SOCIUS

Original Article

Socius: Sociological Research for a Dynamic World
Volume 11: 1–19

DOI: 10.1177/23780231251328714
srd.sagepub.com

Sage

From Funding Equity Initiatives to Research Productivity: Quantifying the Impact of NSF ADVANCE Awards on Recipients' Publication Trajectories

Alexander J. Gates[1], Laura K. Nelson[2], Rachael Grudt[3], and Kathrin Zippel[4]

Abstract

Service work in academia, including organizational change efforts, often competes with time for research, potentially affecting academic careers (tenure, promotion, and pay) through slowed publication productivity. However, little is known about how involvement in such efforts affects publication strategies or whether external funding mitigates the potentially negative impacts on research activity. The authors examine changes in publication trajectories among academics participating in the National Science Foundation ADVANCE program, an externally funded gender equity initiative. Using bibliometric data and a matched sample, the authors find that scholars involved in ADVANCE awards published significantly more articles within the first four years after receiving funding. This increase cannot be fully attributed to shifts in research focus, such as publications on gender, or changes in collaboration patterns. Instead, ADVANCE resources created a spillover effect, boosting publications in gender equity while also enhancing productivity in scholars' primary research areas. These findings suggest that external and institutional resource allocation can offset the additional burdens associated with organizational change work, enabling academics to maintain active research careers while contributing to sustainable change initiatives. This highlights the critical role of robust resource provision in supporting faculty members engaged in organizational change.

Keywords

gender, equity, faculty, publication productivity, NSF ADVANCE, sociology of science

Studies show a trade-off between time spent on high-promotability tasks, such as research and teaching for faculty members at universities, and low-promotability tasks, primarily what universities call "service." The time individual faculty members spend on service tasks reduces their time spent on research, with impacts on certain types of productivity, including publications and grants that most contribute to tenure and promotion in research university settings (Aboagye et al. 2021; Fox 2005; Misra et al. 2021). Gendered and racialized inequities in the division of labor within academic institutions across research, teaching, and service, with women and racialized minorities often taking on more and more intensive service, can additionally have detrimental effects on faculty members' well-being, job satisfaction, and academic careers (Hanasono et al. 2019; Heijstra et al. 2017; Järvinen and Mik-Meyer 2024; Misra et al. 2021; O'Meara et al. 2017).

Much of what counts as academic service work, such as serving on undergraduate curriculum or tenure and promotion committees, is necessary for universities to function. But there is another category of service work that goes beyond organizational functions: work that aims to change the way the institution itself functions to meet evolving demands. These types of efforts include initiatives to, for

[1]University of Virginia, Charlottesville, VA, USA
[2]University of British Columbia, Vancouver, BC, Canada
[3]Northeastern University, Boston, MA, USA
[4]Freie Universität Berlin, Berlin, Germany

Corresponding Author:
Laura K. Nelson, University of British Columbia, Department of Sociology, ANSO 2111, 6303 NW Marine Drive, Vancouver, BC V6T 1Z1, Canada.
Email: laura.k.nelson@ubc.ca

example, promote interdisciplinarity, sustainability, engagement and outreach for public impact, or diversity, equity, and inclusion efforts. We consider organizational change efforts an essential subset of academic service work, a cornerstone of many university missions and, when carried out by faculty members, work that goes above and beyond standard service work. Because of the extra time and cognitive burdens, organizational change efforts that focus on equity and diversity in particular can paradoxically exacerbate existing inequalities among faculty members. Yet, despite extensive research on gendered and racialized inequalities in service work more broadly (Järvinen and Mik-Meyer 2024; Misra et al. 2021; O'Meara et al. 2017; Toutkoushian and Bellas 1999), there is a lack of systematic investigation into how engagement in change-oriented service work, particularly gender equity and other diversity and inclusion efforts, affects academics' research trajectories. This gap is significant, as research output is a key factor in tenure and promotion decisions.

Furthermore, although many change efforts happen institution by institution, there are notable examples of federal agencies and private funders coordinating efforts across institutions via topic-specific funding programs. These programs provide substantial resources, but they also require substantial work to carry out, and we do not yet know if providing extra resources to academics engaged in organizational change efforts might offset the potential detrimental trade-off between time spent on service and research productivity. In this article we ask: Can funding programs that support organizational change efforts ease the burdens for academics involved in such work and shield academics from possible career penalties?

We discuss here one such effort, the National Science Foundation (NSF) ADVANCE program, a unique case in which a large and reputable national agency funds organizational change efforts. Since 2001, the NSF has given awards to interdisciplinary teams of faculty members and top-level administrators at colleges, universities, and other science, technology, engineering, and mathematics (STEM) organizations to support efforts for institutional transformation (IT) to promote gender equity in the professoriate. As one of the prime federal research agencies in the United States, the NSF has the potential to create more favorable conditions for academics engaged in institutional change projects, as ADVANCE provides resources, status, and collaboration networks to those involved. The designers of the ADVANCE program and projects have been particularly aware of the potential damaging pitfalls of the unequal distribution of time spent on low-promotability tasks, especially in equity-minded programs. Indeed, academic institutions more broadly have sought to offset the potential career and promotion impacts of spending time on intensive service work, particularly change-oriented service, by providing extra staff resources to support academics' service work, providing course releases, and/or weighting this work, in particular gender equity and other diversity and inclusion work, more heavily in tenure and promotion reviews. The goal is to reduce the negative impact of service on researcher productivity, creating a fairer intrajob division of labor (O'Meara et al. 2018).

The ADVANCE program has the potential to support and compensate academics for their change efforts, potentially helping mitigate the negative impacts on research productivity. But given the well-documented time demands and political sensitivity of gender equity and other diversity and inclusion work, has this been the case? Does the ADVANCE program ameliorate potentially negative career risks by preventing the loss of publication productivity for academics who have been engaged in these efforts?

We used the Microsoft Academic Graph (MAG) bibliometric dataset, now migrated to OpenAlex (Priem, Piwowar, and Orr 2022), to examine the publication trajectories of 334 individuals (mostly faculty members, as defined later) who were actively publishing in academic outlets and received NSF ADVANCE awards between 2001 and 2018, comparing them with similar scholars who were not involved in ADVANCE during the same period. Our novel matching research design, enabled via large-scale bibliometric and scholarly biographical analyses, allowed us to isolate the impact that receiving an NSF ADVANCE award had on academics' publication trajectories, including both the amount of publications and patterns in the content of those publications.

Our findings are surprising: instead of a decrease or neutral effect, we found, compared with their matched counterparts, a meaningful increase in the number of publications attributed to an ADVANCE author during the first four years after receiving their first ADVANCE award. We explored several potential explanations for this increase. We did not find evidence that this increase in the number of publications was due to a large number of publications related to ADVANCE projects or to changes in the content of publications (e.g., publishing on gender or other interdisciplinary issues in addition to the academic's core areas), nor was it due to an increased number of collaborations.

Instead, we suggest that the resources the NSF ADVANCE program provided to the teams created a specific context and set of conditions that enabled academics who were actively publishing before they received awards to continue to publish in their core research areas, despite being engaged in additional organizational change efforts. The resources NSF

provided to teams for ADVANCE work thus had a spillover effect, leading to additional resources (time, material, or symbolic) that bolstered individuals' non-ADVANCE-related research. These resources may have been particularly significant for women academics, who often face structural inequities in accessing research resources throughout their careers compared with men (Steffy 2021).

In particular, because we found no enduring effect beyond the four years following an award, we argue that the resources the NSF provided to the awarded individuals and institutions likely offset the time commitment involved in typically unfunded, uncompensated extra service work, potentially allowing research active academics to spend more time on their core research while at the same time contributing to institutional change projects. In short, our research suggests that, under the right conditions, academics can indeed do necessary and important change-oriented service work while maintaining, or even increasing, their core research output.

Our study contributes to ongoing scholarly debates about how unequally distributed service workloads might contribute to gendered and racialized inequalities in academia. In particular, our findings suggest that external funding programs and/or additional internal support might shield engaged faculty from the negative impact that change-oriented service work might have on their publication productivity, and consequently the potentially negative impact on their careers. We conclude that future research could build on our insights to further examine the conditions under which institutions can set up sustainable organizational change efforts and could further examine the causal mechanisms linking engagement in change-oriented service work and successful academic careers. Finally, we contribute to methodological approaches in the sociology of science by leveraging large-scale bibliometric data and statistical matching and normalization procedures to compare publication productivity across different disciplines.

The Service/Research Trade-Off in Academia

Research suggests that time allocated to service work in academia, in particular at research universities, has direct implications for research productivity and career success (Fox 1992, 2005; Winslow 2010:790). Faculty members in academia spend their time on a mix of research, teaching, and service responsibilities. The proportion of time spent on each category depends on various factors including discipline, status, gender, race, and institutional or position type (O'Meara et al. 2017; Pyke 2015:93). Service work is essential for an organization to function. In academia, service work includes activities such as chairing and serving on departmental, university, or professional association committees, mentoring students, and assessing colleagues (e.g., for tenure and promotion). Although faculty members are typically required to participate in each of the three core areas (i.e., research, teaching, and service) to maintain employment and to receive promotions (there are exceptions, of course, for different types of faculty members), most faculty members are rewarded primarily for their research activities (for research faculty members) and their teaching activity (for teaching faculty members).

Studies demonstrate a direct trade-off between these activities: faculty members with higher research outputs tend to spend less time on teaching (Fox 1992) and service (Toutkoushian and Bellas 1999:389), whereas faculty members with more service commitments simply have less time for teaching and research (Bird, Litt, and Wang 2004). Service work is additionally often not measurably tracked as closely as, for example, research output or hours spent on teaching (Misra et al. 2021). And importantly, any outcomes involved in service work typically do not align with university metrics of merit (Misra et al. 2021). Time spent on service can therefore lead to career penalties and delays in tenure and promotion (Bird et al. 2004:199).

