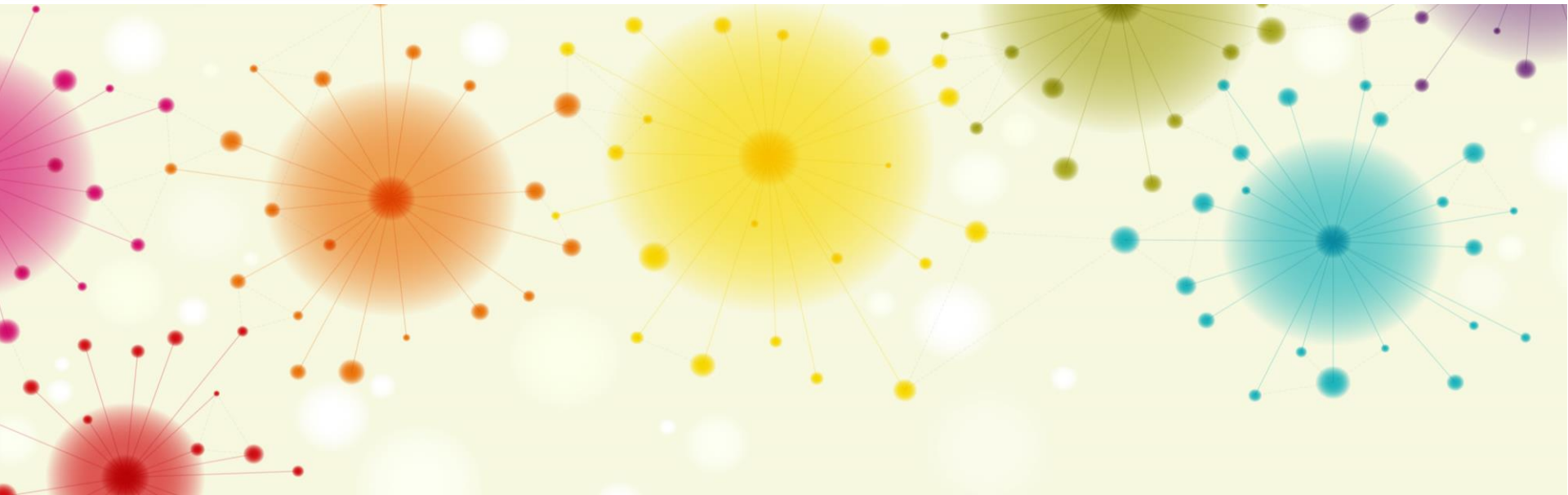




Science-Metrix

Collaboration between men and women in science

A bibliometric analysis of scientific activity by gender and
co-authorship between men and women



SciTS Conference 2017 – Clearwater Beach, FL – June 13, 2017

Session: Gender and Diversity in Teams



Context of the study

- Development of **gender-based bibliometric indicators** for the European Commission for the **She Figures 2015** report
 - Web of Science, corresponding author only, limited coverage
- Support by the **NSF** to further develop the methods and explore the potential of adding gender indicators in the **Science and Engineering Indicators** report
 - Increased coverage (all authors, all countries, Scopus, more years)
 - More systematic approach
 - Increase accuracy, better **understand potential biases**



Toward gender equality

- Important **gains** have been made in **gender equality in research**
- Gender **disparities persist** in the research ecosystem; more acute the higher one looks in the **professional hierarchy**
- Still appear to be important **inequality in employment income and research funding**



Toward gender equality

- Reliance on **bibliometric statistics** in research assessment exercises and in **grant competitions** is rising worldwide.
- If women are at a disadvantage relative to male in terms of the number of publication outputs, and other bibliometric indicators, then women might very well get stuck in a **vicious circle**—lower scores with bibliometric indicators reduces the chance of being funded and/or reduces the actual amount of funding secured, which would in turn reduce capacity to increase research output and scientific impact.



