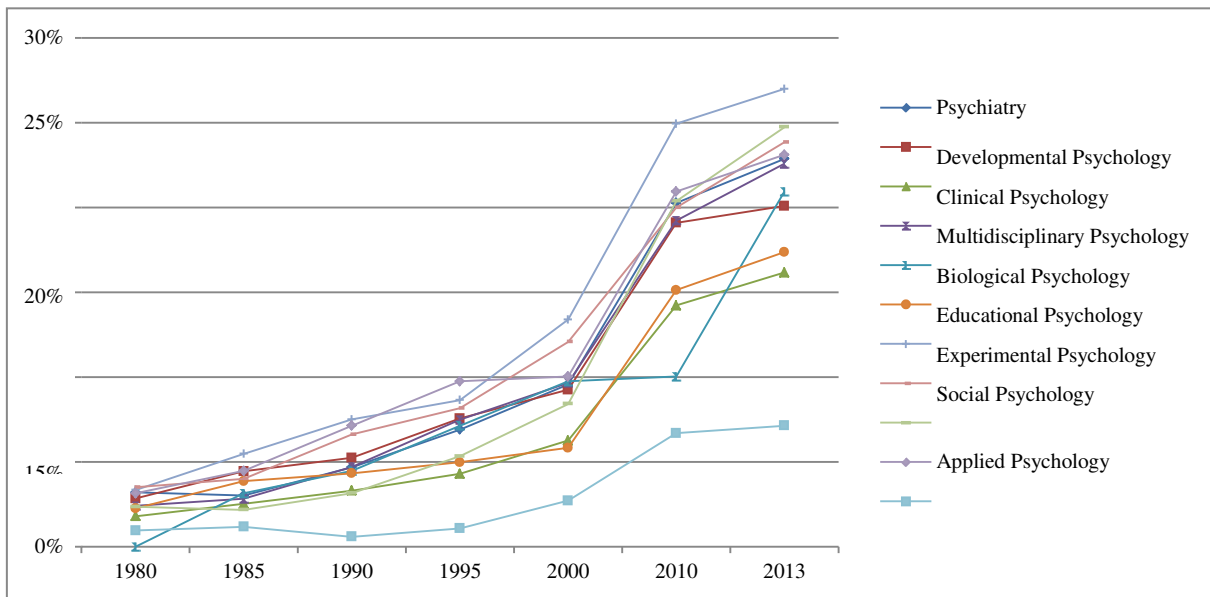


Fig 3c share of international co-authorship Psychology

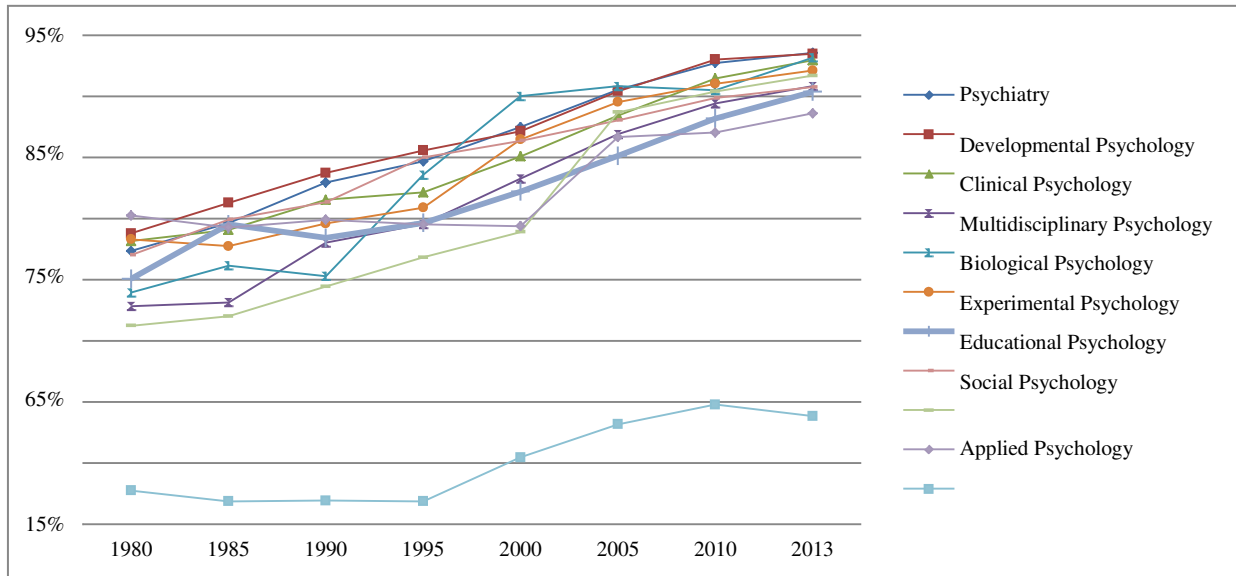


Fig 4a Mean number of authors