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Bibliometric analysis of gender-specific aspects of publication behavior at Technical University Ilmenau

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Various studies show that there are gender-specific differences in the productivity of scientists. In this paper, bibliometric data from the TU Ilmenau between 2012 and 2021 are examined for gender-specific differences. The results show that women are underrepresented in all areas at the TU Ilmenau and that their gender has a negative influence on the publication frequency but not on the citation rate. These differences can be mitigated by other factors such as the research area (faculty) or the title of the employee.
Keywords: *Gender analysis, Productivity analysis, Citation analysis, Collaboration analysis*

1. Introduction

Identifying factors associated with research performance and productivity is the subject of extensive research in higher education. In conjunction with this, scientific studies have shown that there is a difference in productivity between male and female researchers. While the total number of female doctoral students has increased in recent years, women remain underrepresented in many university positions. Some studies conclude that women are, on average, less productive (i.e., they publish less than men). In addition, other studies suggest that men are cited more often than women. On the other hand, there are studies that fail to detect these differences. Although academic and political attention to structural and cultural barriers affecting women's professional success is

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increasing, many actors continue to rely on individual-meritocratic explanations for the gender gap in science.

Related Work

Beginning in 1975 with Harriet Zuckermann and Jonathan R. Cole (see Zhang et al. [1]), the first studies of the relationship between gender and research performance, which focused primarily addressed possible explanations for the low productivity and citations of female researchers. These findings gave rise to the so-called "productivity puzzle" according to which women publish less than men for unknown reasons [2].

Various studies repeatedly attempted to find reasons for the lower productivity of women. For example, Jadidi et al. [3] found that women are more likely than men to drop out of their scientific careers, resulting leading to a higher number of male senior scientists, and that the gender difference almost completely disappears when comparing female and male scientists at the same career age.

Another reason cited is differing family responsibilities [4]. However, the disagreement in the literature as to whether differences in productivity are due to gender and, if so, how pronounced they are, as a literature review by Nielsen [5] suggests.

Another characteristic that could shed light on underlying gender inequality is part-time work. In a Europe-wide comparison, women are more often employed part-time than men. While in 2019, 22.8% of women were employed part-time in scientific jobs, the corresponding figure was 12.1% for men [6].

The European Commission publishes "She Figures" every three years to monitor the current state of gender equality across Europe in research and innovation. This report shows that in 2018, women in Europe represent more than half (54%) of students and 59% of graduates, as well as 47% of academic staff at grade C. Women's representation is declining in B grade (40%) and A grade (26%) positions. This condition has changed little between 2015 and 2018 [6].

In this paper, bibliometric data from the TU Ilmenau between 2012 and 2021 are examined for gender-specific differences. The data for this work was extracted from the Web of Science. The specific aspects of the data such as the assignment of scientists to the respective fields, institutes and faculties in which they work or were working at the relevant time, their position and gender were the subject of previously conducted research. The underlying database structure is shown in Figure 1.

This database structure was supplemented by the assignment of the gender of the scientists, which was determined on the basis of existing first name directories. Data records that were not clearly identifiable, especially from China and the East Asian region, had to be supplemented manually.

In order to analyze the publication performance of scientists at the TU Ilmenau, it was first necessary to identify the appropriate bibliometric indicators. For this purpose, a literature analysis according to Webster and Watson [7] in the Web of Science (WoS) was carried out with the search terms "gender" in combination with "collaboration patterns",

