Determinants of peer review engagement and quality in scientific journals: insights for academic research and the sustainability of the peer-review system

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Research productivity is a common topic in the literature, but peer reviewing for journals has received less attention, although it is a key activity of academic research. We help to fill this knowledge gap by assessing the determinants of peer review engagement and quality in scientific journals. By using known predictors of knowledge production, and metrics of peer review, we aim to answer the following question: What are the determinants of peer review engagement and quality in international peer-reviewed journals? We do so by analysing the combined information from a survey of academics working in different parts of the world and various fields of science, along with their publication and peer review information gathered from Scopus and Publons/Web of Science. We find that age, gender, whether academics' strategic research agendas are focused on a drive to publish, branching out, willingness to engage in research with little or no funding, and the involvement of non-academics in research are equally important predictors of peer review engagement. We also find that academic inbreeding along the educational path has a negative association with the quality of peer-review activities, but we find no statistically significant results concerning academic inbreeding related to the professional trajectory and peer review engagement and quality. Equally importantly, our results suggest that although the activities of publishing and peer reviewing are closely associated, peer review tends to be ancillary to publishing, rather than the other way around. Furthermore, the greater the perceived availability of resources, including research funding throughout an academic's career, the greater the focus is on publishing and the less the focus is on peer reviewing. These findings are discussed in relation to the current valuation of publication versus peer reviewing in terms of scientific and academic career recognition.

Keywords: Peer review–publication nexus; Strategic research agendas; Academic research; Academic inbreeding

Introduction

The productivity and quality of academic research have been a focus of interest for researchers and policymakers for a long time (Ryazanova and Jaskiene, 2022). This line of research has striven to better

understand who publishes the most and identify the most impactful research. It has attempted to determine the conditions, incentives and drivers that lead to greater research output and ensure better research quality and greater impact (e.g., Quimbo and Sulabo, 2014). Whereas much of the literature has focused on understanding the production of knowledge, particularly in academia, our understanding of a critical function related to it, peer review, is minimal, and most of the research in this area has been relatively recent. Knowledge of the peer review system has been analysed mainly by scientometricians, library scientists and interested academics from all fields of knowledge, mostly those involved in journal editorial boards, who have often provided commentaries on how to improve peer-review practices (e.g., Genova and de la Vara, 2019). Much of the literature has analysed historical peer-review practices, focused on the challenges and criticisms associated with peer review and offered new or alternative modalities to assess the rigour, novelty and overall quality of the scientific work produced (Kovanis et al., 2017). Attention to and research on peer review have been increasing, partly because peer review is considered to be in crisis as publish-or-perish dynamics and evaluative regimes push PhD students, postdocs and academics to publish in greater quantity, with the number of submissions overwhelming journal editors and reviewers alike (Raoult, 2020). Surprisingly, however, scarce research has been done on the determinants of peer reviewing in journals. The existing research in this area has been based mostly on descriptive and univariate analyses of those who may be interested in or actually doing peer review, usually focusing only on a single journal, a set of thematically focused journals or journals from a specific discipline (e.g., Fox et al., 2016; Wang et al., 2022).

This paper takes a different approach to advancing knowledge on this topic, reasoning that the conditions and variables that affect the production of knowledge (i.e., the determinants of research productivity) are bound to affect engagement with peer review. This makes sense considering that preparing, submitting, publishing and reviewing are all part of similar knowledge-building characteristics and processes (see Superchi et al., 2019)[1]. This reasoning also makes sense because these practices are part of the ethos and identities that scientific and academic communities contribute to and identify with (Bornmann, 2011). Therefore, this paper asks the following research question: What are the determinants of peer review engagement and quality in international peer-reviewed journals? To answer this question, we use a comprehensive set of indicators that are known to determine or influence research productivity in some way, and we apply those indicators to metrics of engagement and quality in peer review. Engagement is measured through review count, which is the total number of peer reviews conducted by a reviewer throughout their career, and review ratio, which relates to the balance between the number of reviews conducted and the number of papers published. Quality is measured through review length, which indicates the reviewer's overall levels of effort and involvement with the reviews produced.

The paper is organised as follows. The next section discusses the literature on peer review and the traits of those who engage in it. The succeeding section presents the data and the methods used in the study. That section is followed by a presentation and discussion of the results. The conclusion further discusses the findings and enumerates some of their implications for policy and practice.

[1] Superchi and colleagues (2019) identified five overlapping domains across the three dimensions of research of writing papers, publishing skills and peer review quality. The domains they identified were the relevance of the study, the originality of the study, the interpretation of the study results, the strengths and weaknesses of the study and the presentation and organisation of the manuscript.

