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GENDER DIVERSITY IN RESEARCH TEAMS AND CITATION IMPACT IN ECONOMICS AND MANAGEMENT

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Abstract. The aim of this paper is twofold: (1) contribute to a better understanding of the place of women in Economics and Management disciplines by characterizing the difference in levels of scientific collaboration between men and women at the specialties' level; and (2) investigate the relationship between gender diversity and citation impact in Economics and Management. Our data, extracted from the Web of Science database, cover global production as indexed in 302 journals in Economics and 370 journals in Management, with, respectively, 153,667 and 163,567 articles published between 2008 and 2018. Results show that collaborative practices between men and women are quite different in Economics and Management. We also find that there is a modest positive and significant effect of gender diversity on the citation impact of publications. Mixed-gender publications (coauthored by men and women) receive more citations than nonmixed papers (written by same-gender author teams) or single-author publications. The regression analysis also indicates that there is, for Economics, a small negative effect on citations received if the corresponding author is a woman. Finally, the country (affiliation) of the corresponding author affects the citations received in the two disciplines.

Keywords. Citation impact; Economics; Gender diversity; Management; Research areas; Scientific collaboration

1. Introduction

Gender diversity (GD) in science is widely debated in the literature (Campbell *et al*., 2013; Nielsen *et al*., 2018; Nielsen and Börjeson, 2019). Although policy makers are convinced of the positive effect of diversity on team performance (Moore, 2006; Page SE, 2008; European Commission, 2013; Lauring and Villesèche, 2019), results from empirical studies on the issue are mixed (Campbell et al. 2013; Nielsen and Börjeson, 2019).

Although vertical sexual segregation (tertiary level) begins to gradually dissipate, this is far from the case for horizontal segregation (research disciplines) (Charles and Bradley, 2002; Mann and DiPrete,

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2013). Thus, societal norms and expectations may directly affect the choices of career and disciplinary orientations following gendered considerations (Charles and Bradley, 2009; Cech, 2013). This can even concern thematic orientations within the same discipline (Nielsen and Börjeson, 2019). According to Charles and Bradley (2002), one of the reasons for the persistence of horizontal segregation is that gender activists are doing more to undermine vertical segregation than horizontal segregation. Ultimately, the current situation is more compatible with the principle "*equal but separate*" or "*equal but different*" promoted by a category of feminists (Charles and Bradley, 2002). However, this logic is not necessarily the most optimal from a scientific point of view. As emphasized by Nielsen *et al*. (2017), GD should lead to "better science." GD, among several other factors, such as work experience or ethnicity and nationality, could promote creativity and collective intelligence.

In economics and management research, the issue of GD has been widely addressed. The literature has analyzed the question through several prisms like team cohesion (Webber and Donahue, 2001), human capital and collective intelligence (Bozeman and Corley, 2004), productivity (Defazio *et al*., 2009; Abramo *et al*., 2009b; Lee and Bozeman, 2016; Abramo *et al*., 2017), scientific discovery and innovation (Nielsen *et al*., 2018), economic performance of firms (Abduallah *et al*., 2013; Augustine *et al*., 2016), financial performance (Campbell and Mínguez-Vera, 2008; Reguera-Alvarado *et al*., 2017), or business performance (Kochan *et al*., 2003; Hoogendoorn *et al*., 2013; Moreno-Gómez *et al*., 2018). Surprisingly, little research has addressed the issue of the impact of GD in scientific collaboration on academic performance in these disciplines. The Nielsen and Börjeson (2019) study on 25,000 publications is the only one to our knowledge that has studied the issue of GD and the academic impact in management. In economics, we are not aware of any study on the question.

This study focused on the link between GD, mixed collaborations, and citation impact in the fields of Economics and Management. For a better understanding of the place of women within these two disciplines, this study also offers a reflective analysis on the two disciplines with a systematic comparison of publication and collaboration practices according to gender at the level of research areas.

To do so, we used all publications in Economics and Management indexed in the WoS database between 2008 and 2018. This makes a sample of 153,667 published in 302 journals in Economics and 163,567 articles published in 370 journals in Management. A regression analysis has been performed to highlight the relationship between the number of citations received and the gender composition of research articles in the two disciplines. More precisely, we constructed five groups of articles according to the sex of authors: (1) articles cosigned by men and women, (2) by women only (at least two), (3) by men only (at least two), (4) authored by single woman, and (5) by single men. Using a generalized linear regression model, we established a hierarchical order between the different types of publication in terms of citations received. Several control variables were used, such as the county and sex of the corresponding author, the number of authors, number of countries, journal impact factor, and the research area.

The article is organized as follows. In Section 2, we present an overview of the literature dealing with the link between gender and citation impact. Section 3 describes the data and method used. Section 4 presents descriptive on research areas and statistics on gendered collaborations, and finally, Section 5 presents the results of the regression model.

2. Literature Review on Gender and Citation Impact

The literature offers a broad spectrum of analysis on gender and academic impact. The issue has been addressed from many perspectives. Different studies have analyzed the effect of positions of authors according to gender and citation rates (Larivière *et al*., 2013; Thelwall and Sud, 2020), self-citation practices according to gender (King *et al*., 2017; Mishra *et al*., 2018; Azoulay and Lynn, 2020), and gender differences according to the age of the authors (Frandsen *et al*., 2020; Kwiek and Roszka, 2020).

Using a large sample from the WoS database between 2008 and 2012, consisting of 5,483,841 publications involving 27,329,915 authors, Larivière *et al*. (2013) found that publications with women in first or last author positions receive fewer citations than those with men in the same positions. Insofar as international collaboration increases the visibility of articles and the number of citations received (Rigby and Edler, 2005), this citation disadvantage is explained, in part, by the fact that women have less international collaboration than their male counterparts. Several studies on different countries confirm the lower level of international collaboration of women researchers. This is for example the case in Italy (Abramo *et al*., 2013), Poland (Kwiek and Roszka, 2020), Denmark (Nielsen, 2016), and Norway (Aksnes *et al*., 2019). In the case of India, Paswan and Singh (2020) have shown that although articles by male authors have a citation advantage, Indian women researchers tend to have more international collaboration. On this issue of international collaboration, it is important to emphasize that the distributions of men and women by discipline are different (Aksnes *et al*., 2019; Paswan and Singh, 2020). As pointed out by Aksnes *et al*. (2019), the concentration of women is higher in fields where international collaboration is generally lower.

Several studies have shown that gender gaps still persist in favor of men both in terms of productivity and scientific visibility (Abramo *et al*., 2009b; Duch *et al*., 2012; West *et al*., 2013; Beaudry and Larivière, 2016; Budrikis, 2020; Odic and Wojcik, 2020). In the case of Psychology, Odic and Wojcik (2020) have shown a significant effect of gender in favor of men who receive on average 19% more citations. It has also been observed that the greater presence of men in highly cited journals could be an important factor explaining these differences in citations (Nielsen, 2016). Maddi *et al*. (2019) have shown that the number of citations received in Economics and Management is negatively affected by the presence of women as coauthors. The period considered was between 2008 and 2015 with approximately 170,000 publications. Both disciplines were considered as a whole, that is, without taking account of the different specialties of these disciplines. Given that the level of citations can vary considerably depending on the specialties, the citation advantage of men could be due to the distribution of men and women within these different specialties. For example, citation levels are very high in "Environment, agriculture, natural resources, and energy" area and lower in "Accounting and auditing." As the proportion of men and women also varies depending on the specialty, it is important to consider this variable to better measure the specific effect of gender on citation rates (Maddi *et al*., 2019).

