

Does the Winner Take it All? Increasing Inequality in Scientific Authorship

HEIKO RAUHUT, FABIAN WINTER, and DAVID JOHANN

Abstract

Scientific authorship has become a hot topic in the social sciences. We present three avenues addressing this topic from different perspectives to illustrate in which direction research on inequalities in the context of scientific authorship and academic publications may move. We draw on data from the Web of Science focusing on the field of sociology. We demonstrate that (i) the alphabetical order of co-authors' names sends out an ambiguous signal about the actual contributions of each team member, (ii) attention is increasingly paid to a few contributions that are widely cited, and (iii) well-connected authors tend to work together. In short, this essay suggests a rise in authorship inequalities regarding the attention authors and their articles receive. Sociology and related social sciences are arguably developing into academic winner-take-all markets.

INTRODUCTION

Research is not an end in itself. The academic job requires the dissemination of research results. Traditionally, researchers publish their results in monographs, book chapters in edited volumes, articles in scientific journals, and conference proceedings. Accordingly, authorship represents a core element of research.

Authorship, in turn, fulfills different functions (e.g., Birnholtz, 2006; Jabbehdari & Walsh, 2017; Johann & Mayer, 2017; Whitley, 2000): (i) It associates ideas, discoveries, and knowledge with relevant authors in a field, which is why authorship attributes *credit*. (ii) As publications and citations are also employed as evaluation criteria for academic researchers, publications represent the “academic currency” to obtain tenure positions and fellowships as well as third-party funding and grants. Thus, authorship adds to the symbolic capital of scientists by contributing to scientists’

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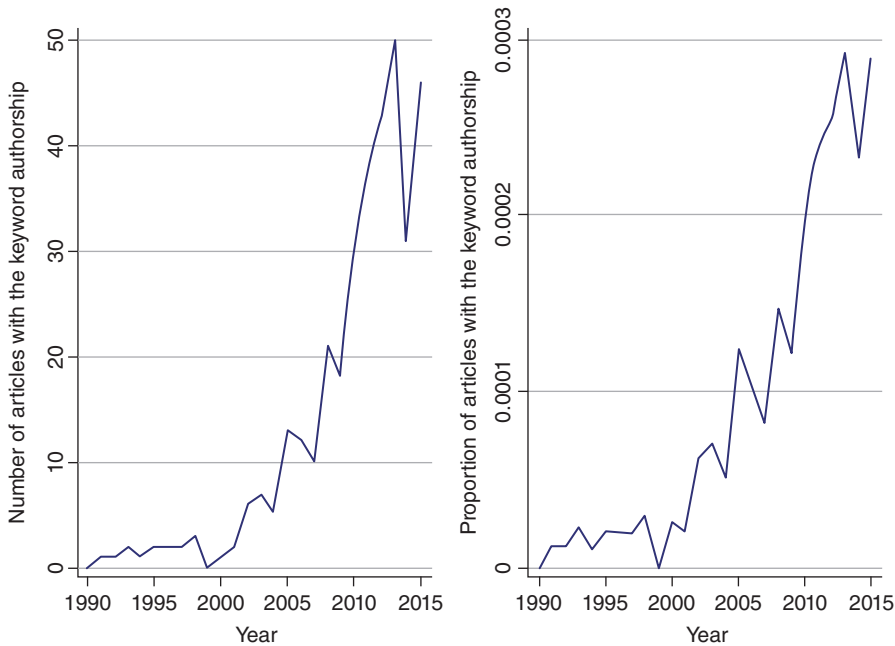


Figure 1 Number and proportion of articles with the keyword authorship in the social sciences. *Source:* Web of Science.

reputation. Finally, (iii) authorship means authors have the *responsibility* for the claims they make, but also for the ethical integrity of their research and potential mistakes in their research.

Credit, reputation, and responsibility associated with academic authorship suggest that authorship is a hot research topic in academia, particularly in the social sciences. Presenting data from the Web of Science Figure 1 demonstrates that the number and proportion of scientific publications dealing with authorship has risen considerably over the last two decades.

