Gender disparities in the field of economics

Liu Junwan [1], Song Yinglu [1], Yang Sai [1], Cassidy r. Sugimoto [2], Vincent Lariviere [3]

[1] *liujunwan@bjut.edu.cn 18810621725@163.com 850846582@qq.com*

School of Economics and Management, Beijing University of technology, Beijing, China

[2]*sugimoto@indiana.edu*

School of Informatics and Computing, Indiana University Bloomington，USA

[3]*vincent.lariviere@umontreal.ca*

École de bibliothéconomie et des sciences de l'information, Université de Montréal, Canada

Abstract

In order to analyse the gender disparities in scientific research output in the field of economics, this paper selected the Web of Science database as the source database. We collected and screened 257,642 articles written by 130,397 authors from 1933 to 2017 in the field of economics. In this study, we use mathematical statistics and bibliometrics indexes to quantitatively analyse the gap between male and female authors in many aspects, including the output and influence in different level of journals and institutions, the dynamic evolution of output and influence and cooperation modes with gender disparities. In addition, we have analysed the disparities in output and influence of male and female authors among different countries. The results show that male authors dominate in the economics research field according to their high output and influence. However, female authors also show advantage when it comes to the research influence. This study can provide an insight of gender different in economics research.

Keywords: gender disparities, economics, output

Introduction

Gender disparities are not only reflected in biological structure and social roles. In the academic field, gender disparities also exist widely and have been influencing the quantity and quality of academic activities for a long time. With the development of the feminist movement and the progress of society, the barriers preventing women from entering the scientific community are gradually being eliminated, but the negative effects of gender role positioning and education restriction still exist, and gender is still an important factor affecting the balanced development of scientific research.

In recent years, many scholars have studied gender disparities in science. Shi Yuantao and Chen Xueling (2011) investigated and analysed the scientific and technological personnel in institutions of higher learning and scientific research institutes in Hubei province and found that the proportion of men in the groups with high scientific research achievements was much higher than the proportion of women. Lin (1997) surved 441 Chinese scientists and also found that women make up a larger proportion of authors with lower scientific production than men. Ma Ying, Zhao Yanling and Gong Xin (2018) pointed out that only 6% of academics were female, and 87% of female college students faced gender discrimination during their job search. Yuan Yuzhi (2017) found that family burden and the level of participation in cooperative scientific research were the key variables influencing the output of scientists. Zhang Jinjie and Zhang Dongshuo (2005) described the phenomenon of the "relative absence" of women in the natural sciences, which was mainly reflected in the obvious gender gap between female and male scientists in the number, level, fields and achievements of scientific research. The traditional concept of the social division of labour and women's personal reasons contribute to this phenomenon.

Schiebinger and Linda (2014)suggested that gender must be taken into account in scientific research, especially in the biomedical field. Guglielmi and Giorgia (2018) demonstrated that men were more successful than women in applying for research grants. The study by Yu Xie and Shauman (1998) found that although the difference between the number of female scientists and male scientists was gradually narrowing, men still ranked higher than women in the scientific community. Preston A (1994) pointed out that women's investment and participation in scientific research are increasing, but women are twice as likely as men to leave science after graduating from school. Garg (2014) calculated the contribution of female authors to papers, showing that female scientists were slightly less productive than men at the individual level. Sax and Hagedorn (2002) showed that in the 30 years from 1972 to 1999, both male and female teachers' scientific research output increased, but the gender gap among high-yielding teachers remained unchanged. Cassidy R. Sugimoto and Vincent Lariviere(2013) presented a bibliometric analysis that confirmed that gender imbalance still exists in research output worldwide. Kyvik and Teigen (1996) investigated the scientific research output of teachers in four Norwegian universities and found that there was also a gender difference in the relationship between age and productivity, which was that the gender difference decreased at first and then increased as age increased. Rauber and Ursprung (2007) confirmed this conclusion, and they found that the scientific research output of female economists changed regularly with the development of their careers. Sotudeh H (2014) showed that although there were only a few female researchers in the field of nanotechnology, the women researchers were also more likely to publish in high-impact journals and performed well in terms of scientific achievements and influence. Mauleo'n and Bordons's(2006) research results showed that there were no significant disparities in scientific output and influence compared with men and women in the field of materials science and that women tend to publish in high impact journals.