Based on a sample of 437,787 publications authored by 4292 faculty members from the top universities in the United States, Duch *et al*. (2012) showed that gender differences in impact rate are discipline specific. In addition, the authors argue that the lower performance of women in certain disciplines is linked to the lack of resources to which they have access. Duch *et al*. (2012) emphasize the importance of GD within disciplines to overcome gender differences in productivity and citation impact.

Another factor that could be at the origin of the differences in impact observed between the two sexes are self-citations. Using a sample of 1.5 million articles from JSTOR database between 1779 and 2011, King *et al*. (2017) have shown that nearly 10% of references are authors self-citations. They have also shown that men cited their own papers 56% more often than women did. In the last two decades of data, men self-cited themselves 70% more than women did. Other studies have, however, arrived at contradictory results. This is the case of Mishra *et al*. (2018) on biomedical articles in PubMed database, and that of Azoulay and Lynn (2020) who examined 36 cohorts of life scientists (1970−2005). Mishra *et al*.'s (2018) study focuses on the limitations in the work of King *et al*. (2017). Specifically, Mishra *et al*. (2018) show that when the number of past publications is taken into account, women and men self-cite at similar rates. In other words, it is primarily the gendered age-distributions of the science system that drive imbalances in self-citations. Currently, there are more senior male researchers that have more papers to self-cite. These studies have shown that men and women self-cite at the same rate. We, therefore, cannot generalize King *et al*.'s (2017) result, which does not seem to be valid in the life sciences. In a sample of 3923 Danish researchers (7820 publications), Nielsen (2016) also found no specificities linked to gender in terms of self-citation practices. In political science, a recent study has shown that self-citation

practices depend on several factors like scientific collaboration and previous experience of authors (Dion *et al*., 2020). Overall, these authors have shown that men are more likely to cite their previous work than women.

The issue of gender differences in citations impact was also been looked at in terms of age and academic career. Based on data from the population of university professors in the province of Quebec (Canada), Larivière *et al*. (2011) showed that past the age of 38, the disadvantage of women in terms of productivity and impact is higher. The authors provide several possible explanations, such as the smaller collaborative networks of women, motherhood, and the division of labor that accompanies it, difficulty accessing resources and funding. These difficulties confronting women impact their productivity from the start of their career (Nielsen, 2018). Beaudry and Larivière (2016) have shown that, in natural sciences and engineering, for equal amounts of funding and publications, women are equally cited.

In a study based on a sample of 25,463 Polish university professors from 85 universities, grouped into 27 disciplines (Scopus database), Kwiek and Roszka (2020) showed that in addition to international collaboration, the disparities in citation impact between the two sexes are also linked to age. Until about 40 years old, the differences are marginal and then they start to grow in favor of men. In a broad analysis of science, technology, engineering, and mathematics (STEM) fields, Huang *et al*. (2020) provided a comprehensive picture of gender differences in scientific performances with a focus on the academic careers of researchers. The authors reconstructed the full publication history of over 1.5 million authors, identified by gender, from 83 countries and whose publishing careers were between 1955 and 2010. The results showed that, overall, men and women publish during their career a comparable number of articles with an equivalent average impact. However, the increase in the number of women during the 60 years of observation paradoxically widened the differences between men and women. The authors concluded that the length of the publishing career and the dropout rate could explain the differences observed between the two sexes.

Contrary to the studies presented above, some papers find an advantage of citations in favor of women. Using a sample of nearly 27,000 publications and more than 65,000 authors, Nielsen (2017) analyzed the differences in academic impact in Management sciences by gender and concluded that women have a slightly greater impact than men, while remaining cautious about the representativeness of their sample and the possibility of generalization. Similarly, women have a larger share in the decile of the most cited publications in Management. In a more recent study, based on a sample of six million articles from the Scopus database between 1996 and 2018 (countries: Australia, Canada, Ireland, Jamaica, New Zealand, United Kingdom, and the United States), Thelwall (2020a) showed the existence of a small advantage of citations in favor of women over the years and for all countries studied except the United States. The female citation advantage is more significant for Australia and the UK. In a similar study, examining publications from the same seven countries, Thelwall (2020a) and Thelwall (2020b) also showed the existence of a female citation advantage in dominant author positions.

By contrast, Nielsen (2016) using a sample of Danish researcher, Thelwall and Sud (2020) analyzing six million articles published between 1996 and 2012 across up to 331 fields, and Frandsen *et al*. (2020) studying health science researchers found no effect (positive or negative) of gender on citation impact. Likewise, Leimu and Koricheva (2005b) showed that there is no empirical evidence for an effect of first author position on the citation rate in the case of ecological papers. On a large sample of 1,269,542 publications in medical research (between 2008 and 2014), Andersen *et al*. (2019) showed the existence of a citation advantage in favor of men. However, the authors have shown that this men advantage vanishes when controlled by self-citations, number of authors, international collaboration, and journal prestige. Andersen *et al*. (2019) concluded on the importance of focusing greater attention on the characteristics of the groups studied when it comes to interpreting the results of gender-based comparisons of citation impact. Lynn *et al*. (2019) came to similar conclusions as Andersen *et al*. (2019), on a sample of 10,000 publications in economics, political science, and sociology. Another important factor that could explain the differences observed between the two sexes is the weight of

"star researcher" with a strong male concentration. As shown by Abramo *et al*. (2009a), in the case of Italy, the concentration of star researchers plays a preponderant role in the general performance of men.

Regarding the relationship between GD and academic impact, previous studies have shown that, overall, GD has no or only a moderate effect on citations impact. Results differ according to the variable studies as well as the disciplines. In environmental sciences, Campbell et al. (2013) showed that articles cosigned by men and women receive, on average, 34% more citations than those written by teams of same-sex authors. However, the positive effect of GD diminishes as the share of women increases in heterogeneous gender teams. Based on 25,000 papers in Management field, Nielsen and Börjeson (2019) found no effect of GD on citation impact. However, they argued that GD could lead to expanded research programs. In contrast, in political science, sociology, and economics, Dion *et al*. (2018) have shown that the more mixed the research teams, the lower the gender citations gap. GD may be a solution to the "Matilda effect," which is a term used to recognize the systematic under-recognition of women's contributions in science, including citation impact (Rossiter, 1993). In a recent article, Lerback *et al*. (2020) showed that the GD of teams positively affects the acceptance rate of scientific publications; the rate is 4.5% higher for publications including both sexes. However, citations are slightly lower for publications cosigned by women and men, compared to mono-gender publications.

From this long literature review, we see that there is a great diversity of the results obtained according to the samples and the variables studied. Whereas some papers suggest an advantage of citations in favor of men, others find the opposite effect or no effect at all. Overall, if one takes account and control for disciplines, equal opportunities, access to resources and grants, etc., it is not easy to conclude that there is a systematic and universal advantage in favor of men (West *et al*., 2013). Furthermore, the literature also showed the importance of experience, age, and position in academic career in determining citation impact. In short, it is possible that specific effects do vary according to disciplines. Here, we will focus on Economics and Management, as they are closely related but also different in terms of methods and collaboration practices.

3. Data and Method

3.1 *Data*

3.1.1 *Database*

The data have been extracted from the Web of Science (WoS) Core Collection database (SCIE, SSCI, A&HCI). Only "articles" are taken into account in the study, other types of documents (such as editorials, letters, etc.) are excluded from the analysis because they are generally not original contributions to scholarly knowledge (Moed, 1996).

The WoS database gives us information on authors, titles of publications, institutional address (institution, city, country, etc.), citations number received by publications, and journal title. We have added variables like the gender of the authors, the number of authors per publication, the number of countries per publication, impact factor of journals, country of journals (publisher), and the research area of journals.