per article Social Health Sciences

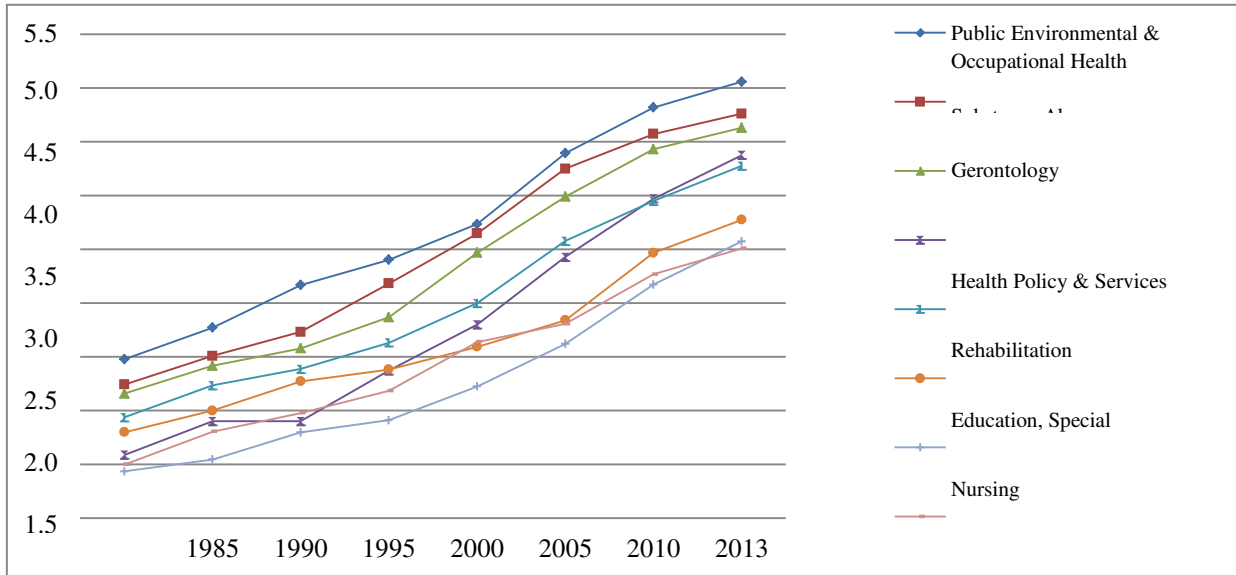


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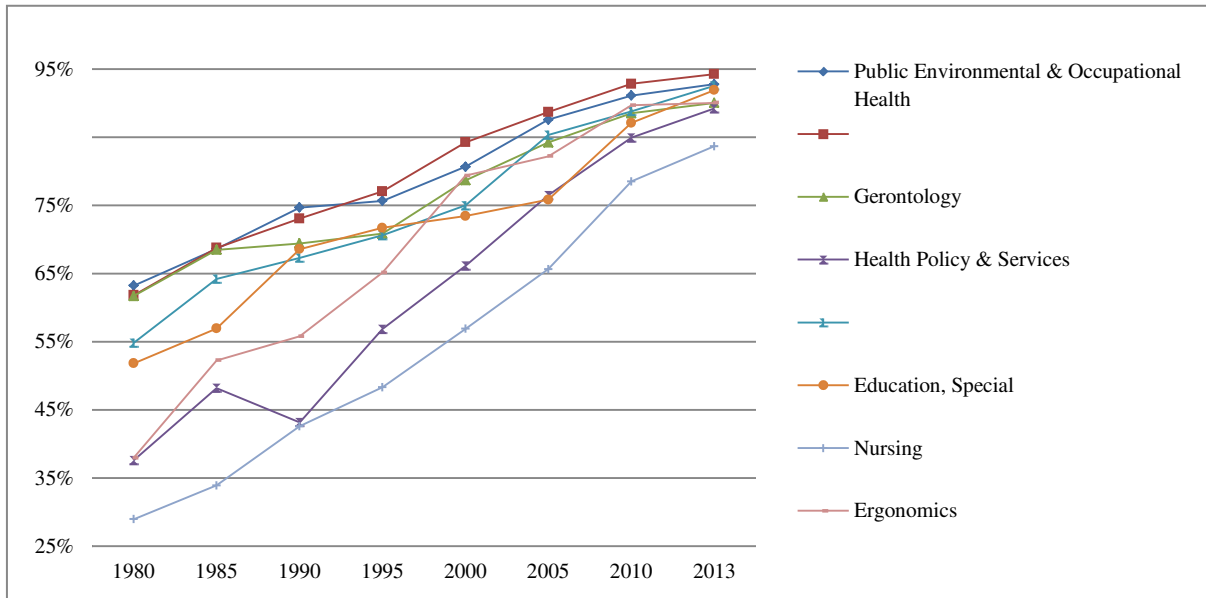