One likely reason for the increasing number and proportion of scientific publications addressing authorship is related to the average number of co-authors listed per publication. The average number of co-authors per publication increased from 1.6 in 1990 to 3.1 in 2015 in the social sciences and from 2.7 in 1990 to 5.3 in 2015 across all disciplines (Source: Web of Science). The motivations for more academic collaborations are manifold. To name but a few, scientific work is becoming more and more specialized, complex, and multidisciplinary. Moreover, the requirement to share data and facilities with other researchers leads to multi-team research (e.g., Katz & Martin, 1997; Lissoni, Montobbio, & Zirulia, 2013; Teixeira da Silva & Dobranszki, 2016; Wuchty, Jones, & Uzzi, 2007).

Another reason for the increasing number and proportion of scientific publications addressing authorship may be due to the substantial importance that publication outputs have gained in a changing, publication-focused academic environment. As a result of the introduction of New Public Management in science and the implementation of performance-based funding systems, scientists compete for financial resources and jobs just like professional athletes compete for athletic victories. One core evaluation criterion in performance-based funding systems is the scientists' individual publication record including the number of received citations of each publication. Hence, today, an increasing number of scientists aim to publish as many papers as possible, preferably in high impact journals being widely read and often cited. Since the seminal work of Merton (1968) and his introduction of the "Matthew Effect," it is well known that success in acquiring publications and citations is unequally distributed among researchers, however (Barabási *et al.*, 2002; DiPrete & Eirich, 2006; Newman, 2001, 2004).

The described development in scientific authorship engenders several consequences. Johann and Mayer (2017) suggest that the larger the number of co-authors per paper the more ambiguous the following aspects become: who contributed how much and to which parts of the publication; who should merit, credit, and earn reputation; and who is responsible for potential errors (see also Birnholtz, 2006; Lissoni *et al.*, 2013). A large number of co-authors per paper thus implies potential conflicts and inequalities. For example, collaboration structures or the order of authors in publications become increasingly important: Which author contributed to which part of the paper? Is it inevitably true that the first author contributed most? How much have the second, third, or last author contributed? Or, in more general terms, does the order of co-authors allow the reader of the publications to identify the author(s) who *should* be granted most of the credit and reputation for the publication?

Based on these considerations, we present three avenues to investigate scientific authorship and academic publications. Our goal is to illustrate with examples the direction in which respective research on *inequalities* in the context of scientific authorship and academic publications could potentially move. We employ data from the Web of Science focusing on the four most important German-speaking journals in the field of sociology, that is, (i) *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, (ii) *Zeitschrift für Soziologie*, (iii) *Soziale Welt*, and (iv) *Berliner Journal für Soziologie*. These journals are the most prominent ones and fully cover the range of sociological research outlets in Germany. The analyzed time period is 1966–2010. Our strategy is as follows:

1. First, we address co-authorship norms and their potential implications for the attention individual authors receive for their work. Here, norms regulate who should be attributed with authorship and in what order the researchers granted authorship are listed on the publication.
2. Second, we address the space accredited to the work of a particular author in other researchers' work. This space can be roughly quantified by the extent to which the authors' work is referenced in other authors' work in direct citations. More precisely, we focus on the increasingly unequal distribution of citations.
3. Finally, we focus on the prestige researchers gain in their scholarly network by looking at who collaborates with whom and exploring whether we find evidence for increased clustering of core researchers who tend to collaborate with each other.

Investigating inequalities in the context of scientific authorship and academic publications from three *very different perspectives* makes our analyses quite innovative compared to previous attempts. We consider such a broad approach essential to fully understand the extent as well as the causes and consequences of inequalities in academic scholarship. Our results suggest that researchers are more likely to be successful if they understand the prevailing authorship norms (in their own and in cognate disciplines), skillfully manage their reputation, and strategically develop their scientific network. Moreover, the results indicate that future research should reflect and explore the importance of factors such as name ordering and who cites whom for performance criteria and research output in more detail.