3.1.2 *Name Gender Assignment*

In this study, we analyze whether GD affects the number of citations received by scientific publications. To represent gender in scientific publications, we used the proxy of the proportion of women per

Table 1. Proportion of Full Names and Given Names Assigned a Gender.

		%	
	Type	Economics	Management
Assigned	Men	63.4%	57.7%
	Women	20.3%	25.1%
	Total assigned	*83.7%*	*82.8%*
Not assigned	Initials	3.9%	3.8%
	Unisex	2.8%	2.8%
	Unknown	9.6%	10.6%
Total not assigned		*16.3%*	*17.2%*

publication. The authors' gender is assigned based on the methodology presented in Larivière *et al*. (2013), which uses the author's first name to assign gender. For each of the articles, we calculated the proportion of authors belonging to each gender, using as denominator the sum of the authors to whom we assigned a gender. For example, an article with five 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 cosigned 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 coauthored by both men and women (mixed-gender publications). The higher the number of women per publication, the more the proportion is closer to 1.

We summarize here the main steps of determining the sex of the authors. For more details, see Larivière *et al*. (2013).

The gender-detection method matches the author list with universal and country-specific name lists. The list of author names requires preprocessing. To be able to do the matching, the preprocessing consists of removing the special characters in the names, identifying if they are initials, separating the composed names by spaces, and replacing hyphens by a space ("Jean-Marc" become "Jean Marc").

Once the preprocessing has been carried out, the author's given names are matched with the following lists (for lists description, see: Larivière *et al*., 2013) in the same order below:

1. US Census;
2. WikiName;
3. Wikipedia;
4. France and Quebec list;
5. Other country-specific lists.

It should be noted that the gender of the authors is identified for each article separately. In other words, we did not carry out matching within the corpus to measure the number of distinct authors or the number of publications per author. This choice is determined by our research question, insofar as we analyze the impact of the gender composition of the articles on the citations received. Table 1 provides gender identification statistics for the two disciplines (Economics and Management). Out of the total number of authors, we identified the gender for about 83% of them.

The proportion of women is about the same in Economics (25.3% but they contribute for 32% of the publications) and Management (25.1% for 26% of publications). These distributions are near the average of the global distribution of women researchers, which is estimated to be around 30% (UNESCO, 2018).

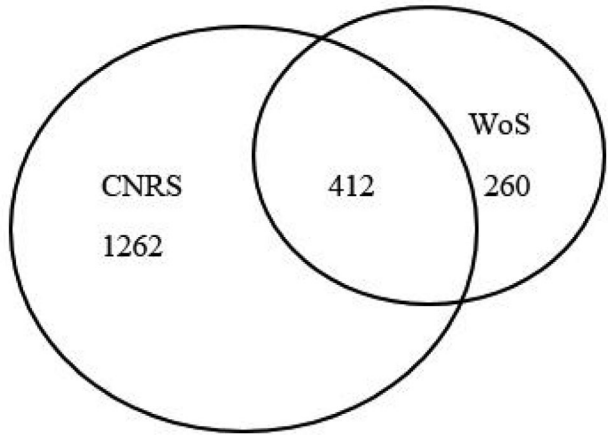

Figure 1. Overlap between Journals Indexed in 2019 CNRS Classification and 2019 WoS Core Collection Database.

3.1.3 *Disciplinary Classification: Research Area of Journals*

A refined classification of subject categories from the WoS database consists of 254 specialties. Economy and Management are not subdivided into specialties, despite the fact that there is a great diversity within these two disciplines. To make an analysis at the level of the research area, a more detailed classification is needed. Therefore, we used the 2019 CNRS (French National Centre for Scientific Research) classification of journals into "specialties" of Economics and Management based on peer evaluation. We thus matched the CNRS list and that of the WoS using the journals names (after cleaning and homogenization). We relied on the expertise of one of us (A.M.) to assign the journals that did not match to one of the 23 specialties of CNRS list. To do so, the information provided on journals websites is used to assign unclassified journals (260 out of 672) to one of the 23 research areas presented in Table 5. The distribution presented in Table 5 provides a global view of the scientific production in the WoS and does not of course include all journals but only the most cited. As it can be seen in Figure 1, the CNRS classified, in 2019, 1674 journals in both disciplines, while the WoS indexes only 412 of them (24.6%).

3.2 *Method*

A regression analysis was used to study the relationship between GD and citation impact. The choice of method depends essentially on the nature of the dependent variable. In our case, we use the citations received by articles as proxy for academic impact.

For our regression, we used the logarithm of the total number of citations received by articles during the period 2008–2018. As pointed out by Thelwall and Wilson (2014), citation counts tend to follow a discrete lognormal distribution. When it comes to modeling citations, negative binomial regression is generally used. However, as shown in the Thelwall and Wilson (2014) study, better strategy for modeling citation counts is to "*add one to the citations, take their log and then use the general linear (ordinary least squares) model for regression*." In many cases, conclusions based on negative binomial regression cannot be reliable for the reasons detailed in Thelwall and Wilson (2014). We, therefore, used a generalized linear model with a logarithmic transformation of the citations as described in Thelwall and Wilson (2014).

Table 2. Distribution of Publications by Gender of Authors.

	Economics		Management	
	#	%	#	%
W_single	7579	5%	6274	4%
M_single	34,395	22%	20,250	12%
W-W	14,643	10%	17,018	10%
M-M	45,702	30%	45,849	28%
M-W	51,348	33%	74,176	45%
Sum	153,667	100%	163,567	100%

3.2.1 *Independent Variables*

To represent GD, we constructed five dummy variables to denote articles published only by a (1) single man (M_single) or by a (2) single woman (W_single), articles involving (3) only men (at least two) (M-M) or (4) only women (at least two) (W-W), and articles involving (5) both men and women (at least one man and one woman) (M-W). Insofar as it denotes GD, the variable representing articles coauthored by men and women is used as a reference modality in the regressions.

Table 2 shows the distribution of publications according to the five types of publication. We observe a much larger proportion of collaboration between men and women in Management than in Economics. This difference also appears in the fact that publications involving a single male author are more important in Economics than in Management. Economics has thus more than half (52%) of its papers written by men only, whereas that proportion is only in 40% in Management. In both disciplines, only about 5% are written by women alone and 10% in collaboration with other women.

3.2.2 *Control Variables*

A number of control variables are included in our analysis. The choice of control variables comes from the literature that shows that they are potentially associated with the number of citations received by publications (Larivière *et al*., 2011; Beaudry and Larivière, 2016). Judge *et al*. (2007) analysis of the citation determinants of articles published in the top 21 Management journals showed that the main factor in the visibility of an article is the journal in which it is published. According to Harzing (2016), both the topic studied by the article and the profile of the author can influence the visibility of publications in Management. Starbuck (2005) and Singh *et al*. (2007) concluded that the evaluation of research articles based solely on the impact of journals provides erroneous results as to the "quality" of publications, given intrareview variability. In addition, there is an abundant literature showing that citation scores are strongly linked to scientific collaboration (Smart and Bayer, 1986; Van Raan, 1998; Hara *et al*., 2003; Leimu and Koricheva, 2005a; Franceschet and Costantini, 2010; Bote *et al*., 2013; Larivière *et al*., 2015).

