Man-woman collaboration practices and scientific visibility: how gender affect scientific impact in economics and management

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Abstract

The question of the place of women in the various sciences is now widely discussed and studied. The field of economics and management is no exception and also requires a reflexive analysis of its practices. This study contributes to a better understanding of the place of women in these disciplines by characterizing the difference in levels of scientific collaboration between men and women (as measured by joint publications) in economics and management. First, the results show for the first time on an empirical basis that the practices of collaboration between men and women are quite different in management sciences compared to discipline of economics. Second, a regression analysis shows that there is a negative and statistically significant relationship between the Normalized Citation Score and the proportion of women per article in economics, which is not the case in management sciences. Results also show that international collaboration and the choice of journals significantly affect normalized citation scores.

Introduction

The question of the place of women in scientific research is widely discussed in all disciplines. The fields of economics and management are no exception and also require a reflexive analysis of its practices. Similarly, reflections on the productivity and "quality" of scientific research have become ubiquitous since the 1980s. Nowadays, no scholar can escape the evaluation of its activities (Pansu, 2013, Gingras, 2016). At the individual level, the "quality" of a scientific publication, an abstract property that some consider unmeasurable, can in fact be approached by measuring its "visibility", i.e. the number of citations it receives in publications by other members of the scientific community (Cronin, 1984). In the bibliometric literature, there are numerous analysis of scientific production both in terms of the choice of indicators and the analysis of the determinants of productivity and visibility of researchers, particularly the question of the difference between men and women (Cole and Zuckerman 1984, Xie et al., 1989, Leahey, 2006, Castilla and Bernard, 2010, Baccin et al., 2014, Mairesse and Pezonni, 2015, Nielsen, 2016, Nielsen, 2018). Despite the multiplicity of bibliometric studies devoted to the evaluation of research in economics and management, the analysis of the determinants of the visibility of articles has rarely been analyzed in these disciplines. Even less the study of the links between the impact factor of the journal, the social characteristics of the authors and the number of citations received.

Judge et al. (2007) analysis of the citation determinants of articles published in the top 21 management journals shows that the main factor in the visibility of an article is the journal in which it is published. Harzing (2016) shows that it is rather the topic studied by the article, as well as the profile of the author, that influences the visibility of publications in management. Starbuck (2005) and Singh et al. (2007) conclude that the evaluation of research articles based

solely on the impact of journals provides erroneous results as to the "quality" of publications, given intra-review variability.

With regard to the link between scientific performances and gender, several recent studies have shown that gender gaps still persist in favor of men both in terms of productivity and scientific visibility (measured by the number of citations). Nielsen (2016) analyzes gender disparities in production, impact and scientific collaboration. It examines a sample of 3,293 Danish researchers (7,820 publications) of which 65% are men and 31% are women (4% indefinite). It shows the persistence of the gender gap in these indicators. Nielsen (2016) concludes that his findings raise deep concerns about the management of research organizations, characterized by an asymmetrical gender structure. This would call into question the validity of meritocratic explanations of discrepancies. For example, the age of the beginning of a scientific career directly affects the level of production of a researcher, as well as family commitments. According to Mairesse and Pezonni (2015), the gaps in production between men and women disappear if one control for differences in access to jobs and different working conditions between men and women.

Based on an econometric study, Nielsen (2017) analyzes the differences in academic impact in management sciences by gender. In a sample of nearly 27,000 publications and more than 6,500 authors, he concludes that women have a slightly greater impact than men, while remaining cautious about the representativeness of the sample and the possibility of generalization. Similarly, women have a larger share in the decile of the most cited publications in this area. However, in a more recent publication, Nielsen (2018) considers that the mere use of quantitative indicators can be very dangerous for the recruitment and promotion of researchers. Although these indicators may appear to be objective and reinforcing the "story of meritocracy", they are often biased ex-ante by the gender barriers. According to Nielsen (2018), these indicators must absolutely be accompanied by a qualitative assessment by peers.

Based on a large sample, the present study aims to (1) investigate the practices of collaboration between men and women in economics and management and (2) its effect on scientific visibility of the publications using an econometric model (Tobit regression). Our data, extracted from the Web of Science (WoS), cover global production as indexed in 300 journals in economics and 330 journals in management, with respectively 79,078 and 90,022 articles published between 2008 and 2015. A Tobit regression model was used to measure the relations between the different variables analyzed and the normalized score of citations.