A review of these literature shows that gender difference is an important factor that affects the output and influence of female scientists in scientific research in both developed and developing countries. Diversity and equality are needed in the field of scientific research, so gender-specific assessments of scientific achievements will demonstrate different scientific capacities and thus contribute to the development of strategic plans that enable women to develop themselves in the scientific community.

This paper takes the field of global economic research data as an example. The main purpose of the paper is to quantitatively analyse the output of scientific research and influence disparities between male and female scientists, preliminarily explore the influence of gender disparities on scientific contributions and comprehensively investigate the gender disparities in scientific research activities in terms of the length of author careers, institutions, nationalities and other aspects. The research results can provide quantitative data and reference for science and technology decision makers to make policy, and make academia develop more balanced.

Data and methods

To ensure the representativeness and authority of data, this paper selected the Web of Science database as the source database. We collected and screened 257,642 articles written by 130,397 authors from 1933 to 2017 in the field of economics. The field of economics was defined using the NSF fields and subfields classification of journals. A total of 450,566 papers published in 348 economics journals were analysed in this study. Authors were disambiguated using the methods developed by Caron and van Eck (2014). The gender of authors was assigned using authors' first names, following the method developed by Larivière et al. (2013). This paper mainly adopts the mathematical statistics method that is commonly used in bibliometrics to conduct regression analysis and the non-parametric test for the collected data with the aim to investigate the quantitative relationship between scientific research productivity and career. At the same time, an independent sample T test was conducted on gender disparities in scientific research output and on the influence of male and female authors to verify whether there were significant difference in the distribution of variables between the two groups. The tools used were mainly Excel for basic data statistics, SPSS for regression analysis and a non-parametric test and Gephi for visualization analysis to draw the network diagram of scientific research cooperation in the field of economics, and node centrality was calculated.

This paper adopts the average counting method to calculate the number of papers (regardless of the number of collaborators). The average counting method (Pang Jingan, 1999) refers to the number of papers calculated according to the method of "one per person" regardless of the rank of authors.

Average annual publication (AAP) and career length (CL): average annual publication refers to the number of publications per year, which is equal to the total output/career length. Career length refers to the time interval between the publication of the author's first paper and the publication of his or her last paper to date.

$$\text{AAP} = \text{Total number of annual publications/CL} \qquad (2.1)$$

Average annual citation number (AAC) and paper citation frequency (PCF): average annual citation number refers to the average annual citation number of a single paper, and paper citation frequency refers to the average annual citation number of all articles of an author, which are added together and averaged to measure the influence of an author. The calculation formula is as follows:

$$\text{AAC} = \text{Total number of annual citations in Y year/(2017-Y+1)} \qquad (2.2)$$

$$\text{PCF} = \text{AAC/Total number of paper} \qquad (2.3)$$

Paper contribution rate: as a paper is often completed by multiple authors, the total of n papers are published by an author, and the number of authors for each paper is mi. Therefore, the author's paper contribution rate formula is:

$$\sum_{i=1}^{n} \frac{1}{m_i} / n \qquad (2.4)$$

Cooperative network graph: to show the cooperative relationship between authors, each author can be abstracted into a node in the graph, and a line can be connected between the two authors (two nodes) to generate the cooperative network graph.

Degree centrality: the degree centrality of a node is also referred to as the degree of the node, which is defined as the total number of edges that the node connects with other nodes.

The calculation formula is as follows:

$$C_D(N_i) = \sum_{j=1}^{g} x_{ij} \; (i \neq j)$$

Concentration index: the concentration index is a measure of the correlation between two variables based on frequency data that varies around the neutral value 1. The index refers to the ratio of the proportion of a certain class of data in the new category to the proportion of the original class in the total sample after classification according to the new classification method. In this paper, the concentration index refers to the ratio of a gender in different groups to the ratio of that gender among all authors.

Gender disparities in output and influence

Of the 130,397 authors, the proportion of men is 2.45 times higher than that of women, indicating that the number of male scholars in the field of economics is far higher than that of female scholars. The first authors of all the papers were counted, among which 81% were men and 19% were women. Statistical data are shown in Table 1: Part of the reason for the large gap between men and women is that the unequal status of men and women causes men to have more opportunities to participate in academic discussions and gain more recognition, while women are less likely to participate in academic discussions because they are more likely to be questioned. Without those opportunities, women can miss out on research collaborations and job offers.

