SPECIAL ISSUE ARTICLE

WILEY

Organizational interventions and the creation of gendered knowledge: US universities and NSF ADVANCE

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Universities are sites of both elite knowledge production and reproduction of intersecting gendered inequalities. The US National Science Foundation (NSF) 'Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers' (ADVANCE) programme uses universities' role as self-reflective knowledge producers to design changes promoting gender equality. This knowledge is shaped by the institutional context of its production: NSF as a funder of scientific research; US universities as participants in highly competitive markets; managerialism as a condition of modern higher education systems; and separation of basic from applied research in the hierarchy of science. The tensions and underlying power dimensions of these contexts reveal local challenges that ADVANCE interventions navigate and the broader politics shaping what and how ADVANCE discovers. Yet, as a learning-oriented intervention, ADVANCE changes over time to create and incorporate more gendered knowledge about inequalities, to legitimize feminist understandings of organizations, and to challenge the division between fundamental and applied knowledge.

KEYWORDS

gender knowledge, gender equity, organizational change projects, institutional transformation, universities

1 | INTRODUCTION

There has been enormous restructuring in research systems and higher education institutions in the United States, Europe and worldwide over the past decades. The globalization of scientific knowledge is driving 'knowledge economies' — including the European Union (EU) and the United States — toward increased competitiveness for positions and funding. While competition can drive innovation and investment, it also shifts constellations of power and conditions of inequality in higher education institutions, for both better and worse. Gendered inequalities are moving targets, constantly reconfigured throughout these restructuring processes (Ferree & Zippel, 2015; Riegraf, Aulenbacher, Kirsch-Auwärter, & Müller, 2010).

The underrepresentation of full-time women faculty in science and engineering has emerged as a significant concern for universities, funding agencies and policymakers around the world. Begun in 2001, the US National Science Foundation (NSF) initiative 'Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers' (ADVANCE) is a national level, government-funded grant programme aiming to respond to gender inequality in the professoriate by identifying and removing structural and cultural barriers to women's success. By setting the conditions for entering the ADVANCE competition, sizes of awards, formal and informal evaluative criteria, institutional targets for transformational change, and rules and guidelines for dissemination of results, ADVANCE defines the conditions of knowledge creation for universities as self-reflective knowledge producers for feminist social change.

ADVANCE grants seek to promote gender equality by combining strategies for organizational change with an explicit emphasis on knowledge production. The large 'Institutional Transformation' (IT) awards support knowledge production both experientially through data-driven, research-based innovations applied to transform academic institutions and scientifically through results from research projects on gendered inequalities in academia. More than 80 per cent of the 61 successful universities with IT grants are public and almost two thirds are considered highly research active (R1).

Although the sites are unique in their approaches to achieving their goals, IT interventions have focused on changing evaluation practices, processes and policies for hiring, tenure, promotion and merit in order to eliminate implicit gender schemas and bias. Sites often focus on retention issues by improving the climate with department chairs, creating measures for work–family conflicts and programmes for networking and mentoring, research support and faculty development. ADVANCE can produce new coalitions within universities by giving women faculty more of a voice, creating allies among men, establishing gender equity officers and committees, and institutionalizing ADVANCE offices, deans and provosts responsible for gender equity (Bilimoria & Liang, 2012; Fox, 2008a, 2008b; Laursen, Austin, Soto, & Martinez, 2015; Morimoto, Zajicek, Hunt, & Lisnic, 2013; Stewart, Malley, & LaVaque-Manty, 2007). Early assessments of the ADVANCE interventions by gender scholars are mixed. Bilimoria and Liang (2012) found that the first 19 IT sites succeeded in increasing the percentages of women faculty and administrators, even across the recession. Yet, earlier cohorts of IT projects still took a 'change-the-women' orientation rather than promotion and tenure, policy or other institutional level change (Fox, 2008b; Morimoto et al., 2013).

This article does not evaluate these sites and their diverse approaches. Rather, it examines the tensions between experiential and scientific knowledge production as they are encountered in the modern managerial university by actors implementing the commitments to gender equality made by their governments and funding agencies. We argue that these tensions in knowledge production are evident in four domains: the institutional arrangements for implementing interventions; the producers of knowledge empowered in this process; the value given to the kinds of knowledge they produce; and the extent to which this knowledge is accepted as generalizable by and for others. The overall organization of the findings follows this fourfold schema of analysis.

However, we also consider ADVANCE grants a learning process. The knowledge work has a local trajectory, from preparing a competitive proposal, to five years of implementation, to projected institutionalization of reforms and dissemination of scientific findings. ADVANCE additionally has a national trajectory across rounds of competition from 2001 to the present, providing more than 60 universities with multi-million-dollar IT grants and many more with

grants for smaller projects, creating both local and national networks of knowledge producers. Both the local and national levels of ADVANCE rely on ongoing knowledge work. In each section, we note specific tensions that are recognized and responded to over time by adjustments in ADVANCE's programme goals, institutional rules and specific local practices.

The analysis we offer of ADVANCE draws on direct experience and analysis of programme materials, discussions with others engaged in this work, and review of research produced by and about the programme over time. To understand the kind of moving target that university gender inequality practices present, we draw on the substantial literature on feminism and managerialism.

2 | FEMINIST INSTITUTIONALISM AND THE MANAGERIAL UNIVERSITY

Fifty years of interdisciplinary research on gender inequities in higher education, science and academia have identified a variety of organizational causes for the underrepresentation of women in science, technology, engineering and mathematics (STEM) fields and high-level positions (Caprile et al., 2012; Fox, Whittington, & Linková, 2017; National Academy of Sciences, National Academy of Engineering, Institute of Medicine, & Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007). By the end of the 1990s, theoretical analyses of gender as a hierarchical social structure had shifted explanations of gender inequality from women's deficiencies to structural obstacles and conscious and unconscious interactional biases (Acker, 2006; Reskin, 2003). We know that universities impede successful integration of women into academia because they are gendered organizations, with institutionalized mechanisms of evaluation and reward that reproduce gender inequities (Benschop & Verloo, 2012; Bird, 2011; Britton, 2017; Fox, 2008a). Gender equality advocates seek new knowledge about institutional mechanisms that matter most: powerful enough to generate equality/inequality routinely but vulnerable enough to be effectively targeted for change (Ridgeway, 2011; Van den Brink & Benschop, 2012).