Collaboration practices in economics and management

At the global level, scientific collaboration, measured by the number of authors per article, is relatively stronger in management than in economics. The proportion of articles co-published by at least two authors is 81% in management (almost half with at least 3 authors) against 66% in economics (see Figure 1). This is a global average and the results vary somewhat by country. This is a first interesting difference between these two disciplines.

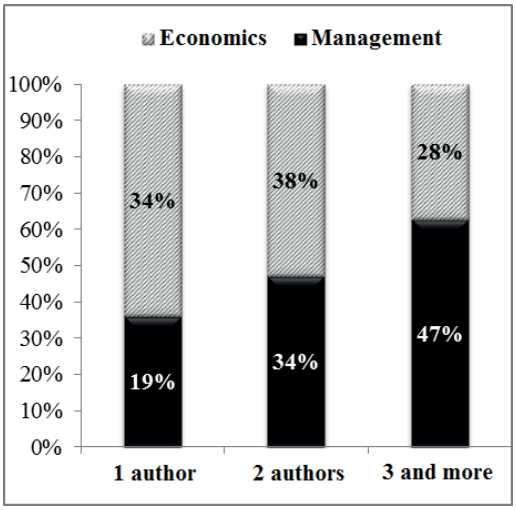

Figure 1: Number of authors per publication in economics and management

Figure 2 shows that the proportion of man-woman collaboration is much higher in management than in economics, 49% versus 27%. It also shows that the proportion of publication by women alone (without men collaboration) is three times higher in economics than in management (7% versus 21%). In economics, the majority of publications (52%) are signed by men and only 21% of women have published alone or with other women. In management, nearly half of the papers (49%) are the result of male-female collaborations. This is a second important observation on the disciplinary differences in male-female collaboration in these two disciplines.

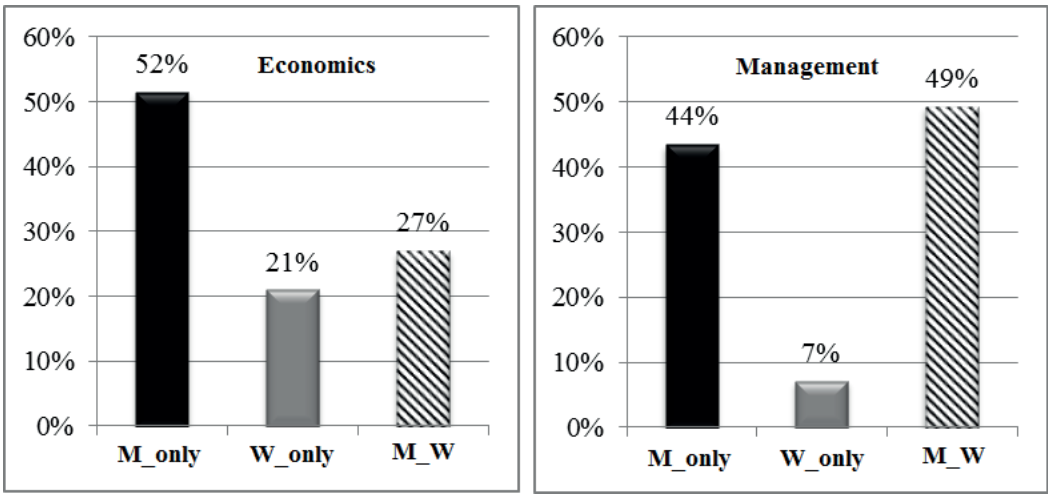

Figure 2: Collaboration between men and women in economics and management

Although the proportion of articles written in collaboration is greater in management, the distribution between national and international co-publications by gender is similar in both disciplines. This is true for co-publications that include only women, only men, or both (Figure 3). It should be noted, however, that women have a lower proportion of international publication than men.