Table 1 Ratio of male to female authors

		M	*F*	*TOTAL*
All the authors	Author Num(proportion)	92633 (71%)	37764 (29%)	130397
The first author	Paper Num (proportion)	186512 (81%)	43159 (19%)	229671

Research on gender disparities in output and influence

Considering that the number of male authors is far higher than the number of female authors, so AAP is adopted instead of the total number to measure the output of each author. By calculating the overall data, male authors' AAP was 0.67, and female authors' AAP was 0.66, making the latter slightly lower than the former. An independent sample T test was used to verify whether the gender difference in output is significant.

Table 2 Independent sample T test of scientific research output

The set of statistics					
	Gender	*N*	*The mean*	*The standard deviation*	*Standard error of the mean*
AAP	F	37730	.663759	.4415452	.0022732
	M	92622	.669698	.4803193	.0015782

Independent sample test								
		Levene test of variance equation		*T test for the mean equation*				
							95% confidence intervals	
		F	*Sig.*	*t*	*Sig. (double side)*	*The mean difference*	*Lower limit*	*Upper limit*
AAP	Variance is equal	112.610	.000.	-2.071	.038.	-.0059385	-.0115578	-.0003193
	Variance is not equal			-2.146	.032.	-.0059385	-.0113625	-.0005146

According to the Levene test results of the variance equation in Table 2, the F value is 112.61, and the sig value is 0.000<0.05, indicating that the difference of the variance between the two groups is significant. In the T test in Table 2, sig (both sides) =0.032<0.05, that is, there is a significant difference of the mean in the two groups, indicating that the difference in the scientific research output between male and female authors is significant.

PCF is used to measure the influence of scientific researchers. By calculating the overall data, it was concluded that the male authors' PCF is 1.48 and the female authors' PCF is 1.28, the latter still being slightly lower than the former. Again, an independent sample T test was used to verify whether the gender difference in influence is significant.

Table 3 Independent sample T test of scientific research influence

The set of statistics					
	Gender	*N*	*The mean*	*The standard deviation*	*Standard error of the mean*
PCF	M	360374	1.481720	3.6044713	.0060043
	F	90089	1.284815	2.7894445	.0092936

Independent sample test									
		Levene test of variance equation		*T test for the mean equation*					
							95% confidence interval	
		F	*Sig.*	*t*	*Sig. (double side)*	*The mean difference*	*Lower limit*	*Upper limit*
PCF	Variance is equal	422.513	.000	15.292	.000	.1969052	.1716674	.2221429
	Variance is not equal			17.796	.000	.1969052	.1752191	.2185912

According to the Levene test results of the variance equation in Table 3, the F value is 422.513, and the sig value is 0.000<0.05, indicating that the difference of the variance between the two groups is significant. Sig (both sides) =0.000<0.05 in the T test in Table 3, that is, there is a significant difference between the means of the two groups, indicating that the difference in the scientific research influence between male and female authors is significant.

Gender disparities among high-product and high-impact authors

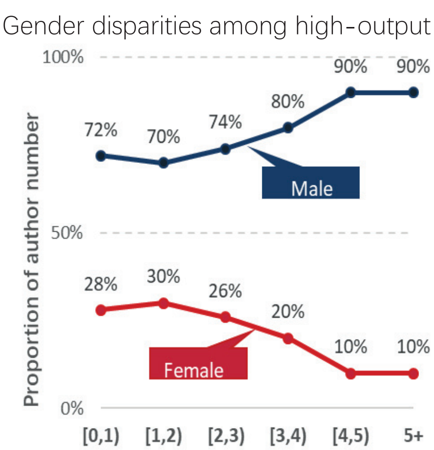

Figure 1 Proportion of author number in different annual output ranges

The average annual publication of authors is divided into 6 intervals from small to large, and the proportion of female authors in each interval is shown in Figure 1. It can be seen that with an increase in average annual publications, the proportion of female authors continues to decrease. The higher the productivity, the greater the gender difference between authors.

In considering the number of authors and the average annual output of all authors, this paper defines the authors with an average annual publication of more than 2, (1-2) and (0-1) as high-product, medium-product and low-product authors, respectively, which account for 2%, 44% and 54% of the total population, respectively. To explore and compare the gender disparities within the three groups, the concentration index was introduced to represent the correlation between the proportion of male and female authors in a certain group and the proportion of male and female authors in all the groups.

