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Gender Differences in Publication Productivity Among Academic Scientists and Engineers in the U.S. and China: Similarities and Differences

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Abstract Gender differences in science and engineering (S&E) have been studied in various countries. Most of these studies find that women are underrepresented in the S&E workforce and publish less than their male peers. The factors that contribute to gender differences in experience and performance in S&E careers can vary from one country to another, yet they remain underexplored. This paper is among the first to systematically compare gender differences in the publication productivity of academic scientists and engineers with doctoral degrees in the U.S. and China. Findings from negative binomial regressions show that women publish less than their male counterparts in science but not in engineering in the U.S. In China, women do not differ from men in publication productivity in science but publish more than their male counterparts in engineering. In addition, we find that some background variables affect men's and women's publication productivity differently. The findings are analyzed in the context of the different cultures of the two fields (science vs. engineering) and of the two countries (the U.S. and China). Limitations and policy implications are also discussed.

Keywords Gender differences · Publication productivity · Science and engineering · Cross-national comparison

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Introduction

Research examining gender differences in career outcomes in science and engineering (S&E) has found that women scientists and engineers face disadvantages at each stage of their careers. Moreover, the disadvantages that impact women at the early stages of their careers often lead to further disadvantages later on. For example, it is more difficult for women to secure employment in S&E compared to men, and women are less likely to be employed by research universities but more likely to be employed by other institutions. These gender differences in employment could be due to women's job preferences, the limited opportunities available to women, and human capital accumulation that often works against women because of their family and childcare responsibilities (Primack and Leary 1993; National Science Foundation 2003; U.S. National Science Board 2014). Women faculty in S&E also suffer from salary bias and are often excluded from informal networks in departments or professional associations (Primack and Leary 1993; MIT Report 1999, 2002; Shen 2013). However, women have made important progress over time by gaining more equity in, for example, employment at research universities, salary and research resources, and tenure. Still, women remain underrepresented among candidates for tenured or tenure-track positions and among candidates for tenure review in S&E (MIT Report 2011; U.S. National Research Council 2010).

Another important career outcome in which women have made significant progress but still not achieved equity is publication productivity. Women scientists and engineers are often found to have lower publication productivity than men. Over time, women have moved towards publishing at rates similar to their male counterparts. For instance, in the 1960s, women scientists published 50%-60% as much as their male colleagues (Cole and Zuckerman 1984; Zuckerman 1991), but by the late 1980s and early 1990s, women scientists were publishing 75%-80% as much as their male peers (Xie and Shauman 1998, 2003). Among biochemists, gender differences in publication productivity increase in the first career decade but decrease in the second: while men's productivity, on average, declines in the second decade of their careers, the productivity of a significant percentage of women increases (Long 1992).

While most early studies of women in S&E or gender differences in S&E were conducted in the U.S. (or other industrialized countries) (*e.g.,* Zuckerman and Cole 1975; Reskin 1977, 1978; Cole 1979; Cole and Zuckerman 1984; Long 1990; Long and Fox 1995), an increasing number of studies focus on women scientists and engineers in developing countries or in the non-western world (*e.g.,* Campion and Shrum 2004; Prozesky 2008; Mozaffarian and Jamali 2008; Jung 2012; Miller et al. 2012). However, few studies systematically compare developed and developing countries in terms of how male and female academic scientists and engineers differ in their career outcomes. While the U.S. has historically been a leader in scientific research, China has been improving in both research and innovation. While it remains debatable whether the leading position of the U.S. is being challenged or overturned by other countries (Xie and Killewald 2012), and while some data on China's growth in S&E education and research may be misleading (Gereffi et al.

2008), it is nevertheless important to understand how men and women differ in their career outcomes – in two drastically different countries – in fields that have relatively objective evaluation criteria.

China's booming economy and tremendous increases in funding for research and development (Sun and Cao 2014) have made it a major contributor to the global scientific community. China's share of publications in international journals (especially Science Citation Indexed journals) has been increasing at an exponential rate since the mid-1980s, when Chinese science recovered from the Cultural Revolution (Liu and Zhi 2010). Although China's system of science and innovation has attracted much interest, past research has tended to focus on issues at the macro level, such as China's funding system (Stone 2011; Sun and Cao 2014), bureaucratic governance (Cao et al. 2013), integrity problems (Xin 2006; Hvistendahl 2011; Yang 2013), and talent programs (Ding 2001). Fine-grained empirical research detailing how the personal characteristics (e.g., gender) of Chinese scientists affect their academic performance is limited (Hong and Zhao 2016). Drawing from two national survey data sets from the U.S. and China, this paper compares gender differences in publication productivity (*i.e.,* the number of published journal articles) among academic scientists and engineers in the U.S. and China to understand the similarities and differences between these two countries in terms of gender gaps in scientific article publication. While scientific productivity is multi-dimensional and can be manifested in various forms, including inventing ways of exploring hypotheses and receiving grants and patents, we focus on publication productivity in this paper because it remains an important indicator of scientific productivity. In addition, this paper examines how various factors – such as marital status, rank, and experience – affect men's and women's publication productivity in S&E differently in these two countries.

Literature Review

Gender Differences in Publication Productivity in Science and Engineering in the U.S.

While working women have historically faced disadvantages in their careers, efforts have been made in the U.S. to reduce these gender gaps. Although different types of laws and regulations, such as affirmative action, have minimized explicit discrimination against women, women are still disadvantaged in various aspects of their careers. While more women are receiving S&E degrees today than in the past, they are still underrepresented in faculty positions, especially in tenured and full professorships, positions with high pay and status (*e.g.,* industrial research as opposed to academic teaching), and leadership positions in academia, industry, and government (Wu and Jing 2011; Mason et al. 2013; Tao 2016). Various intervention programs have been implemented to attract and retain women within the fields of S&E, but not all programs achieve the desired outcomes. For example, programs that aim to increase the representation of women at the undergraduate (Fox et al. 2009) and graduate levels (Fox 1998) tend to perceive the underrepresentation of women as a problem of "recruitment and retention" and use student-centered approaches, such as bringing "a few women together to provide a support system," to address the issue. These programs do not address the institutional or structural barriers facing women in S&E (*e.g.,* male-oriented culture and a lack of role models for female students), and thus they can hardly achieve their goals (Fox et al. 2009).

Researchers have examined why gender inequality continues to be a problem in the merit-based field of science. Robert K. Merton (1973) initiated the discussion of universalism as one of the norms of science. Universalism refers to two concepts: 1) scientific careers should be open to all talented people, regardless of background characteristics such as gender, race/ethnicity, and religious affiliation; 2) the author's background should not affect how his or her scientific claims are evaluated. Since Merton, sociologists have continually investigated universalism in science. One of their major findings is that universalism is *not* always practiced in science, and, relatedly, that gender does affect scientists' careers (Zuckerman and Cole 1975; Long and Fox 1995). In addition, various factors affect scientists' publication productivity (Cole and Zuckerman 1984; Xie and Shauman 2003; Ceci and Williams 2011).