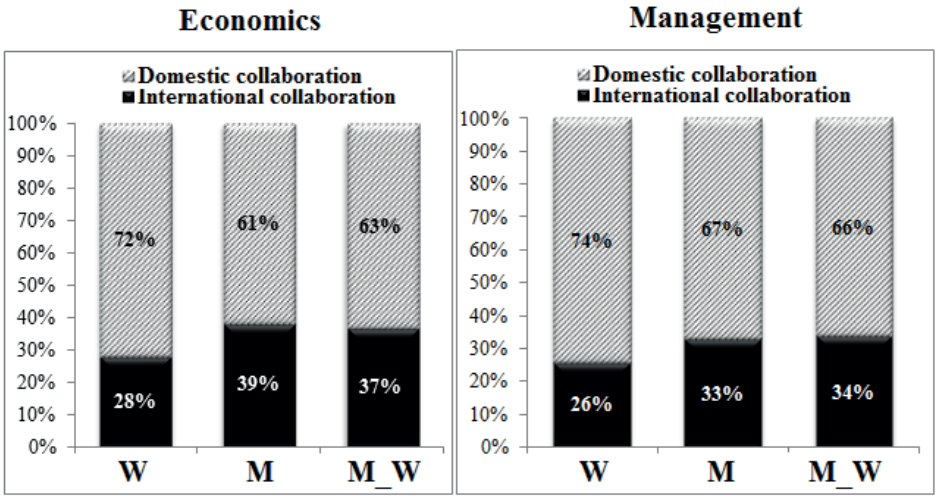

Figure 3: Proportion of articles co-authored according to the type of collaboration and gender

Figure 4 shows the gender distribution according to the CNRS classification of the journal in which articles are published. It can be seen that the proportion of articles published by women in the highest ranked CNRS journals (category 1) is slightly lower than that of men in the two disciplines, especially in management. Women in this discipline also publish more than men in journals classified in category 4, which are much less important in economics. We also observe that collaboration with men allows women to publish in higher-ranking journals.

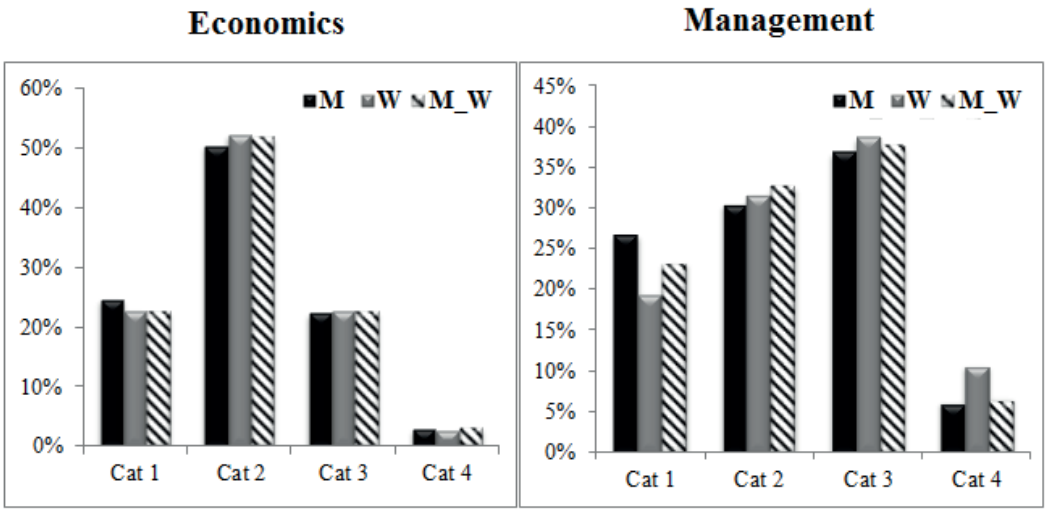

Figure 4: Proportion of articles by sex and CNRS categories of journals

Regression analysis

The database used for the regression analysis includes several information's about authors (names, gender and number), articles (publication year, title, Normalized Citation Score) and journals in which they are published (title, country of publisher, 2 years Journal Impact Factor and CNRS journal classification).

Dependent variable and model choice

The dependent variable is the logarithm of Normalized Citations Score (labelled Log (NCS)) received by each publication during the period 2008-2015. To retain the zeros, we have added 1 to the NCS before making the logarithmic transformation. Log (NCS) is a continuous variable with a lower boundary at zero and an upper boundary at infinity. Thus, a left censored Tobit regression model is used (see, McDonald and Moffitt, 1980) to account for the disproportionate number of observations with zero values, because a significant proportion of the observations in our sample are zeros. Tobit regressions avoid inconsistent estimates from Ordinary Least Square (OLS) regression.