Table 4 Proportion of male to female authors among the three groups

		F	*M*
High-product 2450	Number	514 (21%)	1936 (79%)
	Concentration index	0.72	1.11
Medium-product 57417	Number	17196 (30%)	40221 (70%)
	Concentration index	1.03	0.99
Low-product 70530	Number	19947 (28%)	50583 (72%)
	Concentration index	0.97	1.01

As seen in Table 4, the concentration index of male and female authors with low and medium production changes around the median value of 1, and there is no significant difference. The concentration index of males among high-product authors was 1.11, which was approximately 1.5 times higher than that of female high-product authors. In other words, the number of male authors was more concentrated among the high-product authors.

Gender disparities among high-impact authors

As mentioned before, paper citation frequency is used to measure the influence of scientific researchers by calculating the average citation frequency of all papers published by each author and dividing the citation frequency into 5 intervals from small to large. As shown in Figure 2, there is no significant change in the proportion of female authors in different cited frequency intervals, which is approximately 29%.

By considering the number of citations of an article and the author citation frequency, this paper defines the authors with a paper citation frequency of more than 6, (1-6] and (0-1] as high-impact, medium-impact and low-impact, respectively, which account for 2%, 30% and 68% of the total population, respectively. To explore the internal gender disparities within each of the three groups and to compare the gender disparities between the three groups, we continue to use the concentration index

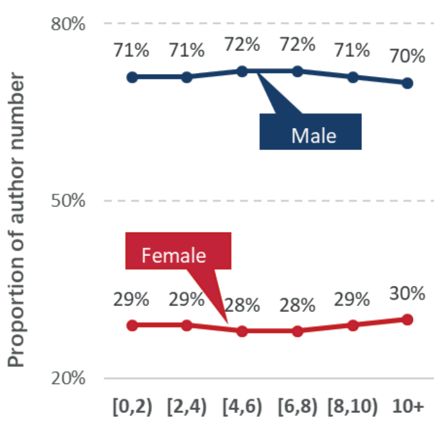

Figure 2 Proportion of author numbers in paper citation frequency ranges

Table 5 Proportion of male to female authors among the three groups

		F	*M*
High-impact 2589	Number	739 (29%)	1850 (71%)
	Concentration index	1.00	1.00
Medium-impact 39693	Number	11487 (29%)	28206 (71%)
	Concentration index	1.00	1.00
Low-impact 88115	Number	25538 (29%)	62577 (71%)
	Concentration index	1.00	1.00

It can be seen from Table 5 that there is no significant difference in the concentration of men and women in the three groups, as the concentrations of both change around the median value of 1. However, we are surprised to find that in the high-impact group, the articles of female authors are cited 10.15 times, which is higher than the citation rate of male authors in that group (9.66 times), while the number of female authors in the high-impact author group is only two-fifths of the number of male authors, which reflects the female authors' abilities and advantages in scientific competition.

Gender disparities at different levels of journals and institutions

Gender disparities at different levels of journals

Journal impact factor is an important index for the quantitative evaluation of journals that was first put forward by the founder of SCI in the United States (E. Garifedl) and has been widely used to evaluate the academic level of journals (Jin Bihui, Wang Shouyang, 1999). The greater the impact factor of the journal, the greater the influence of the journal is. In this paper, journals are arranged according to the order of influencing factors from high to low. The top 10%, 10%-25%, 25%-50% and 50% and above journals are defined as first-level, second-level, third-level, and fourth-level journal, respectively. As shown in Figure 3, the number of papers published by male authors is higher than that of female authors in journals across all levels.

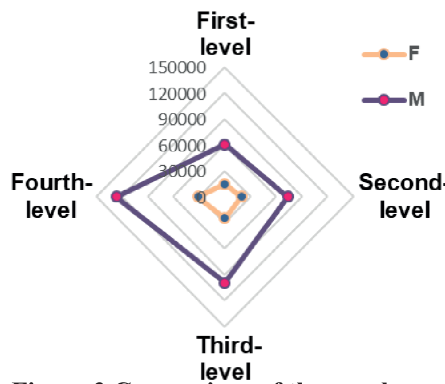

Figure 3 Comparison of the number of papers published in different levels

Gender disparities in different levels of institutions

We rank the total citation frequency of articles published by each academic institution from large to small and define the top 10% most frequently cited institutions as core institutions and the rest as non-core institutions in this field. As shown in Figure 4, the number of female authors in the core institutions accounts for approximately 26% and that of male authors accounts for approximately 74%. The number of female authors in non-core institutions accounts for approximately 30% and that of male authors accounts for approximately 70%. Compared with the proportion of male authors, it can be seen that there are fewer female authors in the core institutions.