All else equal, time spent on research, teaching, and service is unequally distributed among faculty members along gender, race, rank, and disciplinary lines (Hanasono et al. 2019; Nelson et al. 2023; Park 1996; Spencer et al. 2021). Women faculty members and faculty members of color, for example, often report higher service loads than their white men colleagues (Guarino and Borden 2017; Misra et al. 2021). And although some faculty members receive varied compensation for service work, women assistant and associate professors report having less time for research compared with their men counterparts (Pyke 2015:93). Misra et al. (2011) found that among associate professors, "men spent seven and a half hours more a week on their research than did women" (p. 24).

Unequal time spent on service work can additionally require extra emotional labor that can "foster feelings of professional burnout, and increase faculty members' likelihood to leave their institution" (Hanasono et al. 2019:94). Because some forms of service work require intense interactions with students and faculty, time spent on service can lead to higher rates of stress, particularly among faculty members of color (Eagan and Garvey 2015; Joseph and Hirshfield 2023). In short, increased time on service work can lead to lower productivity and higher rates of stress and burnout, and unequal service loads are likely to contribute to inequalities in

promotions and retention for women faculty members and faculty members of color.

Service, Organizational Change Initiatives, and Research Productivity?

Service to the university extends beyond maintaining organizational functions; it also includes efforts to reform and enhance institutional processes. This aspect of service focuses on adapting university structures to address evolving needs, such as changing or building structures to promote interdisciplinarity, sustainability, or equity and inclusion. Organizational change in higher education is often framed through the lens of institutional isomorphism (DiMaggio and Powell 1983), where organizations adopt similar practices because of coercive, mimetic, or normative pressures. At the same time, organizational change frequently originates from individuals or groups who advocate for particular initiatives. Sturm (2006) argued that ADVANCE is one model of organizational change based on empowering women faculty members to be change agents by proposing and testing innovative ideas to address gendered inequalities in STEM within and across institutions.

The rewards and benefits as well as burdens and risks of faculty involvement in such organizational change efforts depend on how the work is recognized by university leadership. However, for research and teaching faculty members, this type of work typically goes above and beyond even the core low-promotability service work required of faculty members. Equity oriented change projects in particular might additionally and ironically contribute to gendered and racial inequities in organizations because they are often even more unequally distributed among faculty members (Bird et al. 2004; Guarino and Borden 2017; Misra et al. 2021). In addition, involvement in equity initiatives is often the type of intensive work that places extra cognitive and emotional burdens on those already marginalized (Joseph and Hirshfield 2023).

Although systematic research on the impact of organizational changes efforts on research productivity and academic careers is lacking, the aforementioned research suggests that inequalities in the time spent on service work, including change-oriented service work, can potentially lead to inequality in research and publication output and thus contribute to the overall inequality in tenure and promotion rates in academia. In particular, as we expect that faculty work on organizational change projects will typically be added on to existing service loads, academics involved might have lower research output compared with faculty members at similar points in their career who do not spend time on organizational change. Yet no research that we know of has directly assessed the impact of service, in particular change-oriented service, on research metrics important to promotion, such as publication rates.

The NSF ADVANCE Program

Since 2001, the ADVANCE program has been a prominent NSF initiative aimed at advancing gender equity in the professoriate in STEM academic fields. Since its inception, it has allocated more than $400 million to more than 217 institutions across the United States and Puerto Rico. This unique program has focused on supporting faculty and administrative efforts to transform organizational structures and cultures by changing practices, procedures, and policies to remove systemic barriers to women faculty members' advancement and leadership in STEM, focused in particular on hiring, promotion, and cultural change.

The structure of the awards given by ADVANCE have changed over time. The largest IT awards have provided on average $2.8 million per award over five years, and since 2008, they have included a social science research component to contribute to the knowledge on equity and organizational change in STEM (see Appendix A for more information on ADVANCE and award types). Other types of awards are smaller in scope and have aimed to broaden the program's reach to a more diverse range of institutions and organizations. The majority (~85 percent) of the authors we track in our study were associated with IT and former Partnerships for Adaptation, Implementation, and Dissemination (PAID) awards, though roughly 15 percent were associated with various other smaller awards (see Appendix A).

We consider work on ADVANCE programs as one type of organizational change effort. Like other forms of equity work, work on ADVANCE programs is a form of (often undervalued) service work that is typically added on to already unequally distributed service loads. Yet compared with typically underfunded work, ADVANCE does provide resources. Unlike other federally funded organizational change projects, for example, NSF's Alliances for Graduate Education and the Professoriate and INCLUDES Initiative, the ADVANCE model centers on the active engagement (and thus time) of women faculty members in driving institutional change (Sturm 2006). We used novel matching and normalization techniques and large-scale bibliometric data to evaluate whether the compensation ADVANCE provided to faculty members for this extra service work mitigated potential research career disruptions.

Methodological Challenges: Matched and Normalized Productivity Measures

To assess the impact of participating in ADVANCE-funded organizational change work on research productivity, we measured the number of publications authored by scholars involved in ADVANCE awards before and after receiving the awards, compared with a matched "control" sample. In addition to grants, publications are the key currency for

status and recognition in contemporary academia, and are particularly important in decisions about tenure and promotion. For this reason, publication productivity has been a key concern for those who study gendered and racialized inequalities in academia. As Fox (2005) put it, "Publication productivity operates as both cause and effect of status in science. Publication productivity reflects women's depressed rank and status, and partially accounts for it" (p. 131). In the deeply stratified world of science, publications are thus an important indicator of academic success, negotiation power, and future career opportunities.

Although the number of publications might seem like a simple metric to measure research productivity, comparison studies based on number of publications are exceedingly challenging because of the significant variability in publication norms and outputs across different disciplines and time periods (Huang et al. 2020; Kyvik 1990; Lotka 1926). Each field has distinct standards for what constitutes productive output, with some emphasizing high volumes of shorter papers while others prioritize fewer, more comprehensive publications. Additionally, interdisciplinary research, such as our case, further complicates comparisons as they merge diverse methodologies and publication practices from multiple fields (Ke, Gates, and Barabasi 2023).

To address these disparities, we used normalization techniques from statistical physics to standardize and adjust productivity metrics by field and career stage (Petersen et al. 2012). This type of normalization is enabled by MAG, a large, structured dataset of academic publications, citations, authors, institutions, journals, and research topics. Researchers have used MAG to analyze citation networks, track research trends, assess author and institutional impact, and explore collaborations across disciplines, among other topics. We used MAG to aggregate publications across fields and time, and to identify the pool of potential matched authors, enabling more accurate comparisons across our diverse population of academic scholars and their matched counterparts.

Research Questions and Hypotheses

As the ADVANCE program offers resources, status, and communities of collaborations to awardees, we explored whether the program was successful in offsetting the potential negative research productivity impact of this extra service work, either by providing the resources necessary for maintaining a core research program, and/or by creating opportunities for new types of research programs (e.g., ADVANCE-related or other gender-related scholarship). In particular, using our novel matching and field normalization technique and by combining unique data collected on the ADVANCE program with broader bibliometric data (described in more detail later), we ask: How did receiving an NSF ADVANCE award impact the publication trajectories of the scholars involved? We addressed this question in two ways. First, did participation in ADVANCE awards lead to quantitatively different publication outputs compared with matched scholars? Second, did receiving ADVANCE awards change the publication strategies of scholars, specifically the content of their post-ADVANCE publications and their post-ADVANCE collaboration patterns?

Publication Output: Quantity

Team members on ADVANCE awards typically face substantial time and energy demands. Writing the proposals for and creating new ADVANCE programs may involve conceptualizing programs, implementing these projects, designing new interventions, and assessing policies. Additional tasks include recruiting, hiring, and getting to know team members, communicating with university administration, learning new skills such as project management, coordinating events, and participating in many meetings. Faculty members are likely to have increased administrative responsibilities related to program coordination and leadership including onboarding and supervising staff. Thus we expect that being engaged in ADVANCE projects reduces the time, mental energy, and focus that awardees have for research-related tasks, including conducting research itself, writing grant applications, presenting conference papers, and publishing articles and books, impacting the awardee's overall publication productivity. Taken together, this suggests that receiving an ADVANCE award will likely lower an awardee's publication productivity.

> *Hypothesis 1:* Awardees produce fewer publications following their first ADVANCE awards compared with before the awards.

Publication Strategy: ADVANCE-Related Content

NSF ADVANCE funds the development and implementation of institutional change projects (DeAro, Bird, and Ryan 2019; McQuillan and Hernandez 2021). In addition, its explicit goal is to also contribute to the knowledge of gender inequities, science, and organizational transformation (Gold et al. 2022; Laursen and De Welde 2019; Morimoto 2022; Zippel and Ferree 2019). We know that researchers often change their publication strategies according to grant criteria (Madsen and Nielsen 2024). We thus expect that the NSF ADVANCE program, with its knowledge-generating focus and involvement

of research faculty members, might change the kind of research and publications awardees produce. This could in turn affect their overall number of publications on particular topics over the course of their engagement with the ADVANCE program.

For example, since 2010, applications for ADVANCE's largest IT awards are required to have a five-page proposal for social science studies to contribute to and disseminate knowledge on organizational change (Laursen and De Welde 2019). Teams have allocated faculty time as well as researchers, postdocs, graduate students, research assistants, and material resources to these research projects. As a result, even if team members had fewer publications on their own research, they might have been able to compensate for this decrease with ADVANCE-related publications, as being on an ADVANCE team provided opportunities and resources for social science research on ADVANCE programs and topics (see Morimoto 2022 for the kind of knowledge produced by ADVANCE teams).

> *Hypothesis 2a:* The number of publications on ADVANCE-related topics increases with an awardee's first ADVANCE award.

Publication Strategy: Gender-Related Content

Publication strategies of awardees might also change through their engagement in ADVANCE, as they are more exposed to gender-relevant questions and issues through their day-to-day ADVANCE work and they are more likely to meet more colleagues and potential collaborators who are gender studies experts through the campus and nationwide ADVANCE network.

> *Hypothesis 2b:* The number of publications on gender-related topics increases with the awardee's first ADVANCE award.