Earlier research has reported that women's publication productivity is lower than that of their male peers but has not been able to explain the gender gap, leaving a "productivity puzzle." After reviewing past studies, Cole and Zuckerman (1984) found that gender gaps in publication productivity in science – even after considering age and other social attributes – had persisted since the 1920s. They then addressed this puzzle by examining scientists who received their doctorates in 1969-1970. They found that among the most prolific group of scientists, women's representation significantly increased from 8% in the 1957-1958 cohort (those who received their doctoral degrees in 1957-1958) to 26% in the 1969-1970 cohort. However, despite social change, the gender gap in publication productivity continues. More recent research has revisited the "productivity puzzle" and finds that this "puzzle" can be explained by certain personal and institutional factors that work against women. Xie and Shauman (1998) use updated data (1969-1993) and find that gender differences in publication productivity have shrunk over time. Additionally, the gender gap is no longer statistically significant after various background variables are added to the models. Women's low publication productivity relative to their male counterparts can be explained by the structural positions and personal characteristics that disadvantage them, especially the type of institution, research funding (resources), time to Ph.D., and marital status (Zuckerman and Cole 1975; Xie and Shauman 1998, 2003; Ceci and Williams 2011).

Factors found to have an impact on scientific productivity range from demographic to employment characteristics. Some of these characteristics affect men and women similarly, but others affect them differently. Marriage can benefit scientific productivity for both men and women. For women, the benefits of marriage could come from the human capital of the spouse, who is likely to be highly educated (and also likely to be a scientist). Astin (1978) reports that a greater percentage of married women compared with single women publish 3 or more articles (the most productive group) in education, biology, physical sciences, and social sciences in the two years prior to their survey. Similarly, Astin and Davis (1985), Clark and Corcoran (1986), and Cole and Zuckerman (1987) find that marriage does not negatively affect – but rather can facilitate – the publication productivity of science faculty, especially among women. Women scientists in subsequent marriages have nearly twice the publication productivity as women in a first marriage, which is due to the greater possibility of marrying another scientist in a subsequent marriage (Fox 2005). However, women scientists are less likely than male scientists to be married, and they are less likely to benefit from marriage (Stack 2004; Xie and Shauman 1998, 2003; Mason et al. 2013).

Research has also examined the effect of children on productivity and reports mixed findings. Cole and Zuckerman (1987) find that marriage and children do not lower women's publication productivity, as married women with children do not differ in productivity from single women (with no children). Clark and Corcoran (1986) and Cole and Zuckerman (1987) find that children do not reduce the publication productivity of women faculty in science and the humanities. Fox (2005) finds that women academic scientists with preschool children are more productive than women with no children or with school-age children. Fox argues that women with preschool children are members of a very selective and committed group and can be more efficient in allocating their time than other women. Stack (2004) finds that among academic engineers and scientists with children living at home, women publish less than men, and compared with their childless counterparts, those with young children (younger than 6 or 6-10) have enhanced publication productivity. However, women scientists publish less than the other groups when they have children younger than 6.

Other factors that are often considered in studies of scientific productivity include administrative positions, rank, and experience. Stack (2004) reports that from 1990 to 1995, net of other variables, academic scientists and engineers whose primary role is administrative have lower publication productivity than those whose primary role is research. In addition, both full and associate professors are more productive than those at lower ranks (assistant professors and others). Yet, experience or years since the receipt of the Ph.D. are found to be negatively related to productivity (Levin and Stephan 1991; Stack 2004; Corley 2005).

Another factor that affects publication productivity is the type of institution or the department. Hargens and Hagstrom (1967) find that the prestige of the institution where scientists received their doctoral degrees is highly correlated with the prestige of their affiliated institutions. This finding is verified by Long (1978) and Allison and Long (1987). As a result, the reputation of the doctoral institution will likely affect publication productivity. Similarly, the current institution or department, which determines the prestige of the position (Long and McGinnis 1981), type of resources available to faculty, level of intellectual stimulation, level of requirements, rewards (Allison and Long 1990), department culture (Fox and Mohapatra 2007), and level of interdisciplinary research (Corley and Gaughan 2005), can significantly affect publication productivity.

While gender differences (at the individual level) do not always mean gender inequality (at the institutional level), gender inequality in S&E often intensifies gender gaps. Researchers have evaluated two major approaches to understanding gender gaps in S&E education and careers: the individual approach and the institutional approach. The individual approach argues that women are underrepresented in S&E because they are not prepared for or interested in these fields. This theory has long been criticized based on empirical data that there is little gender difference in performance on math and science tests, and the slight gender gap on tests does not explain the gender gap in S&E participation (Holton and Sonnert 1995; Xie and Shauman 2003). In contrast, the institutional approach argues that women are underrepresented in S&E because men and women have different structural positions, have different access to resources and are not recognized equally (Allison and Long 1990; Xie and Shauman 1998, 2003). Over the past few decades, increasing institutional-level inequality has led to greater individual-level inequality in science (Xie 2014). In other words, while some gender differences are due to individual choices, most of the gender gaps in S&E are due to structural factors that work against women, indicating gender inequality.

Gender and Science Stratification in China

Since the establishment of the People's Republic of China, the Chinese Communist Party has been promoting gender equity in education. According to Rawski (1979), only 2%-10% of women, compared with 30%-40% of men, were literate at the end of the Qing dynasty. Among people aged 17 to 20 in 1949, 83% of women and 40% of men could not read or write (Population Research Center of the Chinese Academy of Social Sciences 1986). But by the 1960s, the Communist government had eliminated illiteracy. On average, men and women in urban areas in the 1990s received 10.4 and 9.4 years of education, respectively (Tsui and Rich 2002). In addition, education is positively correlated with gender equity in China, and the positive effect of education on gender attitudes is greater for women than for men (Shu 2004). The one-child policy further forces Chinese families to treat girls the same as boys, thus promoting their performance in science-related subjects (e.g., mathematics) and enhancing their opportunities to attend college (Tsui and Rich 2002).

