EQUITY FOR WOMEN IN SCIENCE
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Dismantling Systemic Barriers to Advancement

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À Jean et Louise
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Nevertheless, she persisted.
My mother is a scientist. My daughter is a scientist. I have women scientists in my lab. I publish with women. There are many women in my department. These are the proclamations we hear as we present on gender disparities in science. These assurances are sometimes used to celebrate the increasing presence of women in the scientific workforce. Yet they also serve as a gentle protest against research on gender disparities in science. The statements suggest that disparities are a thing of the past. Optimistically, they suggest that science is now an inclusive space and, perhaps, that the lingering disparities observed may be disparities earned, inherent, or desired.

We have seen great advances in the inclusion of women in the scientific world, as in other spheres of society. Science does not occur in a cultural vacuum; it is deeply situated in the sociopolitical contexts in which it is conducted. It is no surprise, therefore, that the growing recognition of women in science occurred in parallel with their acknowledgment in the political realm. In 1893, New Zealand became the first self-governing country to grant women the vote. It took a few more decades until the same rights were granted to women in Britain (1918) and in the United States (1920). Scientific and educational societies followed the zeitgeist: in 1919, the Geological Society in the United Kingdom voted to admit women; the UK Chemical Society admitted the first woman in 1920; and Cambridge awarded its first degree to a woman in 1921.¹ Not all institutions responded as swiftly. The Royal Society of London did not elect women to full membership until 1945—the same year that Harvard Medical School began admitting women—and the Paris Academy of Science
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did not admit its first woman until 1979. Progress has been slow and uneven across the globe, but the steady steps toward gender parity are marked by these milestones.

Parity represents the degree to which women are equally represented in social institutions. Parity, however, is not always associated with equity. For example, Nordic societies are often heralded as paragons of parity: in the World Economic Forum 2021 report, Iceland, Finland, and Norway were ranked first through third and Sweden was ranked fifth in terms of gender parity. Yet these countries have a disproportionately high rate of intimate partner violence against women; much higher than the Organisation for Economic Cooperation and Development average. The phenomenon was identified as the “Nordic paradox”: How can a society with such high levels of economic parity demonstrate such atrocious inequities in the social realm? Many will argue that the rankings themselves are flawed. This is, of course, part of the story. However, it is also true that merely introducing women—to the labor market, politics, or science—does not itself remove bias and discrimination, in public or private spheres. As the #MeToo movement has shown, even in countries that have exhibited the highest growth in the educational and scientific achievement of women, institutions have not fostered cultures of inclusivity. This reinforces sociologist Mary Frank Fox’s unambiguous argument: “Increasing the number of women will not necessarily change patterns of gender and hierarchy in science.” While achieving parity in participation is an important step, it does not mean that equity has been reached. Furthermore, parity may not come from a place of progress, but rather of displacement and devaluation. As classicist Mary Beard notes in Women and Power, there are plenty of league tables charting the proportion of women within national legislatures. At the very top comes Rwanda, where more than 60 per cent of the members of the legislature are women, while the UK is almost fifty places down, at roughly 30 per cent. Strikingly, the Saudi Arabian National Council has a higher proportion of women than the US Congress. It is hard not to lament some of these figures and applaud others, and a lot has rightly been made of the role of women in post-civil war Rwanda. But I do wonder if, in some places, the presence of large numbers of women in parliament means that parliament is where the power is not.
The ethos of science states, as per sociologist Robert K. Merton, that science should be open to all; that nothing other than the lack of skills or knowledge should prevent people from participating in scientific activities. It is with this principle that many organizations have worked diligently toward increasing the participation of women and other minorities to match their representation in society. Contemporary examples of parity, however, tend not to be laudable exemplars, but rather demonstrations of devaluation. We refer to this phenomenon as the parity paradox: wherein striving toward parity does not result in equity. This paradox presents a strong policy dilemma—parity without corresponding equity devalues the labor it seeks to reward.

Scientific labor has traditionally been defined by men and reinforced the contributions they made. Science is an inherently hierarchical space, and, according to Fox, “gendered relationships are hierarchical inasmuch as women and men are not simply social groups neutrally distinguished from each other, but rather, are differentially ranked and evaluated
according to a standard of masculine norms and behavior.” This is not to suggest that women have not historically contributed to science; they were active in research long before they were recognized by scientific institutions. As Fox has remarked, “Women have long been ‘in science,’ but not central to science.” In some ways, their participation was tolerated more judiciously before the professionalization of science. However, as science sought to establish its credibility among other professions in the early twentieth century, the presence of women and minorities threatened that professionalization.