THREE EXEMPLARY TRENDS OF INCREASING INEQUALITIES IN SCIENTIFIC AUTHORSHIP

CO-AUTHORSHIP NORMS AND THEIR POTENTIAL IMPLICATIONS

Within the field of sociology, there are two different prevailing ways of listing the order of authors' names. Let us think about some of the most famous book publications in sociology, *The Social Construction of Reality* by Berger and Luckmann (1975) as well as *The Communist Manifesto* by Marx and Engels (1967). While the authors of the former book are listed alphabetically, the authors of the latter book are listed in a nonalphabetical order. An alphabetical order may be an expression of equal contributions to the publication by the individual authors. The individual contribution of an author is then roughly $1/N$, which we refer to as the *equality norm*. Listing authors nonalphabetically, in turn, usually indicates a deviation from the $1/N$ rule. The first mentioned author is typically the researcher having made the greatest contribution. We refer to this kind of authorship as the *contribution norm*.

Equality and contribution norms should be taken into account in evaluating publishing performance and reputation attribution.¹ The preservation of an equality norm in teams and its external perception play a key role in the social structural measurement of the distribution of reputation in the system of scholarship. The perception of the extent of an equality norm among authors may be misleading, however. When browsing journals, conference programs or edited volumes, it appears that equal treatment of co-authors is widespread. But the share of publications in which authors are listed alphabetically and the share of publications in which the alphabetical order is *actually intended* because the authors (almost) contributed equally can differ widely. Especially in the case of relatively small groups of authors, which are still common in sociology, a large share of alphabetically ordered papers can be ordered alphabetically *by chance*.

After all, the probability that two authors of a paper are presented in alphabetical order, but actually follow the contribution norm, is 50%. In the case of two authors, the first letter of the “lead” author’s last name is as likely to appear earlier in the alphabet as the first letter of the co-author’s last name. In case of three co-authors, it is already far less probable that the share of the contributions follows the rule of alphabetic ordering by first letters in last names. The probability of alphabetic order with three co-authors is just 17%. As the number of authors increases, the probability declines. More precisely, with the number of authors, n , the probability of an accidental coincidence of contributions and alphabetical order declines by $1/n!$. This is illustrated by Figure 2, which displays the chances for up to five authors.

Using the probability $1/n!$ that refers to the random occurrence of an alphabetical order of co-authors, it is possible to correct the observed rate of articles with alphabetically ordered co-authors. This allows us to derive the rate with which the authors *intentionally* listed their names in alphabetical order. The prevalence of the equality norm among sociologists for articles with the same number of authors, n , can be estimated using the following correction formula (Rauhut & Winter, 2012; Waltman, 2012):

$$p(\text{equality norm}) = \frac{\text{alphabetical rate} - 1/n!}{1 - 1/n!}$$

The observed and the intended rate can differ substantively. Often, a majority of alphabetically ordered articles masks a minority of articles that is actually intended to be in alphabetical order. This especially occurs when most of the co-authors in a discipline work in small teams. Referring to Equation 1, the difference between observed and corrected rates increases (i) the greater

1. The sequence of authors has yet another consequence. In the case of three or more authors, the persons bringing up the rear risk being caught in the “*et al.*-trap”: their names disappear from in-text citations and are thus less visible.

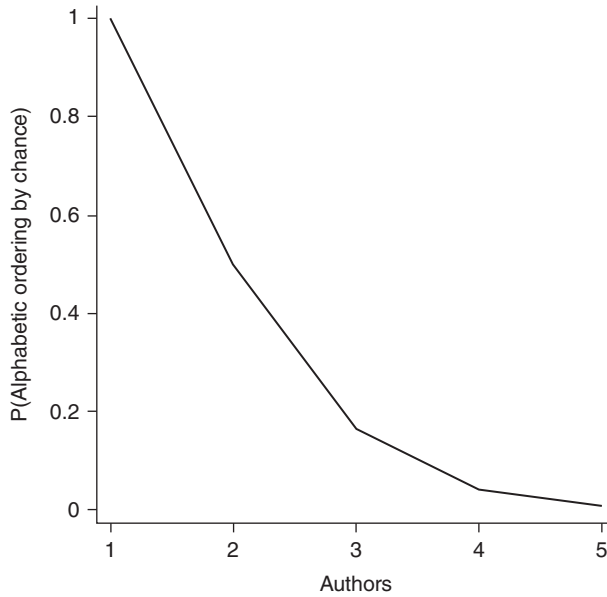


Figure 2 The probability that all authors are listed alphabetically merely by chance is a decreasing function of the number of co-authors.

the number of alphabetically ordered papers and (ii) the greater the number of co-authored publications with two authors are. Hence, obtaining an undistorted estimate of the extent of the equality norm is made considerably more difficult in disciplines with smaller teams of co-authors.