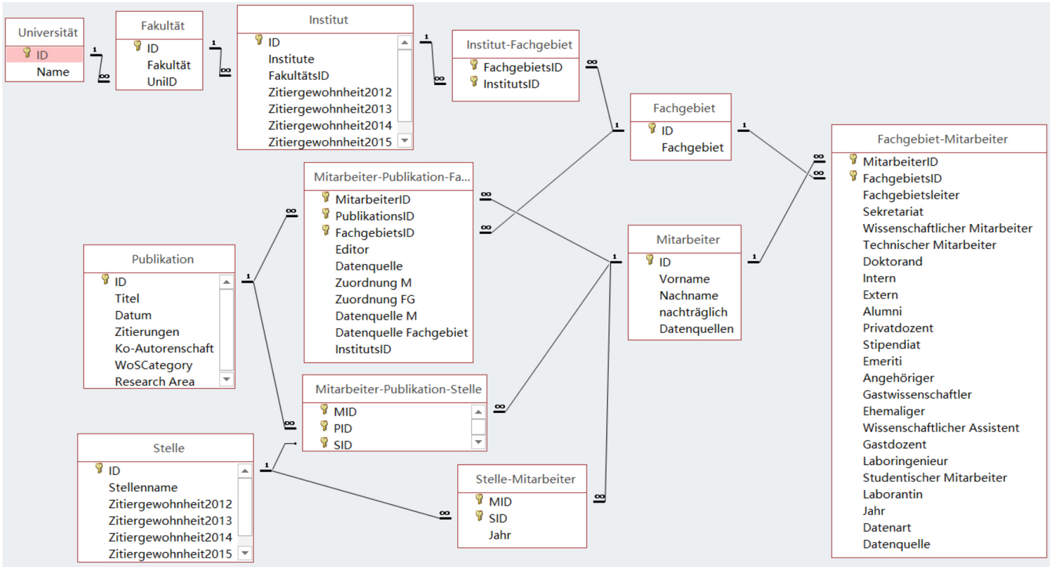

Figure 1

Database structure

"co-authorship", "research productivity" or "citation rate "in the period from 2012 - 2022. As a result, a concept matrix was created that allowed for a structured overview of different bibliometric studies on gender differences. The concept matrix was further used to find relevant indicators for the analysis on the one hand and to determine which variables besides gender are relevant for analyses on the other hand.

The main points of study that emerged were:

- The type of analysis, where a distinction was made between analysis by: Collaboration, Productivity, and Citation.
- The description of the origin of the data, as well as the number of publishers and publications studied.
- Detailed information about the study conducted, such as the country studied; the discipline; the type of document studied and whether a differentiation of document types was made; the definition of productivity, if any; and the study period.
- The methodology used to conduct the study based on the calculations used; the time-related decision, i.e., whether to analyze the data continuously (across all years) or annually; and how to handle co-authorships ("whole count," "fractional count," "first author").
- And which variables were included in the data analysis (Subdivided into: "gender"; "rank"; "age"; "specialization/discipline"; "collaboration"; "other".

Data analysis and results

As a result of the analysis of the found literature, evaluation and processing of the database, a number of research questions were developed, which were substantiated with hypotheses, which are divided into the following parts:

- Productivity Analysis,
- Citation Analysis, and
- Collaboration Readiness.

The selection of analysis methods is based on the methods used in the studies from the results of the literature analysis. For nominal scaled variables the Mann-Whitney-U test is chosen and for ordinal scaled variables the Kruskal-Wallis test is used, because there is no normal distribution in the available data. For comparison of ordinal scaled variables, the Pearson Chi-square test is applied. Finally, multiple regressions are performed to explain the strength of each variable studied in context.

All statistical analyses were prepared with Microsoft Excel and performed with the SPSS software. All subsequent results are considered statistically significant at $p<0.05$.

Publication behavior

Initially, we examined the publication behavior of employees in relation to gender. For this purpose, the full-time employees and their publication output were analyzed. Over the last ten years, the total number of employees has remained relatively constant, ranging between 707 and 794 employees. At the start of the measurement in 2012, the proportion of women was 19%, increasing to 23% over the years. Since the proportion of women remains consistently below 40%, it can be inferred that women are underrepresented at TU Ilmenau. However, with an increase of approximately 4%, it is not yet possible to identify a trend,

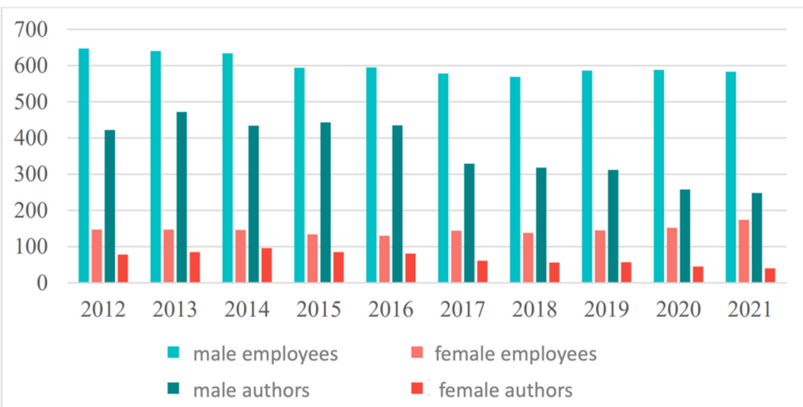

Figure 2

Comparison of Employees and Authors

given the short time period or the small difference, as a 1% increase in the proportion of women corresponds to approximately seven employees.

From Figure 21, it can be seen that the number of authors has decreased over the years. While 500 people published in 2012, only 288 did so in 2021. Despite the declining number of authors, the proportion of female authors remains about the same. The average proportion of women in this table is 15.6%, which is 4.4% lower than the proportion of women among employees. In 2014, the proportion of female authors was the highest at 18.0%, while in 2021 it was the lowest at 14%.