Publication Strategy: Collaboration and Interdisciplinarity

Social capital theory suggests that researchers can use their connections to colleagues for collaborative research projects, which can in turn increase their publication productivity (Abramo, D'Angelo, and Murgia 2017; Leahey and Barringer 2020; Lee and Bozeman 2005). Evidence further suggests that women researchers are more likely to engage with diverse collaborators (AlShebli, Rahwan, and Woon 2018). Here, we expect that awardees use both their local and wider networks through ADVANCE to collaborate with colleagues from other disciplines. ADVANCE teams are expected to be, and indeed are, interdisciplinary, and publications on ADVANCE-related issues from ADVANCE-funded sites are more interdisciplinary than other publications (Gates et al. 2024).

> *Hypothesis 3a:* Upon receiving NSF ADVANCE awards, awardees collaborate more in interdisciplinary teams.
> *Hypothesis 3b:* Upon receiving NSF ADVANCE awards, awardees' publications are more interdisciplinary than their prior publications.

Data and Methods

Scientific Authors

To measure the evolution of publication and collaboration frequency across all of science, we focused on the 86,020,685 journal articles and book chapters that are assigned to at least one level 0 concept (high-level disciplines) or level 1 concept (subdisciplines) in MAG. These documents were authored by 86,166,452 authors, resulting in 291,713,900 authorships (a person-paper relationship). To identify an author's disciplinary expertise, we assigned each author to the most frequent concept appearing in their publication history, representing the primary topic of their work. Note that this topic may or may not align with the department of their academic appointment.

In the absence of gender information for authors in MAG, we infered author gender on the basis of author name. Specifically, we used a commercially available service, genderize.io, which integrates publicly available census statistics to build a name database mapping a first name to a binary gender label. This gender assignment strategy has been successfully used in several academic research projects (AlShebli et al. 2018; Huang et al. 2020; Jadidi et al. 2018), and we refer to those works for accuracy and coverage, including important critiques of this method of estimating gender[1]. As author names in MAG often contain only initials, we strengthened our gender assignment by considering the

[1]Although genderize.io has been used in many published studies and, absent more robust metadata information about authors, is the only way to infer gender on a large scale, this method can lead to systematic errors. In particular, and as detailed in the supplementary material in Huang et al. (2020), this method often performs poorly for East Asian and Brazilian names. As we use this method only to produce our matched sample, and gender was one of many variables we matched on, any errors in inferred gender are unlikely to affect our results. In particular, our measures are normalized for careers, and we control for publication count, both potential confounders with gender. We do note, however, that scholars should use this method with caution, particularly for cross-national studies.

raw string of the author's name provided for each authorship on a publication. In many cases, at least one authorship for an author contains a full first name even when the official author name contains only the initial. Occasionally authorship information induced multiple gender assignments, which we resolved by selecting the most frequent gender across all publications in a career.

NSF ADVANCE

Between 2001 and 2018, the NSF gave 273 competitive ADVANCE awards to 195 universities and STEM organizations, excluding awards that were designated for conferences. To identify the first award of each of the 1,538 team members, we used data available on the NSF Web site, individual institutions' ADVANCE Web sites when available, and data collected via an e-mail survey to all ADVANCE award principal investigators (PIs) (Gold et al. 2022). This process resulted in the name, affiliation, award start year, and award role for 1,538 award team members. Award roles were grouped into seven categories split between internal positions (PIs and co-PIs, day-to-day staff members, social science researchers, and internal evaluators) and external positions (external advisers, external consultants, and external evaluators).

For each award team member, we then collected the demographic and career pathway information on the basis of information available on the Internet (from publicly posted curricula vitae, bios, LinkedIn profiles, archived web pages, publication histories on Google Scholar and MAG, and documents from ADVANCE Web sites). We were able to identify the demographic and job information for 1,527 individuals, including the organization, position title, and position start and end years covering the period from 2000 to 2019.

Of the 1,527 ADVANCE award individuals, we matched 1,394 to MAG author profiles on the basis of name and affiliations, capturing their publication histories. In the 33 cases in which multiple viable author profiles existed, we selected the profile with the most publications. We further restricted our analysis to the 550 internal team members (PIs and co-PIs, day-to-day staff members, and social science researchers) who held university-affiliated research positions at the time of their first awards (i.e., faculty member, postdoctoral researcher, or university staff researcher).

Finally, we identified the 334 researchers who had published at least five journal articles or book chapters and had at least two publications before the starting year of their first ADVANCE awards and at least two publications after the starting year of their first ADVANCE awards. This focus on publication-active researchers was necessary to enable meaningful comparisons of their research output before and after receiving awards. Including only those individuals who were consistently engaged in publishing ensured that the observed changes in productivity can be attributed to the award's impact rather than external factors, such as career interruptions or a lack of baseline publication activity. For consistency, we used the gender and field assignment for these authors as derived from MAG publications.

The resulting sample of 334 researchers—what we call "awardees"—are primarily women (83 percent), and 83 percent are white. At the time of their first ADVANCE awards, 326 (98 percent) were faculty members, 7 were staff researchers, and 1 was a postdoc. About half of the authors were associated with IT awards and about one third with various PAID awards (see Table A2 in Appendix A for details). The average time since first publication, a measure of academic age, was 16 years (minimum = 2 years, maximum = 48 years, median = 14 years), and the average productivity was 54 publications (minimum = 5, maximum = 452, median = 32, a range illustrating the challenges inherent in comparing publication metrics across fields). The sample represents a highly multidisciplinary mix. After assigning each researcher to the most common field in which they publish, 26 percent of our authors are in psychology, 12 percent are in biology, 9 percent are in chemistry, 9 percent are in sociology, 8 percent are in materials science, 7 percent are in health sciences, 6 percent are in computer science, and the remaining 23 percent are in other fields.

We also gathered all ADVANCE-related documents credited as an outcome of an ADVANCE award by consulting NSF records, searching Google Scholar for acknowledgment of ADVANCE funding using the award numbers, and reviewing awarded universities' ADVANCE Web sites. This process resulted in a total of 821 outcome documents, including 561 identified in MAG as peer-reviewed publications.

Normalization and Matching

Our analysis focused on the number of publications and number of coauthors for each individual for each year. These data are nonstationary: both the yearly number of publications and active authors increased steadily over the past century, as did the average number of publications produced by a given author in a given year and the average number of coauthors (Wuchty, Jones, and Uzzi 2007). Furthermore, each discipline has seen its own rate of growth, with disciplinary norms that vary drastically across science. Finally, the productivity and collaboration observed for each author are heavy tailed, such that most authors produce relatively few publications, while a few authors produce many publications.

To assess the impact of receiving an ADVANCE award, the publication and collaboration time series data must be decomposed and normalized. This involves separating individual-specific variation and temporal trends from broader trends in the scientific community, ensuring that the analysis isolates the effect of the award. As research shows that collaboration patterns differ between women and men, with both groups exhibiting tendencies toward homophily, the analysis of changes in individuals' coauthorship with women requires additional consideration. To address this, women and men team members were analyzed separately, and their coauthorship data with women was normalized using data from the MAG for authors of the same predicted gender.

Second, each ADVANCE individual's publication data were centered on their award year (denoted year 0) and grouped into three-year bins relative to that year. Third, to account for individual differences in productivity and collaboration, the binned productivity and coauthorship data were further normalized by each individual's career average. Combined with the earlier steps—centering data on the award year and grouping it into three-year bins—this approach ensured a consistent basis for comparison across individuals and time. Robustness checks using one-year and five-year bins confirmed the qualitative robustness of the findings. After normalization, the data values reflect individuals' productivity or collaboration levels relative to their time- and discipline-normalized career averages. For instance, a normalized productivity value of 1 indicates that the individual published at their typical career average rate relative to their discipline, while a value of 2 signifies publishing at twice that rate, and a value of 0.5 represents publishing at half the typical rate.

For each ADVANCE author, we identified a matched author on the basis of the following criteria: (1) primary affiliation in the United States, (2) same primary field, (3) same name-based gender, (4) same total career productivity, and (5) same year of first publication.

Interdisciplinarity

To quantify interdisciplinarity, we used Simpson's diversity index (Simpson 1949; Stirling 2007) corrected for finite sample sizes. Given a distribution over bins, for example, the fraction of authors who come from each discipline, Simpson's diversity is the probability that two samples come from different bins (i.e., two randomly selected authors come from different disciplines). In this version, 0 reflects a distribution that has no diversity and every author comes from the same discipline, while 1 captures the case that all authors come from different disciplines. Specifically, given a collection of N items into K bins with counts n_k in bin k, Simpson's diversity index corrected for finite sample sizes is given by

$$1-\sum_{k=1}^{K}\frac{n_k\left(n_k-1\right)}{N\left(N-1\right)}.$$

We assessed the interdisciplinarity of the publication influences, measured by the diversity of disciplines appearing in their reference lists, and the interdisciplinarity of authorship, measured by the diversity of primary disciplines appearing in the authorship team (see Figure B2).

Results

We find that within the first three years following ADVANCE awards, ADVANCE authors produce 1.25 times their baseline career- and field-normalized rate of productivity. The observed rise is statistically significant compared with all other three-year periods, as confirmed by the t test for two related samples. For example, in comparison with the three-year span preceding the award ($P < .001$) or the four to six years succeeding the award ($P < .01$), the significance is evident. A similar increase in productivity is not observed for the field and career matched samples (Figure 1B), suggesting that the productivity bump is not due to ADVANCE authors' career stage. Furthermore, a statistically significant increase in productivity limited to the one to three years following the ADVANCE award is observed for all disciplinary expertise except for mathematics (Appendix B, Figure B1).

Surprisingly, this provides evidence suggesting the opposite of hypothesis 1. Rather than either a decrease or no effect, awardees' publication productivity increased following the receipt of ADVANCE awards.