Challenges

- The gender of authors is **not disclosed** on publications
- **Large volumes** of data: 300 million authorships
- **Given names** are often **missing** in the databases
- Not all given names are **gender specific**, and this **varies** considerably **between countries**
- For example, the **discriminating power of given names** drops significantly for **Asian names**, especially those from China and South Korea
- Some given names refer to a man for one nationality and to a woman for another

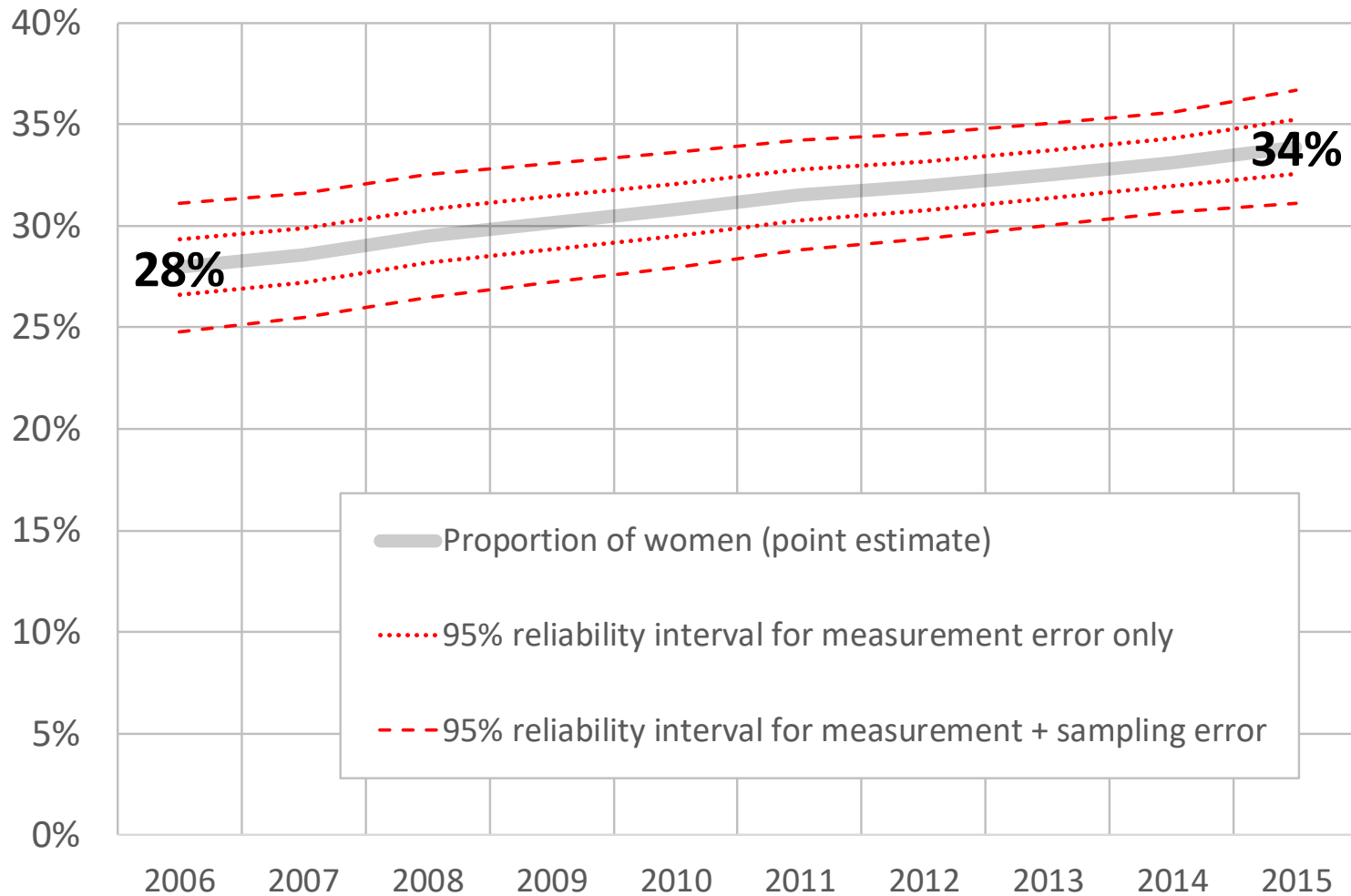


Description of the approach

- Science-Metrix has employed a powerful tool: **NamSor™**
- High degree of **accuracy** and **recall**, and a **global coverage**
- **14.35 million** different combinations of first name and last name have been genderized
- **Built-in reliability score** for each gender attribution
- Calculation of a **reliability interval** based on the **accuracy of the attribution** and the **sampling error**