Literature Review

The relevance and crisis of peer review

The peer review system is critical to current science. Often described as the gold standard of scientific publication, peer review plays the crucial role of filtering out research that does not meet the minimum requirements of novelty, integrity, rigour and ethics. In this context, peer reviewers assume the role of scientific gatekeepers of research quality, because they are responsible for assessing the novelty, soundness, validity and overall contribution and impact that the submitted research may have both for the field and for society. The peer review process also has a pedagogical function in that it contributes to the improvement, revision and eventually publication of research findings (Kovanis et al., 2017). Consistent with the pedagogical function of peer review, peer reviewers actively contribute to improving the research quality of submitted papers before they are published (Mulligan et al., 2013). People involved in the peer-review process reap both tangible and intangible benefits, including the following: early access to new research before it is published, reputational gains within the scientific community, the ability to contribute to knowledge advancement and potential appointment to journals' editorial and advisory boards, which enables them to assume a gatekeeper role and shape science (Crane, 1967). Through the work of peer reviewers and editors, peer review, like publishing, is strongly associated with the legitimate scientific methods that disciplines use, and it is fundamental for enabling the communication of findings to scientific communities and the public (Ahmed and Gasparyan, 2013). An absence of peer review or a peer-review process that lacks rigour can permit intentionally or unintentionally erroneous research to be published, thus influencing general thinking, practices and policies in ways that could ultimately be harmful to society (Severin and Low, 2019). Peer review can be considered relatively recent, because the practice as we know it today only started to become common in the second half of the 20th century, and the term itself was rarely used by academics when referring to publication practices until the 1960s (Tennant et al., 2017). Nowadays, peer review is an essential part both of science and of academic life. Recent research by Aczel et al. (2021) found that in 2020, the total estimated time spent on peer review amounted to 100 million hours or the equivalent of 15,000 years. Using a different metric, the same authors estimated that the monetary value that reviewers based in the United States alone spent on peer review was over 1.5 billion US dollars. These findings indicate that peer review is a practice that demands a substantial investment of both money and time, similar to the investment required to produce research and publish papers.

In recent years, peer review has been seen to be in crisis (Kovanis et al., 2017) and deemed insufficient to ensure the quality of the scientific work submitted to journals (Ahmed and Gasparyan, 2013). It has been argued that the predictive validity of peer-review processes has decreased because of an apparent increase in unreliability and bias (Meruane et al., 2016; Park et al., 2020). There are several reasons for the peer-review crisis. One of the main problems with the peer-review process relates to the long period between the submission of the paper and the arrival at a decision about it (Christie, 2021). This hinders the effective dissemination of findings in the fast-moving fields of science, which have ever-shorter knowledge cycles, and these delays are concerning when one considers that publications (and even citations thereof) are decisive for authors' career recruitment and progression opportunities (Allen et al., 2022; da Silva and Yamada, 2022). The length of the peer-review process is linked to the mounting volume of paper submissions (particularly to leading journals indexed in the Web of Science and Scopus), which

can easily overwhelm journals' editorial teams (Genova and de la Vara, 2019). This surge of submissions has been increasing and has strained journal editors' and competent reviewers' ability to deal with it because they have other commitments and priorities (Severin and Chataway, 2021a). In other words, the balance between demand (the number of papers submitted) and supply (the number of reviewers) has been disrupted, and editors are finding it increasingly difficult to find enough reviewers in a timely manner to assess those papers that pass the editors' initial review (Peterson, 2022). This imbalance between demand and supply is also likely to impair reviewers' ability to provide authors with constructive feedback and thus to help enhance the quality of the reviewed papers (a key element of peer review). As a result, reviewers may provide either contradictory or low-quality referee reports that show disregard or inattention to the work of the authors, resulting in feelings of frustration, anger and hopelessness among the latter group (Huisman and Smits, 2017). This can be highly damaging to the process because it undermines the element of trust within peer review by compromising the collaborative work between reviewers and authors to improve the quality of the authors' research; the appearance that good faith may be lacking may challenge the ideal that each journal submission is treated fairly and impartially (Hoffman, 2022).

The recent publication rush during the COVID-19 pandemic overwhelmed journals and reviewers and magnified several of the aforementioned issues, further undermining trust in the peer review process as a substantial amount of 'bad science' managed to be published during this period in peer-reviewed journals (Tang, 2023). Retraction Watch, a meta-academic website that documents the process of scientific retraction, noted several such incidents during this period (Frampton et al., 2021). This finding can be interpreted as an indication that the peer review system failed a key stress test, as journal editors faced a deluge of submissions that reviewers were either unwilling or unable to review with the necessary rigour. The continuing increase in submission rates forebodes similar issues becoming the norm rather than the exception. The amalgamation of all of these issues has led to several suggestions for improving the current peer-review system as we know it (e.g., Tennant and Ross-Hallauer, 2020) and a proposal of new alternative models (e.g., Kovanis et al., 2017), both of which are beyond the intended scope of this paper.

It is important to understand what contributes to the current issues with the peer-review system. These issues relate to two linked phenomena: (1) academics' adoption of a publish-or-perish dynamic for the sake of scientific acknowledgement and visibility; and (2) academics' need to demonstrate publishing proficiency to secure their academic careers. Academics do not engage in research purely out of curiosity-driven interest. Rather, publishing – particularly in selected leading journals – is, as Kwiek (2021) described, the currency that can propel academics to new heights in the economy of academic prestige. Publishing also determines the thresholds for academic and scientific success in relation to being recruited (and by whom), being promoted and obtaining grant funding to continue to foster the virtuous cycle of scientific recognition and prominence (Kwiek, 2021). This currency was already powerful when higher education systems were elite systems. With the development and massification of higher education, publishing has become essential not only to attain career success but also just to survive, that is, to enter and remain in the academic profession (Sutherland, 2017). The rise of audit and evaluative cultures in higher education, influenced by neoliberal thinking, has urged academics, PhD students and postdocs to foster their research productivity and engage with the publish-or-perish dynamics that have come to dominate global science and academia (e.g., Acker and Webber, 2017). These phenomena have not only impacted the peer-review system but also given rise to potential differences among academics' engagement with peer

review because the publish-or-perish dynamics associated with academic careers are bound to affect some academics more than others. For example, male academics seem to have an advantage compared with female academics, because men publish more and their publications tend to be cited more often (Lariviere et al., 2013). Compared with academics who are older and more established in academia, PhD students, postdocs and early-stage academics may also be more susceptible to the need to publish and be more research-oriented if they wish to secure a successful academic career (Waaijer et al., 2018).