One potential explanation for the enhanced productivity among ADVANCE awardees is their increased production of ADVANCE-related studies. We therefore quantify the proportion of publications attributed to ADVANCE awards (see Figure 2A). Our analysis reveals that in the one to three years following ADVANCE awards, awardees attribute 4 percent of their publications to ADVANCE awards, a figure that peaks at nearly 7 percent of publications in the four to six years after the awards. On average, ADVANCE-related publications listed as outcomes of awards are published five years after the start of the award. This provides evidence to support hypothesis 2a, that the number of publications on ADVANCE-related topics of awardees' increased with their first ADVANCE awards. Similarly, as shown in Figure 2C and in support of hypothesis 2b, we do find a statistically significant increase in publications on gender studies related topics by ADVANCE awardees, from 2.6 percent of publications nine years before the awards, to 5.7 percent of publications nine years after the awards ($P < .001$, Mann-Whitney U test), but these are not statistically differentiable from the

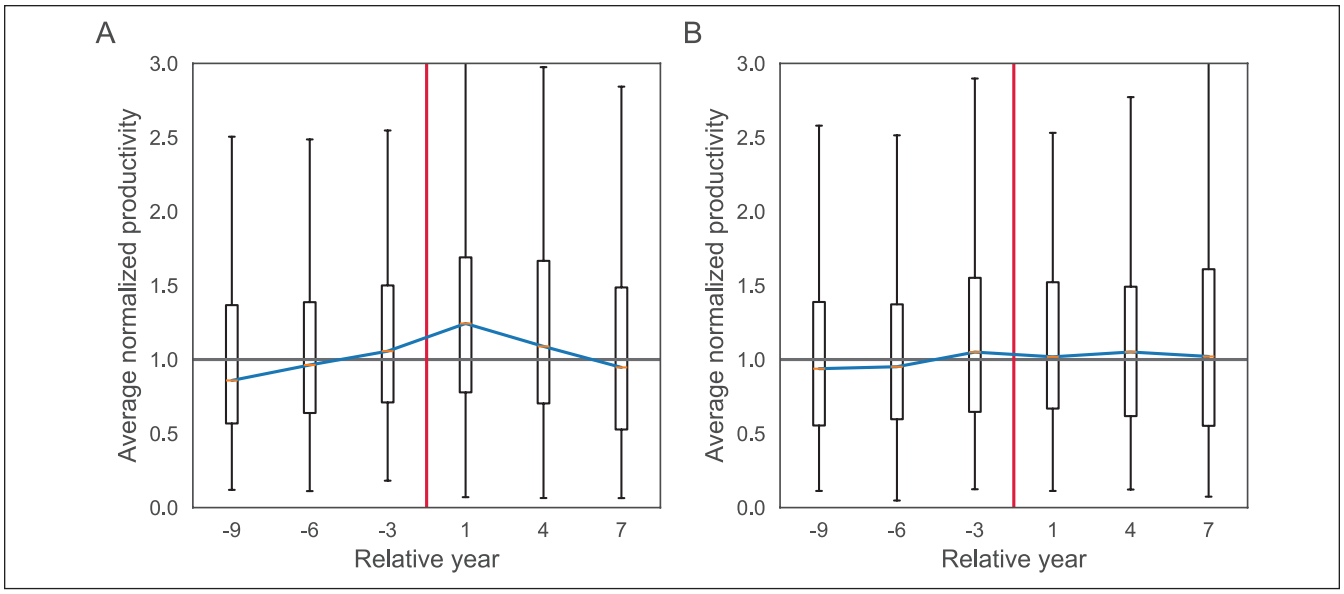

Figure 1. Author productivity relative to the year of ADVANCE award: average discipline-, year-, and career-normalized annual productivity relative to the year of ADVANCE award for (A) ADVANCE authors and (B) their matched authors.

matched authors ($P > .22$, Mann-Whitney U test). Therefore, we are unable to make a direct causal claim that ADVANCE awards influenced the increase in gender-related publications; an alternative explanation is that the focus on gender-related topics may be an overall pattern observed for any similar cohort of researchers at this career stage and time and with the same overall topical focus.

However, even after excluding ADVANCE-related publications from the awardees' careers, we still see a statistically significant surge in the career- and field-normalized rate of productivity (Figure 2B). These findings collectively indicate that although authors do generate more ADVANCE and gender-related publications, they are not the exclusive driver for the observed increase in overall productivity.

A second potential explanation for the enhanced productivity among individuals awarded ADVANCE awards is an increase in collaborative work with colleagues from other disciplines, leading to an increase in interdisciplinary publications and thus numerically more publications. To explore this, we measure the interdisciplinarity of the ADVANCE awardees' publications, assessed by the Simpson's diversity of their references and authorships (see "Methods"). We find that ADVANCE awardees do not have a noticeable change in their levels of interdisciplinarity following ADVANCE awards (Figures 3A and 3B). Similarly, although the publications that are direct outcomes of ADVANCE awards are more interdisciplinary, the authors' complete careers (including non-ADVANCE publications) do not reflect a significantly increased level of interdisciplinary research. These results refute hypotheses 3a and 3b: we did not observe a change in the coauthorship or reference interdisciplinarity of awardees.

Discussion

We explored how participating in (externally funded) organizational change efforts—similar to other low-promotability tasks under the umbrella of academic service work—might affect individual researcher's publication trajectories.

Previous research suggests that publication productivity is likely to decline with extra service obligations. We thus expected that when researchers first receive ADVANCE awards, their publication rates might decline. Surprisingly, we did not find a negative effect on publication rates. Instead, we found a significant increase in the number of awardee publications within the first four years after receiving their first awards. Although we did find changes in publication strategy following an award—for example, awardees published more on ADVANCE-related topics and maybe more on gender (discussed more later)—we also found that these topical changes cannot fully explain the increase in publications overall. Our findings suggest that contrary to expectations, awardees who were already publishing before receiving ADVANCE awards continued to publish, and in fact increased their publication rates, on their own (non-ADVANCE-related) research topics. This finding is stark, as research suggests that higher service loads that come from participating in organizational change efforts, similar to time

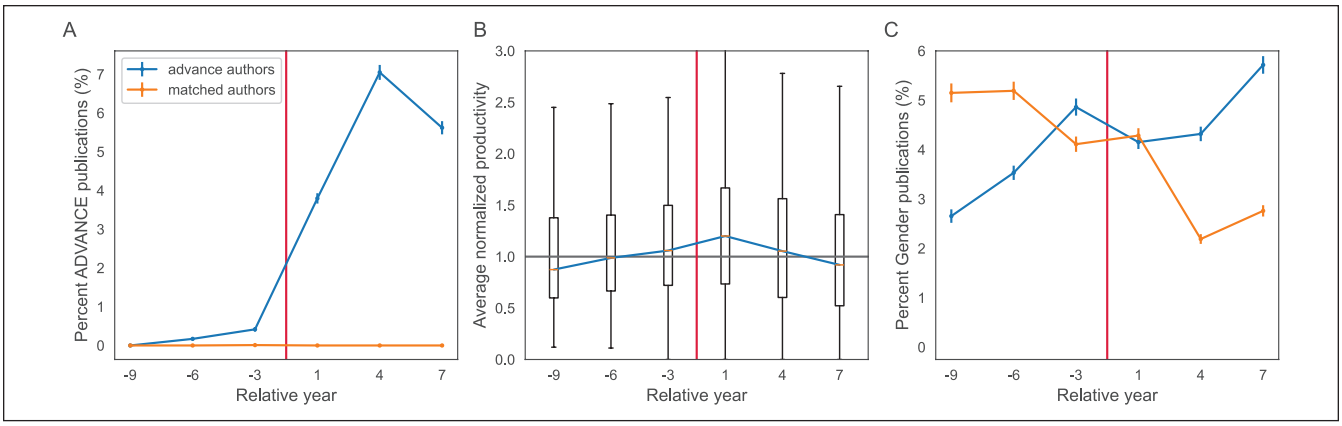

Figure 2. ADVANCE awardee productivity topical breakdown. (A) The average percentage of annual publications that are ADVANCE related. (B) The average discipline-, year-, and career-normalized annual productivity relative to the year of ADVANCE award removing all ADVANCE-related publications. (C) The average percentage of annual publications that are on gender studies topics.

spent on service work more broadly, negatively affects academic careers, including publication productivity (Bird et al. 2004; Hanasono et al. 2019; Laube 2021; Misra et al. 2021; Trejo 2020:2752). We return to the implications of this finding later.

Furthermore, given ADVANCE's distinct focus on producing knowledge, we additionally expected that the patterns of their publication would change, including publication topic and collaboration patterns, as other studies have found that academics change publication topics on the basis of existing funding instruments (Madsen and Nielsen 2024). We expected that ADVANCE awardees would publish more ADVANCE-related research, that they would publish more on gender (especially if gender was not their original research agenda), and that they would collaborate with more colleagues from different disciplines. We further sought to determine if changes in publication strategy might explain changes in publication quantity.

We found that ADVANCE awardees did indeed publish ADVANCE-related research, but these publications accounted for a small proportion of awardees' postaward publications, and removing ADVANCE-related publications did not mitigate the overall impact of an ADVANCE award on publication output. Additionally, although awardees did see an increase in gender-related publications after their first NSF ADVANCE awards, this was not significantly different from the matched cohort of authors, suggesting that there is simply increased attention to gender in publications across all authors. Likewise, there were no measurable changes to the interdisciplinarity of their collaborations or publications. Although ADVANCE-related publications tend to be more interdisciplinary than other comparative publications (Gates et al. 2024), our findings here suggest that awardees engaged with ADVANCE were already publishing interdisciplinary work before receiving awards (and indeed might be a reason they were interested in the ADVANCE program at all).

In sum, on average, we found that awardees continued and increased their research output without shifting focus entirely to ADVANCE-related topics or collaborations. This suggests that awardees were able to maintain their own, independent research trajectories alongside their engagement with ADVANCE.