In China, from the 1950s to the 1980s, the state assigned women to jobs where they earned the same wages as men (Bauer et al. 1992). During that period, women were also encouraged to enter traditionally male-dominated occupations, such as tractor drivers, pilots, soldiers, etc. When economic reform began in the 1980s, the private sector gained more autonomy in determining employees' salaries, and the effect of China's gender-neutral policy was diluted to some extent by the economic reform. Nonetheless, Chinese women have become much more independent than their counterparts in other East Asian countries. They typically work full-time after getting married and giving birth to children. Furthermore, the equal pay policy still applies in the public sector. As a result, China has a much higher female employment rate than many Western countries (Zhu and Guang 1991). Women represent about one third of the Chinese scientific workforce, and this percentage – greater than that of the U.S. – has been stable for decades (Zhao and Li 2008). In addition, women report a relatively high level of gender equity in the scientific workforce. In a survey of 441 science and technology personnel in Beijing, Tianjin, and Jinan, Lin (2000) finds that more than half of the women report never being discriminated against and that seniority and graduate degrees help in reducing discrimination. In addition, 75.6% of the women surveyed report no gender differences in salaries, and 69.6% believe they have the same promotion opportunities as men. Furthermore, over 60% of women report gender equity in research funding (64.3%), intellectual exchange (63.7%), and academic achievement (61.8%).

However, this gender equity does not extend to the scientific elite in China, as has been found in other socialist countries (Etzkowitz et al. 2000). A report by the Chinese Academy of Sciences (Zhao and Li 2008) finds that only 5% of the fellows of the Chinese Academy of Sciences and the Chinese Academy of Engineering are women. Among the 175 chief scientists selected by the "973" program (the National Basic Research Program, a program organized and implemented by the Ministry of Science and Technology), only eight (or 4.6%) are women. There are no women on the committee of the "863" program (the National High-Tech R&D Program). Jin (1997) finds that, from 1990 to 1995, women made up 4.8%, 11%, and 12% of recipients of the National Award for Natural Science, the National Award for Invention, and the National Award for Technology Improvement, respectively – all significantly lower than their representation in the scientific workforce.

Various studies attribute Chinese women's underrepresentation among the scientific elite to their family obligations and lack of motivation (Zhao and Li 2008; Ma 2009). In China's thousand-year-old patriarchal society, women are expected to spend more time than their husbands on housework and other chores. Nevertheless, a comparative study conducted by U.S. scholars suggests that this patriarchal tradition might not disadvantage Chinese female scholars more than their American counterparts. Based on questionnaire results from U.S. and Chinese college professors, Zhang and Farley (1995) find that women in both countries are responsible for more household labor than their male counterparts, but they identify very few cross-country differences. In fact, Chinese women faculty members are more likely than their American counterparts to rely on housekeepers for cooking, dishwashing, repairs and laundry (Zhang and Farley 1995). Another cultural difference between the U.S. and China is family structure. While the nuclear family is the dominant family structure in the U.S., living with extended family is still common in China, and thus grandparents can help with housework and childrearing. In their comparative study on women scientists in industrialized and developing countries, Etzkowitz et al. (2000) find that women scientists in developing countries benefit from the low cost of housekeepers and easy access to grandparents' help. This unique feature of developing societies advantages women professionals in developing countries over their Western counterparts, where such support is not always available.

A number of Chinese government agencies have been concerned about gender inequality in S&E and have conducted and released several surveys addressing this problem. Unlike studies in the U.S., where factors contributing to gender inequality are examined systematically, surveys in China are mainly implemented for policy purposes, with descriptive results as their main output. One exception, however, is the study that examines factors affecting multi-dimensional scientific performance (*e.g.,* publication, patenting, and governmental awards) from a social network perspective (Hong and Zhao 2016).

Field Differences and National Differences

While science and engineering have much in common in terms of gender differences, these fields differ in other aspects. For example, the U.S. National Research Council (2010) finds that in the three years prior to the study, while women published less than their male colleagues in chemistry, they published more than men in electrical engineering. Yet, in the interdisciplinary field of nanoscience and engineering, women do not publish less than their male counterparts—in fact, both men and women have overall low productivity. A possible explanation for this low output is that nanoscience and engineering is relatively new and interdisciplinary, which leads researchers to publish their papers in journals dedicated to other subjects, such as chemistry and physics; and in this case, patenting could be another form of productivity (Sotudeh and Khoshian 2014). In other words, while science and engineering are similar in many aspects, they need to be examined separately to produce a better understanding of gender differences in publication productivity.

In addition, in different cultures, the same field may be preferred by different groups of people. Women's participation in science in some countries (*e.g.,* Turkey) could be due to the lower status of science compared to law and political science, where men are overrepresented, as well as the traditional support system for childcare in that country. In Portugal, however, women's increasing participation and overrepresentation in science at the doctoral level in the 1980s was due to the loss of so many men in the colonial wars of the 1960s and 1970s (Etzkowitz et al. 2000). Additionally, while computer science is a predominately male field in the U.S. and many other countries (U.S. National Science Board 2014), it is a predominately female occupation in Malaysia—computer science is considered more appropriate for girls than for boys because it is an "indoor" job (Mellström 2009). Furthermore, while – worldwide – women are underrepresented among authors of S&E articles, gender equity in authorship is more prevalent in countries with lower scientific output (*i.e.,* number of articles) as well as in communist and formerly communist states, possibly due to the more equal gender ideology in communist societies (Lariviere et al. 2013). As a result, it is important to examine S&E across countries to better understand the gender dynamics of career outcomes.

In summary, the U.S. and China differ in many aspects. First, along with other socialist countries, China experienced a period during which gender-neutral ideology prevailed and had a lasting impact on women's education, labor force participation, and career outcomes. Although the U.S. has experienced several waves of feminist movements and subsequent policy changes, these efforts, although they did increase women's participation in S&E education, did not as effectively promote women's participation and success in S&E careers. Second, women in China can rely on their parents and housekeepers for housework and childcare. Since 1979, the one-child policy has further reduced the burden of childrearing and has created a relatively gender-equal environment for the younger generation. In contrast, women in the U.S. typically take care of multiple children, mainly with the help of their husbands; they rely less on housekeepers and grandparents than do women in China. Third, unlike the U.S., where faculty members' salaries are determined by the market to a certain extent, professors in China usually do not have any bargaining power over their salaries. The government has a universal salary standard for professors at different ranks across regions, and the standard is significantly lower than the average pay scale in industry (Luo 1990; Liu et al. 2004). On the one hand, this policy eliminates any gender inequality in pay. On the other hand, this rigid pay structure has made university professors a social group characterized by low incomes and inferior living conditions in urban areas (Miller 1996). It is thus difficult to attract talented people to this occupation; this is especially true of men, who are expected to earn higher salaries than their wives.

Research Questions

Based on the literature review, we explore the following questions in a multivariate context.

