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Article

Say my name, say my name: Academic authorship conventions between editorial policies and disciplinary practices

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Abstract

Academic publishing is undergoing profound changes that shape the conditions of knowledge production and the way research is communicated, prompting a lively debate on how the various activities of those involved can be adequately acknowledged in publications. This contribution aims to empirically examine the relationship between authorship regulations in journal policies, the disciplinary variance in authorship practice and larger concepts of academic authorship. Analyzing (1) editorial policies and (2) data from an interdisciplinary survey of scientists, we examine to what extent disciplinary variances are reflected in the policies as well as in researchers' individual understandings. Here we find that the regulation of authorship qua policies is primarily effected at the level of the publishers. Although considerable disciplinary variations of journal policies are sometimes suggested in the literature, we find only minor differences in authorship criteria. The survey data however show that researchers' understandings of authorship exhibit significant, discipline-specific differences, as well as differences related to the characteristics of the research practice. It hence becomes clear that discipline-specific conditions of knowledge production with the resulting differences in authorship practices are hardly reflected in authorship policies. We conclude that the regulatory ambitions of authorship policies mostly focus on the prevention and elimination of deficits in the quality and integrity of scientific publications. Thus, it seems questionable whether authorship policies in their current form are suitable instruments for mediating between diverse authorship practices and normative ideals of legitimate authorship.

Key words: editorial policies; authorship norms; disciplinary comparisons; scientist survey

They just use your mind and they never give you credit
It's enough to drive you crazy if you let it
Dolly Rebecca Parton

1. Introduction

Academic publishing is undergoing profound changes with regard to research constellations and collaborative processes that shape the conditions of knowledge production and the way research is communicated. This change prominently manifests itself in the cross-disciplinary increase of co-authorship and mass collaborations as found for example in high energy physics. Together with the increasing differentiation of the division of labour in material- and technology-intensive research fields such as life sciences and persistently high publication pressure, these developments are prompting a lively debate on how the various activities of those involved can be adequately acknowledged in the publications (Biagioli and Galison 2003; Birnholtz 2006).

Looking at the theoretical literature on historical and contemporary understandings of what it means to be an author and empirical studies on current development of authorship in science, we can see a change in academic authorship at least since the end of the 20th century. The diversification of scientific research activities and the increasing size of research teams led to an expansion of authorship claims and a differentiation of existing concepts of authorship. These developments are closely linked to the change in knowledge production in the respective disciplines, which revived the intense debate about tensions that have long-pervaded scientific publishing (Knorr Cetina 1999). Debates revolve around the question to which extent scientific publishing is to be understood as a gift economy characterized by the gift-donor relation and/or whether it can be described more appropriately in the logic of a market model, with copyright aspects, at times conflicting interests, intellectual property rights and the possibility of patenting research achievements. Concerning scientific authorship, these controversial discussions circulate mainly around the concepts of an author-originator and creator, an author as guarantor and an author as contributor (Biagioli 2003; Galison 2003; Mcsherry 2003; Rheinberger 2003; Birnholtz 2006). The persistence and coexistence of quite disparate concepts of authorship also fits the picture, since knowledge production and publication cultures, e.g. in the classical book sciences (philology, history, philosophy), which largely fall within the spectrum of the humanities, are affected by the technology-induced change in knowledge production in a different and presumably somewhat milder way in terms of intensity, amplitude and velocity.

Furthermore, current developments such as the development of a 'Contributor Roles Taxonomy (CRediT)' in scientific publishing bear witness to very heterogeneous authorship practices and equally diversified conditions of scientific knowledge production. Correspondingly the perception of scientific authorship considerably varies across disciplines (Johann and Mayer 2019) and alternative and or complementary roles such as author as well as non-author contributors are considered in relation to existing distinctions between authors and acknowledged persons (Matarese and Shashok 2019). At the same time, in the wake of the massive quantitative growth of scientific publications and the internationally rising importance of English-language journal publications, we observe that publishers, journals, professional societies and non-profit organizations, are providing authorship policies and guidelines in which the handling of authorship in scientific publications is increasingly specified. The literature frequently suggests (e.g. Kornhaber et al. 2015; Chang 2019) that these authorship policies take on a kind of mediating function between authorship practice and traditional ideals and conventions of authorship for scientific publishing in times of change and diverse scientific knowledge production. Accordingly, the policies claim to offer orientation for the confusing diversity of publication- and case-specific authorship practices by establishing guidelines for legitimate scientific authorship.

Against this background, this contribution aims to empirically examine the relationship between authorship regulations in policies, the disciplinary variance in authorship practice and larger concepts of authorship. In order to investigate how the discipline-specific conditions for the production of scientific knowledge are reflected in academic publishing, we analyse authorship policies of scientific journals from various disciplines in order to determine which dimensions of authorship are regulated here for which purpose on the one hand. On the other hand, we explore which dimensions of authorship are negotiated in practice, i.e. based on the research activities required to produce publishable research results. Here, we use data from the Scientist Survey of the German Centre for Higher Education Research and Science Studies (DZHW) that provides insights in which activities scientists from diverse disciplines presume to constitute claims to (co-)authorship. Accordingly, we examine firstly, whether and to what extent a disciplinary variance can be found in the journal policies; and secondly, whether and to what extent a disciplinary variance can be identified in authorship practices. In this way, we hope to gain more insights into whether for the persons and actors involved in the publication process authorship policies are a suitable regulatory instrument for reconciling the existing heterogeneous practices of authorship in academia with normative notions of legitimate authorship.

1.1 Research design

Given that our research question encompasses multiple arenas of scientific authorship practices and discourses, we utilized two types of empirical analysis. Existing research on academic authorship focusses on policies (Resnik and Master 2011; Bosch et al. 2012; Bosnjak and Marušić 2012; Resnik et al. 2016; Chang 2019) or contributorship statements (e.g. Larivière et al. 2016) which allow us to draw only limited conclusions about authorship practices on the ground. Combining quantitative journal authorship policy analysis with survey data from the 2019 DZHW Scientists Survey bridges this gap between the normative discourse and the concrete ways in which authorship is negotiated and enacted while also taking the discipline-specific conditions of scientific knowledge production in academic publishing into account.