Fig 4c Share of international co-authorship Social Health Sciences

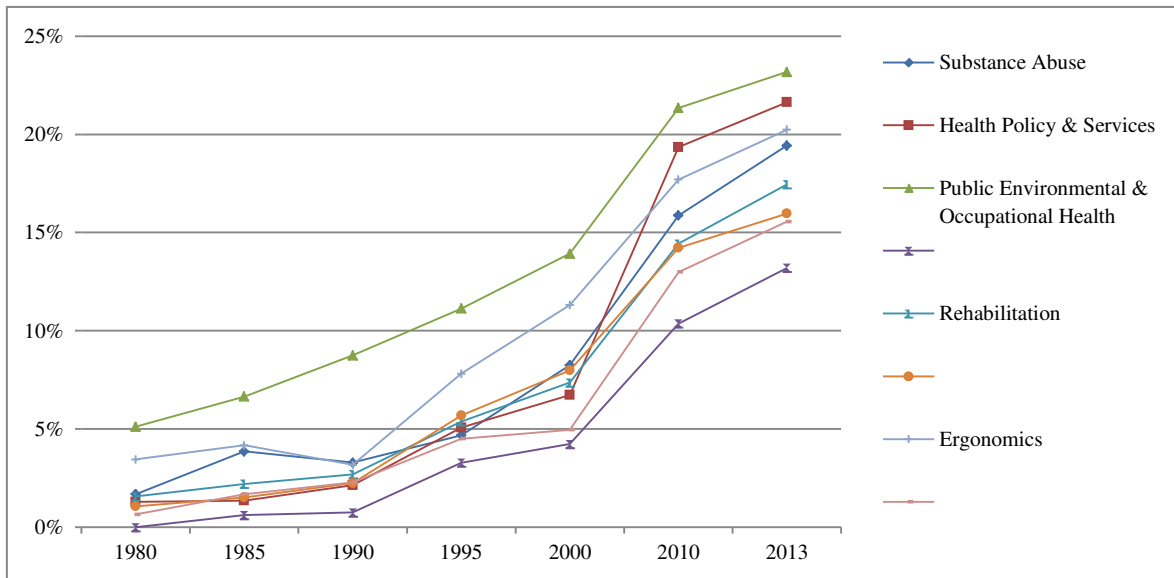


Fig 5a Mean number of authors