Productivity

Productivity is determined by the number of publications per author. In order to first find out whether there is fundamentally a difference between the sexes, the following hypothesis is tested:

Hypothesis 1: There is a difference between male and female authors with regard to the publication rate.

Figure 2 shows the average publication rate of authors between 2012 and 2021. The first thing that stands out is that although the number of authors has decreased over the years, the publication rate has remained roughly the same, or even increased from 2017 onwards. It should be noted that the database was updated in two stages, in a first step until 2016 and then until 2021. The type of data collection and processing may be responsible for this difference.

This figure also shows a difference between the sexes, with female authors having a lower publication rate in every year than the male authors. The median publication rate for authors is 3.31 publications and for 2.26 for female authors, with the publication rates

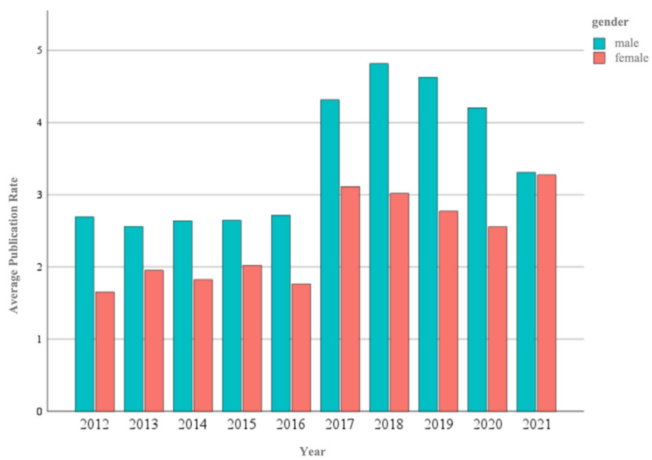

Figure 3

Comparison of publication performance 2012-2021

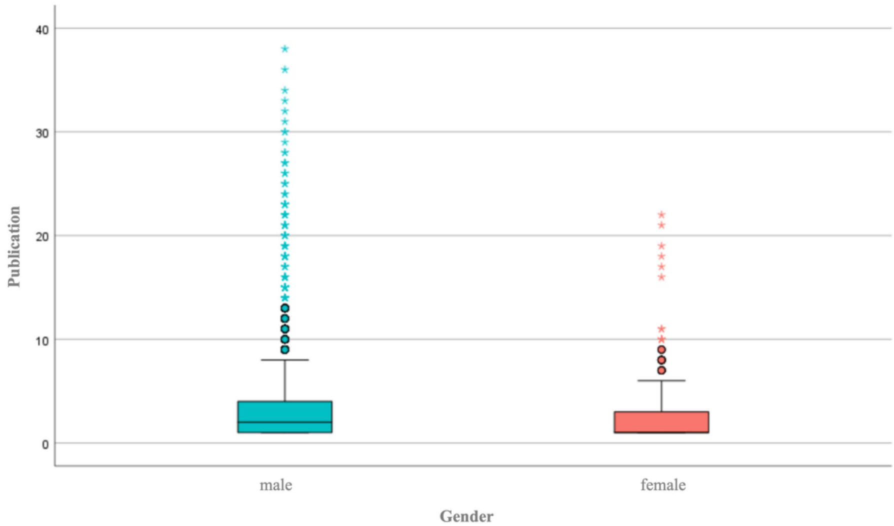

Figure 4

Number of publications by gender (including outliers)

almost balanced in 2021. One attempt to explain the different publication rates of male and female authors is that the variance of 15.89 for male authors is significantly greater than that of 5.54 for female authors. Figure 4 graphically depicts these deviations from the mean. It can be seen that authors not only have more outliers than female authors, but also that the outliers are further away from the mean than those of female authors. This result is in line with evaluated studies [8].

To determine if the differences between male and female authors, in terms of publication performance are significant, a Mann-Whitney U test is performed with the number of publications per year as the dependent variable and gender as the independent variable. The following null hypothesis arises:

H_0: *There is no difference in publication rate between female authors and male authors.*

Table 1 displays the results of the significance test annually from 2012 to 2021, and at the end of the table, the overall result across all years.

Table 1

Mann-Whitney-U-Test publication performance (* = p<0,05)

Year	Male	Female	Sum (N)	z	R	Asymtotic significance
2012	422	78	500	-2,701	0,121	0,007*
2013	472	85	557	-1,678	-	0,093
2014	434	96	530	-2,085	0,091	0,037*

Contd...