1. Gender gaps: What are the gender differences in publication (number of peer-reviewed journal articles) in academic S&E in the U.S. and China?
2. Interaction effects: How does gender interact with demographic, educational, and employment variables in S&E in the U.S. and China? In other words, how do these background variables affect men's and women's publication productivity differently?
3. Field differences: How can we explain the gender differences in article publication and the effects of background variables on men's vs. women's publication productivity in science as opposed to those in engineering?
4. Cross-national comparison: How can we explain the gender patterns described above in the U.S. as opposed to those in China?

Methods

Data

U.S. Sample

This paper uses data from two large national datasets for analysis. The U.S. data come from the 2008 Survey of Doctorate Recipients (SDR) compiled for the National Science Foundation and the National Institutes of Health (NIH) every two to three years. This longitudinal survey includes demographic (*e.g.,* sex, race/ethnicity, marital status, children), educational (*e.g.,* field of the doctorate, year of receiving the doctorate, Carnegie Classifications of the doctoral institution), and employment characteristics (*e.g.,* labor force status, rank, job title, articles published, patents granted). SDR data have been used by researchers and policy makers to investigate various issues regarding the career experiences and outcomes of doctorate recipients in science, engineering, and health fields (Stephan and Levin 1991; Turner et al. 1999; Ginther and Hayes 2003; Stack 2004; Corley and Sabharwal 2007; Sabharwal and Corley 2008; Mason et al. 2009; Kim et al. 2011; Mason et al. 2013; Sabharwal 2013).

SDR is an ideal dataset for research on doctorate recipients' career outcomes because it tracks recipients throughout their careers. In addition, SDR oversamples some underrepresented groups, including women and early-career professionals, to allow for meaningful statistical analysis of these groups. The SDR sample used in this paper includes all individuals who received a doctoral degree in science (not including social or behavioral sciences) or engineering by the year of survey and were employed at an institution of higher education as research or teaching faculty when the survey was conducted. The sample used for this project is of academic scientists (biological, mathematical and computer scientists, as well as physical scientists) and engineers and includes 5,245 academic scientists and engineers (1,518 women and 3,727 men).

Chinese Sample

The Chinese sample comes from the 2008 General Survey on Science and Technology Personnel (GSSTP) in China, which is a national survey of all science and technology personnel and is conducted every five years. The 2008 survey was sponsored by the Chinese Association of Science and Technology and was conducted by the Chinese Academy of Science and Technology for Development.

In the 2008 survey, a multi-stage random sampling method was applied. In the first stage, 209 clusters, including universities, research institutes, hospitals, enterprises, and other relevant institutions in 31 Chinese provinces were sampled. In the second stage, a sample of 150 science and technology personnel was selected in each cluster through random sampling. Each respondent was asked to finish a self-administered questionnaire. Finally, a total of 30,078 questionnaires were collected. The response rate was 93.7 percent.

In the survey, science and technology personnel are defined as people whose work is related to science and technology research, communication, popularization, application, and management. To obtain a sample comparable with the U.S. database, we retain only the respondents who report their occupation as university professors with a doctoral degree in engineering or science (including agricultural but not social or behavioral sciences). Because the Chinese data set does not define subfields within science in the same way the U.S. data set does, this project does not further disaggregate science subfields.[1] The Chinese sample with doctoral degrees includes 1,495 individuals (360 women and 1,135 men). While it is common for

[1] For instance, agricultural science is an independent field from science (including computer and mathematical, life, and physical sciences) in China, but agricultural science is usually considered as a science in the U.S. In addition, in China, the subfields within agricultural science include statistics, which would be considered as mathematics in the U.S. In this paper, agricultural science in China is grouped into science.

Chinese academic scientists and engineers to have only a master's degree (or even a bachelor's degree among older scientists and engineers), our analysis focuses on the doctoral sample to enable better comparison with the U.S. sample.

While the SDR data (U.S. sample) and GSSTP data (Chinese sample) were collected in the same year and include some common variables for comparison, there are also limitations—some variables are available in one dataset but not the other. For example, data regarding collaboration and other network-related variables that are found to affect publication productivity are not available in the U.S. sample. Because we would like to keep the variables and models for the U.S. and Chinese samples as consistent as possible, we do not include in the models those variables that are available in only one dataset but not the other.

Variables and Analysis

The dependent variable is the count of publications (the number of journal articles). While it is desirable to evaluate the quality of the publication, or number of citations, the databases do not include such data. In the U.S. sample, the articles are published or accepted in peer-reviewed journals, and in the Chinese sample, they are articles published or accepted in peer-reviewed journals indexed in the Science Citation Index (SCI), which, in China, are often considered as being of better quality than those not indexed in the SCI (*e.g.,* some journals in Chinese published in China).[2] The articles in the U.S. sample were published or accepted in the period of 5 years (2003-2008), while those in the Chinese sample were published or accepted in the period of 3 years (2005-2008). While this mismatch is not ideal, it does not significantly affect our cross-national comparison because we compare gender differences in publication productivity within each country instead of publication productivity *per se* in these two countries.

The key independent variable is the dummy variable, gender (1 = female; 0 = male). The other independent variables include demographic, educational, and employment variables that have been shown to affect scientific productivity and may also affect men and women differently: marital status, children, type of institution where one received the doctorate, type of the current institution, rank, administrative status, and experience. The three marital statuses are as follows: single and never married, married, and other marital status (*e.g.,* widowed, separated, and divorced). While research shows that different age ranges of children could affect men's and women's publication productivity differently, this project does not further disaggregate children by age range due to data limitations of the Chinese sample. To keep the models for the U.S. and Chinese samples as consistent as possible, we use a dummy variable only to indicate whether the respondents have children living in the household or not.

The type of doctoral institution is a dummy variable, coded 1 for research university (very high research activity) in the U.S. sample (2005 Carnegie Classification; similar to the category Research 1 in earlier Carnegie Classification)

[2] Chinese scientists and engineers also publish in non-SCI journals, mostly in Chinese journals. However, for the purpose of quality control, they are not included in the counts for this study.

and 1 for top Chinese universities (overseen by the Ministry of Education and overseas institutions) in the Chinese sample. The type of current institution is also a dummy variable, coded 1 for research universities (very high research activity) in the U.S. sample and universities overseen by central ministries in the Chinese sample.[3] In China, most universities are public, and the private universities are, in general, not research-focused, so we do not include the distinction between public/private university as a variable. In terms of employment characteristics, there are four ranks in both samples (1 = other; 2 = assistant professor in the U.S., or lecturer, the equivalent to assistant professor, in China; 3 = associate professor; 4 = full professor). Administrative status is a dummy variable coded 1 if the respondent holds an administrative position of dean or above (*e.g.,* provost, president, chancellor, etc.). Experience (or professional experience) refers to the number of years since the receipt of the first doctoral degree. Science in this paper includes computer and mathematical sciences, life sciences (including agricultural sciences), and physical sciences. Engineering includes all areas of engineering, e.g., aerospace, mechanical, electrical, civil, etc.