per article Sociology & Anthropology

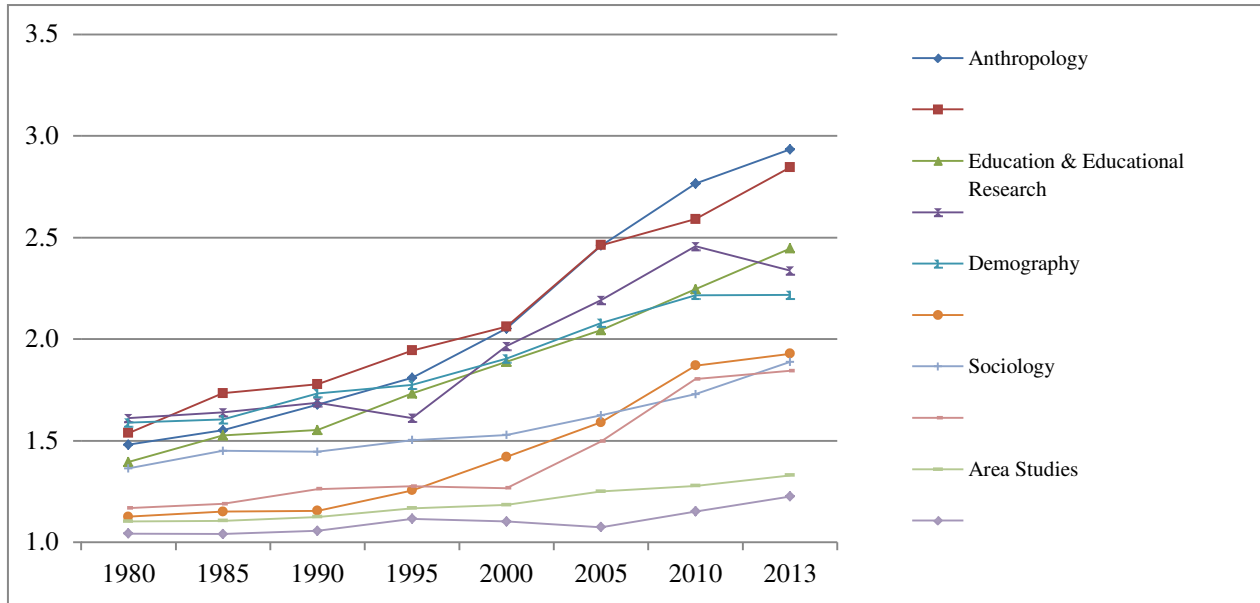


Fig 5b Share of co-authorship Sociology & Anthropology