Feminist scholars thus approach universities both as targets for specific interventions and as sites where equality-promoting knowledge can be created (Braidotti & Waaldijk, 2006; Hesse-Biber, Gilmartin, & Lydenberg, 1999). Seeking both to improve knowledge and to advance the careers of women students and faculty has led advocates to work inside universities to transform them into more egalitarian, democratic institutions (De Welde, Stepnick, & Pasque, 2015; Meyerson & Tompkins, 2007; Riegraf et al., 2010; Sturm, 2006). This applied knowledge agenda is advanced by 'insider activists' who challenge the masculinist norms institutionalized in routine academic practices as well as in the production of knowledge (Kreissl, Striedinger, Sauer, & Hofbauer, 2015; Nielsen, Marschke, Sheff, & Rankin, 2005).

Universities, however, have their own change agendas, focused on the 'high stakes race for innovation, excellence, and grant dollars' to compete globally (Morimoto & Zajicek, 2014), prioritizing 'reforms' in a managerial and marketized direction, so substantive gains in gender justice demand vigilance and struggle (Kreissl et al., 2015; Teelken & Deem, 2013). Selecting among the tools available in academic capitalist organizations, gender equality advocates seek to be both pragmatic in identifying effective strategies and critical of antidemocratic governance (Morimoto & Zajicek, 2014; Striedinger, 2017). Although gender political outcomes for higher education in the United States need more research, the overall impact of managerialism on gender equality efforts has been judged negative to neutral so far in European and Australian institutions (Teelken & Deem, 2013).

From a feminist institutionalist perspective, strategic choices require attention to the specific context of the university systems that are targeted as well as to the local actors and interests affected in particular academic organizations, and why they resist or adopt new knowledge (Bird, 2011; Ikävalko & Kantola, 2017; Verge, Ferrer-Fons & González, 2018). To understand ADVANCE, therefore, we need to place corporatizing US universities into their legal and political framework, one that is distinct from the institutional context of gender mainstreaming in Europe in its specific stratification processes but reflects a shared awareness of structural and cultural barriers to gender equality.

The context for institutional change toward gender equality in the United States is one of long-standing influence of corporate models, but studies of gender equality interventions and change processes in US corporations

reveal mixed outcomes. Some frequent corporate interventions fail to increase equality and create additional resistance to moving white women or women and men of colour into management (Dobbin & Kalev, 2016). Edelman (2016) shows how US corporations have responded with symbolic compliance to antidiscrimination laws by institutionalizing procedures that tend to endorse rather than eradicate unconscious bias.

But US academic institutions are not corporations, even if their governance is increasingly corporate (Tuchman, 2009). As feminist institutionalists point out, embedded change agents working to transform decision outcomes in academia must intervene in organizational logics already institutionalized (Striedinger, 2017). Universities today work through logics that are increasingly mixed and complex, reflecting not only the growing power of corporate managerialism and competitive entrepreneurialism, but the older logic of free scientific inquiry and the new bureaucratic logic of diversity (Ahmed, 2007; Morley, 2016; Riegraf et al., 2010). We see transformational politics in universities as more complexly determined than that in corporations. We select one intervention into the American academic field, the NSF ADVANCE programme, as a site for examining how feminist insider activists generate knowledge about academic organizational change.

3 | CONTEXTUALIZING ADVANCE

US institutional and political forces made the NSF ADVANCE programme possible and directed it in specific ways. Earlier policies, programmes and funding for gender equality in higher education focused on equipping individual girls and women to succeed; ADVANCE shifted attention to transforming academic institutions themselves (Rosser, 2004; Sturm, 2006). There were several reasons for this.

First, ADVANCE was born in the late 1990s, an era of increasing legal ambiguity for US affirmative action programmes and restricted reach for antidiscrimination laws. While legal tools are by no means exhausted, there is little political support for regulations requiring all universities to commit to gender equality plans; funding universities to tackle gendered inequalities in the name of improving science is more politically acceptable (Edelman, 2016).

Second, even US public universities have more autonomy in hiring and promotion than is typical in other countries. Both public and private universities resist direct government involvement in regulating labour conditions or setting programme directions, and state power has largely been exercised indirectly by offering or withdrawing funding. Public universities are creatures of the 50 individual states, and as state-level funding declines, dependence on federal grants for specific purposes has grown. The deeply fragmented, stratified system of higher education (public, secular and religious non-profit, and for-profit institutions; vocational training and predoctoral liberal arts colleges; and more or less research-oriented universities) is driven by competition for students and faculty through national rankings (Espeland & Sauder, 2016; Pusser & Marginson, 2013). In short, the use of funding and prestige to direct policy is well institutionalized, but there is vast variation among US institutions of higher education and comparability of mechanisms among them cannot be assumed.

Third, program officers within NSF, one of the premier US research funders, developed ADVANCE to attract university participation by offering institutions the opportunity to enhance their funding profile and position themselves on the market as actively promoting women. As state enforcement of laws against discrimination weakened, ADVANCE emerged as an entrepreneurial intervention, offering funding for pilot programmes that develop promising practices for STEM departments and units, as well as smaller grants that diffuse these practices from university to university. The logic of ADVANCE is that the incentive of scientifically legitimate, competitive NSF funding will entice universities to consider gender equity part of their core agenda, using visible women-friendliness to rise in institutional rankings.