First, we control for the number of authors (Nbr_Authors) and the number of countries by publication, a proxy of international collaboration (Internat_collab). We have also added dummy variable *Corr_aut_w* indicating the fact that corresponding author is woman. Second, as shown in Figure 8, single authors accrue the smallest average number of citation per paper. Possibly, this observation may be explained by the overrepresentation of scholars in developing countries and emerging economies in this category (single authors) that on average tend accrue less citations per paper. In other words, author-country may be an important confounder, which should be accounted for in the analysis as it may level out the quite small effects observed in the study. We have, therefore, controlled for

the geographic origin of corresponding authors by building two dummy variables. For single author publications, the country of the corresponding author corresponds to the country of the author. The affiliation (institution) country was used as proxy of corresponding authors' country. Corr_aut_USA takes 1 if corresponding authors are American. Corr_aut_EU27 takes 1 if corresponding authors are European and Corr_aut_UK takes 1 if corresponding authors are British. The reference variable are the affiliations not belonging to these geographical areas.

Third, we control the impact of journals in which articles are published using the 2 years impact factor of the journal. And finally, we controlled by the specialties (research areas) using dummy variables. We have included the five main specialties of each of the two disciplines. We also control for the publication year, as we did not use a citation window (we do not have citation data with windows).

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 GD on the citation score. Table 3 summarizes variables of model.

Before interpreting the coefficients, we have verified that all the variance inflation factors scores are much lower than five. This suggests the absence of multicollinearity (James *et al*., 2017; Bruce *et al*., 2020).

4. Descriptive Statistics

Our WoS data cover 302 journals in Economics and 370 journals in Management. This amounted to a global production of 153,667 from the field of Economics and 163,567 articles from Management, all published between 2008 and 2018. (Table 4). The respective contribution of women in both disciplines is 28% and 32%.

We observe that the distribution is contrasted according to specialty and discipline (Table 5). In Economics, nearly 60% of publications are concentrated in three specialties: General Economics, General Management (30%), Environment, Agriculture, Natural Resources, Energy (19%), and Macroeconomics, International and Monetary Economics (10%). In Management, the distribution is less concentrated, with specialties, such as General Economics, General Management (13%), Management Information Systems (13%), Finance and Insurance (12%), Human Resources Management (11%), and Marketing (11%), having the highest proportion of publications (>10%).

4.1 *Textual Analysis on Research Areas*

It is important to emphasize that the research areas are different in the two disciplines. This is why we have presented them separately in Table 5. Although the disciplines share the same classification, the journals and topics they cover are different. Moreover, the distribution of publications by research area is quite different in the two disciplines. For example, the research area "General Economics, general Management" (GEN) represents 30% of publications in economics and 13% in management. Regarding the topics that are covered in this research area (GEN), using co-occurrence of words in articles' titles (van Eck and Waltman, 2011; Chavalarias and Cointet, 2013) shows notable differences (Figures 2 and 3), and this is also the case for other research areas (figures not included here).

As can be seen in Figure 2, the articles in the research area "GEN" in economics deal with several topics, such as monetary and budgetary policies, development economics, and monetary economics (exchange rate, interest rate, inflation, etc.). While the same research area (GEN) in management deals more with topics, such as supply and demand on the market, job satisfaction, entrepreneurship, or even firm performances.

Table 3. Dependent, Explicative, and Control Variables in the Regression.

Dependent variable	
$\text{Log}(1 + citations\ number)_i$	Log transformed of 1 + citations received by publication i.
Explicative variables	
M_single_i	Dummy variable that takes 1 if the publication contains a single male author.
W_single_i	Dummy variable that takes 1 if the publication contains a single female author.
$M - M_i$	Dummy variable that takes 1 if the publication contains authored only by men (at least two).
$W - W_i$	Dummy variable that takes 1 if the publication contains authored only by women (at least two).
$M - W_i$	Dummy variable that takes 1 if the publication involves both at least one man and one woman.
Control variables	
$Corr\_aut\_w$	Dummy variable indicating the fact that corresponding author is woman.
$Corr\_aut\_USA$	Dummy variable indicating the fact that the corresponding author is American. It equals to 1 if it is.
$Corr\_aut\_EU27$	Dummy variable indicating the fact that the corresponding author is European. It equals to 1 if it is.
$Corr\_aut\_UK$	Dummy variable indicating the fact that the corresponding author is British. It equals to 1 if it is.
$Publication\_year$	Publication year.
$Nbr\_Authors_i$	Number of authors by publication.
$Internat\_collab_i$	International collaboration measured by the number of countries by publication.
IF_2	2 years Journal Impact Factor.
Dummies variables by specialty (research area):	
GEN	General economics, general management
$AgrEnEnv$	Environment, agriculture, natural resources, energy
$Macro$	Macroeconomics, international and monetary economics
$DevTrans$	Development and transition economics
$ThEco$	Economic theory, game and decision theory, and experimental economics
SI	Management information systems
Fin	Finance and insurance
GRH	Human resources management
MKG	Marketing

Table 4. Number of Publications, Journals, and Proportion of Women by Discipline.

	Economics	Management	All
# Publications	153,667	163,567	317,234
# Journals	302	370	672
% Average proportion of women on papers	28%	32%	30%

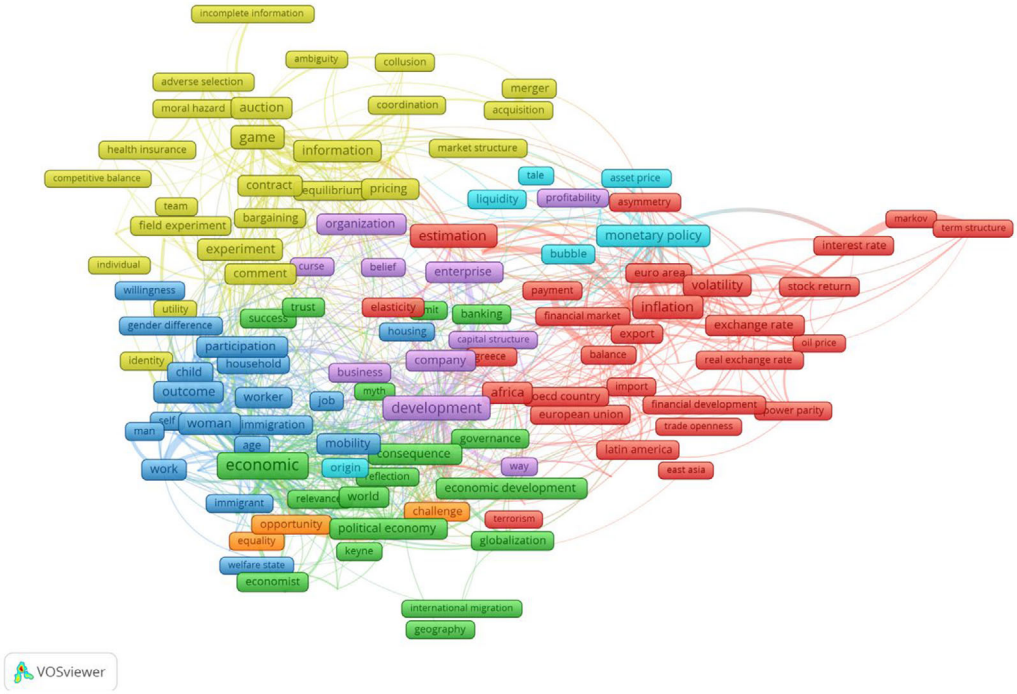

Figure 2. Co-occurrence Analysis of Article Titles in the "GEN" Research Area, Economics. [Colour figure can be viewed at wileyonlinelibrary.com]

Remember that the classification of journals we used is that of the CNRS, which uses the same nomenclature to classify journals in economics and management. This does not mean, however, that the search topics are the same as we have just shown for the larger research area "GEN."