Analyzing authorship policies of scientific journals from various disciplines enables us to determine which dimensions of authorship they regulate and which purpose they might have. If authorship policies are reflective of professional discourse, potential disciplinary variations among journal policies might point us to normative claims or demands unique to certain fields of study. By incorporating publishers and academic associations (see also Osborne and Holland 2009) into our analysis, we also gain insight into the role that these institutions play in setting authorship norms.

To understand how authorship is negotiated in practice and which research activities are seen as justifying authorship we make use of the 2019 DZHW Scientists Survey, which is an interdisciplinary representative study of the German academic system. Survey measures do not give us direct access to research practice and might introduce social desirability bias. At the same time, it is the most feasible option to get data from a large number of scientists from a variety of disciplines. Here, we focus on two main questions: First, the social dimension of authorship negotiations, which concerns the importance of authorship policies as well as research activities for negotiating authorship. Second, the question which research activities justify authorship claims for the respondents. This is motivated by an interest in disciplinary variances, as well as the question how research activities that are judged as justifying authorship map onto attempts to make individual contributions to research outputs more explicit in policies.

In the following, we first present the results of the policy analysis, followed by the results of the survey. In a second step, we will compare and contrast the results of both studies and contextualize our findings within the authorship conceptions found in the literature.

2. Study I: authorship policies of publishers, journals, and societies

2.1 Data and methods

The following analysis aims at identifying how authorship is regulated along organizational levels and disciplinary boundaries. By examining policies, we can infer which claims for governance are made at each respective level. We distinguish between three organizational levels: the individual journal policies, the authorship policies of the journal publisher and the policies and recommendations of editorial associations like the ICMJE—International Committee of Medical Journal Editors.

Our sampling strategy is designed for a comparison of authorship policies along different organizational levels and publishers as well as along scientific disciplines. We sampled 175 different journal policies, five publisher policies and three policies of academic associations. All data was collected between October and December 2019.

The journals were drawn as a stratified random sample from the 2018 Scimago JournalRank, a journal ranking based on data from Scopus. We selected seven disciplines representing different publication cultures (Franzen 2014) and correspondingly different authorship conventions and conceptions (Biagioli and Galison 2003; Pontille 2004; Johann and Mayer 2019): Business, Management & Accounting, Engineering (Misc), History, Law, Linguistics & Language, Mathematics and Medicine. These disciplines also cover a spectrum between more theoretically and more empirically oriented disciplines. We decided not to include Physics because there is already a wealth of studies dedicated to the discipline (Galison 2003; Birnholtz 2006; Borenstein and Shamoo 2015).

In addition, we stratified the sample by four of the biggest publishers (Elsevier, Sage, Springer, Taylor and Francis) and one miscellaneous publisher category that covers the remaining publishers, university presses and academic associations.[1] Five journals were randomly drawn for each combination of publisher and discipline, resulting in a total of 175 journals. We restricted the sample to the first two quartiles of the ranking but were forced to relax this restriction in some cases due to the small size of some disciplines or the lack of journals from one of our chosen publishers. In two cases, we were forced to manually select journals outside the ranking due to a lack of remaining publications within the ranking. We also collected the authorship policies of the sampled publishers. In addition, we collected the authorship guidelines and recommendations of COPE—Committee on Publication Ethics, WAME—World Association of Medical Editors and the ICMJE.

The journal policies were collected from the journal web pages. Each journal policy was compared to the authorship policy[2] of its publisher and coded into one of the following categories:

1. not mentioned (policies fail to mention authorship or no form of journal policy or author guidelines provided)
2. referral to publisher policy (in writing, via link or both)
3. own policy given, identical with publisher policy (policy reproduces the publisher policy fully or in part)
4. own policy given, nearly identical with publisher policy (policy consists of passages from the publisher policy with only a few new sentences changed)
5. own unique policy given

3. Results for authorship policies

Our data shows that only 56.6% of journals in our sample address authorship in their journal policies and author guidelines. This number falls within the range established by previous studies (Bosnjak and Marusic 2012;Resnik et al. 2016; Chang 2019;). Notably, only 10 journals have created unique authorship policies.

The high share of journals omitting authorship in their policies may be due to the fact that the standardized journal web pages all show a footer linking either to a page with information for authors referring to the authorship policy of the respective publisher or linking directly to their editorial policies. Even if a journal does not address to authorship, potential authors are still able to get to the publisher's policy with one or two clicks.

Our data suggests that formal regulation of authorship is mainly performed at the publisher level (Supplementary Table S1). Only 12% of journals modify the publisher policy or even create their own one. Taylor & Francis shows the impact that publisher standardization can have. More than three quarters of its journals' policies include the link 'Read more on authorship' to the publisher policy.

When collecting the policies, we recorded statements pertaining to ownership on the journal webpages. Journals that are published by, or in cooperation with, academic societies, more often have unique policies: Of the 10 journals with own policies, 4 were society journals, while society journals made up only 17.7% of our sample. Because of the small numbers and some conceptual ambiguities around the concept of a 'society journal',[3] these results should be treated with some caution. Nevertheless, we can say that discipline-specific challenges and disparities in dealing with authorship are more likely to be mentioned at the level of societies owned journals.

Looking at the authorship criteria in publisher policies shown in Supplementary Table S2, we observe a large homogeneity between publishers. Even though there are differences in content and phrasing between publishers, they essentially replicate the four criteria laid out in the ICMJE recommendations (2018). Taylor & Francis gives two additional criteria, stipulating that authors have to agree on which journal their article is submitted to and that each author is aware that the corresponding author will perform 'any communication about the article, through submission, peer review, production and after publication' on their behalf.

