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academic careers understood through measurement and norms

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Gender Effects on Evaluation Indicators

ACUMEN Deliverable D.4.13

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1. Introduction

Although there is a growing share of women throughout all phases in academic careers (Gerritsen et al. 2012), women are still significantly underrepresented in higher ranking positions, including senior managerial positions (Chesterman, Ross-Smith & Peters 2005). The historically low participation rate of women in research has stimulated studies of barriers faced by women in academia (Moore 1987). Recently Grosse, Brandt & Kretschmer (2012) and Kretschmer & Kretschmer (2013) conducted a comprehensive literature study by reviewed qualitative as well as quantitative studies about gender imbalance, gap and bias in science. They showed five explanation models that are frequently used in the gender studies in academia: (1) glass ceiling: difficultly identified obstacles that hold women back from accessing the highest position in the hierarchy (She Figures 2009), (2) leaky pipeline: the pipeline has not advanced women to top-level positions due to leaks and blockages in the pipe (review page 104); (3) Matthew & Matilde effect: 'the rich get richer' (Matthew effect: Merton 1968) and 'the poor get poorer' (Matilde effect: Mahbuba & Rousseau 2011); (4) gender myths: persisting myths in favour of men are creating attitudes in relation to the assessment of women's scientific performance' (Grosse, Brandt & Kretschmer, 2012, p.109), and (5) matching hypothesis: 'tendency of individuals to create ties with similar others' bias (Grosse, Brandt & Kretschmer, 2012, p.107). These models are also often mentioned in gender equality debates in higher education in European countries for many years. For example, the lack of women in senior positions in science is called 'leaky pipeline' (Weber 2008). It is obvious, but important to note that the number of women leaving the academic profession, the leaky pipeline, still constitutes an unnecessary waste of talent and could have negative implications for the knowledge economy.

This workpackage (WP4) of the Academic Careers Understood by Measurements and Norms (ACUMEN) project is addressed to promote the recognition of women and gender in scientific production which in turn influences gender aspects in talent recognition, production, career structures and career paths of male and female scientists. The underlying main goal is to increase the number and quality of research on gender and science, and researches with gender approaches. In order to be able to promote gender mainstreaming in scientific production, our results are used in the ACUMEN portfolio to increase the awareness and help design guidelines and criteria for improvement of gender mainstreaming and to increase the scientific authority and production of women.

In this report we present the results of studies conducted in Work Package 4. Chapter 2 introduces the literature published on gender bias in research careers. In chapter 3 we present the data and methods used in this report. Data consist of: (1) a sample of men and women scientists and scholars, drawn from the ACUMEN common data set, (2) questionnaire study about peer review practices, and (3) interviews with scientists about their career development. We used different methods (bibliometrics, quantitative and qualitative methods) to analyse the effects of both existing and new evaluation indicators, criteria, and procedures on women and men. Chapter 4 presents the results. Chapter 5 wrap up the main conclusions and formulates guidelines and gender dimensions to be incorporated in the ACUMEN portfolio.

2. Literature

This chapter introduces the literature published on gender bias in research careers. The findings of these papers are divided into three sections: (a) career development, (b) peer review, and (c) scientific production.

a. Gender in Career Development

Grosse, Brandt and Kretschmer (2012) identified six topics in reviewing qualitative based literature on gender issues with regard to career development in academia. In this section[1] we highlighted and discussed five of them. These are:

(1) Organizational culture

As norms in science are still masculine, this influences rewards and career support and -opportunities for women. Changes in organizational culture alone cannot solve all women career problems. Also policy changes on both national and international level are needed to give suitable stereotypes and frameworks. Pololi and Jones (2010) recommend women to simultaneously holding dual identities – being successful in the organization while trying to change the academic culture as a strategy in order to help women to cope and resist with professional barriers.

(2) Access to resources

Research showed gender differences in salary (Levecque et al 2014), tenure, rank, promotion, mobility and employment outside one's field of training. After controlling for professional characteristics and productivity, the 'pay-gap' between men and women in academia is still prominent (DesRoches et al 2010). Furthermore, females tend to believe that being a woman

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[1] This section is mainly based on a literature review report written by Grosse, Brandt and Kretschmer (2012) as part of ACUMEN Task 4.1.

was a negative factor with respect to academic advancement, leadership, opportunities, salary and resources (Wagner et al 2007).

(3) Self-concept/concept of life/personal characteristics

The reviewed literature focuses on the gap in expectations of career progression. Generally, women have less self-confidence compared to men. Most women believe that they would never reach the professoriate while most men assumed they would (Baker 2010; Chesterman, Ross-Smith & Peters 2005).

(4) Partnership/marriage/parenthood;

Reviewing literature regarding the impact of partnership and marriage on female academic careers show that family patterns still hindering career success and reproduce the gender gap. However, having a partner who is also working in academia has a positive impact on performance. The fact that women bear children and take on the majority of childcare responsibilities often leads to career breaks and fewer weekly working hours for women. To come to a suitable work-life balance with children is harder for women than for men, but also depend on personal determination, networks, and institutional conditions (Baker 2010). As shown by Wolfinger et al (2008) unmarried women with a PhD but without young children have the best position on the academic job market. Male doctoral recipients are more likely to get jobs than married females and females with young children. Compared with marriage, parenthood seems to be more careers hindering than marriage.

(5) Mentoring and other career development instruments;

Mentorship, in different facets, has impact on women's career development and could contribute to closing the gender gap in science. At various universities formal mentoring programmes for female scientific staff members have been developed to promote the advancement of women in science. In order to stimulate the current gender gap debate in science and higher education and to the speed up the process of closing the gender gap in science, female scientists are recommended to search the support of an informal mentor (van der Weijden et al forthcoming). Already tenured female scientists could also act as a role model mentor for female early career scientists as there are some expectations in the literature that underrepresented groups are better served with mentors or role models with similar characteristics of life experiences (Kopia, Melkers and Tanyildiz 2009).

b. Gender in Peer Review Processes

The importance of the gender in peer review processes is often debated. The publications reviewed in the gender and science database (Grosse, Brandt and Kretschmer 2012) showed that women apply grants at a lower rate than men. Most research councils currently formulated gender policy in order to promote and stimulate female participation in science.

The discussion about gender in grant allocation started almost two decades ago with the well-known Swedish study of Wennerås and Wold (1997), which showed that peer reviewers assigned lower scores to female applicants than to male applicants, while their levels of scientific productivity were about the same. Replicating the study of Wennerås and Wold ten years later, Sändstrom and Hallsten (2008), found no sexism anymore; female researchers even had slightly better chances than males. Clearly, the council studied in both publications changed its policy in the meantime. Gender policy in academia is not only applied to the outcomes of the selection process, but also to the panels executing this process (Van Arensbergen, Van der Weijden & Van den Besselaar 2014b). Panel composition is often found to influence decision-making: decisions of panels with no or only a few female members are found to be gender biased (Van Arensbergen, Van der Weijden & Van den Besselaar 2014a). The introduction of gender quotas in career related decision-making is in several countries, e.g. most of the Nordic countries and Spain (European Commission, 2008), is an important development to promote gender equality. Studies (Van den Brink 2009; Zinovyeva & Bagues 2010) showed that adding a female evaluator to the committee increases the number of female professors that are appointed / promoted. This indicates a preference for same-sex candidates. Recently Van Arensbergen, Van der Weijden & Van den Besselaar (2014a) showed that the composition of the panel does not seem to result into a gender bias in the decisions. This suggests that councils' policies to stimulate female participation in science, seems effective – at least at the level of their panels.

c. Gender in Scientific Production

Past studies has shown productivity gaps between male and female researchers. On average, men publish more papers (e.g. Cole and Cole, 1973; Cole, 1979; Cole and Zuckerman, 1984). More recent studies continued to show gender differences in research performance (e.g. Prpic 2002; Symonds et al. 2006; Ledin et al. 2007; Puuska 2009). However, as output is related to academic positions (rank), gender differences in productivity disappear when analysing output among researcher within the same position (Bordons et al 2003; Xie & Shauman 1998). In addition, comparison between disciplines discloses that gender effects in scientific production differ considerably (Kretschmer et al 2012).

With regard to citations per publication no differences between men and women were found (Cole and Zuckerman 1984; Ledin et al 2007). Some authors even claim that females produce higher quality research compared to their male counterparts (Long 1992; Sonnert & Holton 2006 and Symonds et al. 2006).