Occupational terminology can be quite revealing. In the early twentieth century, the two competing terms used to refer to a scientist were man of science and scientific worker. These terms were meant to distinguish professional scientists from the amateurs who preceded them; to mark with distinction those who were qualified to work in science. Distinguished scientists would then be listed in reference works, such as the American Men of Science, which chronicled scientists in North America. As the number of women employed in science began to grow, the exclusionary and imprecise terminology came under fire. A 1924 letter to the editor in the generalist journal Nature bemoaned the term men of science and called for Nature to adopt the more precise and inclusive term scientist. The term scientist had been coined nearly one hundred years prior by William Whewell, in his review of an astronomy article by Mary Somerville—the first woman member of the Royal Astronomical Society. It was not until 1971, however, that the American Men of Science was retitled as the American Men and Women of Science. Nature did not respond until the next century: the journal adopted a new mission statement removing the phrase “men of science” in 2000. This exemplifies the deeply rooted and hierarchical structures of power relations in science.

This book is an examination of the gendered nature of scientific production, labor, and reward. We seek to describe the disparities that exist and reveal some of the mechanisms underlying gender disparities and corresponding inequities in science. We deconstruct the parity paradox by examining the persistence of women in science across time and place and exploring a deeper and more contextualized understanding of disparity in scientific labor. It is critical to both understand the contemporary role of women in science and to be able to identify barriers to success. Only then can we move toward a scientific ecosystem in which women are both included and valued.
Introduction

Motivation

In 1974, Ruth Hubbard was the first woman biology professor to be awarded tenure at Harvard. In an interview with the New York Times following her tenure, she noted, “Women and nonwhite, working-class and poor men have largely been outside the process of science-making. Though we have been described by scientists, by and large we have not been the describers and definers of scientific reality. We have not formulated the questions scientists ask, nor have we answered them. This undoubtedly has affected the content of science, but it has also affected the social context and the ambience in which science is done.”

It matters who is making science. In this book, we demonstrate that women are underrepresented in almost every field of science. When they are present, they are often relegated to the periphery or to technical rather than conceptual roles. Our research supports Hubbard’s claims: women have historically neither asked nor answered the questions of science. But does this matter? A social justice perspective would argue that this underrepresentation is problematic in that it creates barriers where certain populations do not have access to the full range of occupations. However, does this fundamentally alter the content of science and what Hubbard termed the “scientific reality”? Does it matter who is asking the questions? Does this change what we know about ourselves and the world around us?

These were the motivating questions for a study we conducted on sex and gender in biomedical research. Our study sought to analyze whether the inclusion of women in biomedical research affects the populations that were studied, focusing specifically on sex. A large body of research has demonstrated sex differences at the genetic, cellular, biomedical, and physiological levels. Despite this, there have been disparities in the inclusion of sex as an analytic variable in biomedical research. We found some areas of improvement: females, who were historically underrepresented in large-scale clinical trials, are now included at greater rates, and sex reporting is improving in biomedical sciences. Although increasing, the rate of sex reporting for preclinical studies remains low. However, our results demonstrated that when a study was women led, it was much more likely to report on sex and to include female samples or populations in the study. This suggests that diversity in the scientific workforce is essential to produce the most rigorous and effective medical research: when we have
women in biomedicine, we are more likely to have biomedical research that looks specifically at females. Quoting science journalist Angela Saini in *Inferior*, a popular account of research on women, “Having more women in science is already changing how science is done. Questions are being asked that were never asked before. Assumptions are being challenged. Old ideas are giving way to new ones.”

One may contend that these disparities are historical artifacts that will naturally change over time. There is, indeed, a gradual move toward parity. Over the last decade, the proportion of women authorships increased in every discipline, albeit with different growth rates (Figure I.1). From these rates, we can calculate a rough estimate of the time it will take to reach parity. As we were writing this book, psychology reached parity (50%), increasing from 43% in 2008. At this rate, parity will be reached in the social sciences and in arts and humanities in 2044, and clinical medicine in 2049. Earth and space sciences would be the first field in the natural sciences to reach parity (2063), followed by biology (2069), biomedical research (2074), and chemistry (2087). Other disciplines of the natural sciences would still need, at the current growth rate, a century or more to reach parity: 2144 for engineering, 2146 for mathematics, and 2158 for physics. This is not a promising story. Furthermore, increases in parity do not necessarily account for the hierarchical power structures in science, which mediate question formulation and investigation.