Finally, certain research areas in the nomenclatures are specific to one of the two disciplines. This is for example the case of the RO (Operations research) and ThO (Organization studies) research areas in management, and HPEA (History of economic thought, economic and business history, methodology) in economics (Table 5).

Table 5. Number and Proportion of Publications, by Specialty, Discipline, and Sex.

Research area code	Research area	Economics						Management					
		#	%	% average proportion of women on papers	% M-W	% W only	% M only	#	%	% average proportion of women on papers	% M-W	% W only	% M only
GEN	General economics, general management	46,499	30.3	27.7	29%	15%	56%	21,517	13.2	32.7	44%	15%	41%
AgrEnEnv	Environment, agriculture, natural resources, energy	29,004	18.9	35.5	46%	11%	43%	1157	0.7	34.7	47%	16%	37%
Macro	Macroeconomics, international and monetary economics	16,204	10.5	35.2	29%	16%	55%	980	0.6	26.7	33%	13%	54%
DevTrans	Development and transition economics	10,096	6.6	22.0	36%	20%	44%	922	0.6	37.7	52%	16%	31%
ThEco	Economic theory, game and decision theory and experimental economics	9742	6.3	26.4	24%	15%	61%	2450	1.5	31.5	49%	13%	38%
EcoPub	Public economics and public choice	8769	5.7	27.6	27%	15%	58%	1216	0.7	31.5	36%	17%	47%
Metrie	Econometrics	7026	4.6	26.7	31%	16%	53%	1746	1.1	25.8	35%	12%	54%
OrgInd	Industrial organization	4968	3.2	35.0	32%	12%	56%	52	0.0	29.5	23%	19%	58%
Fin	Finance and insurance	4305	2.8	21.9	33%	14%	53%	19,396	11.9	28.3	36%	13%	51%
TravPop	Labor and population economics	4268	2.8	32.1	36%	16%	48%	1376	0.8	36.3	40%	20%	40%
LOG	Production and operations management	3174	2.1	32.0	43%	15%	42%	8274	5.1	32.0	48%	13%	39%
Spatiale	Urban, spatial, and regional economics, transportation and tourism	2239	1.5	28.5	40%	11%	49%	3268	2.0	39.6	51%	19%	30%

(*Continued*)

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Table 5. *Continued.*

Research area code	Research area	Economics #	Economics %	Economics % average proportion of women on papers	Economics % M-W	Economics % W only	Economics % M only	Management #	Management %	Management % average proportion of women on papers	Management % M-W	Management % W only	Management % M only
SI	Management information systems	1477	1.0	29.1	47%	11%	42%	20,795	12.7	31.6	45%	14%	40%
EcoDroit	Law and economics	1452	0.9	34.6	23%	12%	65%	172	0.1	22.1	19%	15%	66%
Innov	Innovation and entrepreneurship	1403	0.9	25.5	48%	13%	40%	9967	6.1	32.3	47%	14%	39%
MKG	Marketing	1127	0.7	30.0	36%	20%	44%	17,581	10.7	36.2	54%	15%	31%
HPEA	History of economic thought, economic and business history, methodology	871	0.6	27.0	11%	17%	72%	0	0.0	–	-	-	-
StratInt	Business strategy and international management	424	0.3	27.3	23%	17%	60%	7041	4.3	32.7	47%	14%	39%
GRH	Human resources management	345	0.2	25.0	40%	20%	40%	17,797	10.9	34.3	53%	14%	33%
CPT	Accounting and auditing	274	0.2	31.2	40%	19%	41%	7853	4.8	32.3	45%	14%	41%
RO	Operations research	0	0.0	–	–	–	–	13,927	8.5	26.8	39%	12%	50%
SANT	Health economics and management	0	0.0	–	–	–	–	122	0.1	31.1	48%	12%	40%
ThO	Organization studies	0	0.0	–	–	–	–	5958	3.6	35.0	43%	17%	39%
All		153,667	100%	28%	33%	14%		163,567	100%	32%	**45%**	**14%**	**39%**

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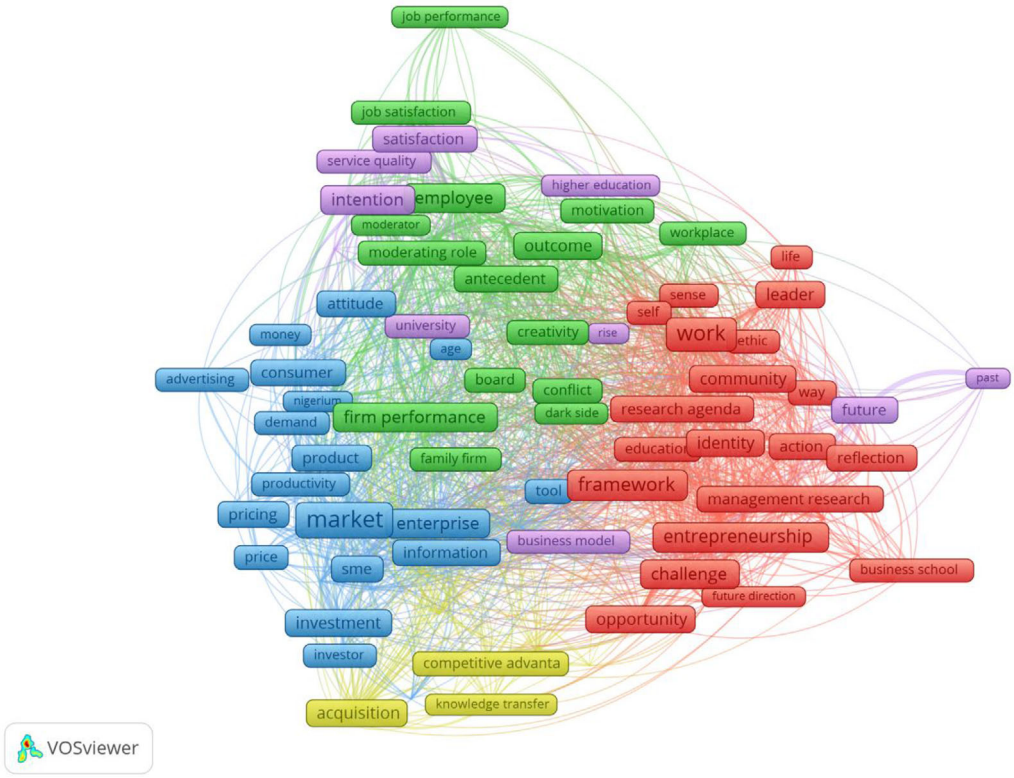

Figure 3. Co-occurrence Analysis of Article Titles in the "GEN" Research Area, Management. [Colour figure can be viewed at wileyonlinelibrary.com]

4.2 *Evolution of 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 with at least two authors is 87% in Management against 77% in Economics (Figure 4). This is a global average and the results vary somewhat by country. Over the decade 2008–2018, the rate of collaboration has increased significantly in both disciplines. The share of publications signed by a single author decreased by 10% in Economics and 7% in Management, between 2008–2010 and 2016–2018.

Figure 5 shows the evolution of male–female collaboration over the last 10 years. We note that the proportion of single-sex collaboration as well as single female authors remains stable over the period. On the other hand, publications with a single male author have fallen sharply in favor of publications with male–female collaboration (especially in Economics). This shows a significant shift in collaborative practices between the two sexes. Men who tended to publish alone are more and more inclined to collaborate with other authors including at least one woman.