3. Methodology

In this chapter we describe the three datasets we used to analyze the gender dimension in relation to the system of career evaluation and performance measurement. The ACUMEN project selected four disciplines: (a) astronomy and astrophysics (A&A), (b) public health (PH), (c) philosophy (Phil) including the history and philosophy of science, and (d) environmental engineering (EE), to focus and harmonize its studies across all Work Packages. The above subject categories are based on the Thomson Reuters (formerly ISI) Journal Citation Reports (JCR) categories. The ACUMEN project selected 15 EU countries (Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Israel, Italy, The Netherlands, Poland, Slovenia, Spain and the United Kingdom) to examine the potential impact of geographical differences in the studies. The EU countries and subject fields were selected by the professional judgement of experts in the field of scientometrics.

3.1 Common Dataset [2]

In each discipline we took a random sample proportion to the total emails in each country, with a maximum of 800 emails. We extracted the list of emails from published research papers indexed in the Thomson Reuters Web of Science during 2005-2011. In order to get sufficient email addresses for philosophy, we used the Scopus citation index. Data protection and privacy issues were secured, and approved by the ethical committee of the University of Wolverhampton. We used SurveyMonkey to conduct an online survey between July and November 2011. The overall response rate of the online questionnaire is about 8% (n=2154). (ACUMEN 2011). Questions were asked e.g. about rank, gender and web presence.

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[2] This subsection is based on ACUMEN 2011. For more detailed information regarding the used methodology to comprise the ACUMEN common dataset we refer to the ACUMEN web presence progress report, published on 24 December 2011.

3.2 Dataset for the bibliometric analyses

We collected a set of papers from the academic researchers, who are included in the common dataset, to conduct a bibliometric analysis. The ACUMEN partners from WP2 and WP3 already provided part of the set of papers. CWTS completed the set by using the "Large scale author name disambiguation using rule-based scoring and clustering" algorithm developed at CWTS to detect publications per researcher. The algorithm used the email information (as described in 3.1) for each researcher to retrieve the publications. Overall the final dataset contains in total 1994 researchers, 560 females and 1434 males. Table 1 shows an overview of the number of researchers by discipline and gender. The discipline in which gender is most equally represented is public health.

Table 1. Researchers by Discipline and Gender

Discipline	Gender	Number of researchers	Percentage per discipline per gender
Astronomy & Astrophysics	Female	101	20%
Astronomy& Astrophysics	Male	393	80%
Environmental Engineering	Female	138	26%
Environmental Engineering	Male	394	74%
Philosophy	Female	92	20%
Philosophy	Male	367	80%
Public Health	Female	229	45%
Public Health	Male	280	55%

Table 2 shows the number of researchers per academic position and gender that has been included in the analysis. The academic position where the female researchers are less represented is full professor (17% of the full professors is female); while the PhD & master student rank has the highest female/males ratio (39% of the students is female).

3.3 Peer Review Practices Dataset

We used the Peer Review Practices (PPP; Must, Otsus & Mustajoki 2012) dataset to analyze gender differences with regard to researchers' attitudes towards the ways in which research quality, success, excellence and impact of scientific production are measured and evaluated.

Table 2. Researchers by Academic Position and Gender. *i=senior teaching and/or research position; ii=junior, possibly temporary teaching and/or research position; iii=PhD or master student)*

Academic Position	**Gender**	**Number of Researchers**	**Position & Gender (%)**
Full Professor	Female	70	17%
Full Professor	Male	352	83%
Associate Professor/ Reader/ Senior Lecturer i	Female	186	29%
Associate Professor/ Reader/ Senior Lecturer	Male	454	71%
Lecturer / Assistant Professor ii	Female	99	33%
Lecturer / Assistant professor	Male	205	67%
Postdoctoral Research Fellow	Female	103	35%
Postdoctoral Research Fellow	Male	189	65%
Student iii	Female	51	39%
Student	Male	79	61%
Other	Female	51	25%
Other	Male	155	75%

Furthermore, we aimed to get suggestions how the current peer review system should be improved or modified. The PPP is the results of a web-survey conducted in November & December 2011 as part of ACUMEN WP1. In total, 2114 respondents affiliated in 66 countries answered the questionnaire. Among respondents, 63% (n=1337) are men, and 31% (n=652) are women. 125 (6%) did not specify their gender. We conducted gender analyses by using SPSS.

3.4 Interviews

We analyzed 18 interviews with academic individuals, employed in four different countries (Germany, Poland, The Netherlands and United Kingdom), about their personal experiences. The interviews were conducted in 2012-2013 and are part of WP1, for detailed information we refer to Van der Most (2013b). The purpose of these interviews was to gain insight into the most important developments in the careers of academics. From WP1 we selected the female scientists (n=9) that agreed upon circulation of their transcript among the ACUMEN project partners. To have an equal gender distribution we randomly selected interview transcripts of 9 male scientists. To get an overview of the careers of the 18 selected interviewees we first read the interview transcripts in detail. Second, we focused on the following codes:

importance>family; importance>gender; micro_stories>family_conditions; micro_stories>gender. More detailed information about the used coding application of the interviews can be found in Van der Most (2013a).

4. Results

4.1. Bibliometric Analyses by Gender

This section shows the results of the bibliometric analysis based on the dataset explained in section 3.2. The researchers involved in the analysis are in different stages of their academic career, and some of them started to publish in the nineteen seventies or even earlier. The database we used for this analysis covers publications since 1980, this is why the overall period of analysis for this study is since 1980. See Appendix 1 for a detailed description of the database and the indicators.

4.1.1 General Gender Analyses

First we investigated possible gender differences in scientific output. We counted the total number of publications per researcher. A total of 23 researchers have zero publications in the WoS database, we excluded them from further analyzes. Results show (see table 3a) that men produced on average a significant higher number of publications compared to women; 23 publications versus 36 publications (*F=34.2; p=.000*). This suggests that men are more productive. This result confirmed previous findings on productivity and gender (ie. Fox 2005, Mauleón & Bordons 2006, Leahey 2006, and Larivière et al. 2011).

Table 3a. Indicators of output per gender (1980-2011/12)

Gender	Number of researchers	Publications	P per researcher
Female	553	12526	**23.11**(Mdn=10.0)
(Male	1418	48721	**36.58** (Mdn=18.0)

In this report we also pay attention to authorship order, given that the first and sometimes also last author publications are at least as important as raw publication counts for hiring, promotion and tenure (Wren et al. 2007). Table 3b presents the proportion of papers in which the researchers in our sample are mentioned as first author, last author and single author on the publications. Here we show that women are not evenly represented across authorship positions. With regard to first authorship, studies showed that women have been historically underrepresented in the first author position. Recently West et al (2012) showed that these discrepancies have been declined. Interestingly, in our sample women are overrepresented in the first authorship position. On average 37% of the papers in the oeuvres of female researchers consist of first authorships; this is a significantly higher percentage compared to males oeuvres (average 28%; *F=41.9; p=.000*). However, women are significantly underrepresented in the last author position (13% versus 19%; *F=29,8; p=.000*) and single-authored papers (15% versus 25%; *F=25.6; p=.000*). This last finding is in line with earlier studies (West 2013; Dotson 2011; Feramisco et al 2009) that also showed that women remain underrepresented as last authors.

Table 3b. Indicators of output per gender (1980-2011/12)

Gender	First authorship	Last authorship	Single authorship
Female	**37%** (Mdn=33%)	**13%** (Mdn=10%)	**15%** (Mdn=0%)
Male	**28%** (Mdn=24%)	**19%** (Mdn=15%)	**25%** (Mdn=0%)

Second, we explored gender differences with regard to the impact of publications. Table 4 shows impact indicators and some citation information per gender. The average number of citations per publication of male scientists (Mcs) is 10.13; this is somewhat higher than females (Mcs=9.74). However this difference is very small and non-significant (*F=0.48, p=0.49*). The mean normalized citation score (Mncs) show that both females and males are having an impact around world average. The average Mnjs is 1.09 for males and 1.08 for females, suggesting that both males and females tend to publish in journals with the same impact. Both female and male scientists have the same proportion of papers (11% for both genders) that belong to the top 10%. In sum, there are no gender differences with regard to impact.

Table 4. Indicators of impact per gender (1980-2011/12)

Gender	Mcs	Mncs	Mnjs	pp top 10%
Female	9.74 (Mdn=6.73)	1.08 (Mdn=0.88)	1.05 (Mdn=1.04)	11% (Mdn=6.0%)
Male	10.13 (Mdn=7.22)	1.09 (Mdn=0.88)	1.09 (Mdn=1.05)	11% (Mdn=6.5%)

Third, we calculated collaboration indicators and analyzed differences between women and men. Currently, lots of publications are written in teams in which researchers from different national and international institutes are collaborating together. Among female researchers in our dataset, on average 59% of their papers are written and published in collaboration with researchers (co-authors) from other institutions, and 32% is the result of international collaboration. As shown in Table 5, the male researchers in our dataset have a lower percentage of publications in collaboration (55%) compared to females (59%; *F=7.3; p=.007*). Many bibliometric studies show that female researchers are less involved in international collaboration than male researchers (i.e. Lewison 2001, Webster 2001, Larivière et al. 2011 & 2013, and Barrios et al. 2013). Our sample shows small and non-significant gender differences in this respect: on average 35% of the WoS publications in the oeuvres of males are the result of international collaboration compared to 32% females (*F=3.3; p=.07*).