In addition to these criteria, all publishers except for Springer specify types of contributions that do not warrant authorship. Sage lists 'Acquisition of funding', 'collection of data' and 'general supervision of the research group'. Elsevier gives language editing and medical writing as examples as well as 'providing advice, providing research space, departmental oversight and obtaining financial support.'

Taylor & Francis and Elsevier use the figures of the ghost author (who substantially contributes to a paper but is not listed as author) and the gift author (who has not contributed to the paper but is listed as an author) as a way of demarcating acceptable from unacceptable authorship practices (Taylor & Francis 2015b; Elsevier 2019). Elsevier further differentiates between guest and gift authorship. Here guest authorship is a form of gift authorship where the reputation of the author in question is leveraged for a higher chance of publication of the article.

The publisher policies all refer to ICMJE and COPE guidelines making them the de facto standard, while Contributor Roles Taxonomy (CRediT) is only mentioned in Elsevier's and Springer's policies. Authorship policies from other academic associations like the WAME are not mentioned at all.

Publisher policies all acknowledge that authorship practices and norms may differ between research fields. Taylor & Francis and

Sage do this implicitly by stressing the need for authors to check the individual policies of specific journals whereas Springer recommends that 'authors adhere to the guidelines for authorship that are applicable in their specific research field' (Springer n.d.) which could also capture informal authorship norms. Elsevier's policy acknowledges that 'there is no universal definition of authorship' and proceeds with the ICMJE definition followed by 'some guidelines which may vary from field to field' (2019).

Journals are hence given the option to deviate from their publisher's authorship policy or to regulate authorship more tightly within the broad authorship criteria of their publishers. Given the different authorship practices and conventions across disciplines, we would expect that journals use their regulatory discretion to account for these differences. Previous studies have also shown significant disciplinary differences in prevalence and content of authorship policies (Bosnjak and Marusic 2012; Resnik et al. 2016; Johann and Mayer 2019). Contrary to those findings however, Fisher's exact test suggests that there is no significant relationship ($p = 0.55$) between a journals authorship policy and its disciplinary category in our data.

When looking at the disciplines we can see that the majority of journals with a unique authorship policy are medical journals (Supplementary Table S3). This seems counterintuitive at first, given the fact that the ICMJE authorship recommendations were drafted by medical journal editors. At the same time Medicine also has the lowest percentage (28%) of journals with no mention of authorship policies at all. In contrast, no journal in the categories 'Engineering' and 'Business, Management and Accounting' in our sample has a unique policy. Both subject categories also have high proportions (BMA = 52%, E = 44%) of journals that do not mention authorship policies. Since this proportion is similarly high in other disciplines such as law (48%), history (48%) and Mathematics (32%) is placed in between the extremes, the discipline-specific significance is questionable and the interpretation of these values is not evident.

At least on article, the regulation and definition of authorship thus seems to happen in a top-down fashion. Journal publishers incorporate the recommendations of the ICMJE and COPE into their own policies. The journals deviate from their publisher's policy only in a small number of cases. Even though publishers give journals the option to account for discipline specific authorship concerns, the absence of a statistically significant relationship between policies and discipline suggests that disciplinary authorship conventions are not incorporated into journal authorship policies.

4. Study II: authorship definitions and negotiations in academic practice

4.1 Data and methods

The second study uses data from the 2019 DZHW Scientists Survey, a national representative, interdisciplinary study of the German academic system (Ambrasat and Heger 2020). It identified scientists at the professorial, the PostDoc and the PreDoc level at German universities by collecting publicly available address data of professors and research and teaching staff from the websites of 132 universities in Germany. Based on this address data, respondents were sampled randomly, stratified by status group, and surveyed through an online questionnaire. The overall response rate was 14.7%. The survey consisted of a shared basis module for all respondents and four additional thematic modules that were assigned randomly. The present analysis makes use of the module 'authorship' that was randomly assigned to a quarter of the respondents. For more detailed information about the survey and the final sample, see the methods report (Ambrasat, Heger, and Rucker 2020).

To explore the issue of disciplinary differences in definitions of authorship, we used the following measures from the survey:

4.1.1 *Authorship negotiations*

Respondents were asked to indicate on a four-point scale how important journal policies as well as research activities were in their field for negotiating authorship, based on their own experience.

4.1.2 *Activities justifying authorship claims*

To capture individual definitions of authorship respondents were presented with nine different research activities and asked to indicate for each item whether it certainly justified claims for authorship, it justified authorship claims depending on the circumstances, or it did not justify authorship claims. Based on this item battery (shown in Supplementary Table S4), we construct an additional variable for authorship definition indicating how narrow or wide the respondents' authorship definitions are by adding up the number of activities that certainly justify authorship claims for each respondent. The resulting variable is a count variable that ranges from 0 to 9.

4.1.3 *Academic disciplines*

Respondents' research fields are classified into five different disciplines, based on a modified version of definition of academic fields provided by the German Research Foundation, comprising Humanities, Social Sciences, Life Sciences, Natural Sciences and Engineering Sciences.

4.1.4 *Characteristics of research practice*

In addition to their research fields, respondents were asked how empirical, and how theoretical their research is, how much they rely on technical infrastructures, and how much they work in teams, rating each item on a four-point scale.

4.1.5 *Number of publications*

A standardized variable measures the respondents' total number of publications, combining journal articles, books, book chapters and miscellaneous publications.

4.1.6 *Status group*

This variable indicates the university status group the respondent belonged to as either professor, Postdoc or Predoc.

4.1.7 *Fixed term*

This variable indicates whether respondents' current employment contracts are fixed-term or not.

4.1.8 *Gender*

Respondents' gender is measured as either male, female or diverse.