Finally, ADVANCE reflects NSF's mandate to improve the knowledge base of US science. As such, ADVANCE is committed to both the agency's applied interest in scientific workforce development and its interests in producing scientifically credible knowledge. ADVANCE institutionalizes the insight that gender equity models and strategies are themselves gendered practices that reveal much generalizable knowledge about organizations: how they are

gendered, how power is structured within them and where resistances appear (Acker, 2006; Benschop & Verloo, 2012; Van den Brink & Benschop, 2012).

As an NSF intervention into the STEM fields of US universities, ADVANCE is fundamentally about both the kinds of knowledge recognized as scientific (theoretically grounded, abstract, generalizable, often quantifiable) and the kinds of knowledge understood as applied (practice-based, context-specific, experiential and interest-driven). The applied knowledge ADVANCE generates is complex, being simultaneously driven by the managerial interests of corporatizing universities, the positional interests of participating scientists and their departments, and the transformational interests of gender equality activists.

Applied knowledge work and the production of scientific knowledge overlap and are experienced as tensions throughout the actual work of ADVANCE IT grants. After a brief discussion of our data and methods, we organize our discussion of the practical tensions between applied and scientific knowledge in four sections. These sections address: (i) the institutional sites where interventions are made; (ii) the individuals empowered as knowledge producers by the conditions of the grants; (iii) the contested evaluations of knowledge generated by participants; and (iv) the dissemination of knowledge to diverse potential users. In each section, we highlight the negotiations among institutionally embedded actors between the priorities of scientific and applied ways of knowing, and we emphasize the learning process by which both the national programme and the participants in local interventions use the knowledge created to change the way ADVANCE actually works.

4 | RESEARCH METHODS AND DATA

Our approach to data collection combined a review of the vast scientific literature on and by ADVANCE projects with more engaged, applied research on how ADVANCE functions on the ground. Between 2001 and 2016, ADVANCE has provided $270 million for awards to more than 160 different universities and non-profit organizations. We primarily consider the largest grants, the more than 60 IT awards (about $189 million), which support efforts of institutions to create equitable policies, procedures and practices to advance women professors and change institutional cultures and structures.[1] IT awards range from approximately $917,000 to $4.16 million (an average of $3.15 million) over a five-year period, organized in a cooperative agreement between NSF and the university administrations.

We collected bibliographic information on all 286 research publications listed by ADVANCE sites between 2001 and 2017. We included articles, (edited) books, book chapters and masters or doctoral theses, but not conference papers, reports and pamphlets. We used the data to assess impact in terms dictated by managerial understanding of productivity and scientific standards of producing generalizable knowledge. Of these, 193 articles were published in 94 different journals that we coded by field. We read as widely as possible in both published ADVANCE-related literature and unpublished reports on strategies for changing gendered science in universities.

We additionally compiled a dataset of individuals who have served in ADVANCE leadership teams since 2001 as Principal Investigators (PIs) and Co-investigators (Co-PIs) on ADVANCE IT grants. In order to understand the composition of teams and the value that participation provided for participants, we looked up each individual's biographical information online and recorded the change in rank, position or employer for each immediately after joining the ADVANCE team. Zippel also served as a research director and Co-PI herself, participated in several yearly workshops of ADVANCE PIs and consulted in NSF's internal evaluative processes. Both authors participated in a series of semi-annual workshops for sociologists doing research in ADVANCE sites and conducted four international workshops that shared information among scholar-activists about the ways gender equality interventions interacted with the university systems into which they were introduced.

Our experientially based knowledge thus extends beyond the Zippel's individual site to various consultations with programme officers at NSF both in ADVANCE; in other programmes, ongoing knowledge-sharing panels, and discussions with experts, participants, leaders of ADVANCE sites, evaluators and researchers involved in these sites; as well as discussions with other scholars over the past five years. We organized our informative interactions

primarily as peer-to-peer conversations about the transformation processes going on in universities around gender equality to explore the kinds of knowledge that are not included in formal research articles or evaluation reports. Our participant observation as peers in networks of gender equality activists has been a crucial source of knowledge for the theoretical organization of the presentation of ADVANCE as an institutional transformation process that follows.

5 | INSTITUTIONS CONDITIONING KNOWLEDGE PRODUCTION

NSF is charged with responsibility for advancing fundamental knowledge in the sciences, fostering public understanding of science, and improving the conditions and supply of scientific work. ADVANCE grants are designed to produce 'knowledge about gender equity and the intersection of gender and other identities in STEM academic careers'[2] through both introducing and evaluating specific local interventions as well as ancillary formal research projects, building in a tension between abstract and practical knowledge from the start. Potential proposers are encouraged to think about the specificity of their own organizational configuration, which in the United States contains wide variations in national and international status, degrees granted, funding streams and endowment size, governance, size, typical and historical populations served, and research capacity.

ADVANCE embraces a data-driven change strategy that promotes transparency in the organization and demands leadership 'buy-in'. ADVANCE proposals require a self-study: universities must collect both quantitative and qualitative institutional data and conduct preliminary research on gender equality on their campus to define the problem, develop locally relevant interventions to address problematic practices, and plan an evaluation of outcomes of changed practices and policies. The upper tier of academic administrative leadership needs to demonstrate institutional commitment for these goals, interventions and willingness to (financially) support the transformation process beyond the five-year grant period.

An NSF ADVANCE IT grant is a mark of prestige for the institution and for the ADVANCE team, composed of a mix of senior administrators and faculty serving as PIs.[3] With an estimated success rate in recent cohorts of only 10 per cent, the competition is stiff, and even successful teams have often revised and re-submitted proposals in several rounds. As universities charge the federal government on average 50 per cent over direct costs in support of overheads, winning a grant contributes to the overall university budget while providing significant resources for gender equity interventions.

If the proposal succeeds, the team is expected to test, apply, evaluate and refine the interventions over the five years of the grant, conduct funded research projects, and share findings and conclusions about best practices widely with broader communities of scientists and administrators. NSF builds feedback into the process, as teams are required to submit frequent reports, undergo a first-year visit from the programme director(s) and a more comprehensive onsite review visit from a team of experts and peers during the third year, and submit a longer final report. Even though many ADVANCE IT sites have published their proposals and reports on their websites, ADVANCE's practical impact on individual universities is only semi-visible as public knowledge.