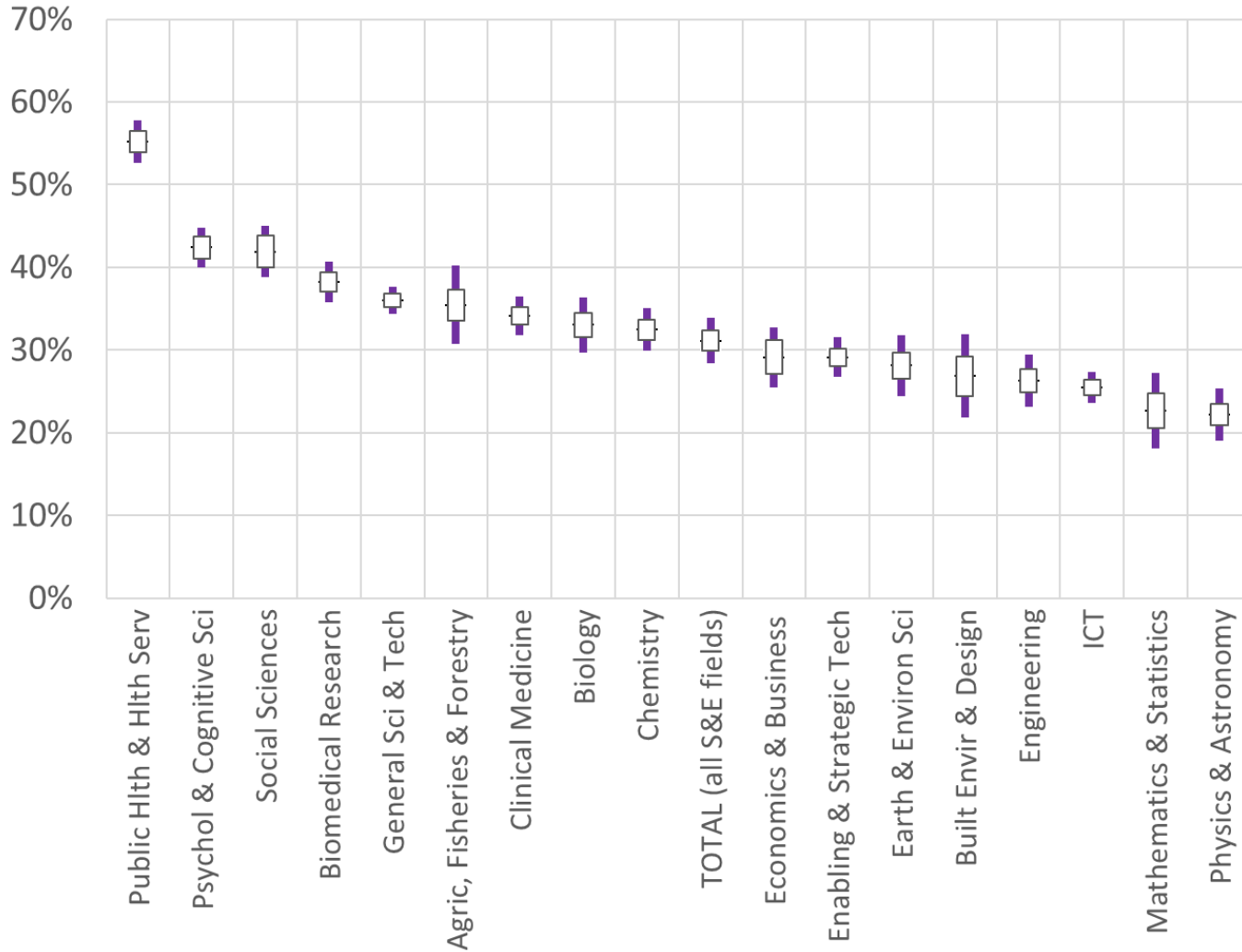


Proportion of women is increasing at world level





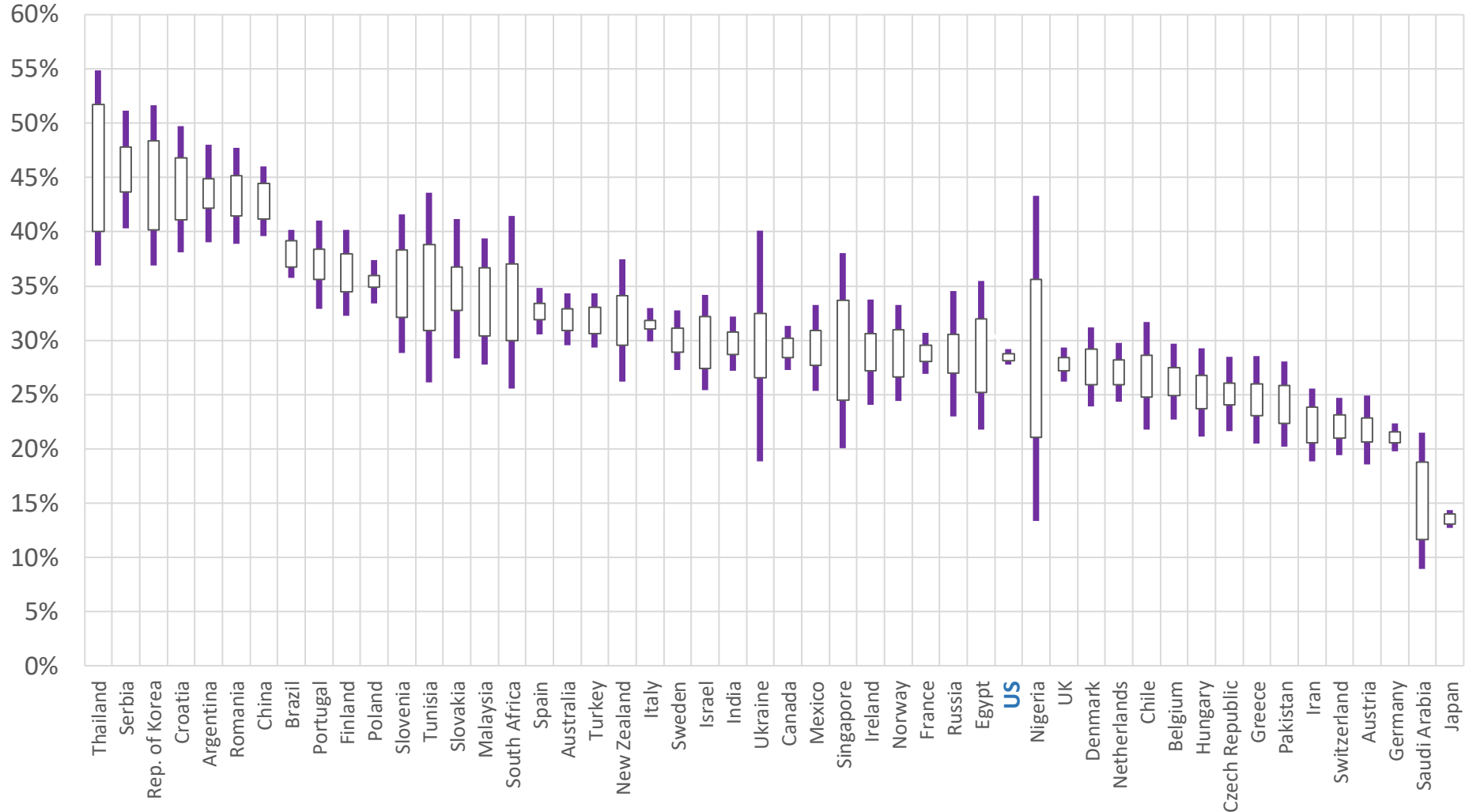
Proportion of women varies by field





Proportion of women by country

Proportion of women in authorship in Scopus in the 50 most publishing countries (2006–2015)





Collaboration between men and women

- **Men prefer to collaborate with men and women with women**
- **This is observed in all fields**



Measuring scientific impact of women and men

The Average of Relative Citations (ARC) is an indicator of scientific impact based on citations received, with correction for variations in citation habits between specialties

Number of Citations: for each paper we count the number of citations received (e.g., 10)

Relative Citations (RC): the number of citations is divided by the average number of citations received by all papers in the specialty of the paper in the same year (e.g., average for organic chemistry = 5, thus $RC = 10/5 = 2$)

Average of Relative Citations (ARC): for a given entity, the ARC is the average of the RCs of all its papers