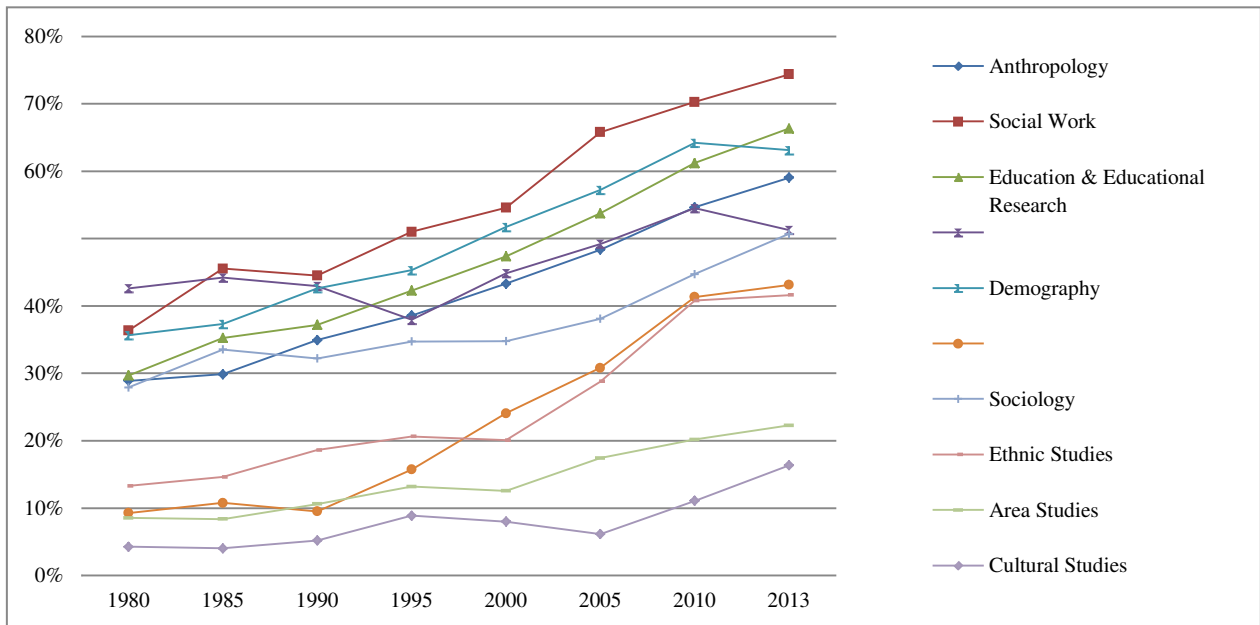


Fig 5c Share of international co-authorship Sociology & Anthropology

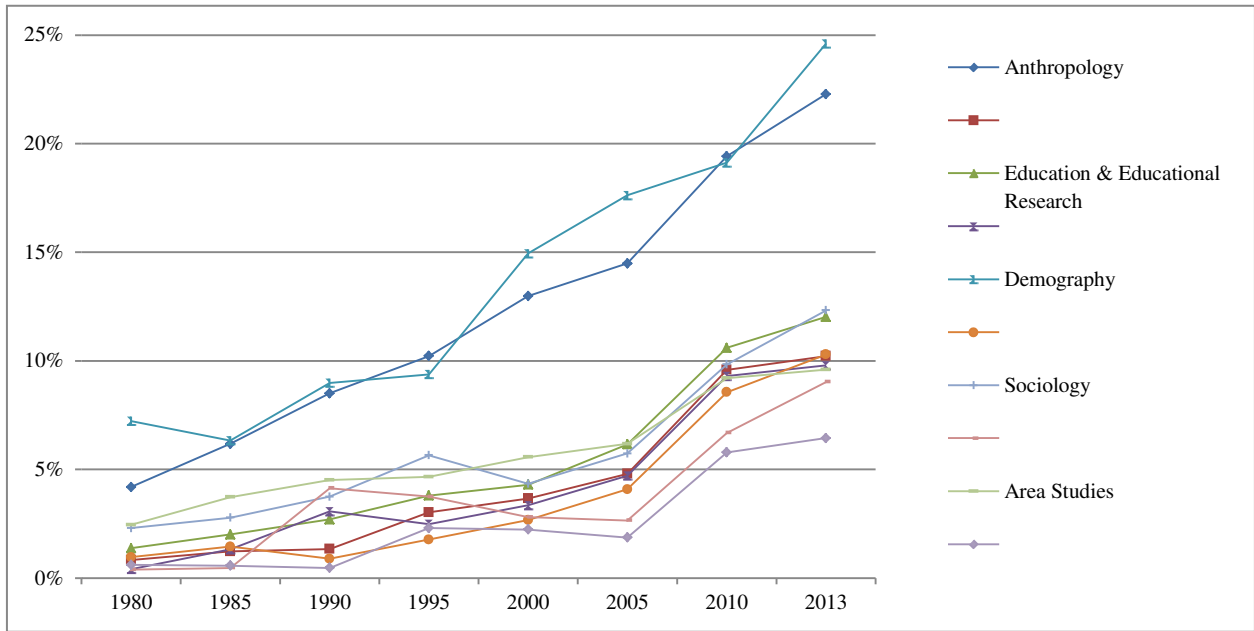