ADVANCE award decisions consider the diversity of the institutions themselves (in status, size, degrees granted and populations served), framing each institution as a unique case study and privileging experiential knowledge created in that organizationally specific site. This makes it difficult for awardees to compare effects of the position of the institution or its sub-units in the higher education market as a whole, or to contrast different ways academic organizations are structured. Additionally, ADVANCE focuses on the professoriate only, so by design it is focused neither on national level conditions for research funding nor on academic career paths before the professoriate. Implicitly, ADVANCE takes the gendered research marketplace as a given, including the inequality of salaries among the heavily gender-segregated subdisciplines this market produces (Nielsen et al., 2005). Direct interventions are local, and effects of the conditions affecting universities are indirect and unmeasured. Thus, interventions can offer no challenge to a definition of 'excellence' that values knowledge according to its market position. As a result, ADVANCE

IT awards create less practical knowledge about disciplinary cultures[4] across multiple institutions or gendered academic markets as such. Rather, interventions focus attention on gendered inequalities in local practices in hiring, retention, measures to deal with work–family conflict and biases involved in evaluation.

ADVANCE has acknowledged that its single institution design failed to consider the effects of organizational variation, and consequently decided in 2016 to provide funding for longitudinal, comparative analysis of at least three ADVANCE IT sites. This change enables different types of institutions to pool knowledge and encourages consideration of variable features of the institutions themselves.

6 | MANAGERIALISM AND EMPOWERING KNOWLEDGE PRODUCERS

ADVANCE targets higher education institutions already in the throes of significant restructuring toward more managerial control. Consequently, ADVANCE demands 'buy-in' from university administrators and places responsibility to institutionalize changes in their hands. Funded projects do seek to engage and mobilize both women and men faculty (Meyerson & Tompkins, 2007; Sturm, 2006), faculty senates and other collective governance structures in support of these efforts. Still, more than half of official PIs are administrators (most often dean, provost or presidential levels); the rest are faculty members (41 per cent) and chairs (7 per cent) primarily from science, social science and engineering fields.

The data-driven change model of ADVANCE coincides with administrative measurements of faculty productivity. The guidelines drawn up in 2005 specify a set of comparable indicators for universities to use in their proposal and to measure progress, based on some agreed questions and perceived feasibility of data collection, though NSF does not require them officially (Bilimoria & Liang, 2012; Frehill, Jeser-Cannavale, & Malley, 2007). The data they are encouraged to collect include distribution of science and engineering faculty by gender, rank and department; outcomes of institutional processes of recruitment and promotion decisions for men and women; gender distribution of science and engineering faculty in leadership positions; and allocation of resources for science and engineering faculty by gender. Thus, sites focus on individual faculty members' success, assessed by research and grant productivity, movement up the career ladder and salaries, even as assessment raises awareness of the gender dimension in these measures (Morimoto & Zajicek, 2014; Morimoto et al., 2013; Sturm, 2006).

Placing administrators in key positions in ADVANCE projects has contradictory effects on applied knowledge creation. On the one hand, the signalling effect about normative commitment and accountability is greater, and the ability to access tightly held institutional data is crucial. These numbers are needed both to convince the stakeholders on campus that gender inequities exist in their own institutions and to make a case for continued support for interventions by evidence of their effectiveness, since across the STEM disciplines in particular such data are ascribed high value as 'facts'. Administrators who manage 'by the numbers' to increase productivity are also open to arguments grounded in 'hard' data, especially when quantified, as institutional data and surveys of departmental 'climate' are.

On the other hand, administrators are likely to direct ADVANCE teams to privilege those interventions most compatible with their own interests in monitoring and managing research productivity, such as quantitative counts. Since administrators are assessed on ranking-relevant measures of success, they are most interested in creating usable knowledge about what organizational aspects inhibit individual faculty productivity (publications, grants and patents) and overall career success, rather than how to achieve more equality or conceptualize more diverse forms of 'excellence'.

Over-reliance on individual administrators is also a cause of concern for the sustainability of change (Furst Holloway, Hardcastle, Douglas, & Page, 2018). The high administrative turnover that is typical for the managerial university creates much frustration among ADVANCE advocates. Reconfiguration of ADVANCE leadership teams and the loss of allies is routine; most ADVANCE sites had at least one change in PIs except for the most recent cohort. Indeed, 38 per cent of the administrators who served as PIs left the university entirely, whereas only 14 per cent of faculty and chairs left. Such turnover of experienced and supportive administrators makes it harder to

sustain data access beyond the grant period. As Furst Holloway et al. (2018) found across 54 institutions: '[t]oo often, efforts to broaden participation are stalled or even reversed when institutions experience a change in leadership at the top' (p. 4).

Yet, from the programme perspective, this circulation of highly mobile administrative elites could enhance the value of ADVANCE by spreading a generalized norm supporting gender equality across institutions. Indeed, ADVANCE leadership team members (both administrators and faculty) moved to more than 74 other universities that did not have an ADVANCE IT grant, and 11 of these universities subsequently applied successfully. Furthermore, several ADVANCE programmes have sought to create new collaborative networks within their university by disseminating social science research findings to create 'gender expertise' among senior men faculty as opinion leaders, strategic allies and advocates.[5]

Although ADVANCE's data-driven change strategy focuses on institutional research privileging managerial problem definitions, quantitative measures of success based on body counts of women, and data accessible and acceptable to faculty and administrative allies, like quantitative surveys of the 'climate' in their units (Morimoto & Zajicek, 2014; Morimoto et al., 2013), this is not all it does. For example, the 2005 NSF call for proposals also included explicitly qualitative measures to study the 'the process of change in organizational culture, experiences of academic climate'. As Nielsen et al. (2005) reported, separating socially desirable answers from real changes in gender awareness or feminist consciousness is impossible using standard quantitative surveys.