To understand gender differences in publication productivity, we first present descriptive results with t-tests. The t-tests can show whether gender differences in article publications (as well as in demographic and employment characteristics) are statistically significant. Then, we use regression models for multivariate analysis. Because the dependent variable for publication productivity is overdispersed (*i.e.*, the variance is much larger than the mean), negative binomial regression models are appropriate (Whittington and Smith-Doerr 2008; Shin et al. 2014).[4]

To answer our first research questions, we test the effect of gender on publication in a multivariate context. To answer our second research question, we add interaction terms of gender and the other independent variables, one at a time, to the previous model used to answer the first research question. Then, if the interaction term is statistically significant, we further calculate the interaction effect (also known as the marginal effect) to understand how the background variable affects men and women differently. For all regressions, we run the models for the full sample first and then for scientists and engineers separately to better detect field differences (Research Question 3). We also run regressions for the U.S. and China separately (Research Question 4).

Findings

Descriptive Results

Table 1a and b list the demographic, educational, and employment characteristics of female and male doctoral scientists and engineers in the U.S. and China with t-test

[3] Universities overseen by central ministries, such as the Ministry of Education, generally have more research activity than those overseen by provincial or municipal governments.

[4] We performed some preliminary tests to determine whether the zero-inflated negative binomial regression model was better than negative binomial regression because of excessive zeros. Tests failed to show that the zero-inflated negative binomial regression models were better.

Table 1a Mean Values of Demographic, Educational, and Organizational Variables (U.S. Sample), by gender

	Full sample		Science		Engineering	
	Women	Men	Women	Men	Women	Men
No.	1,518	3,727	1,353	2,990	165	737
%	28.9	71.1	31.2	68.8	18.3	81.7
Marital Status[a]						
% Single	17.1***	9.7***	17.0***	9.7***	17.6***	9.8**
% Married	67.3***	80.3***	66.8***	80.0***	70.9**	81.8**
% Other marital status	15.7***	10.0***	16.2***	10.3***	11.5	8.4
% Having children	45.5**	49.8**	45.2**	49.5**	48.5	50.9
% Doctoral institution (very high research activity)	79.8	81.3	79.1	80.5	85.5	84.7
% Current institution (very high research activity)	39.9	42.8	39.4	41.3	44.2	48.8
Rank[a]						
% Assistant Professor	35.1***	21.3***	34.3***	21.8***	41.2***	19.0***
% Associate Professor	25.4	24	25.4	23.7	25.5	25.4
% Full Professor	22.0***	43.5***	22.5***	42.7***	17.6***	46.4***
% Other positions	17.6***	11.2***	17.8***	11.7***	15.8*	9.2*
% Admin (Dean or above)	6.8*	8.8*	6.7*	8.7*	7.9	9.1
Mean experience	12.7***	18.2***	13.1***	18.6***	9.3***	17.0***

Table 1b Mean Values of Demographic, Educational, and Organizational Variables (Chinese Sample, Doctorate Recipients only), by gender

	Full sample		Science		Engineering	
	Women	Men	Women	Men	Women	Men
No.	360	1135	128	346	232	789
%	24.1	75.9	27.0	73.0	22.7	77.3
Marital Status[a]						
% Single	7.5	5.6	10.9*	4.9*	5.6	6.0
% Married	90.3*	93.4*	85.9**	93.6**	92.6	93.3
% Other marital status	2.5*	1.1*	3.1	1.7	2.2^{+}	0.8^{+}
% Having at least one child	75.3	79.4	75.0*	83.9*	75.4	77.5
% Doctoral institution (Top Chinese or overseas)	68.3	70.2	58.3	64.3	74.2	72.8
% Current institution (overseen by central ministries)	43.6	45.3	30.5	28.3	50.9	52.7

Table 1b continued

	Full sample		Science		Engineering	
	Women	Men	Women	Men	Women	Men
Rank[a]						
% Assistant Professor	30.6***	21.3***	39.1***	17.3***	26.0	23.1
% Associate Professor	43.2^{+}	37.5^{+}	39.8	32.1	45.0	39.9
% Full Professor	23.4***	40.4***	18.0***	49.7***	26.4**	36.4**
% Other ranks	2.8**	0.7**	3.1^{+}	0.9^{+}	2.6*	0.6*
% Admin (Dean or above)	0.8	1.8	1.6	1.5	0.4	1.9
Experience	4.2***	5.9***	3.8***	6.4***	4.4***	5.7***

Sources: SDR (U.S.); GSSTP (China)

t-test significant levels: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; $^{+}$ $p < 0.1$

[a] May not add up to 100 due to rounding

results. Table 1a shows that in the U.S., while women are underrepresented in science (31.2%), the percentage of women in engineering is especially low in the sample (18.3%). A smaller proportion of women than men are married, and a greater percentage of women than men are single in both fields. Women in science are also more likely than men to have a marital status of "other" (*e.g.,* widowed, separated, and divorced) and less likely than men to have children. There is no gender difference in the type of institution from which they received their doctoral degree or in the type of their current institution, but in terms of rank, a smaller proportion of women than men are full professors, but a greater proportion of women are assistant professors or are in lower positions in both fields. There is no gender difference at the rank of associate professor in either field. A smaller percentage of women hold administrative positions (dean or above) in science, but women have less professional experience than men in both science and engineering.

Table 1b shows that in China, while women's representation is also low in both science (27%) and engineering (22.7%), a greater proportion of women than men are single and have children in science but not engineering. There is no gender difference in the type or prestige of doctoral institution and current institution in either field, but a much greater proportion of women than men in science are lecturers, and a lower percentage of women are full professors in both fields. There is no gender difference at the rank of associate professor.[5] Additionally, women have less work experience than men in both science and engineering.

[5] Different from the tenure system widely used in the U.S., lifetime employment was adopted by most Chinese universities in 2008. Although Chinese professors also need to publish in international journals to receive promotions and awards, the level of pressure and stress they experience is less than their U.S. counterparts. The promotion system in China is different from that in the U.S. as well, and it usually takes less time for a doctorate recipient to be eligible for promotion review in China than in the U.S. (*e.g.,* in China, a doctorate recipient is eligible for promotion review to the rank of associate professor within 3 years of receiving the doctoral degree, although such review does not guarantee the promotion).