Fig 6a Mean number of authors per article Social Sciences, Interdisciplinary

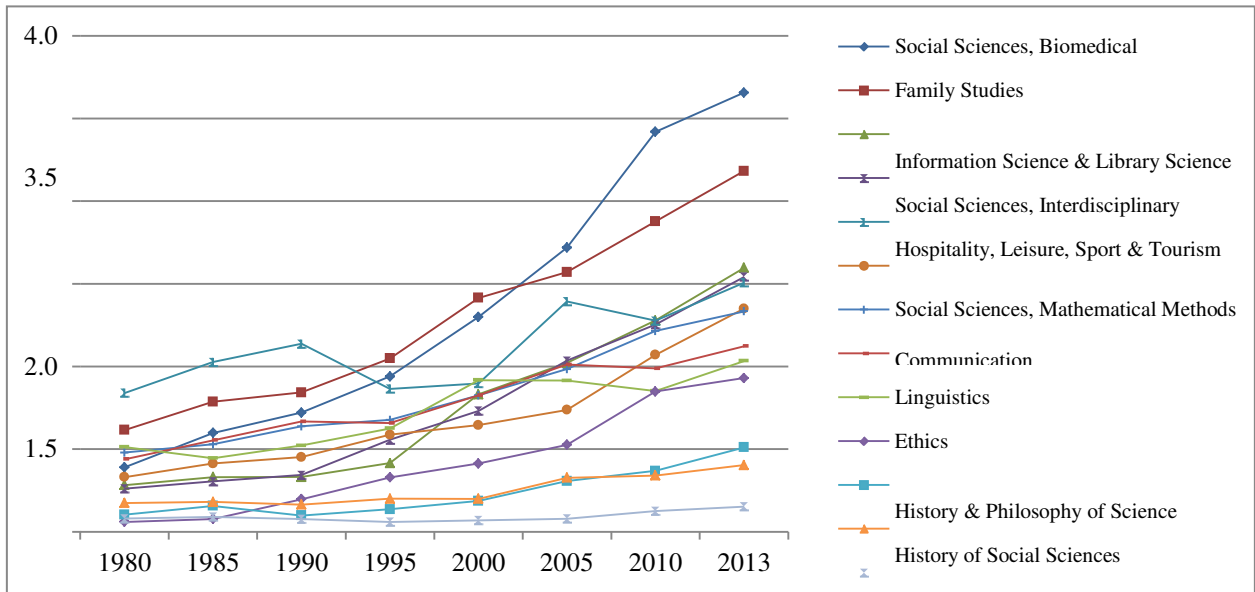