Although the literature has suggested that in recent times publishing and peer reviewing may have become akin to competing activities, they have also remained largely complementary. Besides the known similarities between publishing and peer reviewing (Superchi et al., 2019), both contribute to establishing the reputation of academics in scientific fields. This phenomenon underlies the use of the credibility cycle model as an appropriate conceptual framework to guide this study (Latour and Woolgar, 1986). The credibility cycle model assumes that an academic's reputation rests on their credibility as a central commodity in science and that academics need to accumulate credibility (credits) to participate in knowledge production processes. The credibility of an academic is built based on their continuous participation in a broad range of credit-granting activities. The credits earned in one activity can be used to support other activities, building a broad reputation supported by the academic's involvement in several scientific activities, which is preferable to having credibility in a single activity only. This model is influenced by Mertonian thinking: the model understands scientific work as a process (cycle) in which inputs (e.g., time, energy, funding) are turned into outputs (e.g., publications, reviews) that may increase academics' credibility and thus their ability to obtain more resources (and increase their credibility). However, there is a critical difference between the credibility cycle model and Merton's thinking: in the credibility cycle model, credibility takes the form of a credit that relates to the abilities of academics to do research and is not necessarily associated with the idea of credit as a reward (Latour and Woolgar, 1986). The model reflects the understanding that not all academic outputs have the same potential to attract new resources or confer credibility, but they are all an essential part of the process of establishing an academic's credibility. The credibility cycle model also assumes that multiple activities can mutually support one another in establishing one's credibility, as engagement in scientific practices has a cumulative and interactive nature (Hessels et al., 2019). An excessive or exclusive focus on a single activity or output would create a narrowly focused and somewhat limited academic in terms of their knowledge of and contribution to scientific endeavours.

Traits of relevance for peer review

Studies exploring the engagement of academics with peer review have tended to rely on descriptive and univariate methodologies, but they have provided important insights nevertheless. Research in the field of biomedicine has shown that a disproportionate amount of review work is done by a small number of experienced academics (Kovanis et al., 2016). Perhaps because they are less well-known or deemed inexperienced in reviewing papers, younger academics and postdocs receive fewer requests to do peer reviews than experienced academics do (O'Brien et al., 2019). This may be compounded by the fact that younger researchers and academics, compared with their older, more established peers, are less confident reviewers and perceive peer reviewing as a responsibility that goes beyond their main roles as members of scientific and academic communities (Wang et al., 2022). Some research, however, has suggested that younger researchers and academics in the field of political science seem more willing to

accept invitations to peer review compared with their older peers (Breuning et al., 2015). An analysis of 10 years of peer reviews in the *Journal of Artificial Societies and Social Simulation* also demonstrated that younger researchers and academics wrote longer and more content-rich referee reports than did older, more established academics. The authors of that study concluded that the reliability and efficiency of younger and older academics as peer reviewers were undifferentiated (see also Casnici et al., 2016). Another study indicated that compared with older academics, younger academics placed more emphasis on the improvement of the paper in their referee reports (Severin and Chataway, 2021b), but were also more willing to make peer-review decisions based on the trade-off between personal benefits (such as building a reputation with the editors of the journals who invite them to review, anticipating their future submissions to the journal) and the time/effort costs of peer reviewing (Zaharie and Osoian, 2016). The same study suggested that older, seasoned academics perceived peer review more altruistically, akin to a prosocial behaviour that is concerned with promoting others' rather than one's own interests (Pfattheicher et al., 2022). Older academics were found to expect few to no returns from peer-review activity because they saw it as an obligation to the academic and scientific community (Zaharie and Osoian, 2016).

Analyses focusing on gender and peer review have tended to find that compared with male academics, female academics are less involved in peer review (e.g., Lerback and Hanson, 2017). A study in the journal *Functional Ecology* found that fewer invitations to review were sent to female academics and that female academics were less likely to respond to invitations and took longer to respond to such invitations. However, that study also found that female academics tended to accept review invitations (Fox et al., 2016). Female academics' longer times to respond to review invitations and their performance of fewer reviews than male academics may be related to the time constraints that female academics experience in the workplace, the greater intensity of the combination of their home and work duties than that of their male peers and the mounting challenges and barriers in the neoliberal university (Leisyte, 2016). Fox and colleagues (2016) also noted the relatively small proportion of female academics on editorial boards as a possible explanation for their lower involvement in reviewing papers, finding that male editorial board members were more likely to invite male academics to review. This indicates that gender biases in science and academia – in terms of research productivity and career advancement – may also be related to biases in scientific gatekeeping among journal editorial boards that are dominated by men (Bornmann, 2011).

Some studies have emphasised institutional prestige as a factor affecting the process of peer reviewing, but they have not assessed institutional prestige as a driver of peer review. These studies have found that if peer reviewers become aware that a paper's authors work for world-leading universities, the paper tends to be accepted (Tomkins et al., 2017). To the best of our knowledge, only one study has argued that, contrary to what most may think, prolific or highly cited researchers might not be good reviewers or might not be engaged in peer reviewing, although that paper provided no empirical analysis to assess this claim (Wang et al., 2022). We found only one empirical study that assessed the association between the number of papers published and peer-review engagement, finding a statistically significant positive but weak correlation (Ortega, 2017).