Rauhut and Winter (2018) demonstrate that the majority of sociological publications are still written by individual authors. The share of single authorship in sociology is nevertheless declining and the proportion of co-authored publications is on the rise. Most co-authored publications in sociology are written by two authors. If we assume that a majority of collaborative authorships in a discipline of pairs of authors occurs and that two-thirds of these articles follow an alphabetical order, then we can assume that only one-third are, in fact, intended to be in alphabetical order. If the observed rate is only a little bit less, for example, 60%, only 20% are intended to be in alphabetical order following the given assumptions of this model. Sociology largely moves within this range.

We refer to the difference between observed and intended rate of alphabetical ordering as the *equality illusion*. In the above examples, the extent of the equality illusion was one-third in the first case and 40% in the second case. We use the word “illusion” here in order to draw attention to a fallacy that consists of prematurely drawing conclusions from the observed rates

about the underlying intentions of the actors involved. The underlying mechanism that has been thus far described can be called a *statistical fallacy*.

In addition to a statistical fallacy, however, a framing mechanism can also reinforce the extent of the equality illusion. The so-called confirmation bias (Nickerson, 1998) is often decisive for the subjective impression of the world. This widespread error leads one to consider the evidence in question in the spirit of one's own preconceptions: in our case, of one's own norm. It can be shown that, with the same data, the assessment of equality by representatives of different norms can diverge by up to 90%.

The calculation of the equality illusion is less extreme when only the statistical fallacy is taken into account. In this case, the extent of the equality illusion is quantified as the difference between the observed and corrected rates of alphabetically ordered papers. For the field of sociology, Rauhut and Winter (2018) illustrate that the observable majority of articles follow an alphabetical ordering (observed rates of over 50%). However, presumably, only a minority deliberately intended this order (corrected rates of under 50%). Moreover, Rauhut and Winter reveal that the equality illusion has increased over the years. This means that the publishing market increasingly favors the equality illusion. Accordingly, a growing number of sociologists may overestimate the norm of equal treatment among co-authors. Even though the picture suggests an apparent equal distribution of reputation among co-authors, the contribution norm is coming to play an ever more important role in the business of publishing.

To sum up, the alphabetical order of co-authors' names sends out an ambiguous signal about the actual contributions of each team member. In this respect, future research should factor in the effects and biases associated with the misperception of authors' contributions. For example, how do proponents of the equality norm or the contribution norm, respectively, view the prevalence of "their" behavior in the community, given the increasing number of multiauthored work? How do the biases affect the evaluation of candidates for tenure positions in potentially mixed commissions?

THE INCREASINGLY UNEQUAL DISTRIBUTION OF CITATIONS

Our second avenue addresses the space accredited to the work of a particular author in other researchers' work. As mentioned earlier, a widespread indicator of the influence of scholarly work is the number of citations their publications obtain. Compared to other measures, citations have the advantage of measuring how often an article has been noted and by whom it has been noted. As such, citations represent a measure

of attention of a scholarly argument in relation to other researchers' work.²

Using the Gini coefficient in order to investigate the distribution of citations between 1966 and 2010, the trend in citation inequality appears to be U-shaped. In the 1960s, the bottom half of all articles received around one-sixth of all citations, while the upper ten percent received two-thirds of all citations. In the 1980s, the unequal concentration of citations of a few articles appears to have been canceled out. It is noteworthy that, today, inequality is on the rise again and that the majority of citations refer to the same standard articles (Rauhut & Winter, 2018). In other words, the gap between normally cited and highly cited works first has become smaller, but then grew larger again. Hence, the concentration of many citations on a few articles first decreased and then increased again. Two observations help understand this trend: (i) Fewer articles receive no citations whatsoever. In the past, noncited publications used to be an exception from the rule, but it appears to be norm today that publications are cited at least once. At the same time, (ii) most citations are condensed to a smaller number of publications.