Fig 6b Share of co-authorship Social Sciences, Interdisciplinary

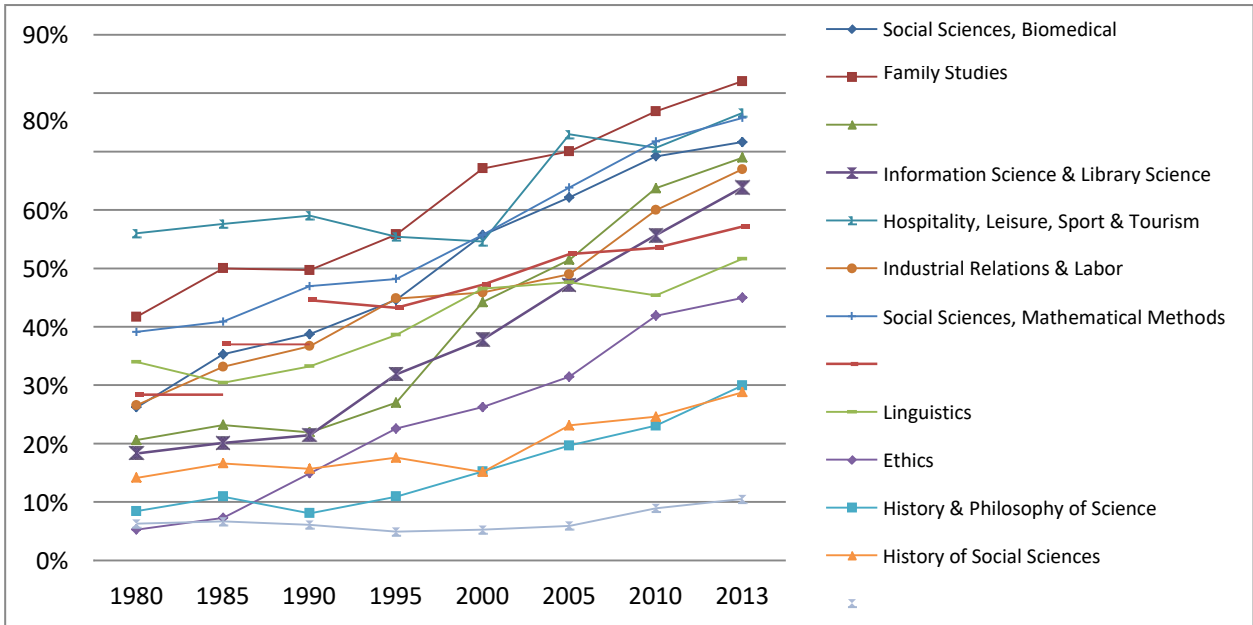
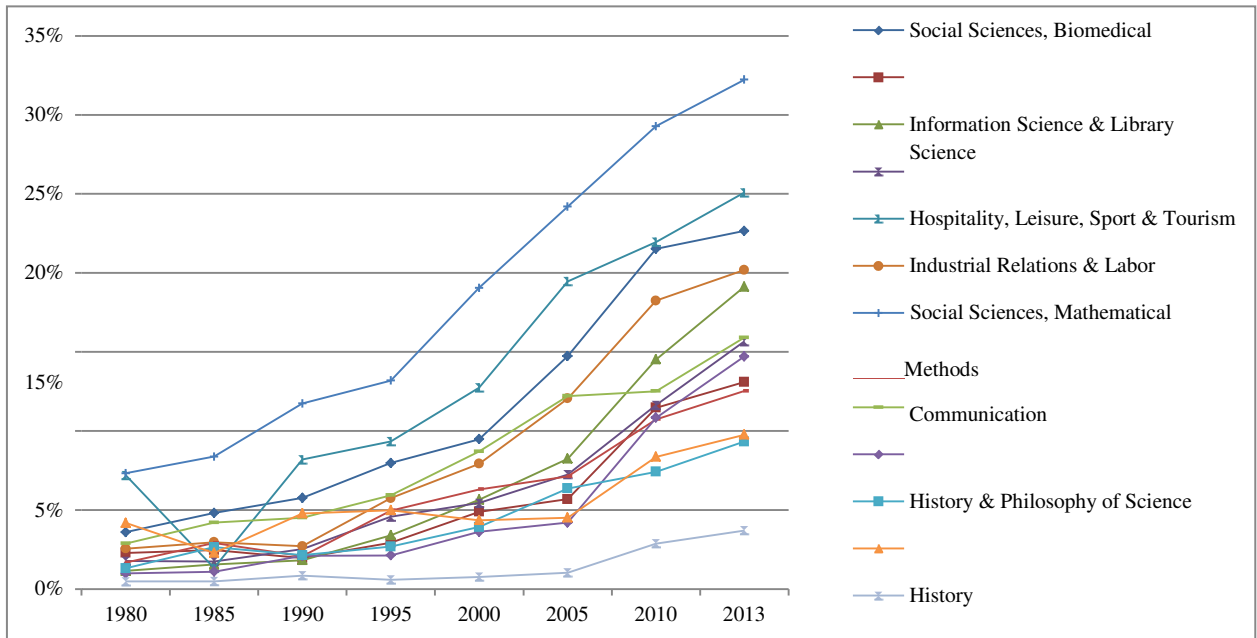