Table 5. Indicators of collaboration per gender (1980-2011/12)

Gender	pp collab	pp int collab
Female	**59%** (Mdn=67%)	32% (Mdn=24%)
Male	**55%** (Mdn=33%)	35% (Mdn=30%)

4.1.2 Gender Analyses based on Research Disciplines

Tables 6a and 6b show the indicators of output per discipline and gender of the researchers. In the discipline labeled as philosophy the number of papers per researcher is low, as we expected in such a field. In all the four disciplines the number of publications per researcher is significant higher per male than per female (as in previous section).

Table 6a. Indicators of output per discipline and gender (1980-2011/12)

Discipline	Gender	Number of Researchers	P	P per Researcher
A&A	Female	101	3465	**36.0** (Mdn=29.0)
A&A	Male	393	18686	**53.8** (Mdn=35.0)
EE	Female	138	3006	**21.8** (Mdn=10.0)
EE	Male	393	13724	**35.5** (Mdn=21.0)
Phil	Female	86	521	**6.0** (Mdn=3.0)
Phil	Male	354	4879	**13.9**(Mdn=5.0)
PH	Female	228	5560	**24.6** (Mdn=13.0)
PH	Male	278	11721	**42.7** (Mdn=26.0)

In terms of the proportion of papers signed as the first author, for the field of astronomy & astrophysics (A&A) and public health (PH) the average percentage is significantly higher for female researchers compared to male researchers. Literature showed that author order varies across disciplines (Waltman 2012). In life sciences and biosciences the last authorship position is a prestige one. Males in each of the four selected disciplines of this study have a higher proportion of last authorship compared to their female colleagues. In the disciplines environmental engineering (EE, *F=20.2; p=.000*) and public health (PH, *F=16.6; p=.000*) these gender differences are also significant.

Table 6b. Indicators of output per discipline and gender (1980-2011/12)

Discipline	Gender	First authorship	Last authorship	Single authorship
A&A	Female	**36.4%** (Mdn=32.7%)	18.3% (Mdn=15.4%)	**1.1%** (Mdn=0.0%)
A&A	Male	**31.2%** (Mdn=25.7%)	21.3% (Mdn=16.7%)	**7.9%** (Mdn=0.0%)
EE	Female	41.4% (Mdn=35.0%)	**14.5%** (Mdn=10.0%)	6.6% (Mdn=0.0%)
EE	Male	37.3% (Mdn=33.3%)	**23.9%** (Mdn=19.6%)	6.4% (Mdn=0.0%)
Phil	Female	14.4% (Mdn=0.0%)	9.3% (Mdn=0.0%)	72.8% (Mdn=100%)
Phil	Male	13.1% (Mdn=0.0%)	12.2% (Mdn=0.0%)	71.8% (Mdn=95.5%)
PH	Female	**44.1%** (Mdn=39.1%)	**12.8%** (Mdn=11.1%)	2.4% (Mdn=0.0%)
PH	Male	**32.6%** (Mdn=28.2%)	**19.1%** (Mdn=17.6)	3.8% (Mdn=0.0%)

In philosophy (Phil) the oeuvres of both female and male scientists consist mainly of single author papers. There are no gender differences in this discipline.

Table 7 shows the indicators of impact per discipline and gender of the researchers. We report no significant differences between both genders.

Table 7. Indicators of impact per discipline and gender (1980-2011/12)

Discipline	Gender	Mcs	Mncs	Mnjs	pp top 10%
A&A	Female	14.11 (Mdn=10.73)	1.28 (Mdn=0.91)	1.12 (Mdn=1.06)	13% (Mdn=8.3%)
A&A	Male	14.74 (Mdn=11.08)	1.18 (Mdn=0.96)	1.15 (Mdn=1.11)	12% (Mdn=9.0%)
EE	Female	8.20 (Mdn=6.50)	1.00 (Mdn=0.91)	1.02 (Mdn=1.05)	9% (Mdn=4.5%)
EE	Male	9.50 (Mdn=7.50)	1.05 (Mdn=0.89)	1.08 (Mdn=1.07)	10% (Mdn=6.3%)
Phil	Female	2.92 (Mdn=0.82)	0.85 (Mdn=0.41)	0.89 (Mdn=0.85)	8.3% (Mdn=0.0%)
Phil	Male	4.24 (Mdn=1.15)	1.05 (Mdn=0.60)	1.06 (Mdn=0.94)	10.0% (Mdn=0.0%)
PH	Female	11.32 (Mdn=8.88)	1.13 (Mdn=0.94)	1.10 (Mdn=1.09)	12% (Mdn=8.2%)
PH	Male	12.02 (Mdn=9.79)	1.07(Mdn=0.96)	1.04 (Mdn=1.03)	11% (Mdn=8.6%)

In terms of collaboration, Table 8 shows the indicators of collaboration per discipline and gender of the researchers. Our results show that depending on the discipline the degree of collaboration in general (inter-institutional) and internationally specifically varies. Interestingly, females in the discipline Astronomy & Astrophysics (A&A) show higher percentages of both inter-institutions and international collaborations compared to males. Inter-institutional collaboration is significantly higher for females (81%) than for males (74%; *F=7.3; p=.007*). In contrast, the percentage inter-institutional collaborative publications and the percentage international collaborative publications for the discipline environmental engineering (EE) is higher for men than for women. International collaboration is significantly higher for male (31%) than for females (26%; *F=4.0; p=.05*). Public Health (PH) shows quite similar percentage of inter-institutional and international collaborations per gender. As the oeuvres of scientists in philosophy (Phil) mainly consist of single author papers, collaboration for both genders is low.

Table 8. Indicators of collaboration per discipline and gender (1980-2011/12)

Discipline	Gender	pp collab	pp int collab
A&A	Female	**81.2%** (Mdn=86.8%)	66.4% (Mdn=71.4%)
A&A	Male	**74.3%** (Mdn=80.0%)	62.9% (Mdn=67.4%)
EE	Female	51.4% (Mdn=51.6%)	**25.9%** (Mdn=18.8%)
EE	Male	55.2% (Mdn=57.1%)	**31.0%** (Mdn=27.5%)
Phil	Female	17.1% (Mdn=0.0%)	10.1% (Mdn=0.0%)
Phil	Male	21.1% (Mdn=0.0%	12.0% (Mdn=0.0%)

PH	Female	70.0% (Mdn=73.3%)	29.8% (Mdn=22.0%)
PH	Male	69.1% (Mdn=71.4%)	32.2% (Mdn=26.7%)

4.1.3 Gender Analyses based on Academic Positions

In terms of the output per researcher and academic position Table 9 shows, as in previous sections, that male researchers produce more papers than females regardless their academic position. For the postdoctoral research fellows is where the differences are lower though.

Table 9a. Indicators of output per academic position and gender (1980-2011/12). FP=full professor; AP/R/SL= Associate Professor/Reader/Senior Lecturer; Ass/L= Assistant Professor/Lecturer; Postdoc=Postdoctoral Research Fellow; Student=PhD Student/Master Student.

Academic Position	**Gender**	**Number of researchers**	**P**	**P per researcher**
FP	Female	70	3292	47.40 (Mdn=31.5)
FP	Male	346	20998	61.45 (Mdn=40.5)
AP/R/SL	Female	182	5340	**29.69** (Mdn=19.5)
AP/R/SL	Male	449	16404	**37.38** (Mdn=25.0)
Ass/L	Female	99	1547	15.69 (Mdn=9.0)
Ass/L	Male	204	3971	19.56 (Mdn=11.0)
Postdoc	Female	103	1400	13.85 (Mdn=7.0)
Postdoc	Male	188	2999	16.81 (Mdn=8.0)
Student	Female	51	224	4.48 (Mdn=3.5)
Student	Male	79	794	10.18 (Mdn=3.0)
Other	Female	49	850	**17.37** (Mdn=7.0)
Other	Male	155	5746	**38.40** (Mdn=22.0)

Table 9b presents the proportion of papers in which the researchers in our sample are mentioned as first author, last author and single author on the publications. At each level on the career ladder, the papers in the oeuvres of female researchers consist of a higher percentage of first authorships compared to men. For associate professors, assistant professors, postdocs and other research positions these gender differences are also significant. With regard to last authorships, associate professors are significantly underrepresented in this prestigious authorship position (16% versus 20%; *F=5.8; p=.016*). At the full professor level we find relatively small and non-significant gender differences (females 24% versus males 26%; *F=0.55; p=.46*). As last authorship positions are mainly dedicated to full and associate professors, as indicated by medians of 0% for both genders at lower ranks we can't elaborate on possible gender differences at these lower positions.