In 2018, the rate of men–women collaboration in Economics reached 40% and 55% in Management. In Economics, the proportion of publications by single men declined from 27% in 2008 to 17% in 2018 in favor of men–women papers.

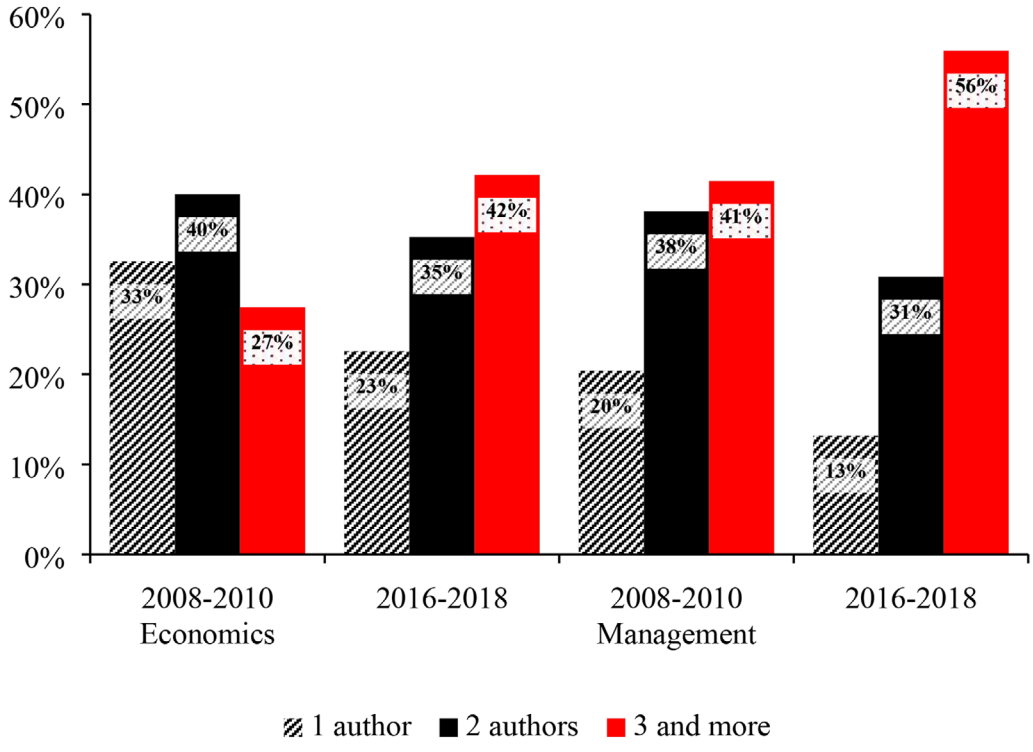

Figure 4. Number of Authors Per Publication in Economics and Management. [Colour figure can be viewed at wileyonlinelibrary.com]

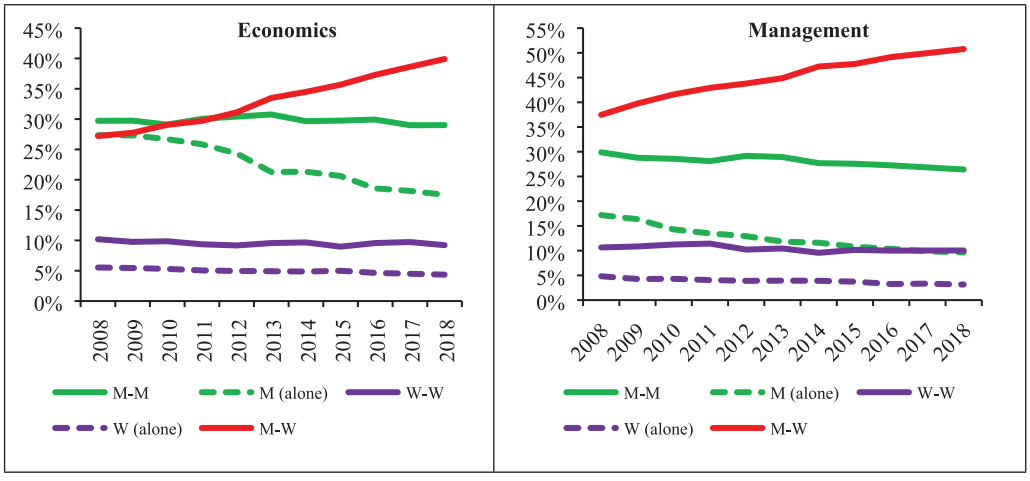

Figure 5. Collaboration between Men and Women in Economics and Management. [Colour figure can be viewed at wileyonlinelibrary.com]

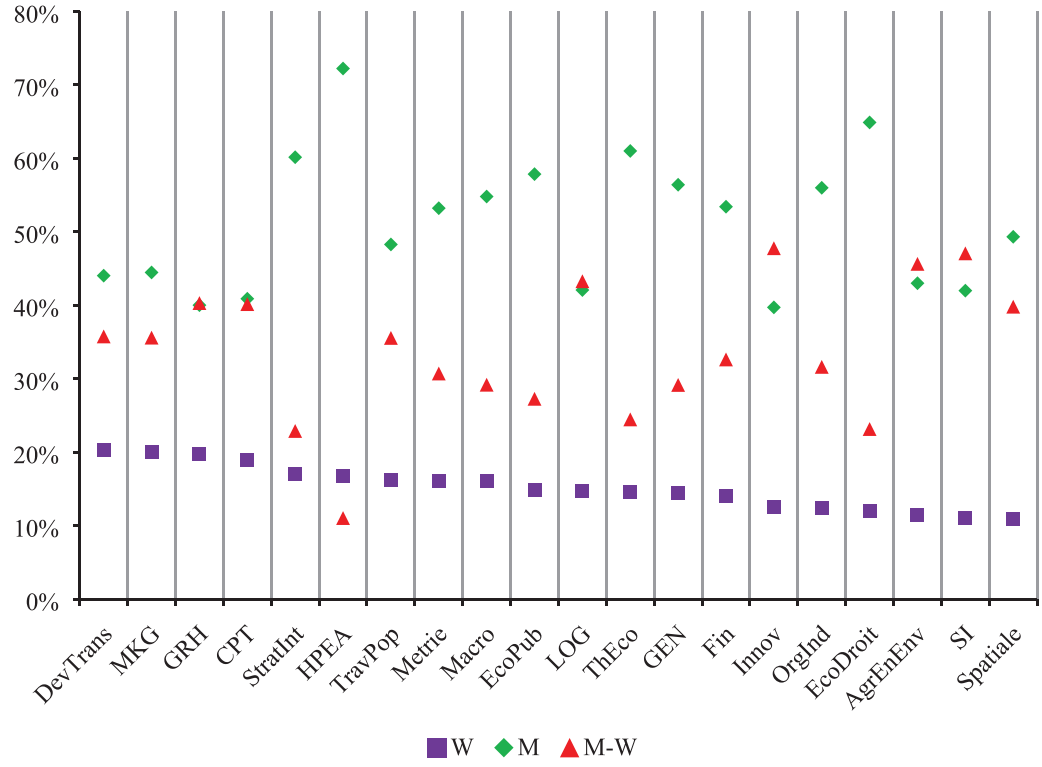

Figure 6. Distribution of Publications by Specialty and Collaboration Type (Economics). [Colour figure can be viewed at wileyonlinelibrary.com]

Figures 6 and 7 show that male–female collaboration practices differ significantly among the specialties. In Economics, Development and transition Economics is the specialty with the highest share of publications including women (20% of publications are signed by women only, and 36% involve at least one woman). In contrast, 72% of "History of economic thought, economic and business history, methodology" publications are signed by men only (without women collaboration). The rate of men–women collaboration in this specialty is 11%. Similarly, in Management, the Development and transition Economics specialty has the largest share of publications involving women, nearly 70%. This share is comparable to that of Marketing. The specialties with the highest proportion of publications, including only men, are Law and Economics (70%) and Industrial organization (60%). We also note that, overall, the percentage of collaboration between men and women is significantly higher in Management than in Economics in almost all specialties.