Most important, NSF wants all its funded projects, including ADVANCE, to meet its primary criterion of 'intellectual merit'. The highest status knowledge in any discipline is that viewed as 'fundamental' and expected to change, perhaps in unanticipated ways, the understanding of the processes involved in generating outcomes. Although the design of ADVANCE privileges applied knowledge about how universities produce unequal academic career paths or could produce more equality, ADVANCE's inclusion of basic research on gendered inequalities and organizational innovations also looks for fundamental knowledge about solutions.

NSF's demand for innovative research empowers (feminist) social scientists, and this demand reflects its learning process at the national level. In the early years of ADVANCE, the teams of administrators and STEM faculty who wrote the proposals were often unaware of published scholarship on gender, science and organizations. Since 2008, the award structure contains an explicit research component, and proposals must show how their change strategies are based on existing social science research literature and employ these conceptual models of change. Already in 2005, the call for proposals mandated that the 'leadership team must include appropriate social science expertise', and so created demand for bringing in social scientists familiar with current research and theoretical literature. This strategy has not only created an official role for social scientists, but also lent legitimacy to their gender expertise. Since social sciences and women's and gender studies have themselves been often devalued, not only in NSF but in many universities, the credibility ADVANCE bestows on their knowledge of gendered organizations matters (Fox, 2008b).

However, since basic research is funded in the same grant as the interventions and assessments, funding is not organized as competition among the most innovative and experienced gender, science and organizations researchers. And because ADVANCE teams are eager to have useful data for their interventions, this design encourages social science researchers to study their own IT site, even though ADVANCE no longer requires that the particular research project be tied to these interventions. Thus, despite ADVANCE's explicit goal to contribute to the broader research knowledge base, larger scale, comparative or generalizable studies tackling fundamental questions about mechanisms of gender inequities remain rare.

In sum, the applied aspects of knowledge production empower administrators to define the reach and focus of interventions in ways that meet their managerial needs as well as speak to the gender change interests of the insider activists. There may be overlap between the category of administrators and activists, but there need not be. However, the increasing emphasis that ADVANCE has learned to place on fundamental research has also empowered social scientists with gender expertise to help advance their own knowledge interests and mobilize institutional resources for their own careers.

7 | VALUING THE KINDS OF KNOWLEDGE PRODUCED

The practical need for ADVANCE to produce credible, generalizable knowledge reflects NSF's central mandate to support basic research, but NSF has also come under increasing pressure to assure Congress (its funder) that its research has 'broader impacts'. American politicians have always been willing to mock basic science projects whose abstracts seem to imply laughable uses for public funds. Such attacks have been amplified more recently by assaults on NSF funding for research that suggests a broader impact in an undesired direction, such as climate science. Assessing the 'quality' of the knowledge that ADVANCE produces is thus subject to scrutiny along multiple dimensions of evaluation: experiential, scientific and political.

The dual mandate to conduct politically defensible action research to improve a particular university and to make theoretically driven social scientific contributions produces a tension that limits both the practical and the basic knowledge gained. Standards understood as scientific are particularly valued because they are seen as objective and as guaranteeing that the work can be defended as apolitical. Thus, the NSF focus on STEM fields privileges the forms of knowledge that are drawn from experiments, quantitative observations and documented procedures, not only because they are persuasive to scientists whose support is crucial to making changes, but because they count as evidence of the validity of the programme to its funders.

The higher status granted to more quantitative sciences extends to the kinds of social science designed for these accompanying research projects (Fox, 2008b). As Nielsen et al. (2005, p. 3) explain their methodological choice: 'Because the proposal was written by a physicist and the project funded by the NSF, we assumed that a quantitative, quasi-experimental approach would be well received.' The social science methods considered most credible are experimental design and large-scale survey research, but ADVANCE projects often involve small numbers and multiple simultaneous interventions, making the effects of any one change difficult, if not impossible, to isolate (Nielsen et al., 2005). If a project involves both leadership training and new leave policies, for instance, it is difficult to disentangle their relative impact. Moreover, many social scientists view data from a single university as being of limited generalizability with low impact on fundamental knowledge. Although the social sciences desire knowledge about organizations that only institutional data can produce, the design of assessment and evaluation in single-site ADVANCE studies is criticized for its small numbers and case studies are often judged by editors and reviewers as 'too applied' and 'ungeneralizable' to contribute to fundamental knowledge.

Claims about the higher value of quantifiable data are simultaneously refuted by the reliance on experiential data by more powerful participants. Faculty and administrators (women and men) who use their own experiences to generalize about the university privilege experiential knowledge in a distinctively non-generalizable form. Despite expressed disdain for interview data and ethnography among many scientists, a considerable number, especially powerful actors on campus, use personal experience as the ultimate test of validity. In campus discussions, social science findings of gendered inequalities are frequently met with responses like 'But not in my lab!' or 'I've asked the women in my lab, and they tell me there is no problem.' Persuading scientists who rely on quantified protocols in their own research can require numerical data specific to their particular case, since they resist the very generalizability they call for (Fox, 2008b). Similarly, Van den Brink (2015) suggests that Dutch university leaders critiqued methodology when they objected to a study's findings, responding defensively to feminist knowledge.

Yet it might also matter who delivers the 'feminist knowledge'. ADVANCE sites learned that STEM faculty members themselves can be powerful actors in moving colleagues and administration to recognize organizational gender inequalities. The University of Michigan STRIDE programme chose to avoid external consultants when challenging hiring practices and turned to high-status faculty for 'peer training'. Stewart et al. (2007) explain that 'we suspected that scientists would be more receptive to ideas they might otherwise dismiss as unnecessary or "political" if they learned about them through [respected] colleagues' (p. 133). When STRIDE used science and engineering faculty members to present social science research findings to colleagues, resistance declined significantly, especially when the presenters were men.