We conduct bivariate analyses to examine the effects of the respondents' scientific fields as well as the characteristics of their research practice on the relevance of journal policies and activities for assigning authorship, performing chi-square tests. To test for the simultaneous effects of academic disciplines and research practice

on authorship definitions, we estimate a series of nested negative binomial models because the dependent variable (number of activities that certainly justify authorship claims) is a count data variable with slight overdispersion.

5. Survey results

5.1 *Authorship negotiations*

Building on our analysis of authorship policies, we are interested in the relevance these policies have in authorship negotiations. We firstly analyze the two measures 'relevance of assigned activities for authorship negotiations' and 'relevance of journal policies for authorship negotiations'. Descriptive results reveal that the assigned research activities in general play a very large role in negotiating authorship: Slightly over 86% of all respondents state that they are relevant or very relevant in negotiations. In contrast, only about 33% of respondents indicate that journal policies are relevant or very relevant for negotiating authorship.

Cross-tabulating the relevance of the assigned activities, we find significant disciplinary differences. The greatest relevance for assigned activities is found in the life sciences, where 92.95% of respondents see them as relevant or very relevant, and no respondents see them as entirely irrelevant. The least relevance of activities is seen in the humanities, where only 75.61% of respondents find them relevant or very relevant. Social sciences, natural sciences and engineering all fall relatively close together in between humanities and life sciences. We also find effects of the characteristics of the research practice: The relevance of the assigned activities is significantly positively related to the dependency on infrastructures ($chi^2(9) = 31.70$, $p = 0.000$), and the empirical orientation ($chi^2(9) = 50.33$, $p = 0.000$), and significantly negatively related to the theoretical orientation ($chi^2(9) = 18.62$, $p = 0.029$). Interestingly, the relevance of activities for authorship negotiations is not related to whether research is typically carried out in teams.

Looking at the relevance of journal policies for negotiating authorship, there are also significant differences between disciplines, but the pattern is less clear than for activities. The most striking peculiarity are the life sciences with a relatively low proportion of respondents who said that policies are 'not relevant at all' (18.78%), but a high proportion of respondents who said that journal policies are 'less relevant' (48.34%). Engineering and humanities both have a relatively high proportion of respondents who said that policies are 'relevant'. Other than that, disciplines seem to mostly follow very similar patterns, which is somewhat surprising. As for the characteristics of the research practice, both the empirical orientation ($chi^2(9) = 24.30$, $p = 0.004$) and working in teams ($chi^2(9) = 23.84$, $p = 0.005$) have a significantly negative effect on the relevance of journal policies. There is also a significant effect of the theoretical orientation ($chi^2(9) = 44.41$, $p = 0.000$), but its direction is less clear. The most pronounced difference is found for respondents whose research is very theoretically oriented, and who answer that journal policies are not relevant at all at comparably higher rates than all other respondents.

Given the importance of the assigned activities for claiming authorship, we conducted a more detailed analysis into the types of research activities that justify authorship claims. The descriptive results reveal that there are some activities for which there is a broad consensus that they justify authorship claims, while some activities seem more contentious. More precisely, writing the manuscript, data interpretation and data analysis strongly justify authorship claims, with more than two thirds of respondents seeing them as certainly justifying authorship claims. A slight majority of respondents indicates that conceptualization of the research design and the collection of data or sources certainly justify authorship claims. Reviewing the state of research, providing comments and revisions, and preparing visualizations depend on the specific circumstances. Due to the standardized nature of the survey response, we cannot say precisely which circumstances respondents refer to here: It is possible that the allocation of authorship for those activities depends on whether the respective researcher also carried out other relevant activities. Such an interpretation would parallel an additive definition of authorship found in some journal policies, whereby a researcher needs to be involved in all four of the main criteria (substantial contribution, writing, approval, accountability) in order to be named as an author. However, those circumstances might also allude to negotiation situations, in which additional factors might come into play. Whether authorship can be negotiated at all and how those negotiations develop is strongly influenced by the organizational structure under which research is carried out (Shen 2016). Given those ambiguities, interpretations of the answer 'depends on the circumstances' should be made with great caution.

The item with the lowest rates for justifying authorship claims is fundraising. Here, almost a third of respondents believes that this does not justify claiming authorship (see also Kassis 2017 for similar results). Still, a relatively large proportion of respondents believes that it might justify authorship, depending on the circumstances. This is interesting, as this represents one case of what guidelines call 'gift authorship' (ICMJE, BMJ). The literature addresses various forms and valuations of 'gift authorship', 'honorary authorship' 'guest-authorship' and coercion authorship (e.g. Smith and Williams-Jones 2012; Larivière 2016: 418; Bülow and Helgesson 2018; Mousavi and Abdollahi 2020: 361). Despite often being judged to be problematic (Kressel and Dixon 2011), it is seen as quite prevalent (Reisig, Holtfreter, and Berzofsky 2020).[4] Here, respondents also seem to be mostly critical of granting authorship for this activity alone. Overall, there seems to be a general tendency to grant authorship for a variety of practices, be it alone or in conjunction with other activities, with relatively few respondents outright denying authorship claims for the listed activities. There seems to be a general willingness to recognize activities that might warrant authorship. Such an apparent courtesy might be the result of social desirability, as respondents might try to avoid seeming strict or tight-fisted in denying authorship. Still, this would indicate a social expectation of being generous or willing to negotiate authorship claims rather than denying authorship outright.

Cross-tabulation of activities and academic disciplines shows that there are significant differences between disciplines for all activities. For most items, life sciences, natural sciences and engineering are similar to one another, and humanities are the most different, with social sciences falling between and exhibiting variable patterns. In life science, natural sciences and engineering, respondents answer that activities justify claims to authorship at higher rates than in the social sciences, and researchers from the humanities grant authorship at the smallest rates. For the collection of data or sources, only 26.09% of respondents from the humanities indicate it certainly justifies authorship, compared to 36.19% from the social sciences, 53.10% from engineering, 60.25% from the natural sciences and 72.31% from the life sciences. Respondents from the humanities are also the most likely to indicate that an activity does not occur in

their field, except for fundraising. This difference is most pronounced for data-related activities (data interpretation, visualizations, data analysis and data collection). The writing of the manuscript deviates from that pattern, but while the chi-square-test does suggest a significant difference, in absolute numbers this difference between disciplines is very small, due to the overall level of consensus that this activity certainly warrants authorship.