To sum up, the segmentation of attention by citation has increased. In this respect, future research could address the causes and consequences of this development. For example, which role does the increasing number of co-authors per paper play for the segmentation of attention? To what extent is the increased segmentation of attention by citation reflected in the performance-based allocation of funds?

THE INCREASINGLY UNEQUAL NETWORK STRUCTURES AMONG AUTHORS

Our third avenue focuses on the connections of scholars among one another. Network positions can be understood as the consolidated visibility of social capital in Coleman's (1990, pp. 300 ff.) sense. Network positions are crucial for productive work relationships and opportunities to accumulate additional attention. They thus represent an important aspect that may foster social inequality in academia. Denser networks with other scholars and taking on central roles within the scholarly networks increase researchers' prestige, their chances of placing their own work in (better) journals and obtaining research support from funding institutions (Merton, 1988) as well as labor market and career opportunities (Plümper & Schimmelfennig, 2007).

A simple measure of interconnectedness is the network *degree*. Quantifying the number of contacts of an actor in a defined network, this measure

2. Of course, self-citations do not add much to the reputation of researchers. Please note that our analyses do not distinguish between self-citations and citations from other researchers. However, we do not regard it as likely that this would bias our results.

is significant for the direct exchange relationship such as scientific favor or scientific exchange. In academia, the network degree can be measured by the number of co-authors. However, this is not a sufficient indicator of advantageous embedding in the network of researchers. It is also relevant to consider whether a researcher takes on a key role within a network. A central position in a network facilitates quicker access to relevant information. Accordingly, Burt (2004) suggests that “broker positions” offer major advantages for obtaining new ideas, alternative standpoints, and creative stimulation. A simple measure of centrality, that is, playing a key role within the network, is *closeness*. For each actor, closeness indicates the average of the shortest paths from one actor to all other actors in a network. Thus, great closeness implies that a researcher has published with colleagues involved in their own networks in which they occupy a central position and who are also closely connected to other co-authors. The two measures considered here (network degree and closeness) can be interpreted as *networking opportunities*: The more co-authors an author has (degree) and the closer these co-authors are to other scholars and other potential co-authors (closeness), the easier it is for the author to find and collaborate with new co-authors.

There is considerable inequality in the number of co-authors in sociology and this inequality remained highly stable over the past decades. Moreover, Rauhut and Winter (2018) show that inequality in closeness to other co-authors has only changed marginally over time. Accordingly, one might conclude that inequality in the possibilities for networking has not substantially changed. However, this conclusion is misleading because it has changed *who is connected to whom*. It is important to maintain ties to “important” people. Put differently, research on network structures among authors should also consider the so-called eigenvector centrality (Bonacich, 1972, 1987) ascribing greater centrality to those actors who have ties to other well-connected actors. The eigenvector centrality has increased over the years, indicating an increase in inequality (Rauhut & Winter, 2018). Hence, there is a trend to more segmented co-author networks: well-connected co-authors preferably establish links to other well-connected co-authors.

In sum, increasing networking of well-connected co-authors who predominantly connect with each other further demonstrates that inequality in the scholars’ statuses is on the rise. In this respect, future research should address the causes and consequences of this development. For example, do well-connected authors particularly collaborate with other well-connected authors due to strategic considerations or is it an unintended by-product of their interests and actions? In addition, the question of what this development means for the allocation of funds and jobs should be raised. If well-connected authors benefit in the allocation of funds and jobs, we may speculate that this development represents an additional catalyst

of deepening inequalities. It remains open, in which areas initially small inequalities develop into large cleavages.

DISCUSSION

Focusing on the field of sociology, this essay discussed three avenues to investigate inequality with regard to scientific authorship and academic publications. Our contribution is threefold: First, we have shown that the alphabetical order of co-authors' surnames sends out an ambiguous signal about the actual contributions of each team member. In addition, our analyses suggest that a growing number of authors in the social sciences overestimates the norm of equal treatment among co-authors. Second, inequality in the form of citations has undergone a similar trend although with some limitations. Sociology is increasingly characterized to be a winner-take-all market in terms of citations. A small number of articles receive a lot of attention so that the importance of influential contributions is increasing today. Third, science is increasingly characterized by a greater segmentation of co-authors' networks: today, well-connected authors tend to work together, forming clusters of "winners."