These data suggest that without strong interventions, several generations will pass before men and women have equal opportunities to shape scientific knowledge. The implications are obvious in health but are equally important in other areas. Engineering, for example, has one of the lowest rates of women, and this is not without consequences. Car manufacturing and testing is one example of the consequences of gender domination in a field. Women are 47% more likely to be seriously injured and 17% more likely to die in a car crash. This has been attributed, at least in part, to the design and testing of automobiles. Female-typed crash dummies were not introduced until 2003 and were cast as five-foot-tall, 110-pound scaled-down male test dummies. They were then only tested in the passenger seat. Women who are driving or outside these dimensions (such as those who are pregnant) were not considered in the engineering of the vehicle. In fact, the manual manipulations that women drivers make—sitting more upright and closer to the dashboard—are seen as acts of “noncompliance” that place them at greater risk. The construction of the vehicle suggests that women are not “fit” to be drivers. A
similar issue developed when the first all-women spacewalk was scheduled. Within days of the scheduled flight, NASA realized it did not have appropriately sized space suits for the two women and had to replace one woman with a man. The message was clear: women were not the right size to be astronauts. These stories suggest that the full inclusion of women into science will dramatically affect all sectors of society. When science fits women, women are more likely to ask the questions and make the innovations necessary to right-size all domains for women.

**Figure I.1.** Percentage of women authorships, by discipline, 2008–2020, projected using 2008–2020 linear growth until 2168.

A precise measure of scientific production is necessary to provide a global and contemporary account of women’s work in science. Unfortunately, generating new knowledge does not naturally lend itself to the same types of “objective” input and output indicators observed in other sectors. In a widget factory, one might count the number of hours worked and the
number of widgets produced. New knowledge, however, rarely takes the form of tangible, standardized artifacts that can be counted in an industrial fashion. Despite this difficulty, the operationalization of scientific labor has largely adopted industrial metaphors: for example, we often measure the “production” of the “scientific workforce” to justify a “return on investment” for resources provided to scientists. To this end, several systematic surveys are conducted—mostly by governmental agencies and international organizations, including the United Nations Education, Scientific and Cultural Organization and the Organisation for Economic Cooperation and Development—to measure the relative strength of science in select countries. These data provide information on, inter alia, the size and composition of the scientific workforce, gathered largely from graduation and labor statistics. Along with data on R&D funding, which are also generally obtained from survey, these data are intended to serve as a proxy for input. However, while these surveys detail the production of scientists, they do not account for the production by scientists.

Measuring research activity directly is a surprisingly difficult task to do at scale. Besides occasional contract work, there are relatively few billable hours in science and no comprehensive analysis of the time that people contribute to scientific labor. Therefore, the production of scientific works—in the form of journal articles, books, and other documents—generally serves as an indicator of the output of research activities. Given that there are relatively few comprehensive indexes on genres of production such as books and conference papers, authorship of journal articles functions as the primary measurement of scientific labor. There are, of course, issues with this operationalization. The first is assuming that all scientific work ends in a publicly disseminated document. Many research projects fail and are placed in the “file drawer” of negative results. Competitive interests may lead to the lack of diffusion of research activity with commercial applicability. Furthermore, although journal articles are the modal production of most fields, only focusing on journal articles underrepresents the scientific activity of some disciplines that favor dissemination in books and conference proceedings or where commercialization activities are valorized. These genres—particularly conference proceedings and patenting—tend to be more prevalent in fields dominated by men. Finally, and perhaps most importantly, there is not a standard amount of time or labor that one can attribute to the production of an article: this will vary across disciplines and even within a single researcher’s oeuvre due to a number of factors (such as scope of inquiry, efficiency
of collaboration, or methodology). Despite these limitations, the production of journal articles remains the most efficient proxy at present for large-scale and cross-disciplinary analyses of research activity. Therefore, we rely largely on journal articles—specifically metadata as indexed in Web of Science, a large-scale bibliometric database—as a proxy for the participation of women in scientific work.