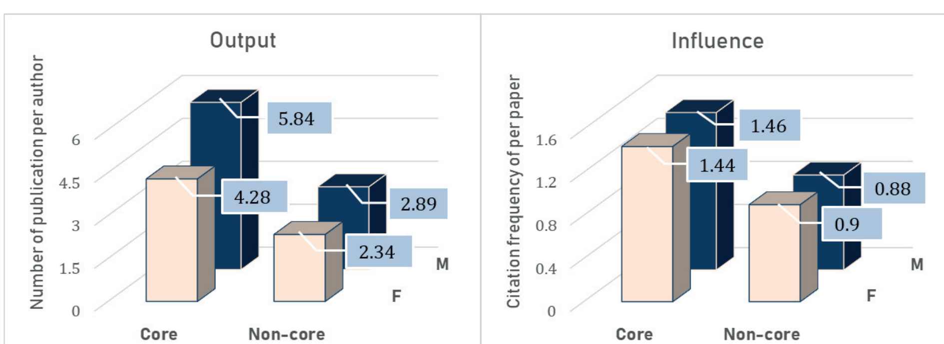

Figure 4 Gender disparities in output and influence

It can be seen from Figure 4 that the output of female authors is also significantly different from that of male authors at institutions of the same level, and the difference at core institutions is greater. In terms of influence, the influence of male authors is slightly higher than that of female authors at core institutions, while that of female authors is slightly higher than that of male authors at non-core institutions.

Dynamic evolution of output and influence and gender difference in Top10 countries

To further explore the dynamic evolution law of output and influence of male and female authors with career development, we first counted the average career length of male authors and female authors. The average career length of males is 2.64 years longer than that of females. Male authors can have careers of up to 73 years compared with 39 years for female authors. Almost all of those whose career length is more than 40 years are Americans.

Dynamic evolution of output and influence

The output of male and female authors at different stages of their careers was studied by comparing the number of publications and using SPSS for the regression analysis of the dynamic evolution of output, as shown in Figure 5(a). The number of publications by women in SPSS fitting is y1 and the female career is x1 in the curve equation of $y_1 = 9376.25 + 2520.52 * \ln(x_1)$. The curve equation between the number of male publications (y_2) and male career (x_2) is $y_2=27850.01 + -7105.97 * \ln(x_2)$. Both fitting curves are logarithmic functions with negative logarithmic coefficients, which indicates that the output of male and female authors decreases logarithmically with the growth of career age.

The influence of male and female authors at different stages of their careers was studied by comparing the citation frequency of each paper. Due to the lack of papers published by female authors after 38 years of a career and the few papers published by male authors, the fluctuation of citation frequency is so large that the results are not representative. Therefore, only the influences of papers published in the first 38 years of a career are compared here.

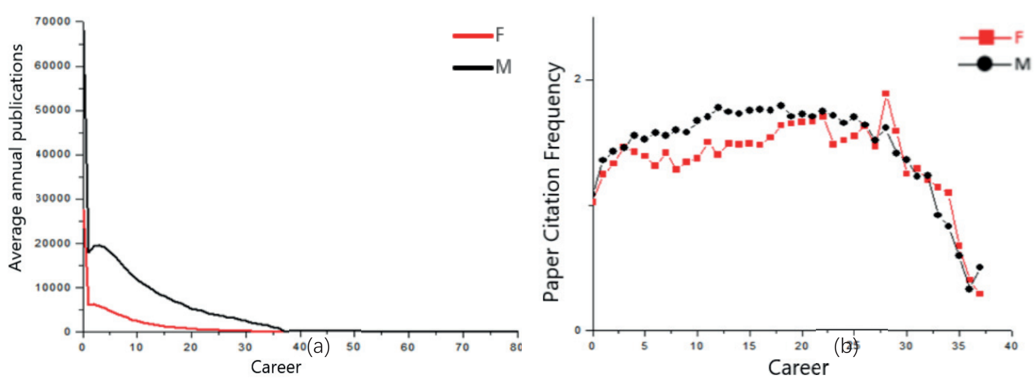

Figure 5 The dynamic evolution of the output(a) and the influence(b)