The Importance of Resources for Sustainable Organizational Change Projects

We interpret these unexpected results as a consequence of the material and symbolic resources provided by ADVANCE that allowed participants to engage in ADVANCE work without detracting from their preexisting research agendas. By providing funding for professional staff members, ADVANCE allowed awardees to delegate administrative tasks and focus on research, alleviating the burdens of uncompensated organizational change effort work. Additionally, the prestige and legitimacy conferred by the NSF award may have enhanced the visibility and value of this change-oriented service work, counteracting its usual devaluation as "institutional housework" (Bilimoria, Joy, and Liang 2008; Bird et al. 2004; Stewart, Malley, and LaVaque-Manty 2007). On ADVANCE awards, faculty members served explicitly as co-PIs next to top-level administrators. These PIs did report that although their previous (unfunded) gender change initiatives were not taken seriously within their institution, having an NSF award in their

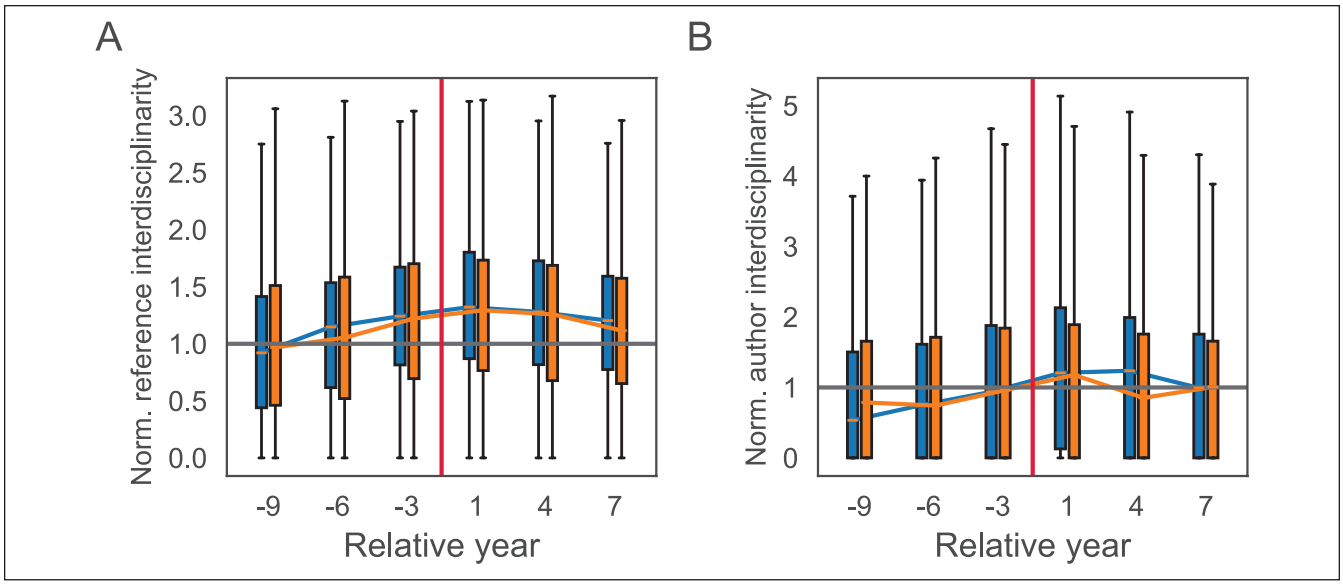

Figure 3. Publication interdisciplinarity. The field-normalized (A) reference and (B) authorship interdisciplinarity for publications by (blue) the ADVANCE authors and (orange) their matched authors relative to the year of ADVANCE award.

hands, women faculty members (and administrators) were able to better advocate for their efforts by leveraging the prestige of the NSF as the major funding agency for research (see Bilimoria et al. 2008; Bilimoria and Liang 2012; Stewart et al. 2007). Although institutions likely varied in how they recognized NSF ADVANCE awards compared with NSF awards focused solely on the core research of faculty members, even change-oriented NSF awards do fit into common metrics used for merit for promotion or pay raises, particularly serving as PIs on large, external grants. PIs noted that, given dwindling state support in public universities, the amount and overhead from these NSF awards was generally welcomed by institutional leaders (Bilimoria et al. 2008; Bilimoria and Liang 2012; Stewart et al. 2007). This material and symbolic recognition can ease potential institutional resistance to change projects and can make this work more effective. For individuals, this recognition can also translate into internal material resources, such as teaching reductions or extra internal research support, potentially empowering awardees to balance organizational change work and research productivity. Finally, ADVANCE's deliberate involvement of university leadership ensured institutional buy-in and sustainability, providing further support for awardees engaged in these efforts.

Key Insights and Implications

This study has several empirical, theoretical, and methodological implications. Empirically, our findings highlight the potential of funding agencies' resources as a mechanism to enable organizational change efforts, including and in particular gender equity efforts, without negative impacts on awardees' careers, at least via publication rates. Our results suggest that the potential negative effects of involvement in such efforts can be mitigated through robust resource provision and institutional recognition, emphasizing the importance of understanding the context in which such change-oriented service work takes place. Institutions that are exploring ways to make organizational change efforts more sustainable can be encouraged by our findings: symbolic and material resources matter for those involved in this work.

Theoretically, we suggest that receiving an NSF ADVANCE award had broader spillover effects that extended beyond awardee involvement in organizational change initiatives and related research. These awards not only provided funding and support for research directly related to ADVANCE projects but, we argue, also created opportunities for individuals to (re)direct their focus toward completing existing or ongoing scholarly work. By alleviating some of the resource and time constraints often associated with balancing competing demands, these awards may have enabled faculty members to finalize projects that had been delayed or deprioritized, whether because of heavy service commitments, lack of funding, or limited institutional support. Whatever the precise mechanism, the observed result was increased research output across a variety of topics, contributing to individuals' overall productivity and academic impact.

Speculating beyond our data, the ability to complete ongoing projects might help scholars strengthen their research portfolios, improve their standing in their fields, and better position themselves for career advancement opportunities, such as tenure, promotion, or leadership roles. In this way, the NSF ADVANCE program not only drives IT but also indirectly supports the long-term professional development and success of the faculty members involved. For institutions seeking to support organizational change efforts this finding is again encouraging: resources spent supporting organizational change work could lead to additional research output from participants which could, potentially, result in additional grants and institutional resources for research faculty members. Institutions thus need not think about resources spent on institutional change as zero sum: this spending, through this spillover mechanism, could grow the overall research resources pie.

Finally, this study offers several methodological contributions to the evaluation of gender equity initiatives in academic organizations. First, we introduced a normalization procedure to account for vast publication differences by year, field, and individual career trajectories. This method enabled precise comparisons across disciplines and career stages, important for understanding interdisciplinary and interrank programs such as ADVANCE. Second, we used a matched cohort design, comparing ADVANCE awardees with nonrecipients who share similar characteristics such as discipline, career stage, and publication history. This approach allowed us to come as close as possible to isolating the program's causal effects, even given the complexity of observational data. As interdisciplinary programs become more popular, in universities and for funding agencies, the academic community needs methods to robustly assess these programs and their impacts not just on the goals of the program (in this case, gender inequality in STEM fields in higher education) but also on the careers of those involved. The method used here, combining complex normalization with matching using large-scale bibliometric data, brings us closer to that goal.

Limitations

As both an observational study and a case study, this research of course has limitations. First, the MAG dataset does not comprehensively include bibliometric records for books or book chapters, potentially underestimating publication productivity for those publishing in these formats, though we have no reason to believe this would affect the specific temporal patterns we found. Second, our sample included only individuals with at least five publications (with at least two before and two after their first ADVANCE awards), focusing on research-active awardees, mostly faculty members. This approach likely excluded less research-oriented individuals, favoring those with strong preexisting research networks and teams, who could potentially more effectively leverage resources from the ADVANCE program and community for research. It is possible, then, that non-research-active faculty members did not see a similar boost in productivity (however productivity is measured in nonresearch career paths) and potentially were negatively affected as predicted in the literature.

Third, it is possible that the institutions that housed the teams that won ADVANCE awards were already investing material and symbolic resources in gender equity work, contributing both to their likelihood of a successful ADVANCE application and a favorable institutional setting for program participants. Thus what we may be finding is a result of institutional investment, not necessarily due directly (or only) to ADVANCE-provided resources. Although this does not undermine our overall claim that resources matter, collecting additional data on institutional resource allocations within ADVANCE sites prior to their award could help us disentangle institutional versus NSF-specific resources on awardee publication rates.

Finally, although our focus on publications allowed comparative analysis across disciplines and career stages, it does not capture broader career outcomes. Some faculty members, for instance, transitioned into leadership roles, using their ADVANCE experience to further organizational equity goals and thus their administrative standing, or became geographically mobile because of their valued expertise (Bilimoria et al. 2008; Bilimoria and Liang 2012). And an increase in publications does not necessarily (and for women in particular) translate to promotions and/or higher pay. Thus, publications alone may not reflect the full material impact (positive or negative) of ADVANCE awards, particularly for junior scholars, staff members, and administrators.

Because of these limitations, we do not claim that the positive effect of the ADVANCE award on publication productivity (and thus potentially on career trajectory in research-focused careers) generalizes to all faculty members involved in ADVANCE, particularly those at earlier publishing stages, those without strong publication records, those transitioning to administrative careers, or, potentially, those who were on multiple awards. Some social science faculty members might have been able to leverage ADVANCE resources to pivot their research agendas, potentially boosting productivity through funding for postdocs and PhD students. Others, however, are likely to have experienced challenges, including a loss of focus, difficulties finding publication outlets for interdisciplinary work, or negative perceptions of "engaged scholarship" within their disciplines, particularly in STEM fields (see Blair-Loy and Cech 2022; Zippel and Ferree 2019).

And ultimately, our observed increase in publication rate is just one limited data point and does not represent the diverse impacts scholars have. This finding thus does not negate the very real challenges organizational change efforts, and (interdisciplinary) equity work in particular, entails. STEM faculty members engaging in organizational change efforts on politically sensitive issues such as sustainability, climate change, gender equity, and other diversity and inclusion work, for example, may face skepticism about their objectivity, as such efforts are often perceived as social or political rather than scientific (Blair-Loy and Cech 2022).

Furthermore, publishing ADVANCE-related work presents unique challenges (Zippel and Ferree 2019). Disseminating ADVANCE findings through reports and book chapters is common, but converting them into peer-reviewed interdisciplinary publications is difficult because of issues like single-university data, privacy concerns with small-*n* studies (especially for underrepresented groups), and the complexity of analyzing organizational change processes (Zippel and Ferree 2019). Challenges in publishing interdisciplinary research—such as limited outlets, varying peer-review standards, and extended timelines—compound these struggles. Despite these challenges, our data show that publication-active awardees generally experienced positive short-term impacts on their publication trajectories.