We use the term science and related terms in the title and throughout the pages of this book. It is critical to clarify that we do not mean this in the exclusionary way to refer to only those sciences classed as “hard” or “natural.” As historian of science Derek de Solla Price observed, “The peculiar English term ‘science’ acts as a barrier to the belief that subjects other than physics, chemistry, and biology (in that order?) can be scientific.” He continues, “In other languages, the words nauka and Wissenschaft carry a breadth of the totality of learning.”33 It is notable that the term scientometrics is translated from one of these root terms. In 1925, Polish sociologist Florian Znaniecki coined the term naukownautstwo, which translates as “science studies” or, more precisely, “science connoisseurship.” Subsequent Polish scholars used the phrase nauka or nauce to refer to the “science of science.” In 1966, Russian philosopher Vasiliy Vasilevich Nalimov coined naukometriya and later defined it as “the information process which uses quantitative methods for the exploration of science.”34 Nalimov credits John Desmond Bernal as the founding father of this field; de Solla Price also argues that Bernal’s Social Function of Science was the founding primer for the “science of science.” This suggests that the two terms—scientometrics and science of science—developed without clear distinction and can be considered synonymous. Quoting from de Solla Price, “This new study might be called ‘history, philosophy, sociology, psychology, economics, political science and operations research (etc.) of science, technology, medicine (etc.).’ We prefer to dub it ‘Science of Science,’ for then the repeated word serves as a constant reminder that science must run the entire gamut of its meanings in both contexts.”35 We employ the fullness of that spectrum in our use of the term science.

Bibliometric data are included in a few reports alongside workforce and funding information, for example, in the Science and Engineering Indicators report produced by the National Science Foundation. This allows for rough estimations of “return on investment”—that is, the relationship between the amount of investment in research and the associated output. In the 2020 Science and Engineering Indicators report, data
were analyzed by gender as well, detailing the proportion of women authorship for science and engineering publications for a sample of countries. Data such as these provide snapshots of global gender disparities in scientific production but often suffer from several weaknesses, most notably datedness, incompleteness, and selection bias. The time that it takes to compile and analyze these data invariably makes them dated upon arrival; furthermore, these data tend to purposively showcase certain high-performing or peer countries and fail to provide comprehensive global analyses.

A scientometric approach provides certain advantages for global and contemporary insights on scientific production. By standardizing scientometric metadata, it is possible to perform rich analyses that take into account differences across countries and disciplines. To study gender, the most important metadata is that of authorship. The relative presence of women on the bylines of articles is, in many ways, an even more important indicator than the number of women in the scientific workforce. This measurement provides evidence of the overall contribution of women to scientific literature and how women’s labor is made manifest to the scientific community. Authorship demonstrates who has a voice in science—who gets to participate in the labor of science and who is acknowledged—and reaps the rewards of the results of that work. In an ideal scenario, authorship signals to the scientific community that an individual is associated with the scientific labor underlying that document.

Authorship is a gateway into the contemporary reward system of science and therefore, a focal point of the present analyses. The names on the byline influence how an article is reviewed and received by the scientific community. It is also critical for the reward system of science: scholars are not assessed by their hours in the lab or their search through the archives, but by the outputs of this labor. Authorship is, therefore, the coin of the realm, providing the currency for the economy of academic reputation. The academic market is built on this concept of capital, wherein one gains authorship for contributing to scientific work and is rewarded for that contribution when it generates citations. This makes authorship a critical lens through which we can examine parity and equity in scholarship.

Two recent methodological contributions have made this book possible. First, advances in gender assignment techniques—that is, estimating the gender of author based on their given names and, in the case of some countries, family names—allowed gender-based analysis of scholarly pro-
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duction at scale, with sufficient precision and recall (see appendix). Sec-
ond, advances in author disambiguation techniques—that is, the attribu-
tion of a body of work to a specific researcher, based on its characteristics
(affiliations, disciplines, cited references, or coauthors)—have provided
opportunities for examining individual researchers’ career trajectories and
are used in this book to assess research productivity and mobility. These
contributions have made it possible to move from institution-level, na-
tional, and disciplinary analyses to large-scale international and multi-
disciplinary analyses of gender disparities in science, and to move from
article-level to individual-level analyses.