ARC > 1 means more citations than world average

ARC < 1 means fewer citations than world average



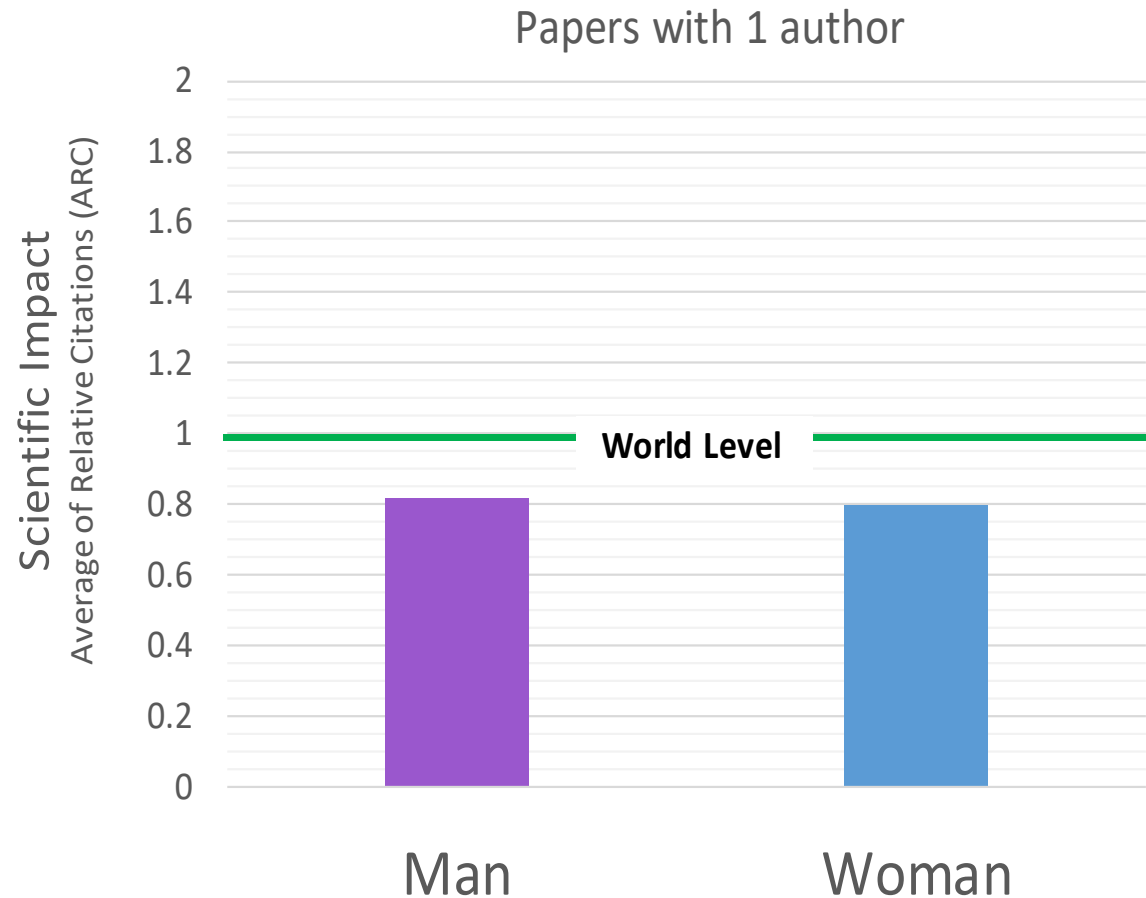
In this analysis we controlled for:

- **Subfield of research**
- **Year of publication**
- **Country: only U.S. papers are used**