2015	443	85	528	-1,449	-	0,147
2016	435	81	516	-2,06	0,091	0,039*
2017	329	61	390	-1,607	-	0,108
2018	318	56	374	-2,901	0,150	0,004*
2019	312	57	369	-2,196	0,114	0,028*
2020	258	45	303	-3,295	0,189	<0,001
2021	248	40	288	-0,607	-	0,544*
Total	1163	270	1433	-3,551	0,094	<0,001*

The results show that there is a significant difference between male and female authors in six of the ten years studied. The difference between female and male authors is also significant across all years. The effect size (r) is calculated with the following formula:

$r = \left| \frac{z}{\sqrt{N_i}} \right|$ (z is readable from the table 1 and N_i is the sample size in the special year i)

We distinguish between a small effect size ($|r| \geq 0.1$), a medium effect size ($|r| \geq 0.3$), and a large effect size ($|r| \geq 0.5$) [9]. The effect size is calculated only for the significant years.

For the significant years, the effect size ranges from 0.091 to 0.189. Thus, gender has an influence on publication frequency in these years, but only with a small effect size. Consequently, the null hypothesis can be rejected for the years 2012, 2014, 2016, and 2018 to 2021. The null hypothesis cannot be rejected for the remaining years (2013, 2015, 2017). One reason for the small difference between genders could be the previously mentioned variance disparity.

Further factors influencing productivity differences: title and position

The results of the literature review showed that in a number of publications [10-20] the title (also to be considered as a euphemism for position within a research group, e.g., subject area leader or research group leader) may be another factor influencing publication performance. Therefore, we will explore two additional hypotheses below:

Hypothesis 2: There is a correlation between authors' gender and title.

Hypothesis 3: There is a difference between titles in terms of publication performance.

The authors were assigned the corresponding title, distinguishing between the academic titles professor and doctor and authors without title. The corresponding null hypothesis to be tested is:

H_0 = *There is no correlation between gender and authors' title.*

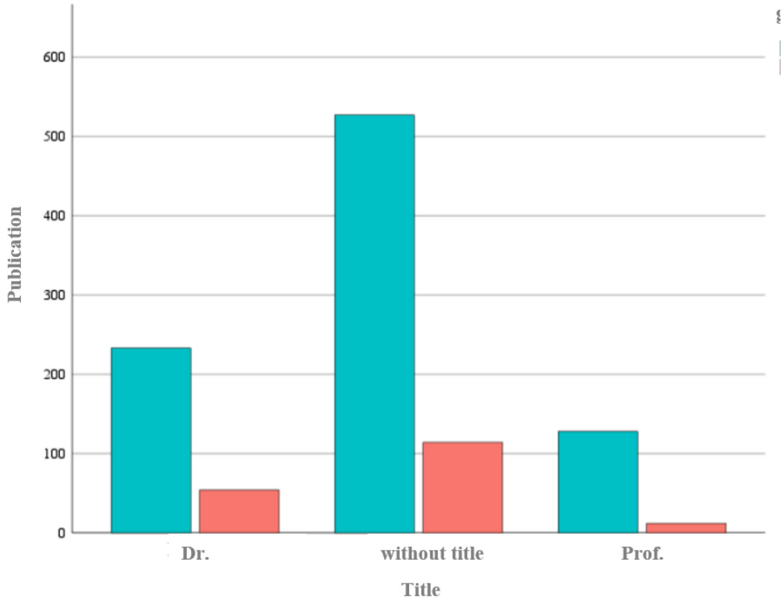

Figure 5

Distribution of the variable "Title"

Figure 5 illustrates the frequency of the individual titles in the dataset. In order to determine a significant correlation between gender and the title of the authors, a chi-square test was performed. Through this test it could be determined that the title of the scientists is related to the gender (p=0.021).

Table 2

Cross table Title*Gender

Title		male	female	Total
Doctor (Dr)	Number	233	54	287
	% of Title	81,2	18,8	100
without title (wt)	Number	527	114	641
	% of Title	82,2	17,8	100
Professor (Prof)	Number	126	12	138
	% of Title	91,3	8,7	100
Total	Number	886	180	1066
	% of Title	83,1	16,9	100

To calculate the strength of the correlation, the Cramer V value was included in the analysis [21]. This value is 0.085 (p=0.021), meaning that there is a weak significant correlation. With this value, the result is considered significant and the null hypothesis can be rejected. Thus a correlation between the gender of the authors and their assigned title could be verified.

Thus, we are able to test whether the title also has an influence on the publication performance.