The scientometric approach, however, is not without limitations. The
published scientific document stands as a proxy for a host of complex in-
terpersonal and cognition processes of knowledge production that pre-
cede it. The document can provide insights into these processes, but there
are several issues on which it is silent. For example, despite the rise of
several mechanisms for ensuring ethical authorship practices, the docu-
ment cannot tell us whether there was justice in the allocation of author-
ship. For this, we need to ask the authors. Moreover, the many caveats
to the Web of Science as a bibliometric data source apply. Despite its high-
quality metadata, the Web of Science has a weak coverage of journals
published in languages other than English and from non-English-speaking
countries, and given its focus on journal articles, it has a poor coverage
of disciplines from the social sciences and humanities as well as of com-
puter science and engineering, which disseminate knowledge through
books, book chapters, and conference proceedings. Furthermore, algo-
rithmic assignment of gender reinforces the binary characterization of gen-
der and may introduce inaccuracies at the individual level. We acknowl-
dege that gender identities are expansive, and that this distinction is
inherently problematic. Therefore, we have complemented our bibliomet-
ric analysis with surveys to both extend and validate our approach. Fur-
thermore, we stress that our goal is not to determine the gender of any
individual author but to provide a rough estimation at the macro level to
begin to unravel gendered distinctions in science. We hope that this work
paves the way for future studies that can examine the plurality of gender
and other identities.

We acknowledge the volumes of work in history, sociology, and re-
lated fields that have sought to provide a deeper understanding of the role
of women in science. This book is deeply indebted to the work of several
scholars who have sought to chronicle the lives of women in science across
the ages. As the first comprehensive scientometric account of women in science, this book should be read not as a replacement for previous work but as a complement to it. Our account of women in science advances the conversation by providing a large-scale description of the role of women in contemporary science. By examining several factors—such as collaboration, mobility, and funding—we can provide both a diagnostic of the degree of disparity for women in science and a policy-relevant account of the barriers to participation in the scientific workforce. Such information is vital for the present and future scientific community—those pursuing scientific careers, mentoring scientists, and all who serve as gatekeepers to the production of science.

Organization of the Book

Each chapter begins with a short set of anecdotes and profiles of women in science. These select exemplars provide historical context to guide the reading of the empirical analyses. These selections were made purposely, to find examples that tied the theme of the chapter together across time and place. Documentation of women in science tends to emphasize white, Western women from historically dominant scientific disciplines (for example, physics, astronomy, and chemistry). It is our hope that the profiles in this book make incremental improvements toward increasing the visibility of a more diverse range of women. We acknowledge the importance of intersectionality: race, era, country, and discipline all have dramatic implications for the experience of women in science. Where relevant, we describe contextual factors of specific countries or disciplines that serve as exemplars in understanding the complex sociocultural factors that contribute to gender disparities in scientific production. These accounts are not meant to be comprehensive histories of science making in these countries; rather, their function is to highlight the rich geopolitical landscapes that must be considered when interpreting scientometric data. Intersectionality and the geopolitical contexts of science are all essential components of understanding the parity paradox and moving toward a more equitable science system. One limitation of our analysis is that we focus on one dimension of social identity—gender—and omit other attributes, such as race and ethnicity. This is due to our emphasis on the position of women in science across the globe. Studies of race, for example, must be conducted within the frame of a single country or region,
where racial constructs are shared. We provide an example of such an intersec-
tional analysis in Chapter 8.

The core contribution of the book is the contemporary scientometric analysis of gender. We focus on six main facets of research that can be studied using bibliometric metadata: production, collaboration, contributorship, funding, mobility, and impact. Chapter 1 (Production) sets the scene by providing a general diagnostic on the place of women on the byline of scholarly articles, looking at both production—the proportion of scholarship that is produced by women, in the aggregate, and productivity—and how much each individual woman produces. Differences across countries and disciplines are disentangled, with a focus on country-level variables as potential correlates with gender disparities. This chapter serves as the basis for the rest of the book, as authorship is the key anchor for studying women through a scientometric lens. Chapter 2 (Collaboration) builds on these results by looking at multiple authorship, also referred to as collaboration. Team organization is essential for understanding scientific trajectories. The chapter examines the gendered nature of authorship ordering in collaborative teams and the interplay between gender, leadership, and team size. Furthermore, this chapter begins to unravel the relationship between authorship and labor contribution, explored in further detail in the chapter that follows. Chapter 3 (Contributorship) explores how men and women within a scientific team are associated with different labor roles and the effect of task specialization on careers.