Table 9b. Indicators of output per academic position and gender (1980-2011/12). FP=full professor; AP/R/SL= Associate Professor/Reader/Senior Lecturer; Ass/L= Assistant Professor/Lecturer; Postdoc=Postdoctoral Research Fellow; Student=PhD Student/Master Student.

Academic Position	**Gender**	**First authorship**	**Last authorship**	**Single authorship**
FP	Female	25.0% (Mdn=22.0%)	23.9% (Mdn=19.4%)	**22.4**% (Mdn=0.0%)
FP	Male	21.3% (Mdn=17.4%)	26.01 (Mdn=23.08%)	**36.8%** (Mdn=0.0%)
AP/R/SL	Female	**32.9%** (Mdn=27.4%)	**15.9%** (Mdn=14.3%)	16.21% (Mdn=0.0%)
AP/R/SL	Male	**27.8%** (Mdn=25.0%)	**19.7%** (Mdn=17.7%)	22.07% (Mdn=0.0%)
Ass/L	Female	**37.9%** (Mdn=33.3%)	10.6% (Mdn=0.0%)	18.22% (Mdn=0.0%)
Ass/L	Male	**31.0%** (Mdn=29.0%)	14.7% (Mdn=10.0%)	27.64% (Mdn=0.0%)
Postdoc	Female	**45.7%** (Mdn=45.3%)	8.26% (Mdn=0.0%)	**7.9%** (Mdn=0.0%)
Postdoc	Male	**36.9%** (Mdn=32.6%)	10.8% (Mdn=0.0%)	**17.7%** (Mdn=0.0%)
Student	Female	49.2% (Mdn=50.0%)	6.6% (Mdn=0.0%)	11.0% (Mdn=0.0%)
Student	Male	40.0% (Mdn=40.0%)	11.9% (Mdn=0.0%)	13.6% (Mdn=0.0%)
Other	Female	**36.4%** (Mdn=30.0%)	**13.4%** (Mdn=10.0%)	17.4%(Mdn=0.0%)
Other	Male	**24.5%** (Mdn=22.0%)	**21.5%** (Mdn=18.1%)	22.7%(Mdn=0.0%)

The impact indicators, based on the academic position and gender, show that the differences between female and male researchers are very small (Table 10). The biggest differences are in the Academic Position called 'Others' where the impact for male researchers is significantly higher for the four impact indicators. Probably this is due to the fact that 'Other' contains a group of researchers working as research directors and research managers, in both female and male category, but only in the case on male researchers there is a group of emeritus professors with long and prestigious academic careers.

Table 10. Indicators of impact per academic position and gender (1980-2011/12). FP=full professor; AP/R/SL= Associate Professor/Reader/Senior Lecturer; Ass/L= Assistant Professor/Lecturer; Postdoc=Postdoctoral Research Fellow; Student=PhD Student/Master Student.

Academic Position	**Gender**	**Mcs**	**Mncs**	**Mnjs**	**pp top 10%**
FP	Female	14.00 (Mdn=8.02)	1.15 (Mdn=0.92)	1.04 (Mdn=1.02)	12.0% (Mdn=10.2%)
FP	Male	12.22 (Mdn=9.25)	1.17 (Mdn=0.98)	1.10 (Mdn=1.03)	11.8% (Mdn=8.0%)
AP/R/SL	Female	10.37 (Mdn=9.09)	0.96 (Mdn=0.89)	1.02 (Mdn=1.02)	10.0% (Mdn=6.7%)
AP/R/SL	Male	10.10 (Mdn=7.75)	0.97 (Mdn=0.83)	1.06 (Mdn=1.04)	9.6% (Mdn=6.3%)
Ass/L	Female	8.57 (Mdn=4.50)	1.05 (Mdn=0.86)	1.02 (Mdn=1.00)	10.4% (Mdn=5.6%)
Ass/L	Male	8.42 (Mdn=5.34)	1.08 (Mdn=0.86)	1.09 (Mdn=1.09)	9.9% (Mdn=5.5%)
Postdoc	Female	9.12 (Mdn=6.6)	1.21 (Mdn=0.93)	1.16 (Mdn=1.11)	11.0% (Mdn=6.5%)
Postdoc	Male	7.99 (Mdn=5.7)	1.10 (Mdn=0.89)	1.14 (Mdn=1.12)	11.6% (Mdn=4.5%)
Student	Female	7.02 (Mdn=3.33)	1.48 (Mdn=0.86)	1.15 (Mdn=1.16)	15.1% (Mdn=0.0%)
Student	Male	6.50 (Mdn=4.12)	1.35 (Mdn=0.86)	1.07 (Mdn=1.06)	9.9 % (Mdn=0.0%)
Other	Female	**7.77** (Mdn=5.33)	**0.82** (Mdn=0.71)	**0.93** (Mdn=1.00)	7.4% (Mdn=0.5%)
Other	Male	**12.29** (Mdn=8.69)	**1.15** (Mdn=0.91)	**1.06** (Mdn=1.02)	11.5% (Mdn=8.1%)

Finally, Table 11 presents the results in terms of collaboration per academic position and gender. At the level of full professors, the percentage of collaboration is higher compared to males who have the same position in academia (57% versus 46%, *F=7.3; p=.007*). At lower rank, the percentage of international collaboration is always lower (although not significantly) for female researchers than for male researchers. In terms of inter-institutional collaboration there are no gender differences among those lower ranked academic positions.

Table 11. Indicators of collaboration per academic position and gender (1980-2011/12). FP=full professor; AP/R/SL= Associate Professor/Reader/Senior Lecturer; Ass/L= Assistant Professor/Lecturer; Postdoc=Postdoctoral Research Fellow; Student=PhD Student/Master Student

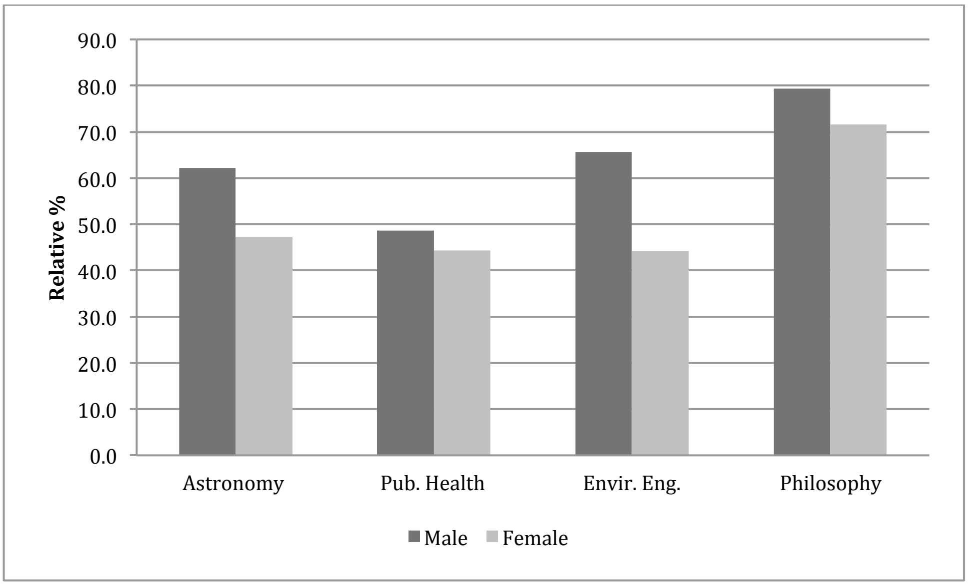
Academic Position	Gender	pp collab	pp int collab
FP	Female	**56.8%** (Mdn=64.9%)	30.7% (Mdn=25.0%)
FP	Male	**46.0%** (Mdn=50.4%)	28.9% (Mdn=25.4%)
AP/R/SL	Female	57.2% (Mdn=66.3%)	30.5% (Mdn=23.5%)
AP/R/SL	Male	56.6% (Mdn=62.5%)	34.6% (Mdn=27.3%)
AP/L	Female	53.3% (Mdn=50.0%)	28.6% (Mdn=18.2%)
AP/L	Male	54.0% (Mdn=58.0%)	31.6% (Mdn=21.9%)
Postdoc	Female	67.1% (M)n=75.0%)	43.2% (Mdn=42.9%)
Postdoc	Male	64.6% (Mdn=69.4%_	46.3% (Mdn=50.0%)
Student	Female	65.8% (Mdn=82.6%)	33.6% (Mdn=19.1%)
Student	Male	58.0% (Mdn=82.6%)	45.0% (Mdn=40.0%)
Other	Female	58.6% (Mdn=66.7%)	**26.3%** (Mdn=15.8%)
Other	Male	57.3% (Mdn=66.7%)	**38.5%** (Mdn=35.1%)

4.2 Gender and Web Presence

The web has provided new opportunities for academics to disseminate their research results. ACUMEN operationalized web presence as online CV's, homepages or publication lists for the scholarly related activities of academics. Web CV's or publication lists can include wider publication types (e.g. journal of conference papers, books, and reports) and pre-prints, which would not be indexed by major scientific databases. In this way, Academic Web CVs or online lists of publications (institutional or personal) can be a significant method to facilitate knowledge transfer (Kousha & Thelwall 2013). Furthermore, online CVs or resumes can be updated frequently and share bibliographic information, abstract or even the full-text of published or in press research through personal or institutional self-archiving practices. In this section we studied, by using the common ACUMEN database, gender effects in having an online CV or an individual webpage for publication lists.