Considering applied knowledge as a priority, as evaluation research does, also directs attention to questions of causality (Nielsen et al., 2005). Finding a model with manipulations that are practical to vary and generalize across

circumstances without flattening out meaningful differences is a challenge inherent in research on gender and organizations. Counting observable gender differences is easier and less controversial than exploring causal processes, even though the best research points to the need to identify gendered meanings and practices (Morimoto et al., 2013; Van den Brink & Benschop, 2012). Thus, counts of female faculty and administrators become the indicator of change having occurred. The capacity of ethnography to make gendered mechanisms visible and provide vividly memorable examples of injustices in interactions is unfortunately undervalued and underused. Yet, because seeing gender equity merely as numbers is obviously too limited, ADVANCE programme officers have increasingly pushed for including qualitative measures of success of programmes, such as change of practices and climate outcomes.

Additional innovations in measuring gender differences in careers that are neither purely quantitative nor qualitative have been part of the contribution of ADVANCE scholars, including flow charts of career paths in universities (Hunter College), faculty workloads (O'Meara, Kuvaeva, & Nyunt, 2017), interviews with both quantitative and qualitative elements to assess departmental climate (Bird, 2011; Bird, Litt, & Wang, 2004; Sheridan, Pribbenow, Carnes, & Wendt, 2016) including exit interviews (Pribbenow, 2009) and measures of service contributions (O'Meara, Kuvaeva, Nyunt, Waugaman, & Jackson, 2017), as well as network analyses of faculty friendships and social support (Watanabe & Falci, 2017; Watanabe, Olson, & Falci, 2016), international collaborations (Zippel, 2017), and bibliometric structures of influence (Osatuyi, Steffen-Fluhr, Gruzd, & Collins, 2010). Some researchers have also conducted experiments on effects of trainings on gender bias (Carnes et al., 2015) and provided other instruments to measure organizational change (Holmes, Jackson, & Stoiko, 2016; Latimer, Jackson, Dilks, Nolan, & Tower, 2014; Smith & Stoop, 2017). These indicators offer insights into existing structures of inequality that should enable more effective interventions. While the goal of the interventions is longer-term institutional change, university administrators and NSF share the expectation that organizational interventions can and should be assessed within the brief implementation period of a five-year grant. This emphasis on immediately measurable outcomes means that valued quantitative and experimental data may fail to reveal change (Nielsen et al., 2005). Oral histories may not be collected at all, and organizational processes embedded structurally over time may escape notice. The immediate aims of the action research projects (persuasion, norm-building and innovative local interventions) are not necessarily congruent with significant contributions to general knowledge about gender, science and organizations.

In sum, the way that applied and basic research are coordinated in the ADVANCE project makes it easier for individual projects to meet administrative criteria of usefulness than to make important contributions to feminist knowledge. But, as ADVANCE has grown, and programme officers and PIs have aggregated and theorized the discrete findings of each intervention, the value of their interdisciplinary contributions has risen. Systematic qualitative studies remain rare and undervalued.

8 | DISSEMINATION AND KNOWLEDGE-BUILDING

ADVANCE's action research programme has generated an abundance of knowledge about how institutions and gender change processes work. NSF has expected ADVANCE IT sites from the beginning to disseminate 'best practices' and later research findings through presentations, websites and publications. In 2005, ADVANCE also started smaller grants in a new programme it called Partnerships for Adaptation, Implementation, and Dissemination (PAID) to share experiential and research findings and created a network of gender experts in STEM and beyond. And ADVANCE teams, evaluators and researchers have given hundreds of conference presentations, including talks and posters at the annual meetings of PIs organized by the Association for Women in Science (AWIS). These yearly AWIS meetings have encouraged collaborative learning across teams and cohorts, and put all presentations online. Former PIs serve on research or external advisory boards for new projects, creating a market for and competition among external evaluators. Email lists for programme officers and PIs further the exchange among those involved in ADVANCE efforts.

Yet, despite this network of ADVANCE gender experts, creating and disseminating their new knowledge, particularly 'meta-knowledge', continues to prove challenging. Although leadership teams and researchers published 286

articles, books, chapters and edited volumes, few of these were published in high-profile social science journals. Recognizing this, NSF awarded AWIS a contract in 2017 to build a network explicitly for 'Connecting Scholars and Practitioners in STEM Equity' to promote both scientific and experiential knowledge sharing.[6] Oregon State ADVANCE created a new online publication called The ADVANCE Journal in 2018, with the goal to create more opportunities for researchers to disseminate ADVANCE-related studies with the imprimatur of peer review.

ADVANCE projects built a consensus that specific disciplinary, departmental and specific organizational contexts matter in how gender inequities are produced and reproduced in academia (Bird, 2011). But it is difficult to publish studies focused on particular ADVANCE programmes and interventions in departments or organizations. Although answering applied questions about single institutions has produced innovations in measurement (such as overtime flow charts for promotion, faculty network maps and routine climate surveys) that offer administrators more tools for management, these are not defined as contributing to science, that is, fundamental knowledge. While such findings could in principle be replicated to build complex, multi-institutional models with generalizable conclusions, the priority in ADVANCE IT has been more on innovation than replication, which is consistent with what critics have noted about current social science generally (Freese & Peterson, 2017).

Edited volumes and special issues from lessons learned in ADVANCE and related projects have pooled knowledge, but less than systematically (Branch, 2016; De Welde et al., 2015; Demos, White Berheide, & Texler Segal, 2014; Holmes, O'Connell, & Dutt, 2015; Stewart et al., 2007). Other research has compared family-friendly measures in several ADVANCE institutions to shed light on their overall impact (Tower & Dilks, 2015). The effort to disseminate findings has also focused on actionable items. Stewart and Valian (2018) summarize key principles for organizational change and Laursen et al. (2015, p. 16) composed a 'StratEGIC Toolkit' for institutions with practical lessons suggested by ADVANCE interventions. The comparative knowledge emerging is shaping the further development of the programme. For example, Torres (2012) and Hunt, Morimoto, Zajicek, and Lisnic (2012) found ADVANCE sites continue to privilege white women's experiences and needs and lack attention to intersectional forms of inequality; the NSF ADVANCE 2016 calls for proposals explicitly addressing this need for knowledge.