Using both bibliometric data and sources from funding agencies, Chapter 4 (Funding) examines gender differences in grant support for research, focusing on gendered differences in the percentage of funded research projects as well as success rates and funding amounts. Funding is increasingly used as an output indicator, rather than an input indicator, with strong implications for retention in science and scientific success. Chapter 5 (Mobility) moves to a relatively new area of research in bibliometric studies—scientific mobility—and uses affiliation data on papers to examine gendered differences in affiliation changes across countries and the relationship with other variables, such as production and impact. Chapter 6 (Scientific Impact) examines the citation received for men’s and women’s papers and how this is mediated by the factors examined in other chapters, including collaboration. Self-citation is explored as one potential explanation for the gender gap observed. Chapter 7 (Social Institutions) examines the social and institutional structures that contribute to
gender disparities in science. Chapter 8 (Recommendations and Conclusions) provides a series of recommendations for various stakeholders, including researchers, institutions, research funders, publishers, and journalists. Taken together, this book provides an overview of the state of equity for women in science and mechanisms that may serve to dismantle systemic barriers to advancement.
Chapter 1

Production

In 2010, the Royal Society published a list of ten British women who had the greatest influence on science.¹ This list contains contemporary scientists such as geneticist Anne McLaren and Nobel laureate biochemist Dorothy Hodgkin. Most of these women have high educational achievements and laudations to accompany their robust pedigrees. One woman, however, is distinctively unadorned with academic accolades.

Mary Anning was born in Great Britain shortly before the turn of the nineteenth century (1799–1847). Her childhood and adolescence did not involve tutors or schooling, but rather days exploring in Lyme Regis on the southern shore of Britain. Her father was an occasional fossil collector and taught his daughter the skills of collecting and dealing. This provided a modest income for the family, as they were lucky enough to live near a rich Jurassic-era marine fossil bed. Around age twelve, Anning found the first full ichthyosaurus to be known to the scientific community. She subsequently discovered the first plesiosaur and pterodactyl fossils. These fossils were purchased by museums and collectors, many of whom noted her strong knowledge of paleontology. Despite this, she received little recognition for her work, besides an obituary notice from the director of Her Majesty’s Geological Survey and president of the Geological Society of London—an association to which neither she nor another woman was admitted until 1904. Her sole published work is a letter to the editor in the Magazine of Natural History. Despite having her fossils featured in the Natural History Museum and other prestigious institutions, her contributions to paleontology were largely forgotten after her death. Her gender and social class prevented her from being
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able to contribute to the permanent scientific record. Anning was engaged in research “activity,” but she did not “produce” science.

It took another generation for women’s work to be made visible in scientific publications. British engineer, mathematician, and physicist Hertha Ayrton (1854–1923) was also featured on the list of notable British scientists. Among her scientific honors is the distinction of being the first woman to read her own research before the Royal Society. Unlike Anning, Ayrton was well schooled, attending Cambridge University and the University of London. As with many successful scholars of her era, Ayrton’s entrance into the scientific community was facilitated through marriage: she met and married her professor, William Ayrton, when she was attending classes at Finsbury Technical College in the late 1880s. The marriage, however, hampered some of her subsequent success. Although she was nominated as a fellow of the Royal Society of London, she could not be elected due to her marital status. Her marriage also led to some disquieting authorship issues. Ayrton’s aging husband was unable to maintain his productivity; to facilitate, Ayrton continued doing his work and publishing under his name in parallel with her own work. She therefore stands at an interesting intersection in the history of scientific production for women: her marriage provided her entrance into science yet also made many of her contributions invisible. Despite these constraints, she eventually developed an independent voice in the scientific community, receiving several notable awards and publishing in the most reputable journals of the day.