It would be interesting to look further into the question of the collaborative strategy based on gender in the case of Economics and Management. Studies on the issue show that there are several factors that can guide the choice of collaboration (Bozeman and Gaughan, 2011). Bozeman and Corley (2004) showed that women scientists have a 12% higher percentage of female collaborators than men (36% against 24%). However, Bozeman and Corley (2004) also show that there are big differences according to rank, as nontenure track females have on average of 84% of their collaborations with women.

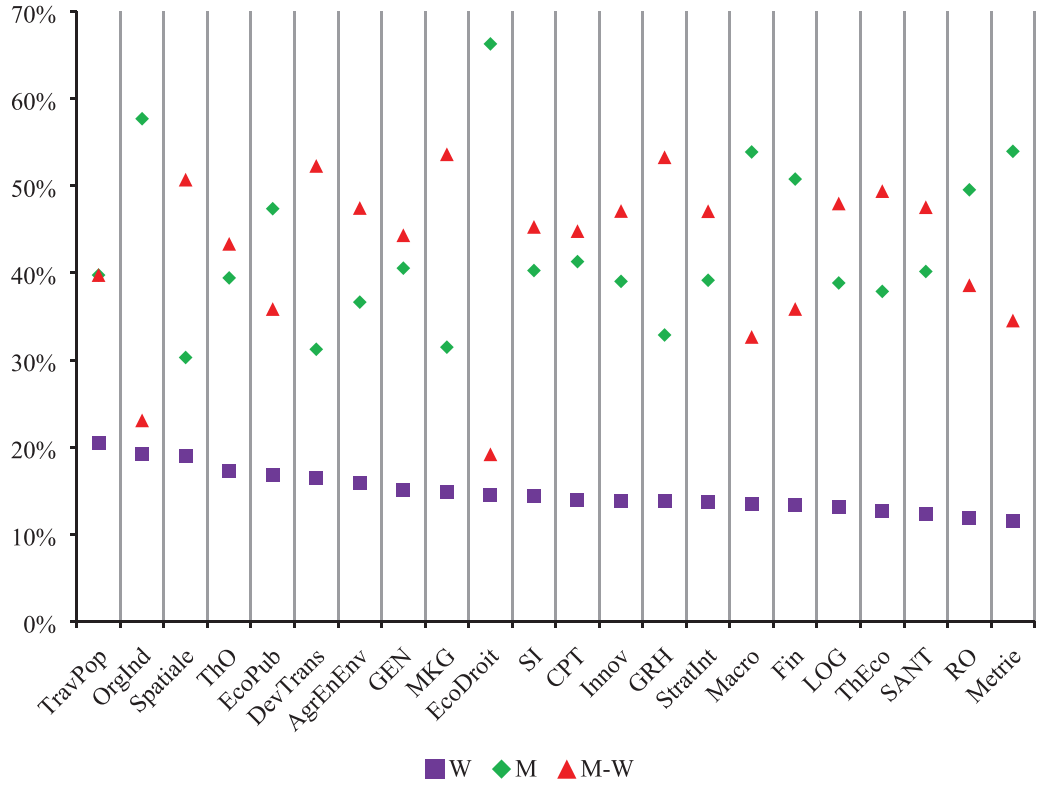

Figure 7. Distribution of Publications by Specialty and Collaboration Type (Management). [Colour figure can be viewed at wileyonlinelibrary.com]

Table 6. Number and Proportion of International Collaboration by Discipline.

International collaboration	Economics		Management	
M	19,179	23.9%	16,212	24.5%
W	5979	26.9%	5518	23.7%
M-W	20,751	40.4%	27,859	37.6%
All	45,909	29.9%	49,589	30.3%

Although the proportion of articles written in collaboration is greater in Management, the distribution between national and international copublications by gender is similar in both disciplines. This is true for copublications that include only women, only men, or both (Table 6). It should be noted, however, that men–women collaborations have a higher proportion of international copublications than men only or women only. The share of international copublications in the two disciplines is about 30%.

Figure 8 shows that publications without collaboration are the least cited, regardless of the author's gender. They are 20–30% less cited than the world average (defined as 1.0). In contrast, publications with

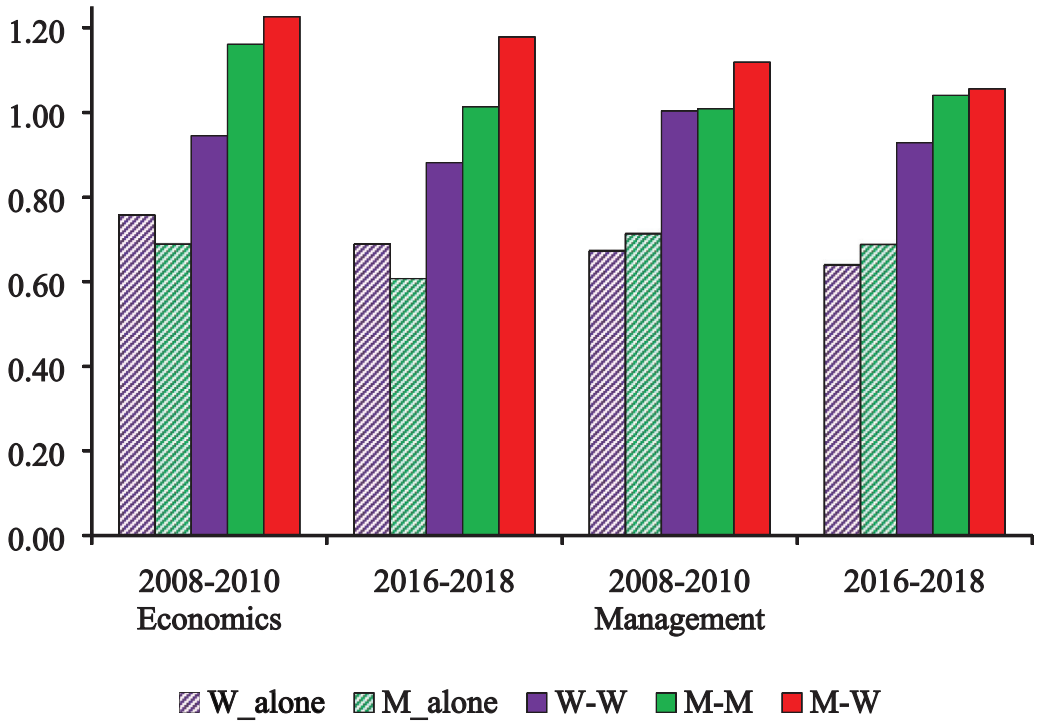

Figure 8. Normalized Citations Score—NCS* by Men–Women Collaboration Type.
* *The NCS of a given article is calculated by dividing the number of citations it received by the average number of citations in the same disciplines and the same year.*
[Colour figure can be viewed at wileyonlinelibrary.com]

male–female collaboration are the most cited in the two disciplines, with a normalized citation score 10–20% higher than the world average. In addition, Figure 6 shows that copublications involving only men are generally more cited than those including only women in both disciplines.