As shown in Figure 5 (b), the influence of male and female authors shows a trend of fluctuation with the development of the career; on the whole, men and women reach peak influence approximately 20 years into their careers, and their influence declines rapidly in the next fifteen years. However, the influence of female authors is significantly higher than that of male authors in the first 28 years of a career, and after that point, the influence of female authors is slightly higher than that of male authors, which is very unexpected. Part of the reason for this phenomenon is that women have higher qualifications and gradually gain more influence in the later stages of their careers. It indicates that women still have a higher influence even though the number of women is relatively small.

The proportion of female authors in the TOP10 countries

This section expands on the analysis of section 4.1 to further explore the gender disparities of output and influence in different countries. The number of papers published in all countries was calculated in this study. To make the data more representative, only the papers published in the top 10 countries were statistically studied for gender disparities. These ten countries are the United States, Great Britain, Germany, Canada, Spain, Australia, Italy, Italy, France, the Netherlands and China, and they are referred to as the TOP10 countries henceforth.

We firstly count the proportion of men and women in the TOP10 countries. The result shows that there are more male authors than female authors in all countries, and the proportion of female authors is between 20% and 40%. Spain and Italy have the highest proportion of female authors at 38%, and China has the lowest proportion of female authors at 24%.

Gender disparities in output and influence of the TOP10 countries

As shown in Figure 6, the output of men in the TOP10 countries is more than twice that of women. The output of American male and female authors is significantly higher than that of authors from other countries. Outside the USA, there is a small gap between the influence of male and female authors in the rest of the nine countries.

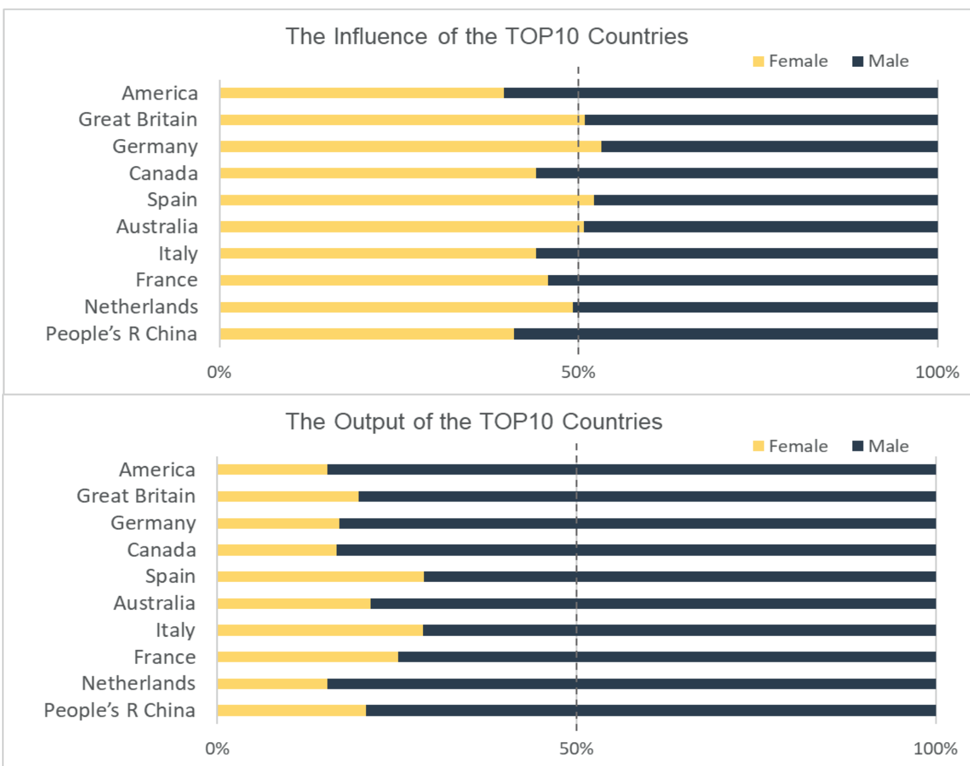

Figure 6 Output and influence of the TOP10 countries

In Great Britain, Germany, Spain, and Australia, the influence of male authors is even lower than that of female authors, although the number of published male authors is almost twice as much as the number of published female authors. Although the number of women is only about a quarter of the number of men, the influence of female authors' achievements is relatively outstanding in the field of scientific research. This result is consistent with the result in different institutions.