One of the leading publication venues then (and now) was Nature, a generalist scientific magazine founded in 1869. In Ayrton’s time, the editor in chief (and founder of the journal) was Sir Joseph Norman Lockyer, who was married to a strong advocate for women’s rights and a noted suffragette, Mary Broadhurst Lockyer. When Ayrton was considered for the Royal Society, Mary Lockyer strongly advocated in her favor. Her husband was similarly supportive of women’s entrance into these societies. In 1904 and 1908, women chemists petitioned the Royal Chemical Society to admit women fellows. A Nature editorial ran in support of the 1908 petition, noting the positive contribution of women scientists to the journal: “It cannot be denied that women have contributed their fair share of original communications. Indeed, in proportion to their numbers they have shown themselves to be among the most active and successful of investigators. The society consents to publish their work, which redounds to its credit.”
Nature editorials also expressed support for women scientists seeking admittance to other societies, such as the Geological Society, where Anning might have been admitted were she of another century. Not all editors were equally supportive. The editor who succeeded Lockyer at *Nature*, Richard Gregory, was far less sympathetic to the cause. He published an obituary of Ayrton by fellow chemist Henry E. Armstrong strongly suggesting that Ayrton’s success should be credited to her husband: “I never saw reason to believe that she was original in any special degree; indeed, I always thought that she was far more subject to her husband’s lead than either he or she imagined.”

Progress toward equity was slow. In 1924, a letter to the editor from renowned physicist Norman R. Campbell requested that *Nature* replace the offensive term *man of science* with the more inclusive term *scientist*. Gregory responded that he would inquire among many “distinguished men of science” on their opinions on the matter. As noted in the introduction, it was not until 2000 that *Nature* adopted a new mission statement, eliminating the reference to “men of science.” It took nearly two more decades after this change for a woman to be appointed to the helm: *Nature* hired its first woman editor in chief, geneticist Magdalena Skipper, in 2018. More than two centuries passed, from Anning to Skipper, for women not only to be recognized for producing science but to serve in the highest echelons of gatekeeping.

Women and the Professionalization of Disciplines

The stories of Anning and Ayrton and the controversy in the pages of *Nature* foreshadow tension between the professionalization and feminization of scientific disciplines. Before the twentieth century, science was associated with amateurism, which allowed wealthy women and those who married scientists to participate in scientific activities. Beginning in the 1870s, women increased their membership in scientific organizations and began obtaining employment in museums and observatories. By the end of the nineteenth century, however, science began a process of professionalization that served to decrease women’s access to scholarship. When science became codified as a professional—and therefore masculine—domain, women were further isolated from participation.
The rise of higher education and the expansion of employment for women happened in parallel with this professionalization. Several institutions across the world opened their doors to women in the late nineteenth century, and by 1910, a large share of universities allowed women to receive degrees across the disciplinary spectrum. This led to an environment where women were being educated but not employed or advanced at the same rate as men. Women were therefore corralled into careers that were perceived as appropriate for their “special talents.” Gender segregation in labor, well established in other professional sectors, intensified in science. Women initially took their science degrees into museums, botanical gardens, and other cultural institutions where they could receive modest employment. Over time, the rise of larger, collaborative teams opened new opportunities for women as science assistants. For example, women’s roles as “computers” in astronomy and physics confirmed their ability to conduct patient and painstaking labor in the lab.

As women matriculated at higher rates, they were more likely to enter disciplines associated with care and domesticity—such as education, child psychology, librarianship, social work, and the newly emerging field of home economics. It is not surprising that Nobel laureate Marie Curie was cast in a caregiving role in her fund-raising trips in North America: rather than being touted for her scientific discoveries, she was aligned with the potential to cure cancer and her work on the military front. It was easier to place a woman in a care-related role than to perceive her as a scientist.

Caregiving fields were feminized at the start of the twentieth century and remain so. In contemporary research, women account for less than a third of authorships (30.9%), with few research specialties where women are in the majority. In practical terms, this means that for every woman scientist, there are about 2.3 men. As our data show, only 10 of the 143 specialties in the National Science Foundation journal classification have more authorships by women than men (Figure 1.1): nursing (75.8%), social work (64.1%), speech-language pathology and audiology (62.2%), developmental and child psychology (61.2%), public health (52.2%), rehabilitation (53.7%), social sciences, biomedicine (53.6%), education (53.5%), geriatrics and gerontology (53.5%), and nutrition and dietetics (50.3%). All these woman-dominant fields have a distinctive service aspect to them, thereby reinforcing the perception of women as more suitable for care-oriented disciplines.
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Note: The letter t following a page number denotes a table. The letter f following a page number denotes a figure. The n following a page number denotes a Note followed by the note number.

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