About 61% (n=1,309) of academics included in the common dataset have either Web CVs or an individual online publication list for academic activities, whereas about 39% (n=845) did not mention any specific URL address in the survey. Furthermore, about 20% (n=421) of the researchers declared that they use other websites such as e-prints and open access initiatives (e.g., arxive.org), blogs or social networking sites to disseminate and/or discuss science. With regard to gender: 65% of the males and 50% of the females has a web presence. This suggests that gender may have impact on the Web presence of academics across selected fields.

Figure 1: Academics with Web CVs or online publication lists (source: ACUMEN, 2011)



As shown in Figure 1, in the field of 'Environmental Engineering' as well as 'Astronomy & Astrophysics' gender differences are remarkable. 66% of the male respondents (n=278) in environmental engineering declared that they have either a Web CV or an online publication list, compared to 44% of the females (n=65). In contrast, we found only small gender differences in web presence in the disciplines public environmental & occupational health and philosophy are small.

4.3 Gender Analyses on the Peer Review Practices (PPP) Dataset

4.3.1 Gender differences in S&T indicators

The quality of research output is measured with different Science & Technology (S&T) indicators. They measure the various components of research activity, including inputs, process, outputs, outcomes and impact and benefits. Some research assessments assign different weightings or values to the various indicators. In this way, some components of research activity are valued more highly than other activities (Must, Ostus & Mustajoki 2012). In the survey we asked respondents to assess on a five-point scale 22 different indicators used in research assessments. The highest rating was given to the following indicators: high ranked publications

(4.5 for males versus 4.6 for females), citations (3.9 for males versus 3.9 for females), research collaborations and partnership (3.7 for males versus 3.9 for females). In this top three there were no differences in rating between men and women.

Views vary at different career stages. Particularly different are the preferences of postdocs and professors. Gender differences in rating S&T indicators are most prominent in the postdoc career phase. With regard to social indicators: relevance to global societal challenges, public outreach, contributing to science education, usefulness to policy decision makers, relevance to citizens' concerns female postdocs give higher value to these indicators compared to males in the same career phase.

Table 12: Preferences of postdocs on social indicators

Social indicators	**Gender**	**Mean**
Relevance to citizens' concern	Males	2.96 (n=257)
	Females	3.25 (n=191)
	Total	3.07 (n=457)
Relevance to global societal challenges	Males	3.24 (n=255)
	Females	3.49 (n=188)
	Total	3.34 (n=453)
Usefulness to policy decision makers	Males	2.85 (n=252)
	Females	3.26 (n=187)
	Total	3.00 (n=447)
Relevance to science communication initiatives	Males	3.26 (n=257)
	Females	3.54 (n=185)
	Total	3.36 (n=449)
Contributing to science education	Males	3.68 (n=259)
	Females	3.93 (n=193)
	Total	3.77 (n=460)

Also output indicators as publications, non-bibliographic outputs, number and completion rates of PhD graduates and public outreach are more important for female postdocs compared to male postdocs, who give on average lower ranks.

Table 13: Preferences of postdocs on output indicators

Output Indicators	**Gender**	**Postdoc**
Publications	Males	4.32 (n=271)
	Females	4.51 (n=202)
	Total	4.41 (n=483)
Non-bibliographic outputs	Males	2.84 (n=244)
	Females	3.17 (n=175)
	Total	2.98 (n=426)
PhD graduates (no and completion rates)	Males	3.25 (n=270)
	Females	3.45 (n=197)
	Total	3.33 (n=476)
Patent development	Males	3.06 (n=250)
	Females	2.89 (n=186)
	Total	2.99 (n=443)
Public outreach	Males	3.25 (n=265)
	Females	3.64 (n=197)

	Total	3.42 (n=472)

Female assistant professors put on average lower value on effect indicators, as citations and the H-index to assess the work of researchers, compared to males in the same career phase. As we mainly observe gender differences in ranking effect indicators on the assistant professor level, this suggests that this could be related with the timing of parenthood. In Germany, Austria and Switzerland, for example the average age to get tenure is 38 (Schulze, Warning & Wiermann 2008). For female researchers, the tenure and the biological clock are ticking at the same time. Joecks et al (2013) suggest installing a 'handicap-system', which means that female researchers with children need a lower number of publications to get tenure or to succeed in an appointment tournament than males of females without children.

Table 14: Preferences of academic scholars, within different career phases, on effect indicators

Items	**Gender**	**Full professor**	**Associate professor**	**Assistant professor**	**Postdoc**
Citations	Males	3.94 (n=239)	3.91 (n=173)	4.02 (n=152)	3.91 (n=270)
	Females	3.81 (n=69)	3.92 (n=73)	3.73 (n=85)	4.01 (n=197)
	Total	3.90 (n=317)	3.89 (n=252)	3.91 (n=247)	3.95 (n=477)
H index	Males	3.52 (n=227)	3.61 (n=161)	3.57 (n=141)	3.49 (n=250)
	Females	3.56 (n=61)	3.33 (n=67)	3.27 (n=77)	3.57 (n=162)
	Total	3.51 (n=296)	3.52 (n=234)	3.48 (n=227)	3.52 (n=417)
Number of prestigious awards and prizes	Males	3.60 (n=240)	3.67 (n=172)	3.61 (n=150)	3.69 (n=269)
	Females	3.71 (n=68)	3.59 (n=73)	3.61 (n=84)	3.72 (n=199)
	Total	3.62 (n=316)	3.63 (n=251)	3.62 (n=244)	3.69 (n=477)
Employability of PhD graduates	Males	2.68 (n=227)	2.81 (n=164)	2.80 (n=144)	2.92 (n=247)
	Females	2.42 (n=65)	2.69 (n=70)	2.58 (n=76)	3.04 (n=184)
	Total	2.64 (n=300)	2.78 (n=240)	2.75 (n=228)	2.97 (n=438)

4.3.2. Gender Differences with regard to Criticism of Peer Review

Peer review relies on mutual trust and transparency. Although generally considered essential to academic quality and used widely, peer review has also been criticized. In the survey we defined, based on the literature review (Must et al., 2012) eleven different biases of peer review. We asked the respondents to rate (on a five point scale) the extent to which each type of bias may affect the assessment of grant applications. As shown in Table 15, females perceive in general more bias in peer review practices compared to males.

Table 15: Rating of the selection of bias by gender

Bias of Peer Review	**Gender**	**Mean**
Matthew effect	Males	3.71 (n=904)
	Females	3.96 (n=445)
	Total	3.80 (n=1367)
Institutional bonus : scientists from prestigious institutes	Males	3.58 (n=904)
	Females	3.76 (n=453)

	Total	3.64 (n=1357)
Friendship bonus	Males	3.51 (n=876)
	Females	3.88 (n=437)
	Total	3.64 (n=1348)
Entrenched academic traditionalism	Males	3.41 (n=844)
	Females	3.79 (n=425)
	Total	3.54 (n=1305)
Language : favouring papers written in English	Males	3.09 (n=899)
	Females	3.29 (n=452)
	Total	(n=1390)
Conflict of interest	Males	3.06 (n=876)
	Females	3.32 (n=441)
	Total	3.14 (n=1355)
Peer review as time consuming process	Males	3.05 (n=868)
	Females	3.24(n=440)
	Total	3.12 (n=1347)
Geographical location	Males	2.99 (n=901)
	Females	3.29 (n=452)
	Total	3.09 (n=1392)
Scope of research	Males	3.01 (n=849)
	Females	3.20 (n=444)
	Total	3.06 (n=1331)
High costs of peer review	Males	2.54 (n=827)
	Females	2.78 (n=403)
	Total	2.63 (n=1264)
Gender	Males	1.72 (n=883)
	Females	2.58 (n=453)
	Total	1.33 (n=1989)

In general, the most urgent concern of the respondents on peer review practices was related to the so-called Matthew effect – "to those who have, more shall be given"(rating 3.8), institutional bonus (3.6), friendship bonus (3.6). It seems that these were the most pressing ones in all research fields.