Scientific Impact of women and men

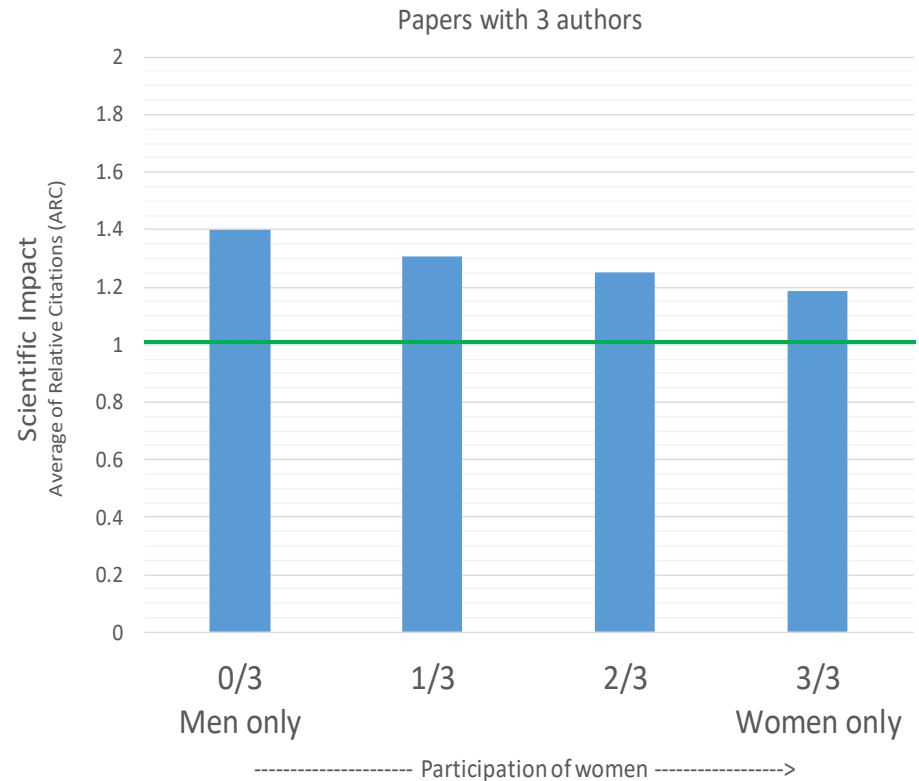
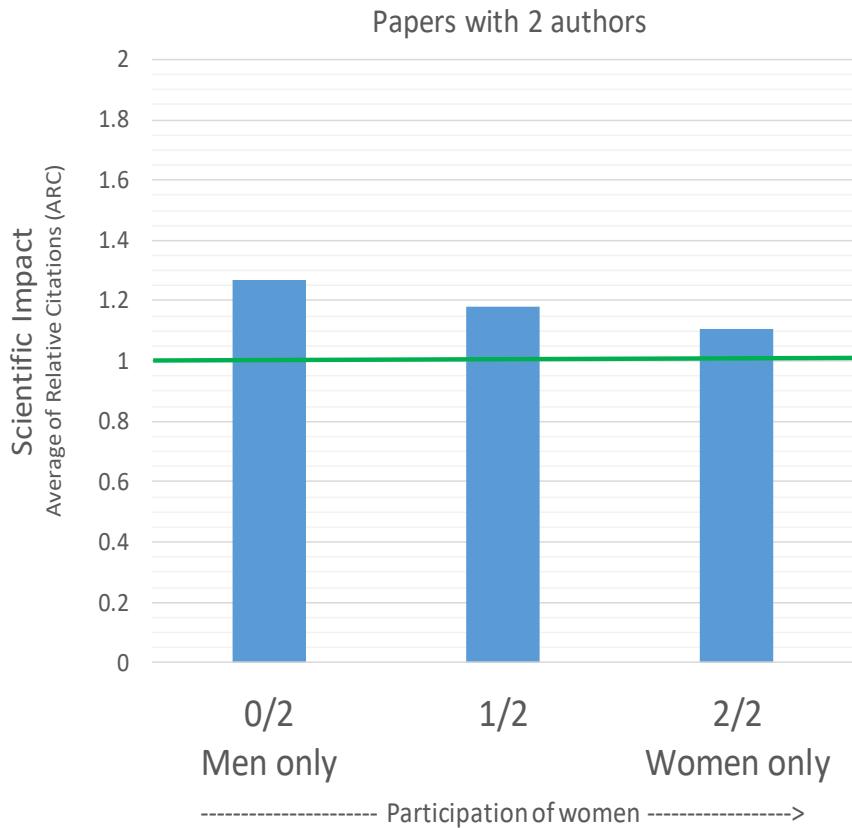
In papers with a **single author**, the scientific impact of women and men is **almost identical**





Scientific Impact of women and men

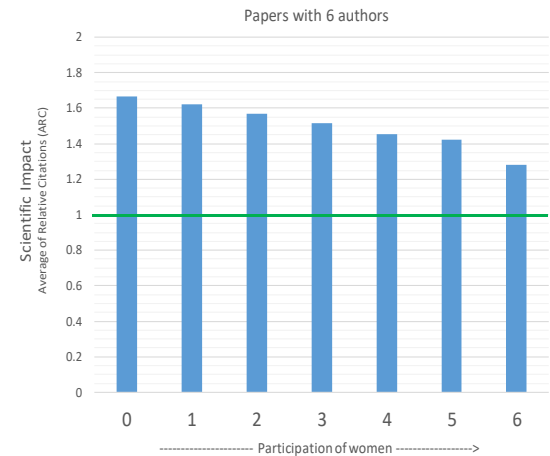
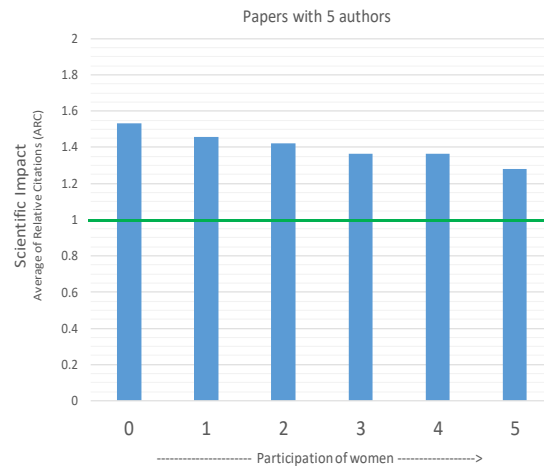
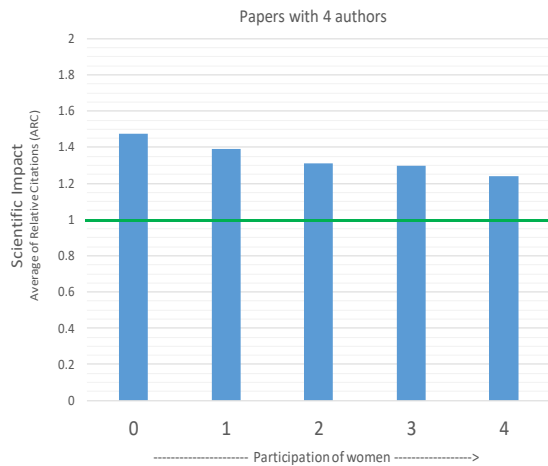
But with **multiple authors**, the scientific impact decreases with the participation of women