The literature has tended to focus on understanding how the results of peer review are reflected in research productivity outcomes. Patterson and Harris (2009) found statistically significant albeit weak correlations between peer review quality scores and citations. In contrast, more recent research has found that it is difficult to estimate whether citations are an actual outcome of peer review, because these citations may result from the reputation or institutional affiliation of the authors or the topic and timing

of the publication (Seeber, 2020). A few other studies have assessed other characteristics, such as academic rank or highest degree, and have concluded that they are not predictors of peer-review engagement or quality (e.g., Glonti et al., 2019). We found no studies that have examined other relevant predictors such as research performance and research work. Academics' level of mobility is associated with research production, and academic inbreeding[2] is particularly likely to be negatively associated with the number of peer reviews conducted and an academic's engagement with peer review because of the particularistic and parochial characteristics that are associated with immobility (see Horta, 2022). Research effects concerning educational immobility (educational inbreeding) are likely to arrive at the same results. Undertaking one's learning at a single university may constrain the ability to conduct reviews and research because of limited access to a broader knowledge base and flows (Horta et al., 2022). The research agendas[3] of academics may also affect broad engagement with peer review because they relate to research cultures, research preferences and research productivity (see Santos et al., 2022). Finally, perceptions of the workplace, access to resources and time allocation are also expected to influence academics' ability to engage with peer review, considering that one of the elements of the peer-review crisis relates to the overemphasis on publishing for the sake of career evaluations and assessments and universities' apparent lack of recognition of the effort put into peer reviewing (Leisyte, 2016; Severin and Chataway, 2021a).

Methods

Data collection

The primary data source for this study was a survey conducted in 2017 and 2018. The first step was to identify all of the corresponding authors of articles published across all fields of knowledge between 2010 and 2016 so that the dataset was composed of active researchers who published internationally. This resulted in the identification of 915,447 authors, who were invited by email to participate in an online survey containing demographic questions, the revised version of the Multi-Dimensional Research Agendas Inventory (MDRAI-R; Horta and Santos, 2020), the Multi-Dimensional University Research Workplace Inventory (MDURWI; Santos, 2018) and career- and education-related questions. The data collection began in June 2017 and ended in August 2018. The invitation included a description of the project, its goals and an opt-out link. Participation was voluntary, and before beginning the survey, the participants were presented with an informed consent form that they were required to sign.

As the data were collected based on Scopus searches, Scopus IDs were retained. This helped us to link the authors' research profiles with Publons (which was integrated with the Web of Science in 2019 and was fully migrated in 2022), a platform that collects verified reviews automatically or manually that are approved or sent by the authors. Publons does not index journals, and it recognises reviewing engagement independently of the journal's quality metrics. Not all reviewers agree to have their reviews acknowledged by Publons, so the platform underestimates the number of reviews performed, and thus these data are

[2] Academic inbreeding refers to the practice of universities hiring their own PhD graduates right after graduation, and it reflects career immobility; we also consider 'silver-corded' academics – those who obtained their PhD at one university, then worked elsewhere, and now work at the first university (Horta, 2022).

[3] Strategic research agendas are defined as an academic's strategic preferences on how to pursue research goals and thematic focuses. Although they are intrinsically personal, they are also influenced by the academic's environment (Santos and Horta, 2018).

only representative of those who signed up for the platform. This was a handicap, but we considered Publons to be the best database for accessing review data both because journals do not make data about reviewers available in a detailed way that allows for analyses and because the platform has been used in previous peer review-related research (e.g., Ortega, 2017). To match Scopus ID data and Publons data, we used the following procedure that prevents the creation of author ambiguity.

We retrieved the Scopus publication record for each participant. Subsequently, we searched for those same papers on Web of Science. After finding a paper that was also indexed on Web of Science, we followed the link to the author's Web of Science profile. From there, we gauged whether there were peer-review data linked to the authors. This allowed us to ensure that the participant data were the same in both Scopus and the Web of Science, and it permitted us to collect peer-review data. Due to the recent migration of Publons to the Web of Science and the fact that Publons is an opt-in system, not all of the authors had peer-review metrics. For those who did, we retrieved those metrics and added them to our dataset.

At the time of our primary data collection, 21,016 participants accepted the invitation. Of these, 301 dropped out at the informed consent stage. Due to the length of the survey, the drop-out rates increased as participants advanced through the survey. The questions designed to elicit professional and educational data, which were necessary for this study, were placed at the end of the survey and made optional to address privacy concerns. Only 8,880 participants provided the relevant professional and educational data. Furthermore, peer-review data were only available for 4,027 participants. Cumulatively, we filtered out participants working outside the academic sector (as they would have no incentive to conduct peer reviews). After filtering out the limiting and non-imputable missing data from the survey and the participants without peer-review data, we reached a final working sample of 2,089 participants.

The working sample for this exercise comprised mostly men (69.9%, N = 1,460), with roughly one third being women (30.1%, N = 629). The participants were on average 48 years old (M = 48.09, SD = 10.77). In disciplinary terms, the majority were from the natural sciences (30.9%, N = 646), followed by engineering and technology (25.4%, N = 531), the social sciences (21.5%, N = 450), the medical and health sciences (20.5%, N = 429) and the humanities (1.6%, N = 33). In terms of geographical distribution, the most represented countries were the United States (11.2%, N = 235), Italy (8.0%, N = 167), Spain (7.3%, N = 152) and Brazil (6.5%, N = 136); the remaining participants were spread across several countries, which are not listed here for parsimony.