Independent variable

In this study, we seek to analyze whether the gender of authors have an incidence on the number of citations received by scientific publications. To represent gender in scientific publications, we used the proxy of the proportion of women per publication labelled $Women\_Prop$. The authors' gender is assigned based on the methodology presented in Larivière et al. (2013), which uses the author's first name to assign a gender to them. For each of the articles in the two domains, we calculated the proportion of authors belonging to the feminine gender, using as denominator the sum of the authors to whom we assigned a gender. For example, an article with 5 authors, including two women, two men, and one unknown, was assigned a proportion of female authors of 0.5, leaving unknown cases out of the calculation. For an article co-signed by men only, the proportion is 0, and for an article whose all authors are women the proportion is 1. The values between 0 and 1 represent articles co-authored by both men and women. The higher the number of women per publication, the more the proportion is closer to 1.

For both disciplines, the proportion of women is lower than that of men. It is 32% in economics and 26% in management. These distributions are similar to the average of the global distribution of women researchers which is around 30% (UNESCO, 2018).

Control variables

A number of control variables are included in the model. The choice of control variables comes from the literature that shows that they are potentially associated with the number of citations received by publications. First, we control for the number of authors (Nbr_Authors) and the number of countries by publication, a proxy of international collaboration (Internat_collab). Second, we have controlled for the geographic origin of journals by building two dummy variables. The country of publisher was used as proxy of country of journals. US_Journal takes the value 1 if journal is American. $EU\_Journal$ takes the value 1 if journal is European. The non-American and non-European journals are the reference variables. Third, we control the impact of journals in which articles are published. In addition to the 2 years Impact Factor of the journal, we have constructed dichotomous variables to control for the journal classification of CNRS (2015). The CNRS classifies journals according to their degree of selectivity and importance in economics and management, thus providing a measure of their "quality". Four dummy variables were created. From $CNRS\_rank\_1$ that refers to the most selective journals in both disciplines, to $CNRS\_rank\_4$ that represent the least selective journals.

The regression model is written as follows:

$$\text{Log}(NCS)_i = \beta_0 + \beta_1 Women\_Prop_i + \beta_2 Nbr\_Authors_{\ i} + \beta_3 Internat\_collab_i + \beta_4 US\_Journal_i + \beta_5 EU\_Journal_i + \beta_6 IF\_2_i + \beta_7 CNRS\_rank\_1_i + \beta_8 CNRS\_rank\_2_i + \beta_9 CNRS\_rank\_3_i + \beta_{10} CNRS\_rank\_4_i + \varepsilon_i$$

Using exactly the same variables, two distinct regressions were used for both disciplines. The aim is to analyze the differences between economics and management regarding the impact of gender on the citation score. The Table 1 resumes variables of model.

Table 1: Dependent, explicative and control variables of model

Dependent variable	
$\text{Log}(NCS)_i$	Log transformed of NCS (Normalized Citations Score) by publication *i*
Explicative variable	
$Women\_Prop_i$	Proportion of women by publication. For example, for an article cosigned by 3 authors: 2 women and 1 man, the value will be 0.66 (66% of women). The value is between 0 and 1 (1 if all authors are women).
Control variables	
$Nbr\_Authors_{\ i}$	Number of authors by publication
$Internat\_collab_i$	International collaboration measured by the number of countries by publication
$US\_Journal_i$	It is dummy variable indicating the fact that the publisher of journal is American. It equal to 1 if it is.
$EU\_Journal_i$	It is dummy variable indicating the fact that the publisher of journal is European. It equal to 1 if it is.
IF_2	2 years Journal Impact Factor
$CNRS\_rank\_1_i$	It is a dummy variable representing categories 1, 1e, 1eg of the CNRS categorization of journals in Economics and Management. This category includes the most selective journals. It equal to 1 if it is, 0 otherwise
$CNRS\_rank\_2\ to\ 4$	Like $CNRS\_rank\_1$, variables $CNRS\_rank\_2\ to\ 4$ represents the journals of rank 2 to 4 of the CNRS classification. the degree of selectivity of journals decreases as the category increases