Scientific Impact of women and men

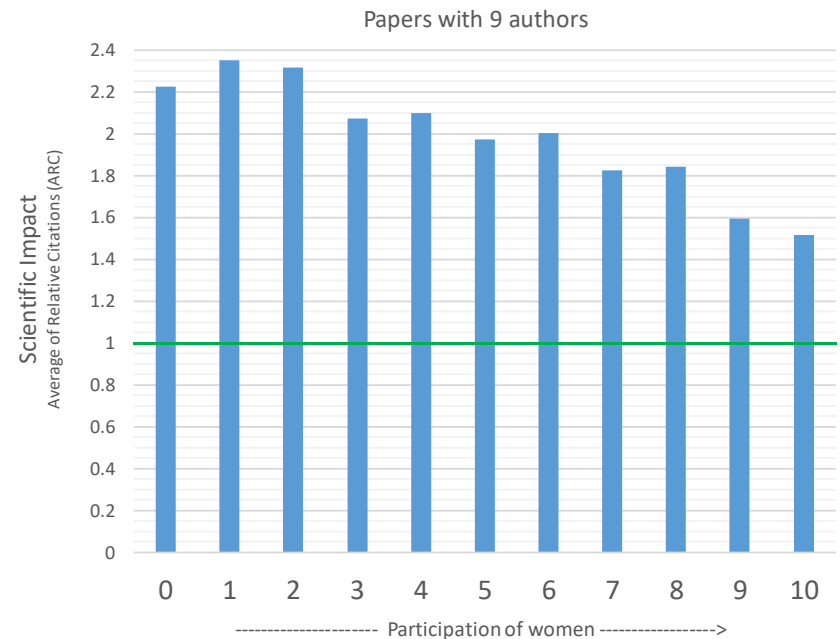
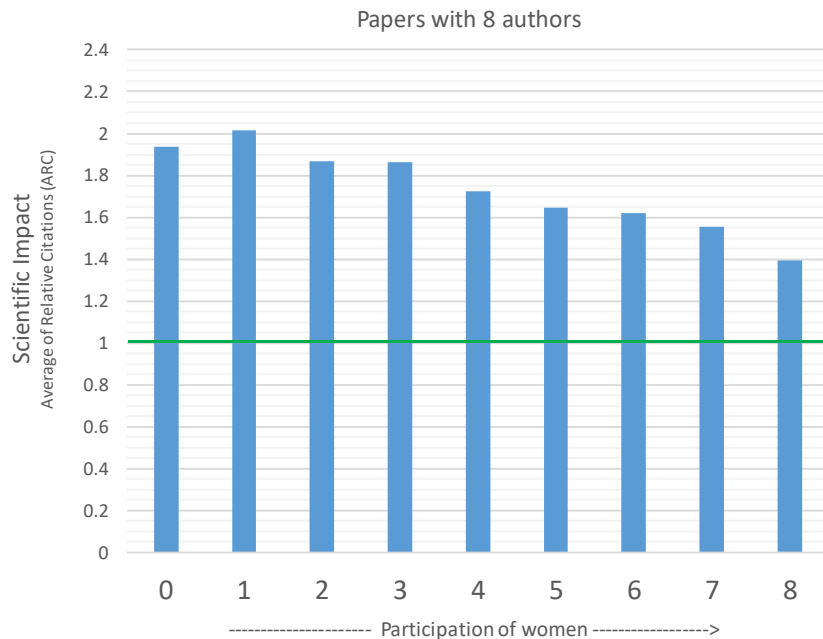
But with **multiple authors**, the scientific impact decreases with the participation of women