Table 2 Article Publication Productivity, by Gender and Field

	Female				Male			
	Mean	SD	Min	Max	Mean	SD	Min	Max
U.S. (5 years)								
Full sample	8.1***	11.7	0	96	10.7***	15.1	0	96
Science	8.0***	11.5	0	96	10.7***	15.3	0	96
Engineering	8.7	13.2	0	96	10.6	14.3	0	96
China (3 years)								
Full sample	5.2	7.0	0	60	5.5	7.1	0	57
Science	4.4*	5.1	0	25	6.1*	7.1	0	50
Engineering	5.6	7.9	0	60	5.3	7.0	0	57

Source: Survey of Doctorate Recipients, 2008 (U.S.) GSSTP (China)

1. Both are samples of doctorate recipients only

2. t-test significant levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

A comparison of the U.S. and Chinese descriptive data shows some similar and different patterns. We find similar gender gaps in terms of marital status, rank, and experience, and in both countries, there is no gender difference in the type or prestige of doctoral and current institutions in either field. Two major differences between the U.S. and the Chinese samples are the ratio of scientists to engineers and the percentage of women in engineering. While there are more scientists than engineers in the U.S. sample (82.8% of individuals included in the U.S. sample are scientists), the opposite is true in China (68.3% of the Chinese sample are engineers). Additionally, while only 18.3% of engineers are women in the U.S., a slightly larger percentage (22.7%) of engineers are women in China. While the gender patterns are similar across fields in the U.S., most of the gender differences (*e.g.,* marital status, representation at the assistant professor level) in China are found in science but not engineering.

Table 2 shows publication productivity by gender and field in the U.S. and China. In the U.S. full sample for science, women published less than men in the 5-year period from 2003 to 2008. Women published 8 articles, and men published 10.7 articles in science. In engineering, women published 8.8 and men published 10.8 articles, but the gender difference is not significant in the t-tests. Similarly, in the Chinese sample, women published less than men in science but not in engineering.

Regression Results

The descriptive results do not consider other factors that may affect publication productivity, such as marital status, children, experience, and administrative responsibilities. To better understand gender differences in publication productivity, we use negative binomial regressions to detect gender differences after other variables are added to the models. Because the articles in the U.S. sample were published in the 5 years prior to the survey and those in the Chinese sample were

Table 3 Negative binomial regression predicating gender differences in article publication

	U.S. sample			Chinese sample		
	Full sample	Science	Engineering	Full sample	Science	Engineering
Female	0.87***	0.85***	1.04	1.10	0.86	1.21*
	(0.03)	(0.04)	(0.11)	(0.08)	(0.10)	(0.10)
Married	1.07	1.09	0.99	1.19	2.36**	0.89
	(0.06)	(0.07)	(0.14)	(0.18)	(0.64)	(0.16)
Other marital	0.98	1.02	0.72	0.38*	0.37	0.39
	(0.07)	(0.08)	(0.13)	(0.16)	(0.30)	(0.19)
Children	1.03	1.06	0.89	0.89	0.71*	1.01
	(0.04)	(0.05)	(0.08)	(0.07)	(0.11)	(0.10)
Doctoral/highest degree inst.	1.09	1.08	1.09	1.04	0.96	1.11
	(0.05)	(0.05)	(0.12)	(0.07)	(0.10)	(0.09)
Current institute	2.09***	2.06***	2.24***	1.58***	1.70***	1.53***
	(0.07)	(0.08)	(0.18)	(0.10)	(0.20)	(0.12)
Rank	1.34***	1.31***	1.55***	1.19***	1.07	1.24***
	(0.03)	(0.03)	(0.08)	(0.05)	(0.09)	(0.07)
Dean	1.07	1.08	1.07	1.15	2.06	0.98
	(0.07)	(0.08)	(0.15)	(0.30)	(1.11)	(0.29)
Experience	0.99***	1.00*	0.98***	1.05***	1.06***	1.05***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)
Science	1.11*			1.15*		
	(0.05)			(0.07)		
Constant	2.62***	2.94***	2.33***	1.27	1.51	1.26
	(0.22)	(0.24)	(0.44)	(0.25)	(0.52)	(0.30)
lnalpha	1.39***	1.41***	1.26***	0.76***	0.74**	0.74***
	(0.03)	(0.03)	(0.07)	(0.04)	(0.07)	(0.05)
Pseudo-R^2	0.022	0.021	0.029	0.04	0.04	0.04
N	5,245	4,343	902	1,184	382	802

Sources: Survey of Doctorate Recipients, 2008 (U.S.); GSSTP (China)

1. Both are samples of doctorate recipients only

2. The coefficients are in exponentiated form; *** p<0.001, ** p<0.01, * p<0.05

published in the 3 years prior to the survey, we converted the coefficients into an exponentiated form that can be easily interpreted as percentages for easier comparison. If the coefficient is greater than 1, it means women publish more than men; if less than 1, women publish less than men. Table 3 shows that in the U.S., women publish 87% as many articles as their male counterparts in the full sample and 85% as many in science, but there is no statistically significant gender difference in publication productivity in engineering (Table 3). In China, there is no gender difference in the full sample or in science, and women publish 21% more than men in engineering.

Table 4 Negative binomial regression results of interaction terms

Variable	Main and interaction effects	U.S. sample	Chinese sample		
		Engineering	Full sample	Science	Engineering
Married	Female	1.55*	0.63	0.32*	0.94
		(0.31)	(0.18)	(0.16)	(0.34)
	Married	1.15	1.04	1.72	0.85
		(0.18)	(0.17)	(0.55)	(0.16)
	Female * married	0.57*	1.80*	2.86*	1.31
		(0.13)	(0.53)	(1.46)	(0.49)
Other marital status	Female	0.95	1.10	0.86	1.22*
		(0.11)	(0.08)	(0.10)	(0.10)
	Other marital status	0.58**	0.43	0.37	0.46
		(0.11)	(0.22)	(0.36)	(0.27)
	Female * other marital status	2.07*	0.71	1.06	0.61
		(0.69)	(0.59)	(1.74)	(0.60)
Children	Female	1.26	1.28^{+}	0.71	1.65**
		(0.19)	(0.18)	(0.18)	(0.29)
	Child	0.95	0.94	0.66*	1.11
		(0.10)	(0.09)	(0.12)	(0.12)
	Female * child	0.68	0.81	1.27	0.67*
		(0.14)	(0.13)	(0.37)	(0.13)
	N	902	1,184	382	802

We ran 50 negative binomial regressions (9 for the full sample and 8 for science and engineering each in each country) but only show the results of variables that have significant interaction effects with gender (marital status and children) in this table. Both are samples of doctorate recipients only

In addition, we find effects of the other independent variables. Marriage and children do not have an effect in the U.S., but in China, in science, marriage has a positive effect relative to being single, and children have a negative effect. The prestige of the doctoral institution does not affect publication productivity, but that of the current institution increases publication productivity in both fields in both countries. Publication productivity also increases with academic rank in both fields in both countries, except for science in China. Experience has a negative but negligible effect in science and a slightly negative effect in engineering in the U.S. but a positive effect in both fields in China. Additionally, scientists are more productive than comparable engineers in both countries.