Future Directions for Research

Future research could expand on our methods and empirical insights. In particular, examining institutional data from ADVANCE sites before and after awards are disbursed could help disentangle the precise causal pathways linking institutional and funder resources for organizational change efforts to faculty publication productivity. Future studies could also examine how faculty members at different career stages and in different institutional types balance successful academic careers with engagement in (increasingly politically controversial) service on organizational change efforts, in particular around equity, even when equally well funded. Investigating how programs and institutional supports enable junior faculty members, in particular those who are additionally marginalized in other ways, to protect research time, sustain their scholarly output, and protect their scholarly reputation, is particularly critical.

An ideal dataset might include grant activity, diverse publication types (e.g., books and chapters), and detailed data on organizational change efforts and service, including associated institutional resources. A longitudinal approach could assess prior involvement in such efforts, funding support, and resource allocation to establish time order and evaluate the impact of various programs on career outcomes. Qualitative interviews could reveal changes in publication strategies, whether voluntary or constrained by commitments to organizational change efforts.

Scholars could additionally use comparative research on the effects of different types of (funded) organizational change programs and service work to better understand how a program's structure affects short- and long-term career trajectories. Such studies could inform how institutional leaders and funders can design organizational change initiatives to support, rather than inadvertently hinder, the careers of academics leading these efforts.

Finally, these programs might have unintended consequences, such as potentially privileging particular groups of faculty members over others who do not receive these awards and thus reproducing known inequalities such as those based on institutional prestige, awardees' career status, seniority, and their social and cultural capital. Future research could take a broader lens to examine the impacts of externally funded change efforts on inequality between institutions and faculty members who receive these types of awards, compared with those who carry out this type of work without external funding.

Conclusion

Efforts to promote organizational change in academia typically create more work for faculty members, work that is often not rewarded in tenure and promotion deliberations. We used the specific example of ADVANCE as a program that provides federal funding for faculty and others to pursue changes aimed at gender equity in the professoriate. Specifically, we examined the effects of participating in ADVANCE awards on the publication productivity of faculty members. Although our study's focus lies on the individuals involved, the political context of course matters for the sustained funding for such organizational change work.

We do know that equity initiatives often have faced politicization and devaluation even within the very institutions they seek to transform. Theories of gendered and racialized organizations and organizational change highlight a troubling paradox: those who challenge entrenched inequalities are often tasked with disproportionate burdens, both emotional and temporal, that can hinder their academic careers. In academia, this dynamic disproportionately affects women faculty members and faculty members of color, who bear the brunt of undervalued and underresourced equity work, a form of institutional service that frequently remains invisible in tenure and promotion evaluations and is rarely rewarded (Bird et al. 2004; Joseph and Hirshfield 2023; Misra et al. 2021).

Because of the uniqueness of the ADVANCE program, its focus on the STEM professoriate, its long history and research orientation, and its location in higher education, we do not claim that we can generalize our findings beyond our case. However, we maintain that as an exceptional case (Ermakoff 2014), the unique structure of ADVANCE allowed us to generate important theoretical and empirical insights. Indeed, our findings do offer an optimistic perspective for funding organizations and institutional supports: the ADVANCE program appears to allow (already research active) awardees to balance engagement in organizational change efforts with active publication careers. We argue that the program's resources—both material (e.g., funding, time, staffing) and symbolic (e.g., legitimacy from a premier scientific funder)—play a critical role. These resources, especially the status and overhead that comes with being a PI on an NSF grant (Bilimoria and Liang 2012; Stewart et al. 2007), likely enhanced awardees' capacity to negotiate institutional support, such as teaching reductions and research assistance, which in turn had a spillover effect, sustaining their own independent research productivity. Importantly, however, we were only able to study awardees who were already publication active prior to receiving ADVANCE funding, who may already be in a strong negotiating position vis-à-vis their university.

Our study contributes to theories of gendered and racialized organizations (Acker 1990, 2000, 2006; Ray 2019) and organizational change by demonstrating that high-profile, well-funded external programs can mitigate the burdens of organizational change efforts of gender equity work for professors. The ADVANCE program in particular exemplifies how external funding empowered the predominantly women academics involved to engage in such efforts without compromising their scholarly output. This study underscores the importance of sustained funding and institutional backing for advancing equity in academia.

Appendix A

As shown in Table A1, the NSF ADVANCE program has undergone significant changes over the past 24 years, adapting to the perceived inequalities among institutions and needs of the community (DeAro et al. 2019; Laursen and De Welde 2019). These changes are reflected in the various funding lines in the ADVANCE program that have varied in size, length, and scope over its more than 20-year history. The largest and longest are the IT awards, with an average of $2.8 million awarded to institutions for an award duration of 5 years. Early in the program's existence, some award types were given to individuals (leadership and fellows awards). One track encourages multiple institutions to collaborate (Partnership) and has continued Adaptation awards (formerly PAID awards) that provide funding to modify programs that were successful earlier at other institutions to own's own (DeAro et al. 2019; Bilimoria and Liang 2012; Laursen and De Welde 2019).

Table A1. ADVANCE Awards by Type, 2001 to 2025.

Award Type	Award Subtotal	Number of Awards	Average Amount Awarded	Years Active
IT	$241,780,647	86	$2,811,403	Since 2001
Partnership and Adaptation[a]	$167,661,056	241	$695,689	Since 2001
Fellows	$19,685,198	65	$302,849	2001-2006
IT Catalyst	$19,551,128	78	$250,655	Since 2008
Leadership	$8,401,679	43	$195,388	2001-2006
Total	$457,079,708	513	$851,197	

Sources: https://new.nsf.gov/funding/opportunities/advance-advance-organizational-change-gender-equity-stem-academic/5383/announcements/115554 and https://www.nsf.gov/awardsearch/. Accessed February 4, 2025.
Note: IT = institutional transformation.
a. Partnership and Adaptation includes Implementation and Dissemination (PAID), Partnerships for Learning and Adaptation Networks, and Partnership (awarded between 2006 and 2018).

In response to critiques that mainly research-intensive (R1) institutions benefited from ADVANCE funding, the ADVANCE program has sought to broaden the institutional type by introducing IT Catalyst awards (with the goal to enable less resource rich institutions to compete for IT awards) and PAID and other funding lines that have been smaller but have benefited a larger variety of institutions and STEM organizations.

The kind of work involved in carrying out an award, including how much focus is on publications, varies by the specific award and also the award type. For our purposes, in addition to the size of the award, the major relevant difference between the IT and PAID and other non-IT awards is that since 2008, IT proposals have been required to include a social science research component to contribute to the knowledge on equity and organizational change in STEM. Although other ADVANCE awards are also expected to disseminate good practices to colleagues in presentations at conferences, they are not required to include a research component. The overall goal is for these funded projects to develop successful models to promote equity, that can then be disseminated, scaled, and adopted and adapted by other institutions nationwide, without the expensive innovation phase which entails much trial and error.

Given the requirements and size of the awards, the majority of publications on the ADVANCE program have been associated with IT and PAID awards. Table A2 shows all ADVANCE publications by award type between 2001 and 2019. Overall, about 65 percent of the ADVANCE publications are associated with IT awards and 18 percent with PAID awards. Table A3 provides this information by authors in our "research active" author list and what award type they were associated with (an author is counted multiple times if associated with multiple awards).

Table A2. Proportion of All ADVANCE Publications Prior to Matching with MAG ($n = 823$) Associated with Each Award Type, 2001 to 2019.

Award Type	Proportion Associated
IT	.64
Partnership and Adaptation[a]	.25
Leadership	.05
IT Catalyst	.01
PLAN-IHE	.01
IT Start	.01
PLAN-D	.01

a. Partnership and Adaptation includes Implementation and Dissemination (PAID), Partnerships for Learning and Adaptation Networks (PLAN), Adaptation, and Partnership.

Note: These are all publications associated with ADVANCE grants and related to gender equity, including conference papers and book chapters that were not matched in Microsoft Academic Graph. Each publication could be associated with more than one grant. IHE = institutions of higher education; IT = institutional transformation.

Table A3. Percentage of "Research Active" ADVANCE Authors ($n = 334$) Associated with Each Award Type.

Award Type	Proportion Associated
IT	.51
Partnership and Adaptation[a]	.33
Leadership	.06
IT Catalyst	.06
IT Start	.03
PLAN-D	.01
PLAN-IHE	.01
Other	.00

Note: "Research active" means that an author has at least five publications recorded in Microsoft Academic Graph, with at least two published before their first ADVANCE award. IHE = institutions of higher education; IT = institutional transformation.

a. Partnership and Adaptation includes Implementation and Dissemination (PAID), Partnerships for Learning and Adaptation Networks (PLAN), Adaptation, and Partnership.