The corresponding null hypothesis is:

H_0 = *There is no difference between titles in terms of publication performance*

To test the hypothesis, a Kruskal-Wallis-test was performed. The results of the test are shown in Table 3. In addition, the effect size was added to the table. Furthermore, the effect size does not refer to the overall correlation between title and publication frequency, but to the significance between the individual groups (wt-Dr; wt-Prof; Dr-Prof). The reason for the group comparison is that the Kruskal-Wallis test alone, can only detect a general relationship [22]. To determine whether significance might depend on only one group, a group comparison was performed.

It is evident that the title in general has a significant impact on the publication performance in each year. However, in 2017, 2018 and 2019 the groups (wt-Dr) is not significant. Furthermore, the effect size between the groups wt-Prof is the highest and that between the groups Dr-Prof is mostly higher than between the groups wt-Dr. This indicates that the title of professor has a higher influence on the publication performance than the other titles.

Table 3

Kruskal Wallis-Test publication performance (* = p<0,05, the group significance is sorted by: wt-Dr; wt-Prof; Dr-Prof; n.s. = non significance, wt= without title)

Year	N	Kruskal Wallis-H	df.	Asymtotic significance	Effect size
2012	458	59,834	2	<0,01*	0,199; 0,434; 0,27
2013	511	53,636	2	<0,01*	0,159; 0,387; 0,26
2014	477	66,361	2	<0,01*	0,18; 0,459; 0,308
2015	477	56,517	2	<0,01*	0,163; 0,416; 0,285
2016	481	70,962	2	<0,01*	0,232; 0,452; 0,255
2017	325	26,093	2	<0,01*	n.s.; 0,35; 0,222
2018	303	21,468	2	<0,01*	n.s.; 0,333; 0,219
2019	267	19,347	2	<0,01*	n.s.; 0,331; 0,220
2020	223	25,470	2	<0,01*	0,217; 0,425; 0,207
2021	188	166,613	2	<0,01*	0,118; 0,316; 0,199
Total	1066	199,288	2	<0,01*	0,312; 0,444; 0,228

By analyzing the last three hypotheses, it can be concluded that the title can explain part of the gender-specific differences in productivity. It could be shown that female and male authors with the title of professor have a higher publication performance, but only 8.7% of female authors hold such a title. This implies that the productivity of female authors may be lower, as they are less represented in the most productive title.

Further factors influencing productivity differences: research area (faculty)

Another important factor influencing publication performance has been identified in a number of studies [23, 12, 24, 15, 17, 18, 20, 25, 1] as the research area. In our study we use the affiliation in a department – in German *faculty* – as indicator for the research area. For this purpose, the faculty is examined as an independent variable, on the one hand for a possible correlation between the faculties and the gender, on the other hand whether the respective faculties show an influence on the publication performance. The hypotheses to be examined are as follows:

Hypothesis 4: There is a correlation between gender and the research area (faculty) in which the authors work.

Hypothesis 5: Faculty has an influence on publication frequency.

Figure 6 shows that most of the authors belong to the faculties EI and IA. The smallest number of authors can be found in the faculty WM. At the same time, it can also be seen in this graph that there are more publishing authors than female authors in each faculty.

Figure 6. Employees per Faculty (EI=Department of Electrical Engineering and Information Technology, IA=Department of Computer Science and Automation, MB=Department of Mechanical Engineering, MN=Department of Mathematics and Natural Sciences, WM=Department of Economic Sciences and Media)

The null hypothesis to be tested is:

H_0: *There is no correlation between gender and the faculty in which the authors are employed.*

Table 4

Cross table Faculty*Gender

Faculty		Male	Female	Total
EI	Number	291	56	347
	% of Faculty	83,9	16,1	100
IA	Number	208	38	246
	% of Faculty	84,6	15,4	100
MB	Number	200	28	228
	% of Faculty	87,7,3	12,3	100

Contd...

MN	Number	138	35	173
	% of Faculty	79,8	20,2	100
WM	Number	49	23	72
	% of Faculty	68,1	31,9	100
100	Number	886	180	1066
	% of Faculty	83,1	16,9	100

Analogous to hypothesis two, a chi-square test is performed for hypothesis four, with faculty and gender as variables to be examined. The significance is p=0.002. The strength of the correlation calculated with Cramer V is 0.126 (p=0.002), which means that there is a weak, significant correlation. Thus, the null hypothesis can be rejected and there is a correlation between gender and faculties.