Notably, for fundraising, respondents from the life sciences indicated that this activity certainly justifies claims to authorship almost twice as often (36.29%) as respondents from the natural sciences (19.25%), engineering (15.17%), the social sciences (13.69%) and humanities (11.04%). Examining the overall number of activities that certainly justify authorship claims, we can see that on average, this number was highest among the life sciences (mean 5.48, SE 0.09), with natural sciences (mean 4.89, SE 0.09) and engineering (mean 4.78, SE 0.11) close together in the middle, and social sciences (mean 4.22, SE 0.10) and humanities (mean 3.75, SE 0.12) on average naming the lowest number of activities that justify authorship. Life sciences thus seem to have the most diverse or encompassing definition of authorship, and humanities the most limited or focused.

As to be expected, performing research that is more theoretically oriented significantly lowers the authorship claims for data-related activities, i.e. conception of research design, data collection, data analysis, visualizations and data interpretation. Interestingly, it also lowers the authorship claims for fundraising, and it increases claims for comments and revisions. The empirical orientation, however, does not yield as clearly a pattern. While it significantly increases the proportion of respondents granting authorship for data analysis and data interpretation, it has equivocal effects on visualizations and data collection. Working in teams significantly increases the rates of respondents answering that activities justify authorship claims for all activities. This indicates that if more persons are involved in the research leading to a publication, then researchers are more willing to grant authorship for diverse tasks. The same pattern can also be found for research that depends on infrastructures. It is also visible in the overall number of activities certainly justifying authorship claims, which steadily increases from 4.15 activities on average (SE 0.13) for respondents whose research is not conducted in teams at all to 5.15 activities on average (SE 0.09) for respondents whose research is very team-based; and from only 3.93 activities on average (SE 0.12) for researchers who do not depend on infrastructures to 5.08 activities (SE 0.07) if the research is very dependent on infrastructures.

In order to simultaneously test the effects of academic discipline and research practices on the number of activities certainly warranting authorship, we estimate nested negative binomial models (Supplementary Table S5). All of the models control for respondents' gender, status group, fixed-term contract and their number of publications (standardized).

The first model reveals significant effects for all academic disciplines. Compared to humanities (base category), all disciplines show positive effects. They exhibit a larger number of activities that justify authorship claims, i.e. they have a more diverse or encompassing definition of authorship than the humanities. This effect is most pronounced for the life sciences (vs. humanities) and least pronounced for social sciences (vs. humanities).

The second model includes the dependency on infrastructures. Consistent with the bivariate results, this effect is positive. Relying on technical infrastructures thus increases the number of activities that justify authorship claims. Including this variable notably decreases the effects of all disciplines. Such a decrease can be found in all subsequent models including characteristics of the research practice, but it is most pronounced for the dependency on infrastructures, indicating that this is where the five disciplines differ the most with regard to authorship. In the third model, similar to the effect of infrastructures, predominantly or entirely working in teams has a significantly positive effect on the number of activities warranting authorship, meaning that working in teams also significantly increases possible activities that can justify authorship claims. The effect of the empirical orientation in model four is also significantly positive. Notably, the effect is significant and quite similar in size for all levels compared to the base level 'not empirical at all'. This suggests that the relevant difference is between research that is not empirical at all and all other research. Model five tests the effect of the theoretical orientation of research. Contrary to the other three characteristics of the research practice, this effect is negative, meaning that the more theoretically oriented a respondent's research, the less diverse their definition of authorship. With the exception of empirical orientation, the effect sizes of all other three characteristics of the research practice increase along with their levels, indicating a somewhat continuous effect.

In the last model, the effects of all four characteristics decrease when considered together, which might also be a result of correlation between the characteristics. Still, all four characteristics yield effects in their original directions. For dependency on infrastructures and working in teams, these effects are almost cut in half and become insignificant. Interestingly, empirical orientation yields significant effects for levels two and three (vs. base level), but not level four, indicating a reverse u-shape for the effects. Similar to the inconsistent effects this item showed in the bivariate analysis, there seems to remain a certain ambiguity for the effect of empirical orientation of research on authorship definitions. The effects of theoretical orientation, however, do not decrease much, indicating that of all characteristics, theoretical orientation yields the strongest independent effects. Tentatively, we might conclude that for the definition of authorship, theoretical orientation is the most defining characteristic of the research practice, while the effects of the other characteristics seem to be highly correlated with theoretical orientation.

Notably, in all five models including characteristics of the research practice, the effects of most academic disciplines become smaller but remain substantial and mostly significant. An exception is the effect for social sciences vs. humanities: This effect becomes less significant in all models controlling for characteristics of the research practice. Throughout all models, we can observe the same pattern between the disciplines, with the difference between humanities and social sciences always being the smallest, and the difference between humanities and life science always being the largest.

This indicates that the effects of academic disciplines can partially be explained by characteristics of the research practice, but large and significant effects of some disciplines remain even when controlling for research characteristics. The difference between humanities and social sciences can largely be explained as a result of their different research characteristics. The difference between natural science and life sciences seems to result mostly from their different theoretical orientations. However, in the last (full) model, we still see significant disciplinary effects. Those effects mostly distinguish between social science and humanities as one group and natural science, life science and engineering as another group, although there also

remain substantial, significant differences between life science and engineering.