Variables

In this paragraph, we list the variables extracted from Web of Science/Publons, which represented the peer-review metrics and served as the dependent variables in our models. *Review Count* was a count variable indicating the number of peer reviews the participant had done. *Review Length* was a continuous variable representing the average length, in words, of the participant's written peer reviews. *Review Count* reflected the frequency of reviewing, whereas *Review Length* reflected the effort that a reviewer had dedicated to each review. Finally, *Review Ratio* was a continuous variable indicating the ratio of peer reviews written by the participant to papers published by the participant. The review ratio variable was important because it assessed the equilibrium of academics' contribution to knowledge both in creating new knowledge and in gatekeeping knowledge creation (through the journal's peer-review system). This

mattered because many academics write reviews in quantities that vastly surpass the number of papers they have published, helping to sustain the scientific community by providing both papers and reviews, which is an altruistic behaviour. In contrast, other academics publish papers without considering the need to review others' papers, selectively and partially contributing to the scientific community, which is a selfish behaviour (Lindebaum and Jordan, 2023). A recent study analysing several Science, Technology, Engineering and Mathematics fields suggested that a one-to-one parity between publications and reviews is the minimum advisable ratio for maintaining a sustainable scientific system (Raoult, 2020). On average, the participants in our dataset had written 51 reviews, with an average of 277 words per review, and had a peer review-to-publication ratio of 0.76, meaning that they published papers more than they wrote peer reviews. All of the variables described above were variables of engagement with peer review, which assessed different modalities of such engagement, thus imparting a broader understanding of academics' engagement with peer review.

The next sentences describe the independent variables. The first set of independent variables reflected findings in the literature related to peer-review engagement: *age*, *gender* and institutional prestige (*Top-ranked University* was a binary variable indicating whether the participant worked at one of the ARWU World University Ranking top 500 universities; 18.8% of the sample did). The second set of variables referred to the strategic research agendas measure (the MDRAI-R), as summarised in Table 1.

Table 1: Dimensions of the MDRAI-R

Dimension	*Definition*
Scientific ambition	**Prestige.** The desire to acquire recognition and academic prestige in a given field. **Drive to publish.** The motivation to publish and drive to publish scientific articles.
Divergence	**Branching out.** The desire to expand into other fields of study or topics. **Multidisciplinarity.** The preference for working in multidisciplinary research ventures.
Discovery	The preference for working in fields or topics with the potential to lead to scientific discovery.
Tolerance for low funding	The willingness to work in fields or on topics for which research funding is scarce.
Collaboration	**Willing to collaborate.** The desire to engage in collaborative scientific ventures. **Invited to collaborate.** The opportunity for and the receipt of invitations to participate in collaborative scientific ventures.
Mentor influence	The researcher's mentor (PhD or otherwise) holds a degree of influence over his or her work.
Academia-driven	**Field-oriented.** The extent to which the research agenda is influenced by scientific priorities that the field community determines by consensus. **Institution-oriented.** The propensity of the researcher to align their research agenda with the strategic research targets of their institution.
Society-driven	**Society-oriented.** The incidence of society-related challenges in the research agenda. **Non-academic-oriented.** A measure of the influence and participation of laymen and non-experts in the design of the research agenda.

Note: Adapted from Horta, Meoli and Santos (2021).

The third set of variables was composed of three dimensions from the MDURWI. *Resources* represented the participant's access to resources, financial or otherwise. *Unconstraint* was the perceived lack of constraints, whether bureaucratic, non-research duties or other types of constraints that are inevitable parts of academic life. Finally, *Autonomy* was the perceived degree of the participant's autonomy in conducting his or her work.

The fourth set of variables related to the professional and educational history of the participants. *Percent Teaching* was the estimated self-reported percentage of the participant's career spent on teaching (M = 54.28, SD = 34.25). *Percent Research Funding* referred to the percentage of the participant's career during which he or she had access to research funding (M = 57.49, SD = 32.33). *Education Inbreeding* was a dummy variable that took the value of 1 if the participant undertook his or her entire tertiary education at a single university (61.2% did). *Inbreeding* was a categorical variable indicating whether the participant was a homegrown academic (working at the same institution where the PhD was obtained and had never worked elsewhere; 9.8%), a 'silver-corded' academic (currently working at the same institution where the PhD was obtained, but had previously worked at other institutions; 24.1%) or a mobile academic (working

at a different university from where the PhD was obtained; 66.1%). The latter was the reference category for this variable. The participant's *Publications* and *Citations* counts, both extracted from the primary source at Scopus, and *Field of Science (FOS)*, were also included, with natural sciences as the reference category. Finally, *Country* was included as a control variable to correct for deviations of the sample's geographical distribution when compared with the global geographical distribution of academics. For parsimony, as this is not a variable of interest, *Country* is omitted from the regression table.

Procedure

Both *Review Length* and *Review Count* exhibited heavily skewed distributions, as expected in bibliometric data. Because both were integer variables without the presence of negative values, we opted to conduct negative binomial regressions (Hilbe, 2011), as this approach is well suited to handling over-dispersed data. Due to the non-discrete nature of review ratio data, a negative binomial regression could not be used. However, this variable also exhibited a heavily skewed distribution, precluding the use of ordinary least squares regression. Thus, we opted to use a gamma regression with a log link function, which is robust to violations of distributional assumptions (Manning et al., 2002).