In the next step, the Kruskal-Wallis test is used to test whether the faculty has an influence on the publication frequency. The null hypothesis to be tested is:

H_0 = *The faculty has no influence on the publication frequency.*

Table 5 presents the results of the test. The results are only significant for the years 2012 to 2017 and the overall evaluation. Table 5 only shows the effect sizes of the significant groups. This shows that there are significant differences between the WM faculty and the other faculties. However, it should be noted in the analysis that the sample of the WM

Table 5

Kruskal Wallis-Test Publication Faculty (* = p<0.05)

Year	N	Kruskal Wallis-H	df	asymtotic significance	Effect size
2012	458	14,624	4	0,006*	WM-EI: 0,156; WM-MN: 0,196
2013	511	20,370	4	<0,001*	WM-EI: 0,245; WM-MN: 0,36
2014	477	28,151	4	0,002*	WM-EI: 0,262; WM-MN: 0,336; IA-EI: 0,198; IA-MB: 0,188
2015	477	15,971	4	0,003*	WM-EI: 0,233; WM-MN: 0,277
2016	481	14,285	4	0,006*	WM-MN: 0,26
2017	325	11,238	4	0,024*	n.s.
2018	303	5,520	4	0,238	n.s.
2019	267	5,127	4	0,274	n.s.
2020	223	7,322	4	0,120	n.s.
2021	188	8,683	4	0,070	n.s.
Total	1066	43,028	4	<0,001*	WM-IA: 0,199; WM-MB: 0,266; WM-EI: 0,282; WM-MN: 0,362; IA-EI: 0,135; IA-MN: 0,158

faculty is significantly smaller, which may be a reason for the results, as the size of the samples is part of the calculation.

The variables tested so far do not occur in isolation from each other in reality and accordingly cannot be considered exclusively in isolation. Although the analyses so far represent correlations between variables, the exact magnitude of the influence of the variables that achieved significant results in the previous analyses is therefore tested in a multiple linear regression according to the following model:

$$Yi = \beta 0 + \beta 1\text{Dfemalei} + \beta 2\text{Ddri} + \beta 3\text{Dprofi} + \beta 4\text{Diai} + \beta 5\text{Dmbi} + \beta 6\text{Dmni} + \beta 7\text{Deii}$$

The dependent variable Yi is the publication frequency per year. Since the independent variables are scaled nominally and ordinally, dummy variables are created so each expression of the variableis coded (0;1). The first independent variable that enters the analysis is gender (categories male and female). Male is considered the reference category and female (Dfemale) enters the analysis. The title of the author enters the analysis, whereby authors without a title are considered the reference category and the titles doctor (Ddr) and professor (Dprof) enter the analysis. Finally, the faculties (Die, Dia, Dmb, Dmn) enter the analysis, with the faculty WM as the reference category.

Table 6 presents the results of the regression as an example for the year 2012. First of all, it is noticeable that all variables continue to have a significant influence on the frequency of publication. The regression coefficient of the variable female is negative, which means that the female gender has a negative effect on the publication frequency and thus women publish less than men. However, the difference is small at 0.825 units. The title of professor continues to have the greatest influence; female authors with this title publish an average of 3.321 units more than those without the title. The model itself describes 19.2% of the variance of the dependent variable.

Table 6

Multiple regression publication frequency, example for 2012 (* = p<0.05)

Non-standardised coefficients			Standardised coefficients		
Regression coefficient β		Std. failure	Beta	T	Sig.
(Constant)	0,164	0,587		0,280	0,780
Dfemale	-0,825	0,365	-0,097	-2,264	0,024*
Ddr	1,011	0,295	0,157	3,423	<0,001*
Dprof	3,321	0,357	0,428	9,311	<0,001*
Dei	2,163	0,594	0,344	3,643	<0,001*
Dia	1,379	0,623	0,187	2,216	0,027*
Dmb	1,477	0,619	0,199	2,386	0,017*
Dmn	1,600	0,634	0,197	2,525	0,012*
R = 0,438; R^2 = 0,192					

The comparison of the various results over the years 2012-2021 and the overall evaluation shows that gender does not always have a significant influence on publication frequency. Only in 2012, 2016 and 2020 is the influence significant. The only variable that is significant across all years is the title *professor* of the author which has a positive influence on the frequency of publications. For all other variables, this statement is less certain, as it is not significant across all years. When looking at the faculty, it can be seen that although it is not significant across all years, the regression coefficient is exclusively positive in the significant years. This means that if the faculty has an influence on the publication frequency, all faculties publish more than the reference category WM. In conjunction with the results of the fourth hypothesis, it emerges that the faculty WM, to which more women belong than the other faculties, has a negative influence on the frequency of publication.