5. Results of Regression Analysis

We distinguish four types of independent variables: sociological (ex. authors' number, international collaboration, and sex of authors), geographical (the fact that corresponding author is American, European, or British), bibliometric (impact of journals measured by Impact Factor), and disciplinary (23 research areas).

Table 7 shows four important results that we can summarize as follows:

- The regression results suggest the existence of a modest positive and significant effect of GD on the number of citations received. The sign of all the coefficients of the authors' gender variables is negative in both regressions (for Economics and Management). This means that the impact of publications involving both men and women (reference modality) is higher. For instance, in both disciplines, papers by women groups are cited 6% less than paper's by a gender diverse group and papers by male groups are cited 5% less than papers by diverse groups in Management and 3% less

Table 7. Multiple Linear Regression Results for Economics and Management.

		Economics		Management	
Dependent variable: Log(1+citations)	Explicative variables	Coefficient	Pr (>|z|)	Coefficient	Pr (>|z|)
y-Intercept		2.98e+02***	2.0E-16	4.86e+02***	2.0E-16
Gender	*W_single*	–0.13***	2.0E-16	–0.16***	2.00E-16
	M_single	–0.20***	2.0E-16	–0.23***	2.00E-16
	W-W	–0.06***	5.4E-11	–0.06***	1.52E-13
	M-M	–0.03***	1.2E-04	–0.05***	6.33E-16
	M-W (ref.)	–	–	–	–
Corresponding author	*Corr_aut_USA*	0.14***	2.0E-16	0.07***	2.00E-16
	Corr_aut_EU27	0.06***	2.0E-16	0.06***	2.00E-16
	Corr_aut_UK	0.19***	2.0E-16	0.12***	2.00E-16
	From other countries (ref.)	–	–	–	–
	Corr_aut_woman	–0.02**	1.8E-02	0.00	9.91E-01
Collaboration	*Nb_Authors*	0.03***	2.0E-16	0.01***	4.77E-05
	Nb_countries	0.09***	2.0E-16	0.09***	2.00E-16
Journal	*log(IF_2)*	1.36***	2.0E-16	1.25***	2.00E-16
Year	*Publication_year*	–0.21***	2.0E-16	–0.24***	2.00E-16
Research areas	*GEN*	–0.16***	2.0E-16	–0.20***	2.00E-16
	MKG	–0.05*	6.2E-02	0.07***	2.00E-16
	GRH	0.15***	2.7E-03	0.04***	1.05E-08
	DevTrans	0.02**	1.2E-02	–0.17***	1.76E-08
	ThEco	–0.12***	2.0E-16	–0.19***	2.00E-16
	EcoPub	–0.04***	2.7E-04	–0.18***	2.08E-11
	Metrie	–0.08***	1.9E-12	–0.14***	1.47E-09
	OrgInd	0.02*	9.5E-02	0.08	5.54E-01
	Fin	–0.04**	1.3E-02	–0.15***	2.00E-16
	TravPop	0.07***	5.2E-06	–0.17***	5.16E-11
	Other research areas (ref.)	–	–	–	–
Model statistics	*Dispersion parameter*	0.81		0.86	
	R^2 *adjusted*	0.43		0.42	
	AIC	403,926		439,299	

***Significant at 1%.
**Significant at 5%.
*Significant at 10%.

in Economics. Regarding publications with a single female author, they receive 13% and 16% less citations than publications with GD, respectively, in Economics and Management. The rates are 20% and 23%, respectively, for publications with a single male author. This result suggests, moreover, that publications with a single female author are cited more than publications with a single male author (the difference between the two coefficients is significantly different from zero according to the Wald test on the two disciplines).

- Although publications with GD are relatively the most cited in both disciplines, the regressions show the existence of a hierarchy according to the collaboration and the gender of authors. The order is

the same for both disciplines. Thus, publications with a single male author are the least cited in both disciplines, followed by publications with a single female author. Publications involving several authors of the same sex are relatively more cited with similar coefficients.

- On the importance of collaboration, regression results show that, for both Economics and Management, the number of authors positively and significantly shapes citations and the number countries involved in a publication. This is a well-known finding in the literature (Smart and Bayer, 1986; Van Raan, 1998; Hara *et al*., 2003; Leimu and Koricheva, 2005a; Franceschet and Costantini, 2010; Bote *et al*., 2013; Larivière *et al*., 2015).
- For both disciplines, the country of corresponding author has a significant impact on citations. Thus, if the corresponding author is British (affiliation institution), the number of citations increases by 19% in Economics and 12% in Management. The rate is, respectively, 14% and 7% if the corresponding author is American. Finally, the citation rate is 6% higher if the corresponding author is European (EU27). In addition, it is important to underline the existence of the same order of the citation advantage in the two disciplines according to the geographical area of the corresponding author: United Kingdom followed by the United States, then of the EU27, and finally the other areas. These differences show the importance of adding the country of the author's institution (here the country of the corresponding author's institution) as a control variable when it comes to modeling citations.
- As could be expected, the academic impact of the journal is the variable that most affects the number of citations received by articles. The more the journal in which the article is published has a high impact factor and is thus more visible, the higher the number of citations of that article. Thus, the highest regression coefficients are recorded for the journal's "impact factor" variable, in both disciplines. Respectively, for Economics and Management: 1.36 and 1.25.

6. Discussion and Conclusion

In this paper, we have investigated the relationship between GD and citations received by academic papers in Economics and Management. Our results show the existence of a positive and modest effect of GD on the citations received. This is consistent with some studies on the topic like those of Campbell *et al*. (2013) and Dion *et al*. (2018). They are, however, different from those of Nielsen and Börjeson (2019) who found no effect of GD on citations. Note that Nielsen and Börjeson (2019) employed other measures of GD, which may contribute to explain why they found no effect. Our results also indicate that publications involving a single male author are the least cited in the two disciplines, followed by publications with a single female author. Publications involving multiple authors of the same sex come second in terms of impact after those with GD. All this suggests that diversity does indeed stimulate better reflections that may lead to more original results.

Our data also highlight for the first time that the practice of collaboration between different genders is quite different according to specialties in Economics and 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 data also show that publications with a single male author have fallen sharply in favor of publications with male–female collaboration, especially in Economics. Thus, men who tended to publish alone are more and more inclined to collaborate with other authors including at least one woman.

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; Gingras and Khelfaoui, 2018). Another important result of our analysis is the role of the characteristics of the corresponding author. In particular, its geographical position. Thus, if the corresponding authors

belong to an American or British institution (the two leading countries in these disciplines), their citations are higher. This is also the case if the corresponding authors are European (EU27) but to a lesser extent. Regarding the gender of the corresponding author, our results suggest a weak negative effect in Economics, and no effect in Management, on the citations received by the articles.

On the thematic orientations (research areas) within the two disciplines, our results confirm the existence of a different distribution according to sex. For example, the "History of economic thought, economic and business history, methodology research" area is characterized by a very high concentration of men (72% of publications are written by men only). In this discipline, the average proportion of women per article varies from 22% in "Finance and insurance" to more than 35% in "Environment, Agriculture, Natural resources, Energy." In Management, the distribution of women by research area is also much contrasted. The average proportion of women authoring articles varies from 22% in "Law" to almost 40% in "Urban, spatial and regional Economics, transportation and tourism." Although our analyses do not allow us to conclude on the existence of a horizontal segregation, we can, nevertheless, underline the fact that the publication practices by research area and their concentration are gender dependent.

Finally, given the strong promotion of GD and inclusion in academic research, our results seem to confirm the benefits of gender collaboration, and further research could test their validity in other disciplines.

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