Scientists, both women and men, view gender bias in peer review as non-urgent, compared to the scores on the different types of bias. Although females gave higher rates compared to males, gender bias is not perceived as a main concern in the assessment of applications.

4.4 Gender in Interviews with Academics

The interview protocol (Van der Most 2012) asks for the three most important developments in the interviewee's career and work, for details about each of these, and why these are important to the interviewee. Interviews with academic individuals show that about a third of the reported most important developments have to do with jobs, whereas two thirds have to do with things that happen within jobs (Van der Most 2013b). Interestingly, the interviewees employed in the Polish academia didn't refer to gender issues at all.

4.4.1 Job changes and family circumstances

In this section we focus on reported job changes in which the interviewees talk about the importance of family circumstances. The first item is related to the partners' careers; the importance to geographically follow the partner in order to combine two careers. As illustrated by five quotes (see below), both male and female academic researchers mention their partners' careers as a reason in making individuals' decisions regarding job mobility.
'My partner was working elsewhere at the time, in A. And I identified someone in B:…a newly appointed professor, who's skills and experience were complementary to mine and I thought ehm, I could work with him' (female scientist, UK, Public Health).

' So there was an opportunity through a friend of mine to apply for a research visit to the University of X…Because I was working closely with him he knew that at that moment for family reasons, my wife was about to get an opportunity in B, he knew that research-wise I wasn't so happy in A . He actually said ehm, hey, you should you should apply for that' (male scientist, UK, Environmental Engineering).

' I moved from A to B because of personal reasons. My wife was appointed director of the …office of her company…so she moved first and then we had the option, either I stay in A and we live separate for six years, or I move to B as well, so I decided to move. It's purely family, personal reasons' (male scientist, UK, Environmental Engineering).

*' I came because my husband had…a permanent position in X…finding a permanent position in the same university was eh, very major task…' (*female scientist, UK, Philosophy).

'*Well, it was driven by personal considerations…because my boyfriend at that time was also starting to work here. He's working in the X group, which is the building just before this. And, so, I had at the time another offer from the group in Y. But it was for a shorter period of time. It was just for one year. To start off with. Whereas this contract was for three years. And. Well.. We would be together. So this is what made me to choose'* (female scientist, UK, Astronomy).

Secondly, the importance to get a permanent position in academia, which gives prospects & security in buying a house and having and raising children, is mentioned as an important family reason to change jobs. Interestingly, as is shown in the two quotes below, only male academic scientists mention this second item.

'It was important that it's a permanent position, so … it gives me some security for buying an apartment and having kids. …Things are more difficult if you have to move around all the time and it just makes things easier. I mean for instance there's no, not really a point in eh buying an

apartment or a house if you have to consider that you eh might move to a few hundred kilometres away the next two or three years' (male scientist, Germany, Astronomy).

'So, then coming to B, I was then thinking, okay what do I actually want to do. So I actually applied for a few positions…I wanted to get something that was more permanent, longer term. So that was important because my future career could have changed based on what I, where I chose to go. Yes. It gave prospect. Well I had. This is where external, well family factors will come in. Because I had two small children by this time. So that was precipitating having to move, we had to change from house in A. So we either tried to stay in A and buy a bigger house. But then, we wouldn't want to do that if I was going to move to somewhere else. And it's also good to move, move around to different places, and we like living in different places, so. So we figured it would be good, a good, the timing was good to move. And career-wise it was, I had achieved enough to be able to get something, you know to move on to another long-term position' (male scientist, UK, Astronomy).

4.4.2 Being a Female Scientist in Academia

In the interviews we deliberately did not ask explicitly for gender differences or gender effects. As gender in general is quite a sensitive and highly debated topic, we wanted to see if (both male and female) respondents would bring up the gender issues by themselves. Only female scientists (three out of nine) who were interviewed spontaneously talked about: (1) the status of female researchers in academia, and (2) the combination of work and private family life with children, and (3) gender bias in applications. From other ACUMEN interviews with female academics (van der Most 2013b), which unfortunately are not part of this analyses, we learned that respondent also talked about: (4) positive discrimination.

Status

Three women shared their individual experiences regarding the status of females in science.

'And I was the first ehm female PhD graduate….in this institute…It was one thing that was important to me' (female scientist, Germany, Environmental Engineering).

"…You're well accepted and there is now no opposition against women' (female scientist, Germany, Environmental Engineering).

'This is a stereotype but I think women more often take on those kind of pastoral roles; supporting students who are failing' (female scientist, Germany, Environmental Engineering).

Combination work and private life with children

One woman left her job in health care after having kids. She decided to go to university to study, obtain her master degree, and wanted to pursue a career in academia. According to her opinion the combination work and private life was easier to make within the university compared to working as a professional in health care. That drives her to take the plunge into the insecure and sometimes non-transparent world of academia.

'Well, the practical thing is that I have two children and the youngest child was about six years when I finished studying. So I thought: well, university, I like the project, and I think it's much more feasible to do it with children' (female scientist, Germany, Public Health).

Another female interviewee told us that she started to work part-time after having kids.

'After the PhD, I had ehm three quarters of a year worked in full time. And then my first son was born…I changed to part-time work. I worked 50% and then after the next 2, I started with 12 hours per week…and then gradually, built up to 50 percent' (female researcher, Germany, Astronomy)

In her country (Germany) it is no option that a mother continued working fulltime in academia. She does not want to become a bad mother 'Rabenmutter' who does not take enough care of the kids. As she explained in this quote:

'…this is really deep in the minds of all the Germans, so to say, that the mother has to care for the children, not the father' (female researcher, Germany, Astronomy).

Gender in grant applications

…I mean gender is really playing a role.

Two female scientists stress the negative impact of being a female scientist on future career development in academia. One female Astronomer indirectly, as being a member of the evaluation committee, experienced gender differences in the assessment of grant applications.

' We had a woman applicant who had three children, like me. And all the guys said: oh yes, in the last year, she hadn't one single first author publication…You'll somehow have to say: then that's accounting for part of her work time or, whatever. But the others members of application committee said: oh no, she decided to have it that way and there are other guys who have all these plenty of first author publications and who did a lot more of research, apparently' (female researcher, Germany, Astronomy)

Another female interviewee directly experienced gender differences in grant applications and tried to avoid this by putting a males' name on the grant application.

'We didn't put my name down as the PI initially. We put down X's name as the PI to try and actually ensure we got the money because he had had large EC grants before. And then after it was funded we changed that with the EC. I wrote the grant. However, whilst I guess that means for the first six months I wasn't origin, officially leading with the ehm with the EC. I was always officially the PI within our university, so I got the academic credit for it, from my university, even though I wasn't initially the PI that was, that only happened, you know, a year later' (female researcher, UK, Public Health).

Positive discrimination [3]

One German interviewee was quite sure that she was asked as a reviewer of EU project applications in her field because she is a German woman and both women and (at that time) Germans were underrepresented in the review committees. She did not like this form of positive discrimination. Similarly, a Dutch woman explained about a job application:

'... I would hate to think, but perhaps it did play a role that my being a woman eh was taken into account, which I would not have liked. I'm not quite sure. I'm reasonably sure that they ... they urged me to apply for associate professorship, which at that time, I was not quite enthusiastic about anymore. ... I'm the only woman on the, on the staff here at [my group]. And they are a bit ashamed about it. So they wanted to show perhaps [laughingly] they were nice to women. But I wouldn't have liked that if that were the case. I want to be evaluated on my, other things that matter, and not on gender, which is quite irrelevant' (Interviewee 10, 01:01:45.85).

She also did not see the point of such positive discrimination, since it will backfire later on:

'Yes, they do, they do a bit of positive discrimination. And I'm, I'm not in favour of it, because eh, if it would have been the case, I didn't know, that I would have been, or other women would have been positively discriminated, they would be discriminated negatively afterwards. People would say: it's not your work, it's just, yes, and it's an easy job for you. I haven't hear that by the way, ever' (Interviewee 10, 01:01:45.85).

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[3] The subsection positive discrimination is copied from Van der Most, 2013b (page 46).

5. Conclusions and Recommendations

Today there is increasing gender equity early in the pipeline, on master and PhD degrees. However, women are still significantly underrepresented in tenure-track and research university faculty positions. The study of West & Curtis (2006) show that women represents one-quarter of full professors and earn on average 80% of the salary of men in comparable positions. More general gender disparity can be ascribed to a male model of science, including masculinity of organisational, social and cultural norms within academic organization (Van Arensbergen, 2014). The task of this project was to promote the recognition of women and gender in scientific production which in turn influences gender aspects in talent recognition, production, career structures and career paths of male and female scientists. The underlying main goal was to increase the number and quality of research on gender and science, and researches with gender approaches. In order to be able to promote gender mainstreaming in scientific production, our results are used in the ACUMEN portfolio to increase the awareness and help design guidelines and criteria for improvement of gender mainstreaming and to increase the scientific authority and production of women.