Research on the cooperation mode with gender disparities

Analysis of centrality in a cooperative network

This paper uses degree centrality as an indicator to measure the importance of authors in cooperative networks (Liu Zhi peng, Zeng Yi, Wang Ting, 2014). Scholars with a high degree of centrality are considered important central people in the cooperative network. The average centrality of female authors was 2.90 and that of male authors was 3.40. This indicates that male authors have a higher influence than female authors in the network of scientific cooperation in the field of economics. The top 10 authors in the centrality ranking are all male, and their centrality is higher than 100. The highest author has a centrality of 204, which is enough to prove that male authors with leading positions in the cooperation network play an important role in discipline construction and information dissemination in the field of economics.

In addition, author's paper contribution rate is another way to measure scientific research output. The paper contribution rates of male and female authors were calculated according to formula 2.3. The average paper contribution rate of female authors is 0.47, which means that the output per female author is approximately 0.47 articles. The average paper contribution rate of male authors is 0.51, which means that the output per male author is approximately 0.51 articles. It is concluded that the average contribution of male authors is higher than that of female authors.

Analysis of output and influence in different cooperation modes

The output and influence of different gender combinations were analysed. If dividing the combination into three forms, MM indicates male cooperation—that is, if all authors of a paper are male; FF indicates female cooperation—that is, all authors of a paper are female; FM indicates at least one male and one female author of a paper. The proportion of each combination is shown in Figure 7. Thus, male authors' communication dominates the cooperation network of economic research. Men have obvious advantages in establishing relations with those in the core academic field, which has long been dominated by men.

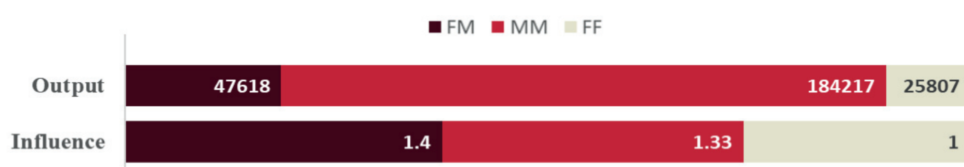

Figure 7 Disparities in output and influence under different group combinations

Comparing the average citation frequency of the articles, it can be seen that the paper citation frequency in the FM group can reach 1.40, which means the papers published by FM groups are more likely to be cited and have the highest influence. The MM group, with a paper citation frequency of 1.33, follows the FM group closely, and the paper citation frequency in the FF group is 1.00. This suggests that the participation of the opposite sex in a team is conducive to improving the influence of scientific research results. Therefore, it is necessary to encourage more female authors to participate in scientific cooperation and establish cooperative relations between male and female researchers.

Conclusion

This paper makes a powerful quantitative analysis of the gap between male and female authors from such aspects as the number of male and female authors, output and influence of different journals and institutions, career, dynamic evolution of output and influence, and cooperation mode of gender difference.The results show that male authors dominate in the scientific research field because of their high output and influence. However, although the number of female authors is only about a quarter of the number of male authors, female authors do not lag behind and even score higher than male authors in regard to the influence of their scientific research. In addition, the influence of research results is enhanced by the participation of women. As a result, the important role of female scientists in scientific research cannot be ignored. The significant gap between male and female authors in science is reflected in every country, but the gap is relatively smaller in places such as Europe and South America, which is due to a series of policies that encourage women to participate in scientific and technological activities. Academia needs to focus on diversity in academia and give scholars more equal opportunities. Countries should work together to adopt policies that support families so as to reduce women's family burdens and provide more opportunities for women to realize self-worth, which will be of great help in arrowing the status gap between men and women and in the balanced development of entire scientific research fields. This paper only studies the gender difference in the field of economics and has not covered all disciplines, so the research results have some limitations. Since the distribution of scholars is closely related to academic characteristics, in order to deeply explore the disparities between male and female scholars, data from other disciplines should also be analyzed in future work, which will provide more comprehensive data support for science and technology policymakers.