Limitations

This study has some limitations. Its primary strength – using Publons, which has substantial data on peer review metrics – is also its weakness. Publons is an opt-in system, and as such it only tracks reviews by academics who explicitly sign up for the system and agree to have each individual review tracked. As such, the number of tracked reviews on Publons is almost certainly lower than the number of true reviews, which is impossible to know because this type of data is only available to journal publishers. Therefore, the findings can only be considered representative of individuals who participate in Publons. As the adoption rates of Publons can vary by age stratum, we used our primary dataset and compared the ages of individuals with and without Publons profiles. Individuals without a Publons profile tended to be slightly older ($M = 51.109$, $SD = 10.821$) than those with a profile ($M = 47.732$, $SD = 10.821$). Although this difference was significant ($t(9294.753) = -15.220$, $p < 0.001$), its effect size was rather small (Cohen's $D = 0.277$), rendering its practical relevance minimal (a difference of 3.37 years). Publons also does not track editorial activity, but we do not consider this to be a limitation, as the scope of this study is limited to actual peer review. While journal editors tend to appraise submissions, they are unlikely to be writing the reviews, relying instead on peer reviewers. The analysis thus pertains exclusively to peer review activity, not editorial appraisal.

Results

The findings of the regression analysis for the three dependent variables can be found in Table 2. We present them with the results for three variables frequently used in the literature: age, gender and institutional reputation. We find that the older an academic is, the less he or she is involved in doing reviews (with a decrease of 3.5% per year), the less he or she writes in each referee report (the number of words in each referee report decreases by 2.2% per year) and the more unbalanced his or her review ratio (with a decrease of 3.6% per year, meaning that the ratio leans more towards publications). These findings are aligned with previous findings that young academics are more willing to do peer reviews (Breuning et al., 2015) and tend to write longer reports, which are expected to be more content-rich and

improvement-oriented than those written by older academics (Casnici et al., 2016; Severin and Chataway, 2021b). Our novel finding is that younger academics also tend to have review ratios that are more balanced or that indicate that they have more reviews than publications. This may be because, due to the number of submissions, younger academics are asked to review even when they only have a few publications. The declining review-to-publication ratios of older academics may be explained by their involvement in project and university management that limits their time to do reviews, while their publication engagement may be driven by collaborations with their PhD students and colleagues (Lariviere, 2012). Compared with female academics, male academics do more reviews (41.6% more) and have review ratios that lean towards more reviews than publications. These findings are consistent with the literature, which has shown that compared with male academics, female academics participate less and are engaged less in peer reviewing (Fox et al., 2016; Lerback and Hanson, 2017). These findings underscore the gender gaps found in science and academia, which are also found in other activities related to knowledge creation, collaboration, dissemination and recognition (e.g., Leisyte, 2016). However, the findings do not confirm that female academics write longer and possibly more thoughtful reviews, as some authors have suggested (e.g., Wing et al., 2010). In terms of institutional reputation, our findings show that academics working at more renowned universities have an undifferentiated number of reviews, review length and review ratio compared with those working in less renowned universities.

Table 2: Regression models for *Review Count*, *Review Length* and *Review Ratio*

Variables	*Review Count*	*Review Length*	*Review Ratio*
Age	-0.033***	-0.023***	-0.040***
	(0.005)	(0.004)	(0.005)
Gender (Male)	0.417***	0.081	0.282***
	(0.098)	(0.064)	(0.093)
Top Ranked University (Top 500)	-0.015	0.102	0.106
	(0.120)	(0.089)	(0.123)
Scientific Ambition – Prestige	0.075	0.013	0.031
	(0.051)	(0.033)	(0.048)
Scientific Ambition – Drive to Publish	0.209***	0.092***	0.177***
	(0.049)	(0.035)	(0.048)
Divergence – Branching Out	-0.148***	-0.112***	-0.144***
	(0.050)	(0.032)	(0.046)
Divergence – Multidisciplinarity	-0.015	0.016	0.017
	(0.047)	(0.031)	(0.044)
Discovery	-0.141**	-0.007	-0.118**
	(0.055)	(0.037)	(0.054)
Tolerance of Low Funding	0.093***	0.013	0.081**
	(0.036)	(0.024)	(0.034)
Collaboration – Willing to Collaborate	-0.030	0.004	-0.051
	(0.059)	(0.042)	(0.054)
Collaboration – Invited to Collaborate	0.108*	0.012	-0.018
	(0.056)	(0.037)	(0.052)
Mentor Influence	-0.056*	-0.091***	-0.050
	(0.031)	(0.022)	(0.031)
Academia-driven – Field-oriented	-0.033	-0.001	-0.037
	(0.043)	(0.030)	(0.040)
Academia-driven – Institution-oriented	-0.009	0.036	0.007
	(0.039)	(0.025)	(0.038)
Society-driven – Society-oriented	0.071*	0.032	0.066
	(0.042)	(0.029)	(0.042)
Society-driven – Non-academic-oriented	0.114***	0.009	0.101***
	(0.041)	(0.029)	(0.039)
Resources	-0.071*	-0.082***	-0.080**
	(0.040)	(0.027)	(0.038)
Autonomy	-0.012	0.013	0.026
	(0.047)	(0.033)	(0.047)
Unconstraint	0.036	-0.006	-0.012
	(0.044)	(0.028)	(0.040)
Percent Teaching	0.003**	-0.001	0.001
	(0.001)	(0.001)	(0.001)
Percent Research Funding	-0.002	0.001	-0.006***
	(0.001)	(0.001)	(0.001)
Publications	0.006***	0.000	-0.003***
	(0.001)	(0.001)	(0.001)
Citations	-0.000***	0.000	-0.000
	(0.000)	(0.000)	(0.000)