While individual institutional reports can be useful in principle to learn about IT sites, these reports are themselves likely to be strongly self-censored. The knowledge on websites and in reports should never be mistaken for 'the facts', but necessarily reflects individual career concerns and 'public relations' strategies of ADVANCE teams and is likely to only partly depict project outcomes.[7] Indeed, the administrative priority is to advance the university's reputation and positivity in reports maintains needed administrative and political support. Researchers also have a career interest in making their team 'look good', and publicly accessible reports are especially likely to be selective, with a tendency not to report 'failures'. Resistances are common in organizational change projects, and even if deep, important changes are occurring, they might be taboo for public discussion because they could encourage backlash. Yet experiential learning through trial and error implies that the missing knowledge about what does not work is as important as knowing what did.

Similarly, the well-documented bias of journals toward not publishing null results can only add to invisibility of reported instances of failed interventions, ambiguous assessments and non-replicable results. Publication norms present the action research model with significant obstacles reaching the wider scientific communities formed around disciplines and research areas. Our bibliometric analysis of the 94 journals that published research explicitly produced as part of ADVANCE IT grants shows that only 45 of these were in the Web of Science and 13 were not peer reviewed. In addition, 83 per cent are social science journals, with only 17 per cent in science and 3 per cent in medical journals, where STEM researchers would be the readers.

In sum, beyond managerial audits, ADVANCE demands attention to the fundamental scientific goal of creating knowledge about where gender inequalities persist in academic institutions (Morimoto et al., 2013) and what mechanisms are effective in gender equality change. Although ADVANCE aims to recognize the vast interdisciplinary literature that is relevant and contribute new knowledge to gender expertise in the social sciences, to do so will also require challenging current standards of excellence in social science. More actionable knowledge, replication across multiple studies and ethnographic study of processes are necessary and fundamental. Despite the obstacles to

publication of participatory action research in the most highly regarded journals, ADVANCE PIs have found innovative strategies to broadly disseminate ideas, build cross-institutional conclusions and offer feedback into the programme.

9 | CONCLUSIONS

NSF has legitimated and produced knowledge on gender, science and organizations by emphasizing the value of gaining access to the data held by administrators, building the experiential knowledge of insider activists and making greater use of social science gender expertise. The very structures of NSF have created ADVANCE as a particular programme that is designed both to support innovative interventions increasing gender equality and to further generalizable knowledge about the gendered mechanisms of inequality in STEM fields in US universities. There is a mix of knowledge interests among programme funders, university administrators, targeted departments and scientists, and faculty participants. These different interests are expressed in the shape of the overall programme's interventions in institutions, the influence of the differently situated knowledge producers, the value ascribed to the different forms of knowledge created and the structures through which the knowledge about these interventions circulates.

These diverse interests overlap and produce an ongoing learning process, as Alice Hogan, the founding programme director at NSF, recently observed:

> It is interesting to think back to the original design process, what we knew and what we thought we knew, and when I think about that, I am actually amazed that the program has lasted so long. Unlike many NSF programs, ADVANCE has continually learned from the community and revised the program guidelines. (personal communication, 2018)

However, whether NSF will continue to fund the ADVANCE programme will depend on several factors. The economic and competitive pressures that encouraged its formation remain. Public universities increasingly depend on federal funds and are aware of being critically evaluated as unsafe spaces for women, and so are likely to continue to be eager to win such economically useful and prestigious grants. But within NSF, ADVANCE is in a precarious situation. So far, its budget has been negotiated yearly and all the major directorates contribute to its funding. The current national political climate is less supportive of research funding for all sciences per se, meaning that each of the NSF directorates is under pressure to focus on its own core mission. This pushes collaborative projects on gender equity to the margins. Whether NSF perceptions of gender equity as a national priority issue will be sufficient to sustain ADVANCE is an open question.

ADVANCE has been able to make some promising changes within NSF itself. For example, all its panel reviewers in all directorates now receive training on implicit bias in evaluation practices. Public awareness is supporting more accountability at least in regard to sexual harassment, since NSF has encouraged and suggested that universities report if PIs or other senior personnel have been investigated and found to have violated the university's sexual harassment policies. Whether the positive value of ADVANCE for affirmative practices of social inclusion is seen as equally important is unknown.

ADVANCE introduced long-term, long-lasting change projects that embrace a learning process in their very design and so has stimulated ongoing learning processes at both the national and local level. Over time its action research has fed back into the general principles of its own programme design, including a consensus on core status indicators; acknowledgement and validation of expertise in gender, science and organizations as necessary both for the process and as an outcome; innovations in measurement arising from theorizing mechanisms of career development; and networks for sharing experiential knowledge and research findings.

These considerable benefits are gained despite notable limitations: the kinds of knowledge sought and valued are biased; structural characteristics outside the individual university are left untouched; administratively useful and quantifiable indicators are preferred; longer-term, intersectional and negative impacts are less likely to be measured;

site-specific decisions about theories and measures make replication more difficult; and small samples tied to quantitative designs limit the perceived value of the individual case studies.

For those who look to generalize from the ADVANCE experience, we caution that US and European higher education systems and understandings of knowledge often differ in important but unarticulated ways. European views of 'science' typically include humanities and social sciences; the United States tends to equate 'science' with science, technology, engineering and mathematics departments collectively known as STEM fields. NSF ADVANCE projects are focused on STEM fields only, as NSF funds only STEM research in its mandate to support fundamental scientific knowledge and contribute to developing the US scientific workforce.