Acknowledgments

This research received the financial support from National Science Foundation of China: Study on the Structure and Evolution of the Scientific Collaboration Network of Academicians from the Perspective of Symbiosis: A Case Study of Academicians of CAS and NAS under grant number 71603015. Also supported by the Natural Science Foundation of Beijing, China (Grant No. 9182001). Our gratitude also goes to the anonymous reviewers for their valuable comments.

References

Caron, E., & van Eck, N. J. (2014). Large scale author name disambiguation using rule-based scoring and clustering. In Proceedings of the 19th international conference on science and technology indicators (pp. 79-86).

Danell, r. & Hjerm, m. (2012). Career prospects for female university researchers have not improved. *Scientometrics*. 94, 999-1006.

Fox, m. f. Gender. (2005). Family characteristics and publication productivity among scientists. *Social Studies of Science*. 1(35), 131-150.

Garg K C,Kumar s. (2014). Boston profile of Indian scientific output in life sciences with a focus on the contributions of women scientists. *Scientometrics*. 98, (pp.1771-1783).

Guglielmi, Giorgia. (2018). Gender bias tilts success of grant applications. *Nature*. 554(7690), (pp.14-15).

Jin bihui, Wang Shouyang, Ren Shengli, Liu Yajuan. (1999). On the relationship between journal influencing factors and academic quality of papers. *Monograph and review*. 11(4), (pp.202-205).

Larivière, V., Ni, C., Gingras, Y., Cronin, B., & Sugimoto, C. R. (2013). Bibliometrics: Global gender disparities in science. Nature, 504(7479), (pp.211-213).

Li Lexuan, Wen ke. (2008). Review and enlightenment of foreign policies and measures to promote women's participation in science and technology. *Journal of China women's university*. 20(6), (pp.75-80).

Lin Ju-ren. (1997). Introduction to research on gender differentiation in science. *Collection of women's studies*. (2), (pp.49-53).

Liu Zhipeng, Zeng yi, Wang ting. (2014). Coauthor network data model construction and core author mining research. *Software guide.* 12, (pp.141-143).

Ma Ying, Zhao Yandong, Gong Xu, Sun Li, Zheng Yonghe. (2018). Close the gender gap in Chinese science. *Nature*. 557(7703), (pp. 25-27).

Mauleo ́ n, E. & Bordons, m. (2006). The Productivity, impact and publication habits by gender in the area of materials science. *Scientometrics.* 66(1), (pp.199-218).

Pang Jingan. (1999). Research methods of scientific metrology. *Beijing: science and technology literature publishing house.*

Preston A E (1994). Why have all the women gone? A study of exit of women from science and engineering professions. *American Economic Review.* 84, (pp.1446-1462).

Rauber, M. & Ursprung, H.W. (2007). Life Cycle and Cohort Productivity in Economic Research: The Case of Germany. *CESifo Working Paper.* 9(4), (pp.2-46).

Sax, L. J. & Hagedorn, l. s.,& Arredondo, m.,& Dicrisi F.A.R. (2002). Faculty Research Productivity Exploring the Role of Gender and family-related factors. *Research in Higher Education.* 43(4), (pp.423-446).

Schiebinger, Londa. (2014). Scientific research must take gender into account. *Nature.* 507(7490), (pp.9-9).

Shi Yuantao, Chen Xueling. (2011). Exploration of the mystery of scientific research output of female scientists from the perspective of gender difference -- based on an empirical survey in Hubei province. *Journal of China women's university*. (2), (pp.60-65).

Sotudeh, H. Khoshian n. (2014). Gender disparities in science: The case of scientific productivity in nano science & technology during. *Scientometrics.* (98), (pp.457-472).

Sugimoto Cassidy R. Lariviere, Vincent. Ni. (2013). Chao qun Gingras Yves, Cronin, Blaise. Global gender disparities in science. *Nature.* 504, (pp.211-213).

Svein Kyvik, Mari Teigen. (1996). Child Care, Research Collaboration, and Gender Disparities in Scientific Productivity. *Science Technology Human Values.* 21(1), (pp.54-71).

Xie Yu, & Shauman K. A. (1998). Sex Disparities in Research Productivity: New Evidence about an Old Puzzle American. *Sociological Review.* 68(6), (pp.877-870).

Yuan Yuzhi. (2017). Analysis on gender difference in scientific research output of university teachers and its causes -- based on the empirical analysis of pedagogical teachers in a research university. *Exploration of higher education.* (3), (pp.5-12).