Before estimating the coefficients, we have verified the existence of multicollinearity. Multicollinearity is a problem that occurs when more than one of the model's predictor variables measures the same phenomenon. We are talking about multicollinearity when one of the explicative variables of model is a linear combination of one or more of the other variables introduced in the model. The absence of perfect multicollinearity is one of the conditions required to estimate a linear model. Two collinear variables are characterized in particular by a strong correlation. However, a strong correlation is not necessarily synonymous with collinearity. Both variables must, in addition, measure the same phenomenon. For example, the two variables $US\_Journal$ and $EU\_Journal$ are very negatively correlated (see Figure 5). This is normal since in our database a journal cannot be both American and European. On the contrary, the impact factor and the CNRS classification of journals measure more or less the same thing; the impact of journal. The difference between the two is that the impact factor is an objective measure based on the citations received by the journal, and that the CNRS classification incorporates a subjective dimension related to peer appreciation. The correlation test indicates that there is no strong correlation between the

variables of model; all the correlation coefficients are less than 0.6 (see Figure 5: the larger and darker the bubble size, the higher the correlation).

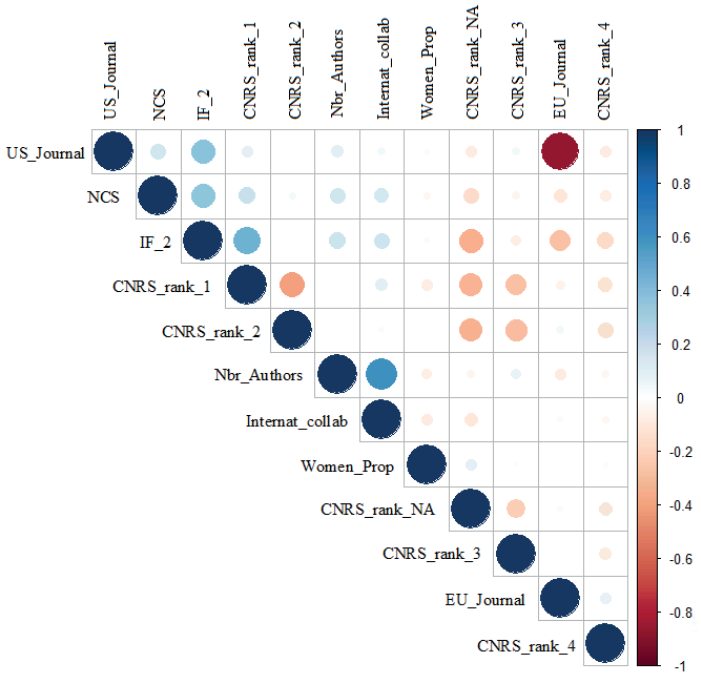

Figure 5: Correlation test of model variables

Results of regression analysis

In order to observe the interaction between the variables of the model, we chose to proceed by iteration. We can distinguish three types of explicative variables: sociological (proportion of women by publication, authors number and international collaboration), geographical (the fact that the journal is American or European) and bibliometric (impact of journals measured by Impact Factor and CNRS journal classification). This makes it possible to define three regression models; denoted respectively M1, M2 and M3. Tables 2 and 3 show, respectively, the regression results for economics and for management.

Table 2: Tobit maximum likelihood estimation, results for economics

Variables	(M1)		(M1) + (M2)		(M2) + (M3)	
	Coefficient	Pr (>|z|)	Coefficient	Pr (>|z|)	Coefficient	Pr (>|z|)
$Women\_Prop_i$	-0.065***	**$6.71e^{-13}$**	-0.057***	**$1.8e^{-10}$**	-0.034***	**$3.41e^{-05}$**
$Nbr\_Authors_{\ i}$	0.076***	**$< 2e^{-16}$**	0.065***	**$< 2e^{-16}$**	0.058***	**$< 2e^{-16}$**
$Internat\_collab_i$	0.043***	**$< 2e^{-16}$**	0.044***	**$< 2e^{-16}$**	0.011***	**0.00215**
$US\_Journal_i$	-	-	0.546***	**$< 2e^{-16}$**	0.176***	**$1.65e^{-13}$**
$EU\_Journal_i$	-	-	0.276***	**$< 2e^{-16}$**	0.107***	**$< 2e^{-16}$**
IF_2	-	-	-	-	0.290***	**$< 2e^{-16}$**
$CNRS\_rank\_1$	-	-	-	-	0.304***	**$< 2e^{-16}$**
$CNRS\_rank\_2$	-	-	-	-	0.290***	**$< 2e^{-16}$**
$CNRS\_rank\_3$	-	-	-	-	0.147***	**$< 2e^{-16}$**
$CNRS\_rank\_4$	-	-	-	-	0.010	0.55468
Wald-statistic	1425	**$< 2.22e^{-16}$**	3147	**$< 2.22e^{-16}$**	1.081e+04	**$< 2.22e^{-16}$**
Log-likelihood	$-4.901e^{+04}$		-4.818e+04		$-4.471e^{+04}$	