Overall, we see that the more dependent research is on infrastructures, the more it involves teams, the more empirically oriented, and the less theoretically oriented it is, the more expansive is its authorship definition. Additionally, life sciences, natural sciences and engineering all have more expansive definitions of authorship than the humanities (and the social sciences), an effect that cannot fully be explained by the characteristics of the research practice.

6. Discussion

From our first study, we can conclude that the regulation of authorship qua policies is primarily effected at the level of the publishers. Although considerable disciplinary variations of journal policies are sometimes suggested in the literature (Bosnjak and Marusic 2012; Resnik et al. 2016; Johann and Mayer 2019; Matarese and Shashok 2019:2) according to our analysis the authorship criteria show only minor differences: for example, in whether requirements and activities are formulated in a more additive way, connected by 'and' or in a more alternative way connected by 'or'. The content of the authorship criteria often occurs in demarcation from activities that are not sufficient for authorship or in distinction to terms such as ghost- and gift-authorship, which are labeled as illegitimate authorship practices. Against this background it can also be assumed that the perceived need for authorship policies and guidelines on the part of publishers is related to existing or anticipated problems of quality assurance. Furthermore, despite the frequent mention of discipline-specific differences in authorship concepts and practice, publishing and journal policies are remarkably homogeneous and consist essentially of the four criteria proposed by the ICMJE. These findings are in line with Chang (2019: 578) who concludes that '[t]he interdisciplinary influence of the ICMJE authorship criteria has thus reached the social sciences. This indicates that journals across various disciplines tend to adopt identical authorship definitions, rather than tailoring them according to their needs.' This surprising homogeneity calls into question the function of policies as an instrument to handle the diversity of authorship practices and conceptions. It is hard to imagine how policies could effectively help to handle or to prevent the resulting problems and conflicts without incorporating discipline-specific differences in authorship practices.

Contrary to the assumptions in the literature, the regulatory claim of journals hardly seems to consist of effectively influencing authorship practices and offering discipline-specific, suitable solutions to typical problems. On the contrary, given that publisher policies place disproportionate emphasis on the authors' responsibility for review, scrutiny and accountability, the main purpose of declaring authorship policies seems to be legal and reputational protection of publishers in cases of quality deficits or conflicts. Publishers can point to the responsibilities accepted by the authors and thus stay out of the line of fire. Furthermore, the establishment of policies means that these guidelines can be made available to editors as needed, i.e., when problems arise, thus reducing the need for complex individual case management on the publisher's side. Against this background, the homogeneity of the guidelines can be seen as advantageous, as they can be presented as a common denominator that is mostly shared by the large and important publishers, thus securing their reputation. The safeguarding objective of the policies can also make sometimes restrictive orientation—e.g. that all authors must fulfill all criteria concurrently—appear attractive: A strict policy can be represented particularly well as a clear and consistent authorship policy, which signals that utmost importance is attached to academic quality standards and integrity and that authors are fully committed to this. Regarding the positioning of the publishing house and depending on the field of research and publication culture, such messages may also function as a mechanism of distinction.

Our second study shows that the understandings of authorship exhibit significant, discipline-specific differences. Looking at activities warranting authorship, the writing of the text, the interpretation and analysis of data establish secure entitlements to authorship. Given the relatively high accordance on these items (> 50%) it must be assumed that the elaboration of the conceptualization, the research design, as well as the gathering and collection of the data often leads to sufficient claims to authorship that can be asserted. All other activities seem to be negotiated between the participants on a case-by-case basis. A similar pattern of 'core' activities that justify authorship claims and some more contentious activities has also been found in previous studies (Kassis 2017; Patience et al. 2019). Moreover, regarding differences in concepts of authorship related to the respective research practice, relevant divergences can be identified, such as how narrow or how broad authorship and the activities that legitimize it are defined. Hence, it can be shown that research practice and thus the discipline-specific conditions of knowledge production have a considerable role to play here. Disciplinary effects point in the directions anticipated based on the research literature: with humanities exhibiting the narrowest concept of authorship that is focused on writing and working with the literature, and life sciences and natural sciences exhibiting the most encompassing concept that places a higher emphasis on empirical and data-related activities (for similar results see also Johann and Mayer 2019; Patience et al. 2019). Likewise, on the basis of self-reported contributions in the PLoS Journals, the analysis of Larivière and colleagues indicates that in the life sciences, technical and experimental activities are more likely to be associated with authorship. Moreover, the study finds that life sciences announce the highest relevance to the listed activities, consider more activities than the social sciences and humanities to justify authorship, and have the most fragmented understanding of authorship. Fragmented here means that usually barely anyone of the authors is involved in all tasks, but rather that contributing to one central task, e.g. data analysis, is sufficient (Larivière et al. 2016).[5] Social sciences and engineering fall in between those two conceptions. Moreover, in our analysis, most disciplines have a bigger effect size than the characteristics of individual research practice. Our analyses thus fit the theoretical juxtaposition of the classical book sciences with their ideal of a single author-genius on the one hand and the empirical sciences with their high division of labour and resulting multi-author groups on the other hand.[6]

In the synopsis of both studies, it becomes clear that first, discipline-specific conditions of knowledge production with the resulting differences in authorship practices are hardly reflected in authorship policies. We consequently agree with Larivière and colleagues that 'ICMJE recommendations are not able to deal with disciplinary differences in authorship practices' (Larivière et al. 2016: 419). Second, the regulatory ambitions of authorship policies do not directly target authorship practice in all its manifest diversity. Rather, they focus on the prevention and elimination of deficits in the quality and integrity of academic publications. Thus, authorship

policies as provided by publishers do not seem suitable for the mediating and operationalizing function between diverse authorship practices and normative ideals of legitimate authorship that is partly ascribed to them. They lack information about the concrete discipline specific characteristics under which authorship in academia is legitimate or illegitimate. Neither do they provide consistent definitions of ghost-, guest-, gift-, honorary-, coercion authorship etc. or unified standards for (il)legitimate forms of authorship and how to deal with the related conflicts. Thus, it comes as no surprise that many researchers find these authorship policies rather difficult to apply in practice (Breet et al. 2018). However, by means of their guideline setting function, publishers and academic associations such as ICMJE and COPE can be seen as setting standards with regard to administrative processes when dealing with violations of good scientific practice or other deficiencies in a particular paper.