Appendix B

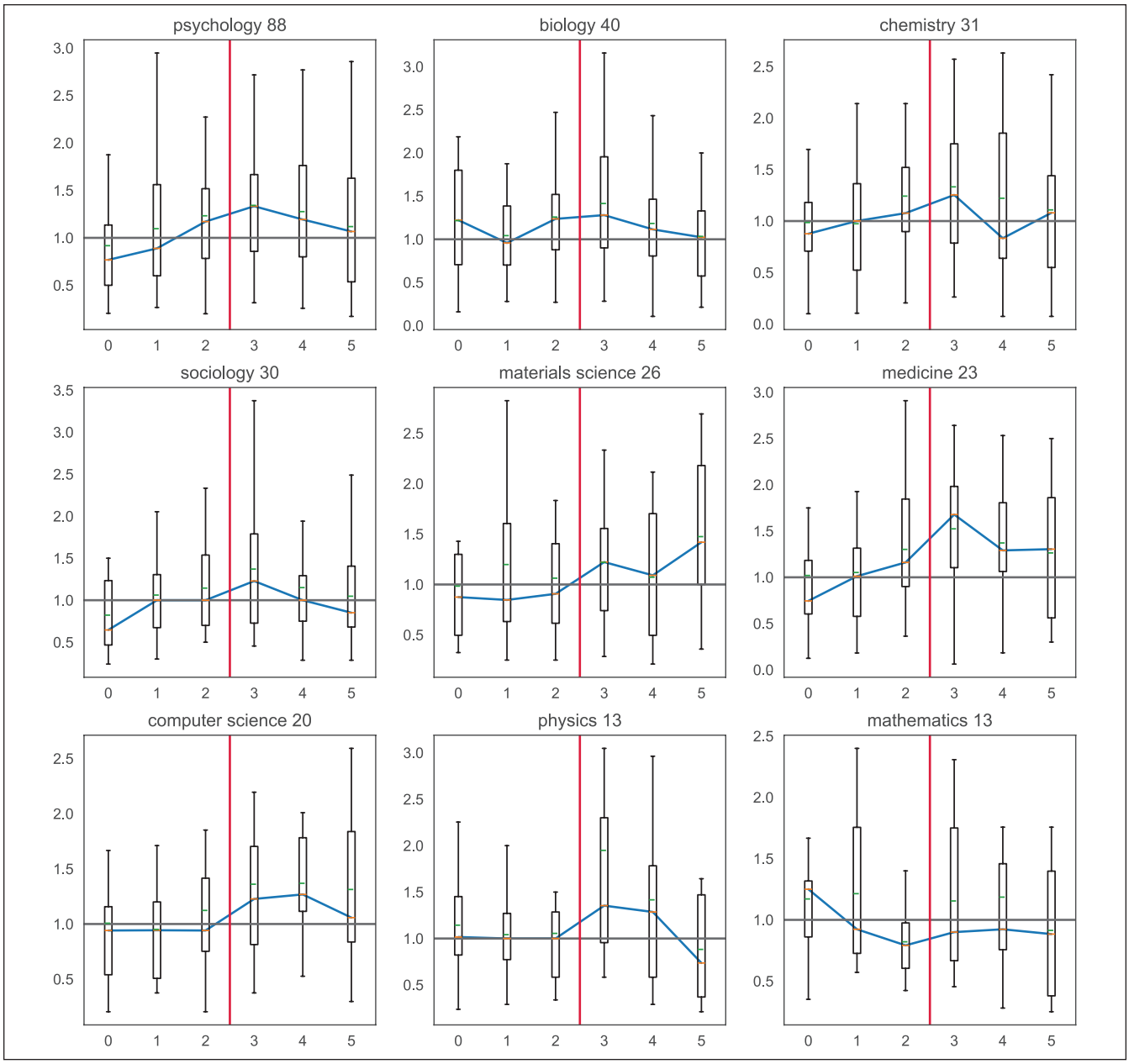

Figure B1. Author productivity relative to the year of ADVANCE award by field. The average discipline, year, and career normalized annual productivity relative to the year of ADVANCE award for the ADVANCE authors in each field.

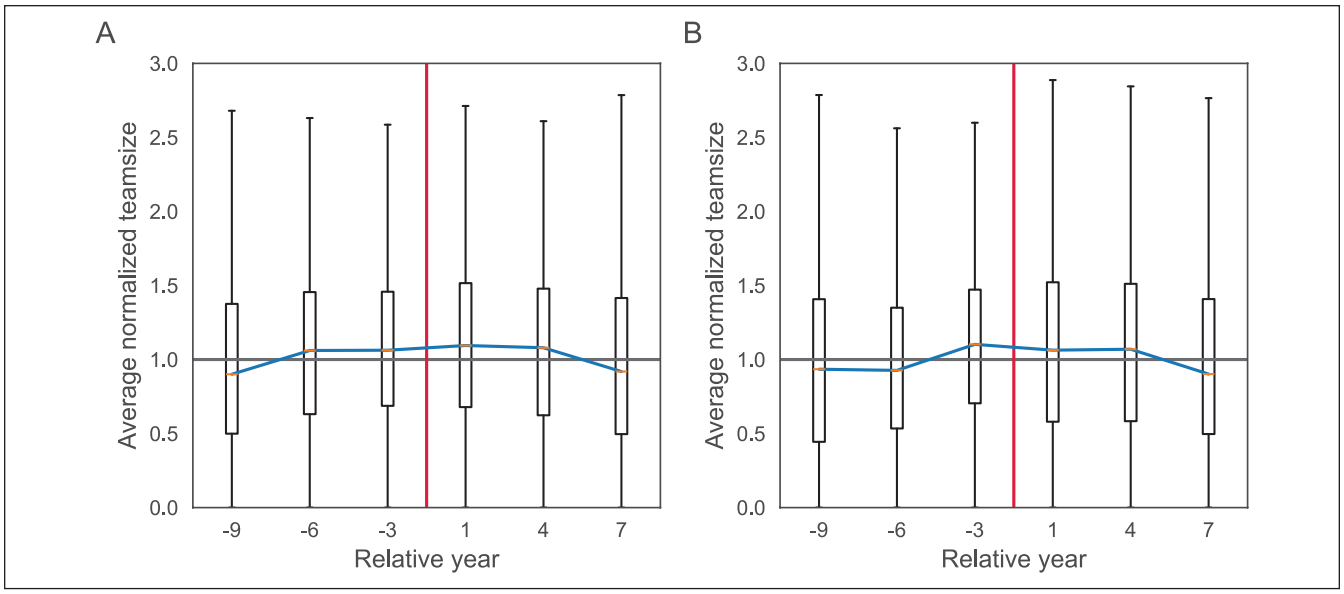

Figure B2. Normalized team size relative to the year of ADVANCE award: average discipline-, year-, and career-normalized annual team size (i.e., the number of coauthors on a publication) relative to the year of ADVANCE award for (A) the ADVANCE authors and (B) their matched authors.

Acknowledgments

We thank the wonderful research community at the Center for Complex Network Research, in particular A. L. Barabasi, for helpful discussions. Overwhelming thanks to the many undergraduate and graduate researchers who assisted with data collection and cleaning and data analysis that enriched this article. Without their work, this article would not have been possible. In particular, thanks to Blanca Vidal i Jiménez for research support.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This material is based upon work supported by the NSF under awards 1836671 and 2000713. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

ORCID iD

Alexander Gates https://orcid.org/0000-0003-0099-7480
Laura K. Nelson https://orcid.org/0000-0001-8948-300X
Kathrin Zippel https://orcid.org/0000-0002-4635-7115

Data and Code Availability

The MAG is now publicly available under a different name, OpenAlex. The code for this project is based around the pySciSci Python package (Gates and Barabasi 2023), available on GitHub (https://github.com/SciSciCollective/pyscisci). The article-specific code is available from the authors upon reasonable request.

References

Aboagye, Emmanuel, Irene Jensen, Gunnar Bergström, Elisabeth Björk Brämberg, Oscar Javier Pico-Espinosa, and Christina Björklund. 2021. "Investigating the Association between Publication Performance and the Work Environment of University Research Academics: A Systematic Review." *Scientometrics* 126(4):3283–3301.

Abramo, Giovanni, Andrea Ciriaco D'Angelo, and Gianluca Murgia. 2017. "The Relationship among Research Productivity, Research Collaboration, and Their Determinants." *Journal of Informetrics* 11(4):1016–30.

Acker, Joan. 1990. "Hierarchies, Jobs, Bodies: A Theory of Gendered Organizations." *Gender & Society* 4(2):139–58.

Acker, Joan. 2000. "Gendered Contradictions in Organizational Equity Projects." *Organization* 7(4):625–32.

Acker, Joan. 2006. *Class Questions: Feminist Answers*. Lanham, MD: Rowman & Littlefield.

AlShebli, Bedoor K., Talal Rahwan, and Wei Lee Woon. 2018. "The Preeminence of Ethnic Diversity in Scientific Collaboration." *Nature Communications* 9(1):5163.

Bilimoria, Diana, Simy Joy, and Xiangfen Liang. 2008. "Breaking Barriers and Creating Inclusiveness: Lessons of Organizational Transformation to Advance Women Faculty in Academic Science and Engineering." *Human Resource Management* 47(3):423–41.

Bilimoria, Diana, and Xiangfen Liang. 2012. *Gender Equity in Science and Engineering: Advancing Change in Higher Education*. New York: Routledge.

Bird, Sharon, Jacquelyn Litt, and Yong Wang. 2004. "Creating Status of Women Reports: Institutional Housekeeping as 'Women's Work.'" *NWSA Journal* 16(1):194–206.

Blair-Loy, Mary, and Erin A. Cech. 2022. *Misconceiving Merit: Paradoxes of Excellence and Devotion in Academic Science and Engineering*. Chicago: University of Chicago Press.

DeAro, Jessie, Sharon Bird, and Shermaine Mitchell Ryan. 2019. "NSF ADVANCE and Gender Equity: Past, Present and Future of Systemic Institutional Transformation Strategies." *Equality, Diversity and Inclusion: An International Journal* 38(2):131–39.

DiMaggio, Paul J., and Walter W. Powell. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." *American Sociological Review* 48(2):147–60.

Eagan, M. Kevin, Jr., and Jason C. Garvey. 2015. "Stressing Out: Connecting Race, Gender, and Stress with Faculty Productivity." *Journal of Higher Education* 86(6):923–54.

Ermakoff, Ivan. 2014. "Exceptional Cases: Epistemic contributions and Normative Expectations." *European Journal of Sociology* 55(2):223–43.

Fox, Mary Frank. 1992. "Research, Teaching, and Publication Productivity: Mutuality Versus Competition in Academia." *Sociology of Education* 65(4):293–305.

Fox, Mary Frank. 2005. "Gender, Family Characteristics, and Publication Productivity among Scientists." *Social Studies of Science* 35(1):131–50.

Gates, Alex J., and Albert-László Barabási. 2023. "Reproducible Science of Science at Scale: pySciSci." *Quantitative Science Studies* 4(3), 700–710.

Gates, Alexander J., Jessica R. Gold, Laura K. Nelson, and Kathrin Zippel. 2024. "Translating Interdisciplinary Knowledge for Gender Equity: Quantifying the Impact of NSF ADVANCE." *Social Science Quarterly* 105(2):342–58.