**** significant at 1% / ** significant at 5% / * significant at 10%.*

Tableau 3: Tobit maximum likelihood estimation, results for management

Variables	(M1)		(M1) + (M2)		(M2) + (M3)	
	Coefficient	Pr (>|z|)	Coefficient	Pr (>|z|)	Coefficient	Pr (>|z|)
$Women\_Prop_i$	-0.026***	**0.00114**	-0.026***	**2.47e-10**	0.001	0.823
$Nbr\_Authors_{\ i}$	0.040***	**$< 2e^{-16}$**	0.037***	**$< 2e^{-16}$**	0.026***	**$< 2e^{-16}$**
$Internat\_collab_i$	0.059***	**$< 2e^{-16}$**	0.062***	**$< 2e^{-16}$**	0.028***	**$5.10e^{-15}$**
$US\_Journal_i$	-	-	0.185***	**$< 2e^{-16}$**	0.086***	**$< 2e^{-16}$**
$EU\_Journal_i$	-	-	0.085***	**0.000529**	0.040***	**$1.16e^{-05}$**
IF_2	-	-	-	-	0.259***	**$< 2e^{-16}$**
$CNRS\_rank\_1$	-	-	-	-	0.201***	**$< 2e^{-16}$**
$CNRS\_rank\_2$	-	-	-	-	0.161***	**$< 2e^{-16}$**
$CNRS\_rank\_3$	-	-	-	-	0.100***	**$< 2e^{-16}$**
$CNRS\_rank\_4$	-	-	-	-	0.059***	**$2.12e^{-08}$**
Wald-statistic	1008	**$< 2.22e^{-16}$**	1592	**$< 2.22e^{-16}$**	1.081e+04	**$< 2.22e^{-16}$**
Log-likelihood	-9.039e+04		-9.01e+04		-8.314e+04	

**** significant at 1% / ** significant at 5% / * significant at 10%.*

Tables 2 and 3 show four important results that we can summarize as follows:

The impact of gender on citation scores

In economics, there is a negative and statistically significant relationship between the Normalized Citation Score and the proportion of women per article. In other words, the number of citations decreases as the proportion of women increases. The value of the coefficient (-0.034) of the variable $Women\_Prop$ means that when the proportion of women increases by one unit (1%), the NCS decreases by 3.4%. Thus, for example, for an article with three authors, 2 men and 1 woman ($Women\_Prop$ = 0.33), if the number of women increases by one unit ($Women\_Prop$ = 0.50), the NCS decreases by 5.78% (17% * 3.4%). It should be noted that the value of the coefficient decreases as one includes in the regression new groups of variables. We also note that the coefficients are statistically significant in the three models.

For management, the finding is different. Table 3 shows that if we do not take into account the impact of journal (M1 and M2) there is a negative and significant relationship between the Normalized Citation Score and the proportion of women per article. As soon as the variables Impact Factor and CNRS journal classification are integrated (M3), the coefficient of the variable $Women\_Prop$ becomes statistically insignificant. Therefore, all things equal otherwise, there is no evidence of a significant relationship, either positive or negative, between the gender and citation impact in management. This result may be due to the very strong collaboration between men and women in management: more than half of the publications in this discipline are the corollary of the collaboration between men and women (see Figure 2).

The importance of collaboration

Regression results show that, for both economics and management, citations are positively and significantly shaped by: the number of authors and the number countries involved in a publication. This result is true for the three models M1, M2 and M3.