Inbreeding (Homegrown)	-0.048	-0.164	-0.029
	(0.149)	(0.102)	(0.146)
Inbreeding (Silver-corded)	0.031	0.070	0.028
	(0.109)	(0.074)	(0.106)
Education Inbreeding	-0.109	-0.103*	-0.116
	(0.088)	(0.057)	(0.083)
FOS (Engineering & Technology)	0.294**	-0.160**	0.368***
	(0.118)	(0.079)	(0.110)
FOS (Medical & Health Sciences)	0.124	-0.114	0.117
	(0.121)	(0.083)	(0.118)
FOS (Social Sciences)	-0.256**	0.239***	0.275**
	(0.122)	(0.086)	(0.119)
FOS (Humanities)	-0.923***	0.441*	-0.250
	(0.294)	(0.250)	(0.314)
Constant	1.777**	6.788***	0.434
	(0.709)	(0.531)	(0.861)
Observations	2,089	2,089	2,089

Notes: Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1; Country included as a fixed factor but omitted from the table.

The most significant sub-dimensions of the strategic research agendas of academics concerning peer reviewing are their scientific ambitions in terms of their drive to publish, which have a statistically significant and positive association with all of the dependent variables, and their divergence in terms of branching out, which has a statistically significant negative association with the same dependent variables. This is a finding that stresses the following two characteristics associated with peer review. First, it emphasises the fact that peer reviewing is very closely associated with publishing and that the practice is essentially limited by disciplinary boundaries because of scholarly identity and the need for specialised disciplinary knowledge about theories, context and methods to be able to evaluate research submitted to journals (Bornmann, 2011; Superchi et al., 2019). Second, and in contrast, it emphasises that peer review is a relatively undervalued scientific endeavour because academics whose strategic research agendas strongly rely on garnering prestige do not do more reviews than other academics. These findings are aligned with the expectations of the credibility cycle model: publishing and peer review are associated, but although both provide credit that is relevant to the improvement of an academic's abilities and reputation, one activity generates more credit than the other (Latour and Woolgar, 1986). The lack of institutional recognition of peer review may play a role in these findings (as argued by Severin and Chataway, 2021a). Tolerance of low funding and the non-academic orientation of a society-driven research agenda are both statistically significant and positively associated with the number of reviews made and the review ratio. These findings indicate that the prosocial character of peer reviewing (Pfattheicher et al., 2022) is particularly favoured by academics who are comfortable with initiating or engaging in research activities without the need for funding (and most peer-review systems are voluntary and unpaid) and are concerned about exchanging knowledge with practitioners and making sure that their knowledge can be used. In other words, prosocial academics are likely to engage in peer review to some extent because of the prosocial characteristics of peer reviewing. The fact that academics with a highly society-oriented strategic research agenda do not engage more or less in peer review, but academics with

research agendas that involve non-academics (i.e., practitioners) do, suggests that on its own, undertaking research with applications to society in mind is not sufficient to foster engagement with peer reviewing.

The other dimensions of the strategic research agenda measure have either a negligible association with peer reviewing or no association at all. Of these dimensions, one merits further discussion. Academics with more discovery-oriented strategic research agendas do 14.2% fewer reviews per unit increase than non-discovery-oriented academics, which is surprising, because reviewing may provide access to new research, something that likely would be of interest to discovery-oriented academics. This may be a sign that increasing the number of peer reviews conducted will not contribute to the generation of new ideas among more discovery-inclined academics.

Autonomy and unconstraint, two of the dimensions related to academics' perceptions of the workplace, are not predictors of any metric of peer reviewing. This result suggests that neither a greater perception of autonomy in conducting academic work nor a greater decision-making authority to decide what to do and when to do it are associated with peer reviewing. Because global surveys on the academic profession have suggested that academics tend to prefer to be engaged in research, and if possible, in an autonomous way (Stephenson et al., 2020), one would expect these variables to be associated with greater engagement in peer reviewing. Another variable whose results do not meet expectations is teaching. The more one is engaged in teaching, the more one does peer reviews (by a 0.3% per percentage unit increase), but this increased engagement is not reflected in longer referee reports. The positive association between teaching and the number of reviews is not surprising, but the non-statistically significant relationship with review length is, considering that the practice of peer reviewing has a pedagogical component that it shares with teaching – i.e., contributing to authors' learning through providing guidance, along with the improvement of the paper under review.

Academics' perception that their workplace has resources available for them to use has statistically significant and negative associations with all of the peer-reviewing variables. The more an academic feels that he or she has access to resources made available by the university, the fewer reviews are done (by a 6.9% per unit increase), the shorter the reviews are (by an 8% per unit increase), and the more the review ratio imbalance favours publications (by a 0.08% per unit increase). The greater the research funding in one's career, the more unbalanced one's review ratio is towards publications (by a 0.005 per percent unit increase). Essentially, these findings suggest that when research funding and other resources are available, academics prefer to prepare and publish papers rather than use their time and energy for peer review. This is because time and energy are finite and mutually exclusive, and thus they are part of a zero-sum competing game between publishing and peer reviewing, and academics tend to opt for the activity that grants them more reputation. This creates a tension similar to the teaching–research nexus (see Geschwind and Brostrom, 2015). This preference for allocating time and effort to publications is empirically suggested by our results (particularly those related to the review ratio) and by the literature, which has underscored the importance of publishing to academic career advancement and peer reviewing's lack of a relationship to that goal (Kwiek, 2021).