Then, we add the interaction terms of gender and the other independent variables to answer the second research question. We add one interaction term (*e.g.,* female*married) at a time into each model as presented in Table 3. Table 4 shows only the results of variables that have significant interaction effects with gender. Two of the interaction effects—both related to marital statuses—in the U.S. engineering sample are significant. In the Chinese sample, marriage and children have interaction effects with gender in science and engineering, respectively

(Table 4). Because both interaction terms in the U.S. sample are related to marital status, we further calculate the interaction effects of gender and each of the three marital statuses (as a dummy variable) as well as the interaction effect of gender and marital status (as a categorical variable with three values). The results all show that in the U.S. engineering sample, women who are single or married do not differ significantly from their male counterparts in article publication, but women with other marital statuses publish 5.3 more articles than their male counterparts; however, this result is only marginally significant ($p = 0.087$). Isolating the effect of marital status, we find that men in other marital statuses publish 3.86 fewer papers than married men ($p=0.000$). In other words, the significant interaction effect between gender and marital status in the U.S. sample comes from the publication productivity difference between married men and men with other marital statuses but not between men and women sharing a specific marital status. In the Chinese sample, gender differences in publication productivity are significant among single scientists and childless engineers. Marriage has a positive effect on productivity for both male and female scientists, but women seem to benefit more from marriage (4.4 more papers) than men (2.5 more papers) in terms of publication productivity. In addition, while childless women engineers publish 3.1 ($p = 0.014$) more papers than their male counterparts, female and male engineers with children do not differ in publication productivity.[6]

Discussion

In this paper, we examine research questions regarding gender differences in article publication productivity in S&E in the U.S. and China, the interaction effects of gender and background variables, and both field differences and national differences in these patterns. One major finding is that women in the U.S. publish less than their male counterparts in science but not in engineering. The finding regarding the gender gap in science is consistent with findings in the literature regarding women's disadvantages in science. Science remains a male-dominated field, despite the progress women have achieved over time. Empirical research finds that universalism is an ideal type that is not always practiced in science. This paper further supports this finding. While the gender gap in publication productivity in science has been narrowing over time, it has not been completely eliminated. When interpreting results in engineering, however, readers are reminded of the small number of women engineers in the U.S., which makes it difficult to detect statistically significant gender gaps. The failure to find a gender difference in this case does not necessarily mean the absence of a gender difference. In addition, not finding gender differences after the other independent variables are added does not mean that men and women do not differ in those independent variables. The fact that U.S. women engineers are highly concentrated at the rank of assistant professor indicates that women are disadvantaged in engineering in the U.S. On the other hand, engineering does differ from science in terms of career opportunities outside

[6] Tables and graphs are available upon request.

academia. Research shows that gender disparities (with women being disadvantaged) in tenure success rates are lower or do not exist in fields with more non-academic employment opportunities (*e.g.,* electrical engineering) but are much greater in fields with fewer non-academic opportunities (*e.g.,* English) (Aanerud et al. 2007). This disparity exists because male engineers are more likely to find employment outside academia, leaving academic employment opportunities and more gender equity to women who remain in academia.

A second major finding is that in China, female doctorate recipients who become faculty do not publish less than their male counterparts in science but publish more in engineering. These findings are consistent with the literature that reports a relatively high perceived level of gender equity in China. However, the sample size of Chinese doctoral women scientists is quite small and may make it difficult to detect any significant results. The finding regarding women's advantages in publication productivity in engineering looks surprising but may be explained by data. Data from a survey conducted in 2007 on graduating doctoral students' career orientations in four Chinese cities (Doctorate Recipients' Occupational Orientation Project Team 2009) show that academically capable women in engineering are more likely to find employment in academic research than men (77.2% of women vs. 64% of men), while academically capable men in engineering were more likely than women to find jobs in industry and government. In addition, the Chinese data in GSSTP 2008 (table not shown) show that among academic engineers, men receive more industry projects or funding from industry (1.3) than women (0.8). Nonetheless, the total amount of funding does not differ significantly between men and women because women engineers have more internal projects (projects funded by the university) (0.9) than men (0.3). Internal funding is less competitive than industry funding, and publishing papers is sufficient to satisfy the funder. In contrast, industry funding usually targets a specific product and involves a greater time commitment but does not guarantee publications. However, one advantage of industry funding over internal funding is that the funds can be spent flexibly, and a considerable percentage can be used as salary. Women's lack of motivation or success in securing industrial funding may lead to their success in publication. As Hong and Zhao (2016) have argued, in the multi-dimensional evaluation system used in the Chinese science community, researchers deploy different strategies to find their proper niches. Therefore, women engineers' high productivity in publication may only suggest that female and male engineers focus on different aspects of success. Male engineers' contributions to industrial innovation can be evaluated and rewarded in the same way as publications are rewarded by universities and governments, while benefitting them financially.

Another finding of this paper involves the interaction effects of gender and background variables. In both countries, marital status has an interaction effect with gender. In the U.S. sample, married men publish more than men who are divorced and separated. While this finding does not reveal gender differences in the effect of marital status, it supports the existing literature that marriage benefits publication productivity in S&E, although this paper finds that it only benefits men. In China, single women doctoral scientists publish less than their male counterparts, but married women scientists have publication productivity similar to their male counterparts. This finding is also supported by the literature showing that women in the U.S. (Bernard 1972) and China (Gao and Zhang 2011) often marry men who have higher educational levels, are older in age, and have better economic backgrounds. We suspect that Chinese women scientists benefit more from marriage than men because women are more likely than men to marry senior scientists and thus are more likely to benefit from the human capital of their spouses, similar to the U.S. (Cole and Zuckerman 1987; Fox 2005). Additionally, according to a survey of Chinese science and technology personnel (Zhu and Lu 2014), while single women spent 0.37 more hours per day on housework than single men, married and childless women spend about the same time as their male counterparts. These data imply that marriage alone, to some extent, decreases the gender disparity in housework among science and technology personnel, allowing more time for married women to conduct research – relative to their male counterparts – than single women. In China, childless doctoral women engineers publish more than their male counterparts, but having children eliminates this advantage. As described in previous literature (Zhao and Li 2008), women are the primary caregivers for children in China. Zhu and Lu (2014) also find that it is child-rearing rather than marriage that leads to the gender disparity in housework among science and technology workers.[7]

The similarity in field differences observed in the U.S. and China, as well as the regression finding that scientists publish more articles than their engineering counterparts in both countries, raise further questions about field differences. We run the data for both countries again and find that in the U.S., in the five years prior to the survey, 7.8% of scientists had patents granted, while 24.2% of engineers did; 3.1% of scientists had patents resulting in commercial products, while 7.3% of engineers did. In China, in the three years prior to the survey, 24.8% of scientists and 36.1% of engineers had patents granted, and 25.2% of scientists but 44.5% of engineers conducted research (not just patents) that resulted in commercial products or industrial production. In other words, in both countries, engineering is more oriented towards patenting and commercialization of research than science. In the context of multi-dimensional evaluations of scientific productivity (Hunt et al. 2013; Hong and Zhao 2016), women's equal (or higher) publication productivity relative to men in engineering might result from men's pursuing productivity in other dimensions.