Fig 6c Share of international co-authorship Social Sciences, Interdisciplinary



Appendix A1 The median number of authors per article



Appendix A2 The median number of authors per article

SSCI	1980	1985	1990	1995	2000	2005	2010	2013
Anthropology	1	1	1	1	1	1	2	2
Area Studies	1	1	1	1	1	1	1	1
Business	1	1	1	1	1	2	2	2
Business, Finance	1	1	1	2	1	1	2	2
Communication	1	1	1	1	1	2	2	2
Crimonology & Penology	1	1	1	1	1	2	2	2
Cultural Studies	1	1	1	1	1	1	1	1
Demography	1	1	1	1	2	2	2	2
Economics	1	1	1	1	2	2	2	2
Education & Educational Research	1	1	1	1	1	2	2	2
Education, Special	2	2	2	2	2	2	3	3
Environmental Studies	1	1	1	1	2	2	2	2
Ergonomics	1	2	2	2	2	3	3	3
Ethics	1	1	1	1	1	1	1	1
Ethnic Studies	1	1	1	1	1	1	1	1
Family Studies	1	1.5	1	2	2	2	2	3
Geography	1	1	1	1	1	1	2	2
Gerontology	2	2	2	2	3	4	4	4
Health Policy & Services	1	1	1	2	2	3	3	4
History	1	1	1	1	1	1	1	1
History & Philosophy of Science	1	1	1	1	1	1	1	1
History of Social Sciences	1	1	1	1	1	1	1	1
Hospitality, Leisure, Sport & Tourism	2	2	2	2	2	2	2	2
Industrial Relations & Labor	1	1	1	1	1	1	2	2
Information Science & Library Science	1	1	1	1	1	2	2	2
International Relations	1	1	1	1	1	1	1	1
Law	1	1	1	1	1	1	1	1
Linguistics	1	1	1	1	1	1	1	2
Management	1	1	2	2	2	2	2	2
Nursing	1	1	1	1	2	2	3	3
Planning & Development	1	1	1	1	1	2	2	2
Political Science	1	1	1	1	1	1	1	1
Psychiatry	2	2	2	3	3	4	4	5
Psychology, Applied	1	1	2	2	2	2	3	3
Psychology, Biological	2	2	2	2	3	3	3	3
Psychology, Clinical	2	2	2	2	2	3	3	4
Psychology, Developmental	2	2	2	2	3	3	3	3
Psychology, Educational	2	2	2	2	2	2	3	3
Psychology, Experimental	2	2	2	2	2	2	3	3
Psychology, Mathematical	2	2	2	2	2	2	2	2
Psychology, Multidisciplinary	2	2	2	2	2	3	3	3
Psychology, Psychoanalysis	1	1	1	1	1	1	1	1
Psychology, Social	2	2	2	2	2	2	3	3
Public Administration	1	1	1	1	1	1	2	2
Public Environmental & Occupational Health	2	2	3	3	3	4	4	4
Rehabilitation	2	2	2	2	3	3	4	4
Social Issues	1	1	1	1	1	1	1	1
Social Sciences, Biomedical	1	1	1	1	2	2	3	3
Social Sciences, Interdisciplinary	1	1	1	1	1	1	2	2
Social Sciences, Mathematical Methods	1	1	1	1	2	2	2	2
Social Work	1	1	1	2	2	2	2	2
Sociology	1	1	1	1	1	1	1	2
Substance Abuse	2	2	2	3	3	4	4	4

Transportation	1	1	2	2	2	2	3	3
Urban Studies	1	1	1	1	1	2	2	2
Women's Studies	1	1	1	1	1	1	2	2