In addition, the NSF ADVANCE programme shares a focus on addressing structural and cultural barriers to women's full inclusion in research institutions with gender equity programmes that the European Commission has funded, but the EU programmes differ from it in several important ways. First, they stress designing in comparisons among different countries, fields and universities, so structures are seen as reaching beyond those of individual institutions. Due to the variation of national university systems, however, programmes like STAGES, TRIGGER, FESTA, GARCIA and other EU-funded programmes for gender equity intervention-based studies have challenges to create knowledge to generalize across such differences. The characteristics of these national systems, such as in-house hiring, inclusion of international scholars, competitiveness among faculties and productivity pressures are themselves of interest, though a process of mutual learning is clearly envisioned. Second, building on its several rounds of 'framework programmes' to shift research institutions toward inclusive excellence, the EU's most recent such programme, Horizon 2020, defines gender as a cross-cutting issue for all projects, and gender balance is sought in proposals, evaluation panels, research groups and advisory panels, thus including among its goals creating reflexive change in the EU funding system itself. Finally, feminist knowledge production is defined as relevant, not only with regard to the workings of university science, and across all areas the gender dimension in research and innovation is to be explicitly included as a matter of showing excellence.

While the US National Institutes of Health (NIH) have asked biomedical clinical research to take into account both women and men as subjects of research, NSF has never paid direct attention to gendered research content as part of the 'intellectual merit' of the proposal. Its requirement that all research proposals address their 'broader impacts' suggests that researchers might attend to gendered training or applications of gender knowledge related to the work process. The core of the science in NSF proposals is understood to fall outside such gender-aware self-examination, despite the attention feminist epistemological approaches have brought to problem choice and research design as carrying gendered expectations into scientific practice in fields as diverse as cognitive science, engineering and economics.

While it may seem, therefore, that EU programmes are avoiding crucial limits that ADVANCE has encountered, the EU interventions are much more recent and their track records in making lasting change are untested. By contrast, some of the earliest ADVANCE programmes have successfully been institutionalized within their universities a decade or more after the grant-funded stage of the intervention was over, and they continue to introduce new data, measures and policies. Although the NSF programme characteristics outlined here are specific to US universities, we suggest that the tensions we identified among activist interests in gender equality, managerial interests in productivity-enhancing knowledge, and the norms of scientific knowledge production, validation and dissemination are broadly generalizable to other action research projects on gender and academic organizations. The consequences of these tensions for other institutional designs are very much worth further exploration.

ADVANCE sites reveal how the production of practical knowledge and research about how an organization is gendered is an intrinsically political, often conflictual process at every stage from proposal to publication. The power differences and managerial imperatives of US universities are ever more evident, but insider activists can and do use the legitimacy of numbers and research to press for equality-enhancing changes in the EU as well as the United States. Striedinger (2017) argues that it is not co-optation but a strategic advantage to use the 'master's tools' while turning them to other ends. Similarly, Morimoto and Zajicek (2014) argue that ADVANCE indeed is a powerful tool for gender equity efforts, though they assert that:

> [d]ismantling the academic house, however, entails dismantling a structure that ties excellence to a system of rewards for scientific productivity grounded in competition, individual achievement, and the disembodied 'ideal worker' who, historically, is male. (p. 143)

As programme directors and ADVANCE leadership teams generate experiential knowledge, they are also pooling information about what works and doesn't. These networks of knowledge are not being validated by the arbiters of social scientific impact, but their sharing of insights offers reflexive, actionable contributions to the feminist knowledge project. NSF legitimation of social science expertise has proved crucial to its successes and has opened doors for a new wave of interdisciplinary research on gender and science. The funding for ancillary research projects has supported researchers and facilitated careers in these fields.

An important, albeit unintended consequence of NSF ADVANCE has been the creation of crucial, dynamic national and local networks of actors with gender expertise. These networks include administrators and faculty who have had or acquired some form of gender expertise during the course of their involvement in ADVANCE, as well as social science researchers who work on gender, STEM and universities. Future research should illuminate how these networks disseminate and bridge both applied and scientific forms of knowledge production, creating the foundation for further self-reflexive processes of institutional transformation both within and across disciplines and systems.

In addition, we will need to find out which measures do not really work, which are fleeting and which create more longer-term changes; what gaps exist between actual experience and reportable data; and how programmes can scale up across institutional and disciplinary variations. The methodological, political and scientific challenges of making gender visible in institutional transformation as more than simply counts of male and female bodies suggest that the changes initiated by ADVANCE projects will require continued struggle over what counts as knowledge (Morimoto et al., 2013; Nielsen et al., 2005). Indeed, these debates over the nature of knowledge are part of the change process itself. As ADVANCE continues to learn from its interventions at both the local and national level, it not only reflects but potentially challenges the hierarchies of gendered knowledge visible in the institutionalized distinctions between quantitative and qualitative, fundamental and applied, scientific and experiential ways of knowing. In the context of larger economic and competitive pressures on institutions, creating sustainable networks that can continually inform the design of long-lasting transformations is one crucial ingredient for achieving more gender equality in universities.

DECLARATION OF CONFLICTING INTERESTS

The authors have no conflict of interests.

ENDNOTES

[1] Other ADVANCE grants have included Catalyst awards to help universities prepare IT proposals, Leadership Awards, Adaptation, and Partnerships and others formerly called PAID or PLAN grants.

[2] ADVANCE Program Solicitation NSF 16–594, https://www.nsf.gov/pubs/2016/nsf16594/nsf16594.htm.

[3] In the following we use PIs to include Co-PIs and the PI of each project.

[4] The smaller ADVANCE PAID grants though have supported projects in disciplines in geosciences, economics, computer science and cognitive science (Holmes et al., 2015).

[5] For example, the North Dakota State University FORWARD Advocates/Allies programme.

[6] https://www.awis.org/about-the-arc-network/

[7] Thanks in particular to Laura Kramer for sharing her important insights on these points.

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