Despite the similarity in field differences, the gender dynamics in publication productivity also differ significantly in these two countries. Gender equity is better in both fields in China than in the U.S. These differences could be attributed to the

[7] Because women doctoral scientists are not similarly disadvantaged, we further run the models within different age groups (below 30, 30-34, 35-39, 40-49, above 50) for scientists and engineers. Both women scientists and engineers have a time period when children have a negative effect on their publication productivity, relative to their male counterparts (or fathers). After that, having children does not have an impact. In the sample of scientists, only 26.4% are in the age range of 35-39, when children have a negative effect on journal publication. In the engineering sample, in contrast, the period susceptible to the effect of children is longer (30-39), and half (51.1%) of the engineers are in this age range. In summary, the different effects of children found in science as opposed to engineering are the result of different age compositions of scientists and engineers in our sample. Therefore, the effect of children on women engineers is not idiosyncratic.

cultural differences between the two countries that we discussed above. First, the communist ideology of China, although weakened in the market economy, may still encourage and facilitate the progress of women doctoral scientists and engineers. Second, the abundance of housework helpers in China and the one-child policy may relieve the burden of child rearing and family obligations among Chinese women scientists and engineers. Third, the relatively low salary of Chinese professors has pushed many competent male scientists and engineers out of academia. This is especially true in engineering, where men can find better-paid, non-academic jobs, similar to the U.S. (Tao 2016), resulting in an environment where women are more likely to excel over their male counterparts in publication productivity relative to other fields.[8]

However, we are not claiming that Chinese women have gained dominance over or won equity with their male colleagues. Women's catching-up in publication productivity does not necessarily mean gender inequality has been significantly reduced or even eliminated. Women are still overrepresented in junior ranks and underrepresented in senior ranks in both countries. Women's continuous underrepresentation among senior faculty members in the U.S. can be attributed to 1) the leaky pipeline by which women leave S&E at each junction (Holton and Sonnert 1995), 2) family obligations that conflict with women's scientific careers (Long et al. 1993), and 3) demographic inertia such that the age and sex structures of scientific fields can severely limit women's representation in faculty positions (e.g., tenure-track and full professor positions) in these fields, even with the increase in women receiving doctoral degrees (Hargens and Long 2002). In China, female faculty members are less likely to leave the pipeline at the faculty level because most Chinese universities only adopted lifetime employment in 2008. Family obligations might be an obstacle, but to a lesser extent for Chinese women than for American women. However, demographic inertia is likely to affect women in China. Data from China's Yearbooks on Education (2004-2013) show that the percentage of female doctoral recipients increased from 31.3% in 2004 to 36.9% in 2013. With their competitive performance, these women are expected to be promoted gradually, but it may take decades to change women's percentages in the senior ranks due to demographic inertia.

Conclusion

This paper is among the first to systematically examine and compare gender differences in publication productivity among academic scientists and engineers in the U.S. and China. In this paper, we found both similar and different gender

[8] Since a large percentage of Chinese academic scientists and engineers (55.3%), especially the older generation, do not hold a doctoral degree as the highest degree, the Chinese doctoral sample examined here does not represent the whole Chinese science community. We run the same regression models for the Chinese general sample, with education as an additional control variable. Women in the Chinese general sample publish less than their male counterparts in science but not in engineering, similar to the findings in the U.S. sample (doctoral).

patterns in article publication productivity in S&E in the U.S. and China. In both countries, women fare better in engineering than in science. We attribute this field difference to engineering's orientation towards market recognition in a multi-dimensional evaluation system in universities in the world. When comparing doctoral recipients in both the U.S. and Chinese samples, the Chinese sample demonstrates better gender equality. The special case of China suggests that the disadvantages faced by women might be circumvented by gender-equality campaigns and movements. A supportive social system (characteristic of less-industrialized societies), a smaller number of children, and the relatively low economic status of university professors could be the other factors contributing to gender equity in publication among academic scientists and engineers in China, although these advantages are not necessarily desired. It is also worth mentioning that our comparisons are made between doctoral recipients only. If the Chinese general sample were included, the gendered pattern of publication in S&E would be similar to that of the U.S. Furthermore, publication productivity is only one dimension of evaluating faculty members' performance and achievement. When attention is shifted to ranks, women still lag far behind men in both fields in both countries.

Marital status affects men and women differently in both countries, and children affect men and women differently in China; future research that examines the career outcomes of scientists and engineers also needs to consider cultural differences in these effects. While science and engineering are considered to have objective evaluation criteria, they differ in the representation of women and in how women fare relative to their male counterparts. The country in which researchers practice S&E also affects their experience and career outcomes. Policies to improve the participation, experience, and productivity of men and women in S&E need to take field-specific and culture-specific factors into account. In the U.S., policies need to focus on expanding the participation and retention of women and making the engineering field more female-friendly. In science, however, there is still a long way to go to eliminate gender disparities in male and female scientists' career outcomes. In China, while it is worth celebrating women's success in achieving equal performance in academia, readers are cautioned that this gender equity may have been achieved because men leave academia for industry. Brain drain from academia to industry has been a long-lasting problem in China, and policies need to focus on attracting and retaining excellent men and women in academia. Implementing policies designed for a specific field and culture can help facilitate the career performance of "the best and the brightest."

The findings and analysis in this paper fill the void in the literature regarding how men and women differ in their career outcomes in two drastically different cultures, the U.S. and China. Future research can further examine gender differences in publication productivity after more variables, such as network-related variables, are controlled for in more disaggregated scientific fields, e.g., life sciences and physical sciences, with larger sample sizes of women scientists and engineers. In addition, with the rise of academic entrepreneurship in S&E, other forms of productivity – *e.g.,* patenting and patent licensing – can be measured, and gender differences in these areas can be examined to reveal how male and female academic scientists and engineers are faring in the U.S. and China, what factors affect their patenting and licensing behavior, as well as whether and how patenting, licensing, and publications (articles and books) affect each other.

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