Citation Analysis

In the following section, we will have a closer look at the reflection of scientific output in the form of citations. Table 6 shows the mean and median values, as well as the standard deviations of the mean citation rates for the individual years. It is already noticeable in this table that the difference between the genders is less clear in the citation analysis than in the analysis of productivity. The median is higher for female authors than for male authors in 2013 and 2015. In 2012, 2015 and 2016, the standard deviation and the median of female authors is higher than that of male authors. Nevertheless, the differences are clearly more pronounced in the years in which the mean value of the authors is higher.

Table 7

Mean Citation Rate 2012 -2021

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	Mean Value									
	4,78	4,95	3,51	1,95	0,36	21,33	23,19	20,12	18,57	15,23
	Median									
	2,32	2,00	1,54	0,52	0,00	17,13	18,00	15,80	14,00	13,00
	Standard Derivation									
	6,80	21,70	5,91	4,04	0,85	16,38	21,04	19,55	24,24	16,71
	Mean Value									
	 6,65	3,89	3,24	2,00	0,60	20,99	15,20	13,17	14,65	11,37
	Median									
	2,00	2,38	1,50	0,67	0,00	16,29	13,75	9,50	9,00	2,00
	Standard Derivation									
	9,68	4,38	4,64	4,21	1,10	14,90	11,62	15,86	13,36	19,97

The process for investigating the influence of gender on the citation rate is carried out analogously to the investigations of productivity. We use also Mann-Whitney U test to check whether gender has a significant influence on the mean citation rate. As a result we found that the test is only significant for the years 2016 and 2019, and with a low effect size. For all other years, *no significant* difference could be found.

The same methodology as in the above section is used to calculate the influence of the title on the citation rate. The Kruskal-Wallis test is used to check whether there is a difference between the titles in terms of the average citation rate. As with the previous Kruskal-Wallis tests, the effect size refers to the significance between the individual groups (wT-Prof; wT-Dr; Dr-Prof). The results show that only the years 2012 to 2016 and 2019 provide significant results. Moreover, compared to the analysis of productivity, it is primarily the wT-Dr group that determines the difference. However, as in the previous analyses, the effect size is also low here. There is no significant difference for the other years.

In the next step, we examine whether there is a difference between the faculties in terms of the mean citation rate. As in the previous analysis, the Kruskal-Wallis test is performed to determine whether there is a difference between the faculties in terms of the mean citation rate. Similar to the previous analysis, only the years 2012 to 2016 are significant, but the year 2019 is not. Furthermore, we found that significance emanates primarily from the MN faculty in conjunction with other faculties. Compared to the previous results, effect sizes in this test are significantly higher. For example, in 2012 there is a strong effect (0.55) for the IA - MN group. Thus, there is only a difference between the faculties in terms of the average citation rate for the years 2012 to 2016.

Finally, the mean citation rate is tested in a multiple regression. The corresponding model is as follows, with mean citation rate per year as the dependent variable Y.

$$Yi = \beta 0 + \beta 1\mathrm{Dfemalei} + \beta 2\mathrm{Ddri} + \beta 3\mathrm{Dprofi} + \beta 4\mathrm{Diai} + \beta 5\mathrm{Dmbi} + \beta 6\mathrm{Dmni} + \beta 7\mathrm{Deii}$$

The variables gender, title and faculty are coded equivalently to the multiple regression of publication frequency. Like the results before, the model is only significant for the years 2012 to 2016. In this, gender has a positive significant impact on the mean citation rate in 2012. Furthermore, the faculty MN has a positive significant influence on the mean citation rate in the years 2012 to 2015. It should be noted that the coefficient of determination (R2) of this regression is only between 5% and 15% and thus less than 20% of the variance can be explained by the model.

h-index

Figure 7 shows the mean h-indices for the years 2012 to 2021 broken down by gender. It can already be seen here that the difference between the genders is less clear-cut than was the case in the previous analyses. In some years, the h-index of female authors is larger than that of male authors. In the years in which the authors' h -index is higher, the difference is smaller than in the previous analyses. Despite the fact that no correlation between gender and the h-index can be discerned from the graph, for the sake of completeness, a