6.1 Limitations and further research

Taking into account that academic authorship and its attribution is a quite intricate subject of research, the instrument of a standardized survey has its limitations to identify in detail which research related activities justify authorship claims. Moreover, the survey questions analyzed here do not allow a differentiated weighting of the activities. Besides the classic problems already mentioned, such as social desirability, the statements of the respondents cannot be linked to the concrete publication constellations, specific cases and experienced situations, which may stand behind their concepts, views and expectations of legitimate authorship. In order to explore more precisely how the discipline-specific production conditions of academic knowledge become effective, more qualitative studies that systematically compare developments in a wide range of different disciplines would be needed in order to elucidate the complex development of the heterogeneous academic publication system.

6.2 Bills, bills, bills or fame? The intricate relation between publishers' and researchers' interests

To contextualize the results, we situate them within the spectrum of current ideals of authorship discussed in the literature. We therefore ask which authorship practices and ideals are reflected in the empirical findings and which conclusions can be drawn from this with regard to current guidelines and practices of authorship.

From our analysis, we can assume that authorship practices and the related negotiations are considerably marked by a logic of credit. 'Credit' here refers to Biagioli's explanations on the 'peculiar logic of scientific rewards' (Biagioli 2003: 255), meaning that 'credit is attached to qualitative notions such as truth, novelty, and scientific relevance, which have been proven very hard to quantify precisely because they operate (and need to operate) in an economy that is distinct from capitalist economy' (ibid.). He concludes from this that the credit obtained through academic authorship as a reward must not be conceived under a 'logic of interest'. In line with the often noted tension between a kind of 'donor/gift-economy' and a 'capitalistic market like economy' he concurrently states that 'the dichotomy between truth and interest is one of the standard topoi of the logic of scientific authorship (ibid.).' Given this, the logic of credit is driven by the idea that authorship is a way of paying tribute to the (co-)authors for the academic work they have done which underlies the publication. One way to realize it in multi-author constellations is to assign 'authorship in terms of credit for accumulated labor' (Biagioli 2003: 270), as it is common for example in high energy physics. Another way to implement a logic of credit in the case of co-authored papers is the idea that the author constellation rewards the co-authors equitably according to the type and extent of their performance, in the sense of a fair reflection of the type and amount of work done. The underlying logic would then be to represent the various services relevant to the genesis of the publication as closely as possible. According to our analysis, credit is given more commonly to activities that are likely to be seen as academic achievements, rather than to technical contributions.[7] In any case deserving this credit encompasses the academic contribution to the publication as well as the accountability for the communicated content. Likewise, the question of responsibility and accountability for the correctness of the statements made in the publication, which is particularly present in authorship policies, completes the picture.

Beyond that, the spectrum of achievements that can be associated with authorship, both historically and today, is very broad. It ranges from creating and inventing to processing and producing knowledge through experimental design and data analyses or pure reasoning, to compiling, depicting and writing down knowledge as well as revising and commenting (Woodmansee 2000; Biagioli 2003; Jaszi and Woodmansee 2003; Rheinberger 2003; Birnholtz 2006;). It is interesting however, that these various dimensions of academic authorship are reflected only very distortedly in the authorship criteria addressed by the policies. The criteria of final approval and accountability place an extraordinary emphasis on the authors' responsibility (see also Alfonso et al. 2019). In comparison, the various activities belonging to knowledge production and knowledge communication in a broad sense are subsumed under the two categories of 'substantial contribution' and 'drafting, writing, revising', i.e. everything that has to do with composing the text. On the one hand, this shows the already discussed focus of publishers on their own protection against problems that may point to quality deficiencies or possible scientific misconduct. Moreover, it can be assumed that journals and publishers, following their increasing relevance in academic publishing, see an increased need to ensure regulation, control and accountability of authors by means of specified guidelines and directives. Other studies deduce research desiderata from similar assumptions: 'Given the expansion of the competitive academic environment and the increase in misconduct in research, the role of each regulatory sector, including universities, journals/publishers, government, etc., in preventing this phenomenon must be fully focused' (Mousavi and Abdollahi 2020: 359). However, the current positioning of publishers is beneficial in two ways: firstly, to safeguard their reputation as high-quality and high impact publisher while secondly, retaining a position of pure provision and marketing of research results.

The apparent mismatch of very heterogenous authorship practices and in contrast quite homogenous authorship policies can be addressed through the 'credit—responsibility nexus' (Biagioli 2003: 262). The extent to which a person is able and willing to be accountable and responsible for the entire paper and the statements it contains can play a crucial role in realizing this authorship potential (see Biagioli 2003: 259). Regarding the persistence of the credit-responsibility nexus the concept of contributorship comes into play as a challenging operator, questioning the holistic conjunction of authorship and accountability (Borenstein and Shamoo 2015: 274). Lined up to supersede authorship (Rennie et al. 1997; Rennie et al. 2000) with its encompassing claims it now takes on the role not of a real alternative but of a complementary concept allowing to specify and to distinguish the activities on which authorship is assigned in

multi-author constellations. Nevertheless it puts pressure on the consistency of the credit-responsibility nexus: As Matarese and Shashok argue, the transparent designation of non-author contributors, who in contrast to author contributors are not held accountable for the entire content of the publication (Matarese and Shashok 2019: 9), would dissipate the conjunction of credit and responsibility.[8] Taking into account the functioning principles and mechanisms of quality management of the academic publication system this is a major issue especially for the publishers clinging so tightly to this nexus, as demonstrated in the policies: From the publisher's point of view insisting on a close alliance of authorship-credit and responsibility clears up the question of accountability. In this regard, it is questionable why publishers should be interested in a designation of non-author contributors, for this could reopen gateways for a dispersion of responsibility.