Social norms that increasingly attend to "high-impact" teamwork and toward lead authors create an even greater concentration of success to just a few authors. It is plausible that the growing divergence between the objectively observed order of co-authors' names and the subjective perception of this ordering ("equality illusion") leads to a reinforcement of the concentration of success. Overall, these results provide support to theoretical arguments on the concentration of success in the academic labor market following the so-called Matthew effect (Barabási *et al.*, 2002; DiPrete & Eirich, 2006; Newman, 2001, 2004). In sum, sociology and related social sciences are arguably developing into academic winner-take-all markets.

While we illustrated the direction research on inequalities in the context of scientific authorship and academic publications *could* take, our analyses only represent examples and selected trends. Future research should conduct alternative bibliometric analyses and draw on additional measurements, for example, from surveys and comparable analyses in other social sciences. It should also focus on theory in order to understand the underlying mechanisms and the consequences these may have for the scientific community in more detail.

Moreover, *inequality* is just one aspect further research on scientific authorship should address. Considering the growing size of research teams and the increasing number of co-authors listed per publication, research on scientific authorship should clarify the meaning of and criteria for authorship (Jabbedhari & Walsh, 2017). Past research suggests that authorship practices vary

across disciplines (e.g., Jabbehdari & Walsh, 2017; Johann & Mayer, 2017; Teixeira da Silva, 2011; Teixeira da Silva & Dobranszki, 2016). However, current research suffers from lack of data. A systematic examination of researchers' authorship practices and internalized authorship norms, beliefs and perceptions has yet to be achieved (Johann & Mayer, 2017). In this context, future research should also investigate gift and ghost authorship in greater detail (Jabbehdari & Walsh, 2017; Sauermann & Haeussler, 2017; Walsh & Lee, 2015) as well as the relatively new phenomenon of "scientific writers" (Johann *et al.*, 2018).

As highlighted above, the conditions of text production in academia have changed. Future research should, therefore, reflect and explore whether and under which circumstances current performance criteria are still appropriate. Inherently, this also leads to the question how these conditions could be revised to ensure that they adequately measure individual researchers' contributions to the research output (e.g., Walsh & Lee, 2015).

While shedding light on the "objective" side of the winner-take-all market in the social sciences, it remains open whether and to what extent researchers are *subjectively* aware of this trend and how this affects motivation and research behavior. To this end, our contribution may have practical implications for strategic career planning of scientists. Researchers may only have little awareness of the trends in inequality regarding the order of names in publications, citation acquisition, and networking. At the same time, it may encourage scholars to plan publications and authorships more strategically. However, this comes with a risk as well: research that increasingly focuses on strategic career planning, optimization of reputation acquisition, and instrumental networking may block intrinsic motivations and undermine creativity and courage for great discoveries.

AUTHOR CONTRIBUTIONS

All authors contributed equally to writing this manuscript. We thank Justus Rathmann for help with data analyses in Section 1.

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Heiko Rauhut is full professor of Social Theory and Quantitative Methods at the Institute of Sociology at the University of Zurich. He has been awarded an SNSF Starting Grant on social norms, cooperation, and conflicts in scientific collaborations. His research focuses on the emergence, change, and decay of social norms, cooperation and conflicts, trends in collaborations in science and measurement methods for scientific misconduct. Before working at the University of Zurich, he has been at the ETH Zurich, University of Leipzig and London School of Economics.

Fabian Winter, PhD, is a head of Max Planck Research Group "Mechanisms of Normative Change" at the MPI Institute for Research on Collective Goods in Bonn. He studies mechanisms determining different dynamics of normative change from an interdisciplinary perspective, aiming to understanding and managing social change using a broad range of experimental and non-experimental empirical methods.

David Johann is principal investigator of the Scientists Survey at the German Center for Higher Education Research and Science Studies (DZHW) and assistant professor ("Oberassistent") at the University of Zurich. His substantive research focuses on research methods in social sciences, scientific authorship, implicit attitudes as well as electoral behavior. Before working

at the DZHW, he was a postdoctoral research associate in the Department of Methods in the Social Sciences at the University of Vienna.

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