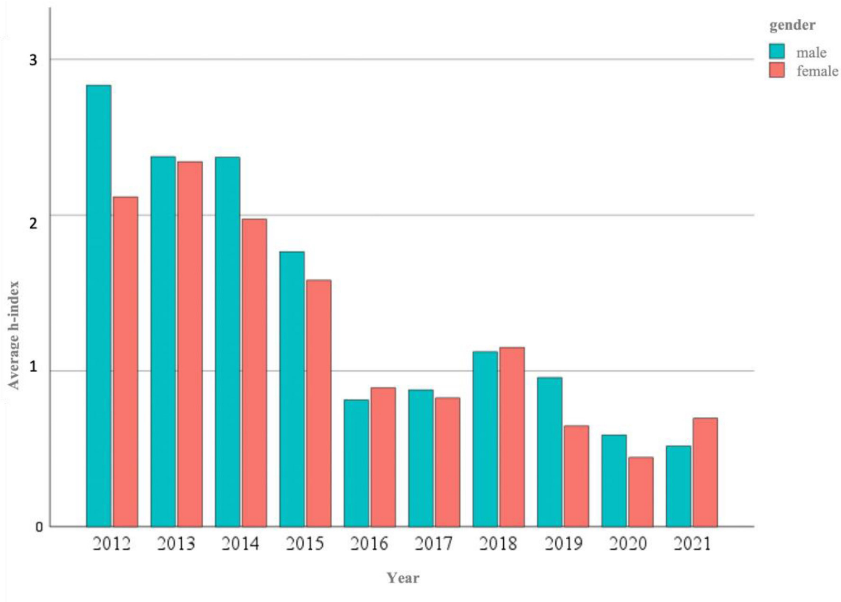

Figure 7

Mean h-indices for the years 2012 to 2021 broken down by gender

Mann-Whitney U test is used here to test whether there is a significant difference between female authors and male authors with regard to the h-index.

As a result of the Mann-Whitney U test, we found that in no year is the result significant. The conclusion from this is that, as already suspected, there is no difference between the female and male authors in terms of the h-index.

Readiness to collaborate

The literature analysis shows differences in collaboration behaviour between authors. Our available data only provide information on whether the authors under investigation collaborate or not, which severely limits the analysis. In order to check whether there is a correlation between gender and the authors' readiness to collaborate, gender is chosen as one variable with the characteristics male and female. The second variable is readiness to collaborate with the characteristics yes and no. In this context, readiness to collaborate means that the authors are at least two people when publishing. To check this, a cross-table is formed and tested for significance using the chi-square test.

Table 8 shows the results of the cross-tabulation. At this point it can already be seen that only a small number of authors publish alone. More than 99% of both female and male authors enter into a collaboration. The chi-square test is also not significant with p=0.688. Accordingly, it could not be proven that there is a correlation between gender and readiness to collaborate. With this small number of authors who do not collaborate,

Table 8

Cross table Collaboration Gender

Collaboration			**No**	**Yes**	**Total**
Gender		Number	7	1046	1053
		% of gender	0,7%	99,3%	100,0%
		Number	1	229	230
		% of gender	0,4%	99,6%	100,0%
Total % of gender		number	8	1275	1283
		0,6%	99,4%	100,0%	

an analysis of the influence of collaboration on publication frequency and citation rate is unnecessary.

Summary and future work

Main aim of this work was to analyze the publication performance of female and male scientists at the TU Ilmenau with regard to gender differences. In order to be able to analyze the available data accordingly, a literature analysis was first carried out to determine common methods of analysis. In the process, various variables were detected that we have used in the subsequent analysis.

First, descriptive analyses showed that female authors are underrepresented in all areas considered. Furthermore, the analysis of gender alone, in agreement with the literature examined, concluded that gender has a significant influence on publication frequency, while in contrast to the literature, a significant influence on the citation rate could only be determined in two years. Since gender alone is hardly meaningful, and thus cannot be considered in isolation, the influence of the research area (faculty) and the title was subsequently examined. For both variables, an influence on the publication frequency and average citation rate was initially determined and a correlation with gender was established, which is why two multiple regressions were performed. These regressions, also in line with the literature, reduced the influence of gender. In some years, the influence became so small that the results were no longer significant. Only the title was able to show a significant influence across all years and in both the publication and citation analysis. The influence of the research area could not be clearly identified; there was a significant influence of some research area, but not across all years.

In addition to the citation analysis, the h-index was analysed. No significant results could be obtained from this. Furthermore, no statements could be made about different collaboration behaviour, since 99% of the scientists collaborated.

Future Work

One aspect of the bibliometric analysis that was only marginally examined in this paper is the collaboration of authors. Further analyses that include all co-authors involved in publications could reveal possible differences in cooperation behaviour. By including all authors, it would also be possible to count the publications proportionally (fractional count) in order to include the number of co-authors in the analysis. In addition, the existing database can be supplemented with further publications from other databases, such as Scopus or from the lists of publications of the subject areas, in order to increase the amount of data and thus the sample and thus to be able to draw a better overall picture of the university. Further analyses could start at this point and identify other variables that explain the difference in productivity and citation rates. For example, the quality of the publications can be examined by including the journal.

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