Gender & Bibliometric Indicators

Since academic publishing is still very important for career opportunities of both males and females in sciences we focus in the first part of the study on the gender in bibliometrics, by comparing the oeuvres of female and male scientists. Our bibliometric research confirms the traditional gender pattern; men produce on average a higher number of *publications* compared to women, regardless their academic position and research field. In this report we also pay attention to authorship order, given that the first and sometimes also last author publications are at least as important as raw publication counts for hiring, promotion and tenure (Wren et al. 2007). Our results suggest that women are not evenly represented across authorship positions. In our sample women are overrepresented in the first authorship position, especially in the disciplines A&A and PH. At each level on the career ladder, the papers in the oeuvres of female researchers consist of a higher percentage of first authorships compared to men. With regard to last authorship position, women in all four selected disciplines are significantly underrepresented this prestigious position. Female associate professors are significantly underrepresented. As last authorship positions are mainly dedicated to full and associate professors we can't elaborate on possible gender differences at these lower positions. Interestingly, we show no gender differences regarding research *impact* in each studied disciplines and positions in academia, as measured by three indicators (MCS, MNCS, and PPtop10%). Our results show that depending on the discipline the degree of *collaboration* in general (inter-institutional) and internationally specifically varies. Interestingly, at the level of full professors, the percentage of collaboration is higher compared to males who have the same position in academia. At lower rank, the percentage of international collaboration is always lower for female researchers than for male researchers. As collaboration is one of the main drivers of research output and scientific impact (Larivière et al 2013), we recommend to develop and promote programs for female early career researchers. To increase internationally collaboration opportunities, female scientists should search for support of an international mentor. In the mentor-mentee conversations, female mentees will also be trained to improve their personal & managerial skills such as negotiation, self-promoting and networking, as research (West et al 2011) suggested that these qualities are necessary in discussions about authorship order. In this way mentorship could contribute to speed up the process of closing the gender gap in science. Female full professors could act as a role model mentor for female early career scientists as there are some expectations in the literature that underrepresented groups are better served with mentors or role models who had similar characteristics of life experiences (Kopia, Melkers & Tanyildiz 2009).

Gender & Peer review

The questionnaire study, among 2114 scientists affiliated in 66 countries, show that both women and men view gender bias in peer review as non-urgent, compared to the scores on different types of bias. The interviews study show only one female scientist who experienced gender bias in applications. These results suggest that gender bias is not perceived, at least not at this moment, as a main concern in peer review processes

Gender & Social Indicators

From the survey on peer review practices it can be concluded that the new generation of researchers give higher rates to *social (relevance) indicators* compared to the older generation; women even more than men. Gender differences in rating social indicators are most prominent in the postdoc career phase; female postdocs give higher values to these indicators compared to males in the same career phase. As research evaluation systems have only recently started to include societal impact as one of their criteria (van der Weijden, Verbree & Van den Besselaar 2012), the incentives for scientists to focus on societal impact are still relatively weak. As the ACUMEN project includes other important tasks of academic such as contributions to the society, we recommend researchers to list the magazine or newspaper articles, encyclopaedia articles and popular books & articles that they have written. In addition, to show the influence of your scientific work on the society you could include in the ACUMEN portfolio examples of: (1)

specialist advices that you have given outside academia; (2) professional practice that has used your subject expertise; (3) laws, regulations and/or guidelines that are initiated, developed or amended on (partly) your research.

Gender & Web Indicators

This ACUMEN research show the personal homepage as the most common type of academic *web presence*. Our data suggest that gender may have impact on the Web presence of academics, especially in the field of 'Environmental Engineering' as well as 'Astronomy & Astrophysics' gender differences are remarkable. However, it is impossible to measure its impact. As internet has opened up new and fast ways to communicate with various audiences, ACUMEN recommends scientists to maintain a presence on professional social media sites such as academia.edu, ResearchGate.com, and Mendeley.com and on the more general professional social media site, LinkedIn. As these social media sites also allow other members of the network to follow the researcher and to get update on his/her activities, web presence could also accelerate the process of reducing the international collaboration gender gap in science. Impact from these social websites may be calculated, from statistics like visitors, followers and readers. These are examples of altmetric indicators (Bar-Ilan et al. 2012), where altmetrics is "the creation and study of new metrics based on the Social Web for analysing, and informing scholarship" (Priem et al 2010).

Academic Age

It is unfair to directly compare ACUMEN portfolios irrespective of gender, because results can be misleading. An academic who has taken some year off in order to raise children and/or who has worked part-time should not be disadvantaged for this. ACUMEN recommends scientists to calculate their academic age (for more information read the guidelines for Good Evaluation Practices with the ACUMEN portfolio). To compensate for gender, one year is subtracted for each child born after the PhD defence for which the academic is the single main responsible person. This allowance can be shared between carers, if agreed.

Academic Age = Number of full - time working years since PhD defence – number of children raised - special allowances.

Our interview studied showed that there are large country differences regarding maternity leave, childcare facilities and possibilities to work part-time in academia. We realize that the academic age calculation can't compensate for all these country-specific facilities. Both evaluators and researchers should take this into account in comparing academics from different countries on their ACUMEN portfolios.

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7. Appendix Bibliometric Indicators

In this appendix, we discuss the methods underlying the bibliometric analyses presented in this report[4].

7.1. Database Structure

At CWTS, we calculate our indicators based on our in-house version of the Web of Science (WoS) database of Thomson Reuters. WoS is a bibliographic database that covers the publications of about 12,000 journals in the sciences, the social sciences, and the arts and humanities. Each journal in WoS is assigned to one or more subject categories. We note that our in-house version of the WoS database includes a number of improvements over the original WoS database. Most importantly, our database uses a more advanced citation matching algorithm and an extensive system for address unification. Our database also supports a hierarchically organized field classification system on top of the WoS subject categories. To determine the appropriateness of our indicators for assessing a particular research entity, we often look at the internal WoS coverage of the entity. The internal WoS coverage of an entity is defined as the proportion of the references in its oeuvre that points to publications (also) covered by WoS. The lower the internal WoS coverage of an entity's output, the more careful one should be in the interpretation of our indicators. We refer to our in-house version of the WOS database as CI. The rest of this chapter provides an in-depth discussion of the main bibliometric indicators that we use in this report.

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[4] We refer to Moed (2005) for a general introduction into the use of bibliometrics and citation analysis for research evaluation.

Overview of the bibliometric indicators.

Indicator	*Dimension*	*Definition*
P	Output	Total number of publications of a unit.
MCS	Impact	Average number of citations of the publications of a unit (self-citations not included).
MNCS	Impact	Average normalized number of citations of the publications of a unit (self-citations not included).
MNJS	Journal Impact	Average normalized citation score of the journals in which a unit has published.
pp top 10%	Impact	Proportion of papers that belong to the top10%.
pp collab	Collaboration	Percentage inter-institutional collaborative publications.
pp int collab	Collaboration	Percentage international collaborative publications.

7.2 Indicators

7.2.1 Indicators of Output

To measure the total publication output of a unit, we use a very simple indicator. This is the number of publications indicator, denoted by P. This indicator is calculated by counting the total number of publications of a research unit. Only publications of the document types *article* and *review* are taken into account..

7.2.2 Indicators of Impact

A number of indicators are available for measuring the average scientific impact of the publications of a unit. These indicators are all based on the idea of counting the number of times the publications of a unit have been cited. Citations can be counted using either a fixed-length citation window or a variable-length citation window. In the case of a fixed-length citation window, only citations received within a fixed time period (e.g., four years) after the appearance of a publication are counted. In the case of a variable-length citation window, all citations received by a publication up to a fixed point in time are counted, which means that older publications have a longer citation window than more recent publications. An advantage of a variable-length window over a fixed-length window is that a variable-length window usually yields higher citation counts, which may be expected to lead to more reliable impact measurements. In this study, we have used a variable length window, so all citations received by all publications up to 2012 are counted, for the whole period analysis 2002-2011. For the trend analysis though a fixed-length citation window (four years) have been used. This approach is most suitable for being able to make a trend analysis and compare between periods. In the calculation of our impact indicators, we disregard self citations. We classify a citation as a self citation if the citing publication and the cited publication have at least one author name (i.e., last name and initials) in common. We disregard self citations because they have a somewhat different nature than ordinary citations. Many self citations are given for good reasons, in particular to indicate how different publications of a researcher build on each other. However, sometimes self citations can serve as a mechanism for self promotion rather than as a mechanism for indicating relevant related work. This is why we consider it preferable to exclude self citations from the calculation of our impact indicators. By disregarding self citations, the sensitivity of our impact indicators to manipulation is reduced. Disregarding self citations means that our impact indicators focus on measuring the impact of the work of a researcher on other members of the scientific community. The impact of the work of a researcher on his own work is ignored.