Despite the persistence of the credit-responsibility nexus, changes can already be observed as contributions are identified: In the context of transformations in the conditions of knowledge production and academic authorship, more and more researchers and publishers recommend and require the differentiated indication of the contributions of all co-authors (see Nature 2009; Borenstein and Shamoo 2015: 277). While contribution statements for authors are now widespread in the natural sciences, life sciences and engineering (see PLoS Journals, EMBO Journal, Nature & Nature research), they appear not to be actively promoted by authors in the humanities and large parts of the social sciences, nor are they required or consequently suggested by journals in these subject groups. Apart from this, Study 1 showed that contribution statements still play a marginal role in publishers' authorship policies. Thus, the signs of change are characterized by the very same heterogeneity as the lived models of authorship. Given this, despite the discrepancies found when comparing our empirical studies, the interrelation between knowledge production-related concepts of authorship and notions of authorship provided and regulated by publishers seems to exist, albeit it is a very intricate one. This stimulates further research to elucidate how all the mentioned possibly relevant aspects—such as differing publication cultures, single- or co-authorship constellations, publication format (article, monograph, books), career relevance of journal publications, impact factors etc.—articulate in the interplay of researcher's author comprehensions and publishers author conception. These interrelations need to be taken into account and analyzed in context to get an idea of possible effects of author signing conventions. Only then urging questions on how author-constellations, author-ordering, contribution statements etc. affect publication counts, the accumulation of credit and career progress (e.g., through application procedures) can be answered.

Summing up, by offering rough categories such as 'substantial contributions' and 'drafting, writing, revising' publishers are able to avoid positioning themselves in detail on the controversial question which of the further differentiating research practices justify authorship and to what extent. On the other hand, it is noteworthy that publishers link their concept of authorship very closely to the writing or composition of the text. They thereby remain in a rather conservative position with regard to the transformation of knowledge production, since the close connection between author and text is characteristic especially of the romantic ideal of authorship, according to which the creative genius of the author as the master of a piece is revealed in the text. Taking this further, the tension of these two ideals is also reflected in the debates on contribution taxonomies, their level of detail and extensiveness, e.g. when activities of writing and manuscript drafting and activities of data analysis compete for their position as essential contributions, be it through differentiated gathering of writing or data analyzing tasks or through reducing elaborateness of the classification.

Still the policies provide diverse reference points to which different practices with possibly different underlying ideals can tie up to; be it conventions considering writing as the central activity of knowledge production that is essential in order to justify authorship, which often tend to label data related activities as supporting; or be it conventions conceiving writing primarily as compiling activity and correspondingly perceiving the empirical, experimental and data related activities as crucial tasks of knowledge production. From a science policy perspective, this non-positioning of publishers concerning different and sometimes competing authorship conceptions can be interpreted as a volitional blurring of sharp contoured or even selective authorship conceptions. From a conceptual point of view. the vagueness of an almost all-encompassing potential of the term 'author' can also be seen as its major strength as an umbrella term, since it enables to keep it all together, so that we can at least still discuss it in interrelation, instead of a dispersion into fragmented discussions.

However, remembering the institutional, financial and status-based structure of the academic system and especially the international publication system, and the related reputational dynamics we need to bear in mind to which extent academic authorship is related to struggles for the distribution of scarce resources. These conflicts and tensions remain, regardless of which concept of authorship, contributorship, guarantorship, writership or alternative topos prevails. Of course, new labels, concepts and their elaboration can break up authorship traditions and force gatekeepers to move on and sometimes open up concerning the assignment of different roles. This may be relevant for individuals, insofar as it can be made valuable for pursuing career ambitions. But the struggles mentioned cannot be resolved in terms of transparency and openness (in the designation for example of contributors independent of their status as author) because they cannot hinder the dynamic and immanent logic of distinction, nor do they prevent rising mistrust.

Notes

1. The sample contains 28 miscellaneous publishers, among them large publishers like Cambridge University Press or Wiley-Blackwell, as well as relatively small academic institutions like the German Historical Institute London or the Nordic Forum of Sino-Western Studies.
2. The comparison was performed manually but augmented by an algorithmic comparison tool: https://people.f4.htw-berlin.de/~weberwu/Tools/Text-Compare.html
3. First and foremost, this would involve deciding if journals that are 'published in cooperation with', 'published on behalf of' or 'affiliated with' academic societies all count as owned by an academic society. In some cases, the journal publishers itself are academic societies. In other cases, if a university is listed as the journal publisher, does this mean that the journal is owned by a specific department (which one could count as an academic society) or does the university maintain a publishing arm?
4. For a more specific distinction of gift-, guest, ghost- authorship also see Mousavi and Abdollahi 2020
5. This finding must be interpreted with the reservation that in the sample of PLoS journals examined here biomedicine and medicine are clearly overrepresented in comparison to other

fields, and in particular, that physics as a discipline with a strong division of labor is not represented here (Larivière et al. 2016: 421–422).

6. Similar to this distinction and our gradation between narrow and broad authorship conceptions Borenstein and Shamoo discern between a so called 'traditional definition of an author, upheld by many scholars in the humanities and social sciences, and a more 'expansive' definition (Borenstein and Shamoo 2015: 269–270).
7. For the long-standing distinction between scientific and technical contributions see also Shapin (1989).
8. Concerning the concrete implementation of CRediT they argue that the 14 taxa of CRediT are prone to identify and capture in more detail the contributions of authors but to neglect the contribution of non-authors. CRediT thereby tends to reinforce the authorship-topos instead of establishing the contributor as alternative discursive operator.

Supplementary data

Supplementary data are available at *Research Evaluation Journal* online.

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