However, some differences between the two disciplines are worth noting. In economics, the number of authors per publication is a stronger factor than the number of countries. The Normalized Citations Score increases by 5.8% when the number of authors per article increases by one, while the number of citations increases by 1.1% when the number of countries involved in the publication increases by one. In management both number of authors and number of countries, have similar coefficients (M3). Normalized Citations Score increase by nearly 3% when the number of authors or countries involved in the publication increases by one.

The country of journal and citation level

For both disciplines, the country of journal has a significant impact on citations. Thus, the fact that the journal in which the article is published is American or European increases the number of citations, which is not the case for journals published in any other country (that is outside US and EU). It is important to note also that citations increase faster if the journal is American than if it is European. In economics, if the country of the journal's publisher is American, the Normalized Citations Score is 17.6% higher than if it is neither American nor European. The percentage is 10.7 if the journal is European. In management, the percentages for American and European journals are much lower (respectively 8.6% and 4%).

The importance of the impact of the journal

The academic impact of the journal is the variable that most influences the number of citations received by articles. The more the journal in which the article is published has a high impact factor (or well classified by the CNRS), the higher the number of citations. Thus, in economics, citations increase by 29% if the impact factor increases by one. The rate is comparable (26%) in management. Likewise, citations increase as the journal is in the first classes of CNRS categories. However, for economics, the fact that the journal is classified in Category 4 of CNRS (class of least selective journals), has no positive or negative effect on citations. This means that there is no obvious gain from publishing in these journals (compared to journals not classified by the CNRS). This shows that this category 4 is very subjective and does not reflect a consensus within the community on the “quality” of these journals.

Discussion and conclusion

In this paper we have investigated the relationship between gender and citations received by academic papers in economics and management. The most striking results relate to the fact that the author's gender does effect the citations received. We observe that as the proportion of women per article increases, the citations tend to decrease, especially in economics. These results are consistent with previous works that has shown that, across all disciplines, women have less international collaboration than men and that the level of citations is higher for articles written in international collaboration (Larivière et al, 2011; -Salinas et al, 2011). This result is also valid in the natural sciences and engineering as well as in the health sciences (Beaudry and Larivière 2016). In a recent article, Mairesse and Pezonni (2015) showed that, in the case of physics in France, the difference in productivity of female physicists vanishes when other variables are taken into account, particularly inequalities in the chances of promotion of women to positions of full professor, and family commitments. One may wonder if the academic status (lecturer/assistant professor versus full professor) also influences the level of visibility. However, data is lacking to measure such an effect in our sample of nearly 170,000 articles covering two disciplines worldwide. Also, the choice of research objects may be different according to the gender. To take this effect into account and to neutralize it, it would be necessary to normalize the number of citations received by the subfield to which it belongs, which would require the topic of each article to be determined.

Otherwise, the lower impact of articles with a high proportion of women as co-authors may also be due to the fact that women are dealing with topics that have less prestige in the discipline. In field of management, Nielsen et al. (2019) have shown that women are well-represented in social- and human-centered areas of management, while men comprise the vast majority in areas addressing more technical and operational aspects.

Our data also highlight for the first time that the practice of collaboration between genders is quite different in economics and in management. While men publish among themselves in a similar way in both disciplines (about half of the articles are written between men only), we observe that in economics there are much less men-women collaborations (27%) than in management (49%) and therefore more collaboration between women only (21%) compared to only 7% in management. Explanations of such practices would require an in-depth, interview-based qualitative study, but highlighting such differences in collaborative practices is in itself an important result.

Our results also indicate that the visibility of research articles in economics and management is closely linked to the visibility of the journal in which they are published. This was to be expected because we know that there is a Matthew effect related to the journal impact factor (Larivière and Gingras, 2010). A more important result in the current context of bibliometric evaluation of research is the weight of American journals in the visibility of research articles both in economics and management. Indeed, if the journal is American, the citations to the articles will nearly double compared to a journal is European. It is likely that the important role of US journals (as the country of publication of the journal) in determining publication visibility as measured by citations is related to the fact that the WoS database (just like that of SCOPUS by elsewhere) has a strong Anglo-Saxon bias (Gingras and Khelfaoui, 2018). It remains true, however, that researchers' evaluations are, in fact, based on these databases. Our results are therefore all the more important as they may in turn influence the future publication practices of scholars in order to improve their "score" of citations.

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