Gold, Jessica R., Alexander J. Gates, Syed A. Haque, Miranda C. Melson, Laura K. Nelson, and Kathrin Zippel. 2022. "The NSF ADVANCE Network of Organizations." *ADVANCE Journal* 3(1).

Guarino, Cassandra M., and Victor M. H. Borden. 2017. "Faculty Service Loads and Gender: Are Women Taking Care of the Academic Family?" *Research in Higher Education* 58(6):672–94.

Hanasono, Lisa K., Ellen M. Broido, Margaret M. Yacobucci, Karen V. Root, Susana Peña, and Deborah A. O'Neil. 2019. "Secret Service: Revealing Gender Biases in the Visibility and Value of Faculty Service." *Journal of Diversity in Higher Education* 12(1):85.

Heijstra, Thamar M., Þorgerður Einarsdóttir, Gyða M. Pétursdóttir, and Finnborg S. Steinþórsdóttir. 2017. "Testing the Concept of Academic Housework in a European Setting: Part of Academic Career-Making or Gendered Barrier to the Top?" *European Educational Research Journal* 16(2–3):200–14.

Huang, Junming, Alexander J. Gates, Roberta Sinatra, and Albert-László Barabási. 2020. "Historical Comparison of Gender Inequality in Scientific Careers across Countries and Disciplines." *Proceedings of the National Academy of Sciences* 117(9):4609–16.

Jadidi, Mohsen, Fariba Karimi, Haiko Lietz, and Claudia Wagner. 2018. "Gender Disparities in Science? Dropout, Productivity, Collaborations and Success of Male and Female Computer Scientists." *Advances in Complex Systems* 21(03n04):1750011.

Järvinen, Margaretha, and Nanna Mik-Meyer. 2024. "Giving and Receiving: Gendered Service Work in Academia." *Current Sociology*. doi:10.1177/00113921231224754.

Joseph, Tiffany D., and Laura E. Hirshfield. 2023. "Reexamining Racism, Sexism, and Identity Taxation in the Academy." *Ethnic and Racial Studies* 46(6):1101–1108.

Ke, Qing, Alexander J. Gates, and Albert-Laszlo Barabasi. 2023. "A Network-Based Normalized Impact Measure Reveals Successful Periods of Scientific Discovery across Disciplines." *Proceedings of the National Academy of Sciences* 120(48):e2309378120.

Kyvik, S. 1990. "Age and Scientific Productivity—Differences Between Fields of Learning." *Higher Education* 19(1):37–55.

Laube, Heather. 2021. "Outsiders within Transforming the Academy: The Unique Positionality of Feminist Sociologists." *Gender & Society* 35(3):476–500.

Laursen, Sandra L., and Kristine De Welde. 2019. "The Changer and the Changed: Evolving Theories and Practices of Change in ADVANCE Calls for Institutional Transformation." *Equality, Diversity and Inclusion: An International Journal* 38(2):140–59.

Leahey, Erin, and Sondra N. Barringer. 2020. "Universities' Commitment to Interdisciplinary Research: To What End?" *Research Policy* 49(2):103910.

Lee, Sooho, and Barry Bozeman. 2005. "The Impact of Research Collaboration on Scientific Productivity." *Social Studies of Science* 35(5):673–702.

Lotka, Alfred J. 1926. "The Frequency Distribution of Scientific Productivity." *Journal of the Washington Academy of Sciences* 16(12):317–23.

Madsen, Emil Bargmann, and Mathias Wullum Nielsen. 2024. "Do Thematic Funding Instruments Lead Researchers in New Directions? Strategic Funding Priorities and Topic Switching among British Grant Recipients." *Research Evaluation*. doi:10.1093/reseval/rvae015.

McQuillan, Julia, and Nestor Hernandez. 2021. "Real-Life Conundrums in the Struggle for Institutional Transformation." *Gender & Society* 35(3):300–29.

Misra, Joya, Jennifer Hickes Lundquist, Elissa Holmes, and Stephanie Agiomavritis. 2011. "The Ivory Ceiling of Service Work." *Academe* 97(1):22–26.

Misra, Joya, Alexandra Kuvaeva, Kerryann O'Meara, Dawn Kiyoe Culpepper, and Audrey Jaeger. 2021. "Gendered and Racialized Perceptions of Faculty Workloads." *Gender & Society* 35(3):358–94. doi:10.1177/08912432211001387.

Morimoto, Shauna A. 2022. "The Social Science of Institutional Transformation: Intersectional Change in the Academy." *Frontiers in Sociology* 7:824497.

Nelson, Laura K., Alexandra Brewer, Anna S. Mueller, Daniel M. O'Connor, Arjun Dayal, and Vineet M. Arora. 2023. "Taking the Time: The Implications of Workplace Assessment for Organizational Gender Inequality." *American Sociological Review* 88(4):627–55.

O'Meara, KerryAnn, Audrey Jaeger, Joya Misra, Courtney Lennartz, and Alexandra Kuvaeva. 2018. "Undoing Disparities

in Faculty Workloads: A Randomized Trial Experiment." *PLoS One* 13(12):e0207316.

O'Meara, KerryAnn, Alexandra Kuvaeva, Gudrun Nyunt, Chelsea Waugaman, and Rose Jackson. 2017. "Asked More Often: Gender Differences in Faculty Workload in Research Universities and the Work Interactions That Shape Them." *American Educational Research Journal* 54(6):1154–86.

Park, Shelley M. 1996. "Research, Teaching, and Service: Why Shouldn't Women's Work Count?" *Journal of Higher Education* 67(1):46–85.

Petersen, Alexander M., Massimo Riccaboni, H. Eugene Stanley, and Fabio Pammolli. 2012. "Persistence and Uncertainty in the Academic Career." *Proceedings of the National Academy of Sciences* 109(14):5213–18.

Priem, Jason, Heather Piwowar, and Richard Orr. 2022. "OpenAlex: A Fully-Open Index of Scholarly Works, Authors, Venues, Institutions, and Concepts." arXiv. Retrieved March 17, 2025. https://arxiv.org/abs/2205.01833.

Pyke, Karen. 2015. "Faculty Gender Inequity and the 'Just Say No to Service' Fairy Tale." In *Disrupting the Culture of Silence*. New York: Routledge.

Ray, Victor. 2019. "A Theory of Racialized Organizations." *American Sociological Review* 84(1):26–53.

Simpson, Edward Hugh. 1949. "Measurement of Diversity." *Nature* 163(4148):688.

Spencer, Sade, Catherine Burrows, Sarah E. Lacher, Kait C. Macheledt, Jerica M. Berge, and Rahel G. Ghebre. 2021. "Framework for Advancing Equity in Academic Medicine and Science: Perspectives from Early Career Female Faculty during the COVID-19 Pandemic." *Preventive Medicine Reports* 24(101576):9.

Steffy, Kody. 2021. "Gendered Patterns of Unmet Resource Need among Academic Researchers." *Socius*. doi:10.1177/2378023 1211039585.

Stewart, Abigail J., Janet E. Malley, and Danielle LaVaque-Manty. 2007. *Transforming Science and Engineering: Advancing Academic Women*. Ann Arbor: University of Michigan Press.

Stirling, Andy. 2007. "A General Framework for Analysing Diversity in Science, Technology and Society." *Journal of the Royal Society Interface* 4(15):707–19.

Sturm, Susan. 2006. "The Architecture of Inclusion: Advancing Workplace Equity in Higher Education." *Harvard Journal of Law & Gender* 29:247–91.

Toutkoushian, Robert Kevin, and Marcia L. Bellas. 1999. "Faculty Time Allocations and Research Productivity: Gender, Race and Family Effects." *Review of Higher Education* 22(4):367–90.

Trejo, JoAnn. 2020. "The Burden of Service for Faculty of Color to Achieve Diversity and Inclusion: The Minority Tax." *Molecular Biology of the Cell* 31(25):2752–54.

Winslow, Sarah. 2010. "Gender Inequality and Time Allocations among Academic Faculty." *Gender & Society* 24(6):769–93.

Wuchty, Stefan, Benjamin Jones, and Brian Uzzi. 2007. "The Increasing Dominance of Teams in Production of Knowledge." *Science* 316(5827):1036–39.

Zippel, Kathrin, and Myra Marx Ferree. 2019. "Organizational Interventions and the Creation of Gendered Knowledge: US Universities and NSF ADVANCE." *Gender, Work & Organization* 26(6):805–21.

Author Biographies

Alexander J. Gates is an assistant professor in the School of Data Science at the University of Virginia and group leader of the Connected Data Hub. His research fuses network science and computational social science to analyze and model how organizational structure and strategic decisions affect innovation, creativity, and success. His work has been featured in top journals including *Nature*, the *Proceedings of the National Academy of Sciences*, and *Social Science Quarterly*.

Laura K. Nelson is an associate professor of sociology at the University of British Columbia, where she also directs the Centre for Computational Social Science. She uses computational methods to study social movements, gender, culture, and institutions, and to advance qualitative computational text analysis methods. She has published in outlets such as the *American Journal of Sociology*, *American Sociological Review*, and *Gender & Society*, among others.

Rachael Grudt is a senior data scientist at LineVision, where she is part of a team working to accelerate the transition to a net-zero grid. Prior to this, she received her master's degree from Northeastern University. Her master's thesis was titled "Quantifying the Impact of NSF ADVANCE Grants on Recipients' Publication Careers." She has an ongoing interest in supporting women in the sciences.

Kathrin Zippel is Einstein Professor of Sociology and Gender Studies at the Freie Universität Berlin. She has published on comparative gender politics in the workplace, public and social policy, social movements, welfare states, and globalization in the United States and Europe. Her research has also explored gender and global transformations of science and education, focusing on organizational change processes, particularly in universities and STEM organizations. In her book *Women in Global Science: Advancing Careers through International Collaboration* (Stanford University Press), she argues that global science is the new frontier for women, providing both opportunities and challenges as gender shapes the dynamics and practices of international research. She directs a research project on the creation and diffusion of innovative gender equity ideas in the network of colleges, universities and STEM organizations funded by the NSF ADVANCE program.