However, the results related to the publications variable support a more nuanced association between research and peer review, because a larger number of publications is associated with a larger number of peer reviews being done (in accordance with the credibility model cycle; Latour and Woolgar, 1986). This suggests, as in the results concerning the variable scientific ambition – drive to publish, that there is a complementarity between peer reviewing and publishing (as suggested by Superchi et al., 2019). However,

this complementarity may ultimately favour publishing, because the results seem to suggest that peer reviewing is an ancillary activity to publishing rather than the other way around. This assessment is supported by the fact that the larger the number of publications, the more unbalanced the review ratio is towards publications (by 0.002 per publication), rather than the other way around or an equilibrium between the two variables (which would be indicated by a statistically non-significant review ratio). A larger number of citations is only statistically significantly associated negatively with review counts, but the effect is negligible (basically zero, at 0.01% fewer reviews per citation).

In terms of career immobility, academics who are homegrown and silver-corded perform in the same way as mobile academics, suggesting that career mobility plays no apparent role in academic practices concerning peer reviewing. More significant is the role of educational inbreeding, in which academics undertake their entire education at a single university. Educationally inbred academics provide referee reports with fewer words (by 9.9%). Finally, the fields of science are essentially included in the models as control variables, and the results are aligned with our expectations. Examples of such results are the fact that referee reports in the social sciences and humanities tend to be longer than those in the natural sciences, and that academics in the social sciences and the humanities do fewer peer reviews because the numbers of journals and papers submitted in the latter fields of science are proportionally smaller than those in the natural sciences.

Conclusion

Peer review continues to be an essential pillar of academic research. Our research confirms the previous finding that known traits of academics, such as age and gender, are associated with peer reviewing (e.g., Lerback and Hanson, 2017; Severin and Chataway, 2021b). However, our analysis is novel in terms of the data used and the analytical breadth of the variables; it brings to the fore other relevant determinants of peer reviewing engagement and quality that contribute to a more comprehensive understanding of how academics interact with peer reviewing than was available in the past. The findings suggest that although publishing and peer review are closely linked, this association is partly synergetic and partly imbalanced in terms of the prioritisation of one activity over the other. This synergy is manifested in the positive association between the drive to publish and peer review, which offers good evidence of the complementarity between the two activities. This is aligned with the expectations of the credibility cycle model: publishing and peer reviewing are associated even though one receives more credit than the other. Our findings contribute to the theoretical development of the credibility cycle model, as they suggest that the level of engagement with the activity bringing less credit seems to relate to individual values, perspectives and choices around science and strategic research agendas. The synergetic link between publishing and peer review seems to be particularly strong for academics who have a prosocial view of science, are interested in contributing to the advancement of knowledge in a broad sense, do not feel the need for their research to be well-funded and are committed to involving non-academics in their research agendas to exchange knowledge. This synergy is also more apparent among academics who are invested in developing disciplinary knowledge than academics who are not. This is because the peer review of journal submissions tends to be bounded by disciplinary cognitive and scientific boundaries, as are the publications that the more disciplinary-focused academics tend to produce.

Concerning the imbalance between peer review and publishing, the latter clearly emerges as more powerful and the priority for academics. This does not come as a surprise considering the competitive

nature of academic and research evaluation systems, mostly associated with career advancement, which are based on the publication profiles of academics (e.g., Acker and Webber, 2017)[4]. Peer-reviewing profiles are relatively recent, having gained visibility through Publons, and are likely to be ignored or assigned little importance. This dynamic is bolstered by perceptions of the resources available in the workplace and research funding obtained during an academic career. Taken at face value, this may seem surprising: some may expect more resources to be positively associated with doing more peer reviewing, but the finding makes more sense if it is understood from a rational choice perspective. Academics are likely to use more resources and time to publish more if they consider publications to be the key currency of scientific prominence and career advancement in academia (Kwiek, 2021); nobody receives meaningful scientific accolades for being a super reviewer, and this is reflected in the results: academics do not see peer reviewing as a strategy to enhance their scientific prestige. This suggests that, similar to research–teaching tensions, a publishing–peer review tension seems to exist based on academics' limited resources (time, energy, effort) and the fact that publishing is the most critical activity for one's academic and scientific survival and thriving. From this perspective, academics' choice to publish rather than review makes sense, fuelling the publish-or-perish dynamics that are overwhelming journal editors and reviewers (academics themselves) and that are placing the peer review system in a state of crisis.

The peer review system can be improved, and many of the new and alternative models offer meaningful ideas for its improvement (e.g., Tennant and Ross-Hallauer, 2020; Kavanis et al., 2017). Nonetheless, if the sustainability of the peer review system is to be ensured, and in consideration of the findings discussed above, research funding agencies, scientific associations and university managers should consider increasing the symbolic and actual value of doing peer reviews and including this metric alongside the number of publications when undertaking assessments for funding allocation, career progression and scientific recognition.

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[4] An argument could be put forth that paper to review ratios that are skewed in favour of reviews are a result of academics finding publishing difficult; however, our model controls for individual track records, so this is not the case.

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