As we have mentioned previously each journal in WoS is assigned to one or more subject categories. These subject categories can be interpreted as scientific fields. There are about 250 subject categories in WoS. Publications in multidisciplinary journals such as *Nature*, *Proceedings of the National Academy of Sciences*, and *Science* were individually allocated, if it was possible, to subject fields on the basis of their references. The reassignment was done proportionally to the number of references pointing to a subject category. It is important to highlight that the impact indicators are calculated based on this assignment. Each publication in WoS has a document type. The most frequently occurring document types are article, book review, correction, editorial material, letter, meeting abstract, news item, and review. In the calculation of bibliometric indicators, we only take into account publications of the citable document types article and review. Publications of other document types usually do not make a significant scientific contribution

Our most straight forward impact indicator is the mean citation score indicator, denoted by MCS. This indicator equals the average number of citations per publication. Only citations within the relevant citation window are counted, and self citations are excluded. Also, only citations to publications of the document types: article, and review are taken into account.

A major shortcoming of the MCS indicator is that it cannot be used to make comparisons between scientific fields. This is because different fields have very different citation characteristics. For instance, using a three-year fixed-length citation window, the average number of citations of a publication of the document type article equals 2.0 in mathematics and 19.6 in cell biology. So it clearly makes no sense to make comparisons between these two fields using the MCS indicator. Furthermore, when a variable-length citation window is used, the MCS indicator also cannot be used to make comparisons between publications of different ages. In the case of a variable-length citation window, the MCS indicator favors older publications over more recent ones because older publications tend to have higher citation counts.

Our mean normalized citation score indicator, denoted by MNCS, provides a more sophisticated alternative to the MCS indicator. The MNCS indicator is similar to the MCS indicator except that it performs a normalization that aims to correct for differences in citation characteristics between publications from different scientific fields, between publications of different ages (in the case of a variable-length citation window). To calculate the MNCS indicator for a unit, we first calculate the normalized citation score of each publication of the unit. The normalized citation score of a publication equals the ratio of the actual and the expected number of citations of the publication, where the expected number of citations is defined as the average number of citations of all publications in WoS that belong to the same field and that have the same publication year and the same document type. The field (or the fields) to which a publication belongs is determined by the WoS subject categories of the journal in which the publication has appeared. The MNCS indicator is obtained by averaging the normalized citation scores of all publications of a unit. If a unit has an MNCS indicator of one, this means that on average the actual number of citations of the publications of the unit equals the expected number of citations. In other words, on average the publications of the unit have been cited equally frequently as publications that are similar in terms of field, publication year. An MNCS indicator of, for instance, two means that on average the publications of a unit have been cited twice as frequently as would be expected based on their field, and publication year. We refer to Waltman, Van Eck, Van Leeuwen, Visser, and Van Raan (2011a and b) for more details on the MNCS indicator.

In addition to the MNCS indicator, we have another important impact indicator. This is the *proportion top 10% publications indicator*, denoted by $PP_{\text{top 10\%}}$. For each publication of a research group, this indicator determines whether based on its number of citations the publication belongs to the top 10% of all WoS publications in the same field (i.e., the same WoS subject category) and the same publication year and of the same document type. The $PP_{top\ 10\%}$ indicator equals the proportion of the publications of a research group that belong to the top 10%. If a research group has a $PP_{top\ 10\%}$ indicator of 10%, this means that the actual number of top 10% publications of the group equals the expected number. A $PP_{top\ 10\%}$ indicator of, for instance, 20% means that a group has twice as many top 10% publications as expected. (see Appendix I for an illustration of the calculation on the indicator)

To assess the impact of the publications of a unit, our general recommendation is to rely on a combination of the MNCS indicator and the $PP_{top\ 10\%}$ indicator. The MCS indicator does not correct for field differences and should therefore be used only for comparisons of groups that are active in the same field. An important weakness of the MNCS indicator is its strong sensitivity to publications with a very large number of citations. If a unit has one very highly cited publication, this is usually sufficient for a high score on the MNCS indicator, even if the other publications of the group have received only a small number of citations. Because of this, the MNCS indicator may sometimes seem to significantly overestimate the actual scientific impact of the publications of a unit. The $PP_{top\ 10\%}$ indicator is much less sensitive to publications with a very large number of citations, and it therefore does not suffer from the same problem as the MNCS indicator. A disadvantage of the $PP_{top\ 10\%}$ indicator is the artificial dichotomy it creates between publications that belong to the top 10% and publications that do not belong to the top 10%. A publication whose number of citations is just below the top 10% threshold does not contribute to the $PP_{top\ 10\%}$ indicator, while a publication with one or two additional citations does contribute to the indicator. Because the MNCS indicator and the $PP_{top\ 10\%}$ indicator have more or less opposite strengths and weaknesses, the indicators are strongly complementary to each other. This is why we recommend taking into account both indicators when assessing the impact of a unit’s publications.

It is important to emphasize that the correction for field differences that is performed by the MNCS and $PP_{top\ 10\%}$ indicators is only a partial correction. As already mentioned, the field definitions on which these indicators are based on the WoS subject categories. It is clear that, unlike these subject categories, fields in reality do not have well-defined boundaries. The boundaries of fields tend to be fuzzy, fields may be partly overlapping, and fields may consist of multiple subfields that each have their own characteristics. From the point of view of citation analysis, the most important shortcoming of the WoS subject categories seems to be their heterogeneity in terms of citation characteristics. Many subject categories consist of research areas that differ substantially in their density of citations. For instance, within a single subject category, the average number of citations per publication may be 50% larger in one research area than in another. The MNCS and $\mathrm{PP}_{\mathrm{top}\ 10\%}$ indicators do not correct for this within-subject-category heterogeneity. This can be a problem especially when using these indicators at lower levels of aggregation, for instance at the level of departments or individuals.

7.2.3 Example: hypothetical research group

To illustrate the calculation of the MNCS indicator, we consider a hypothetical research group that has only five publications. **Table 0** provides some bibliometric data for these five publications. For each publication, the table shows the scientific field, to which the publication belongs, the year in which the publication appeared, and the actual and the expected number of citations of the publication. (For the moment, the last column of the table can be ignored.) .Citations have been counted using a variable-length citation window. As can be seen in the table, publications 1 and 2 have the same expected number of citations. This is because these two publications belong to the same field and have the same publication year. Publication 5 also belongs to the same field. However, this publication has a more recent publication year, and it therefore has a smaller expected number of citations. It can further be seen that publications 3 and 4 have the same publication year and the same document type. The fact that publication 4 has a larger expected number of citations than publication 3 indicates that publication 4 belongs to a field with a higher citation density than the field in which publication 3 was published. The MNCS indicator equals the average of the ratios of actual and expected citation scores of the five publications. Based on Table 1, we obtain

$$\mathrm{MNCS} = \frac{1}{5}\left(\frac{7}{6.13} + \frac{37}{6.13} + \frac{4}{5.66} + \frac{23}{9.10} + \frac{0}{1.80}\right) = 2.08$$

Hence, on average the publications of our hypothetical research group have been cited more than twice as frequently as would be expected based on their field, and publication year.

Table 0: Bibliometric data for the publications of a hypothetical research group.

Publication	*Field*	*Year*	*Actual citations*	*Expected citations*	*Top 10% threshold*
1	Surgery	2007	7	6.13	15
2	Surgery	2007	37	6.13	15
3	Clinical neurology	2008	4	5.66	13
4	Hematology	2008	23	9.10	21
5	Surgery	2009	0	1.80	5

To illustrate the calculation of the $\mathrm{PP}_{\mathrm{top\ 10\%}}$ indicator, we use the same example as we did for the MNCS indicator. **Table 0** shows the bibliometric data for the five publications of the hypothetical research group that we consider. The last column of the table indicates for each publication the minimum number of citations needed to belong to the top 10% of all publications in the same field and the same publication year and of the same document type.[5] Of the five publications, there are two (i.e., publications 2 and 4) whose number of citations is above the top 10% threshold. These two publications are top 10% publications. It follows that the $\mathrm{PP}_{\mathrm{top\ 10\%}}$ indicator equals

$$\mathrm{PP}_{\mathrm{top\,10\%}} = \frac{2}{5} = 0.4 = 40\%$$

In other words, top 10% publications are four times overrepresented in the set of publications of our hypothetical research group.

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[5] If the number of citations of a publication is exactly equal to the top 10% threshold, the publication is partly classified as a top 10% publication and partly classified as a non-top-10% publication. This is done in order to ensure that for each combination of a field, a publication year, and a document type we end up with exactly 10% top 10% publications.