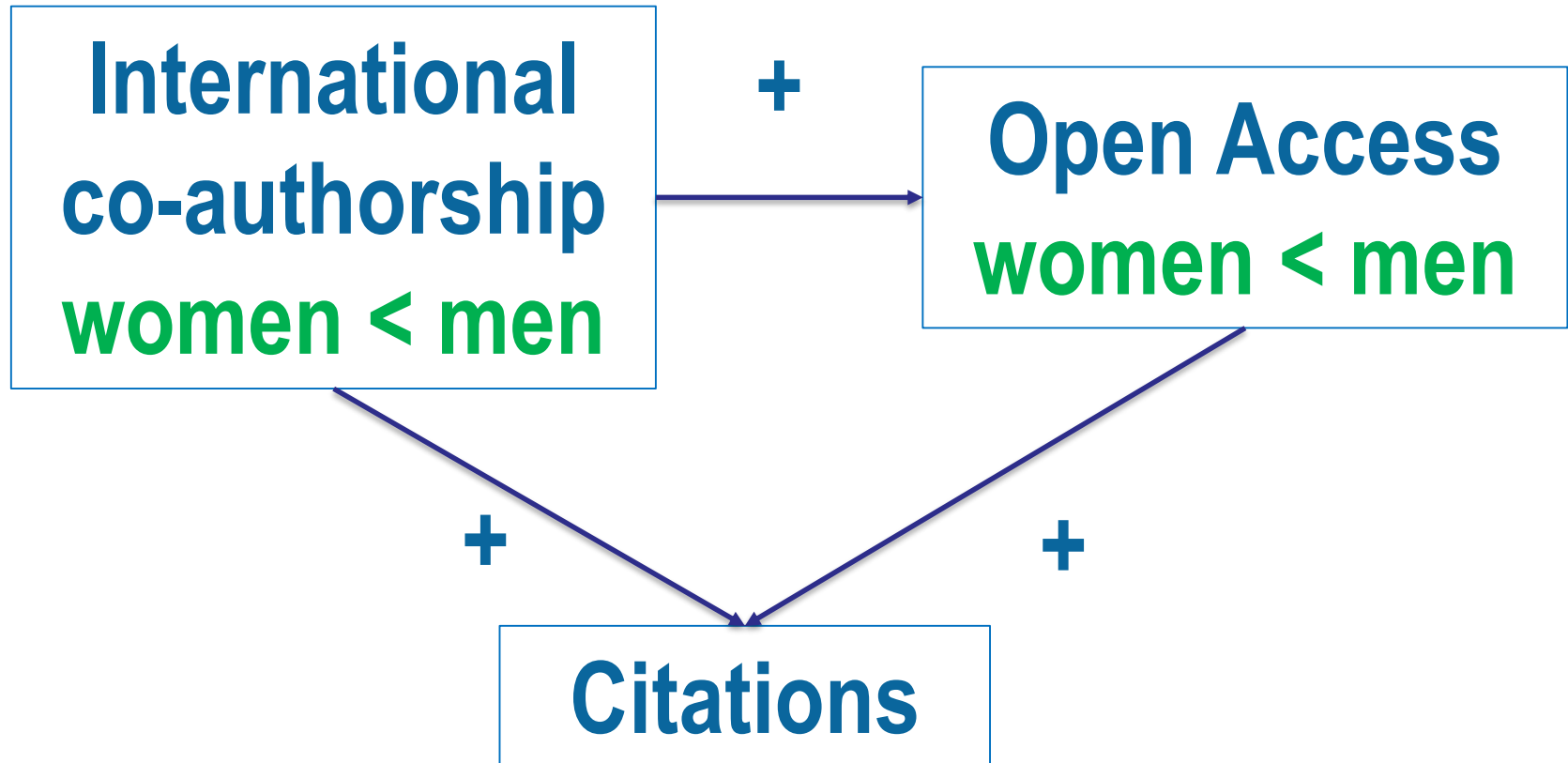
Scientific Impact of women and men

With **larger groups of authors** we observed that highest impact is not with men-only collaboration



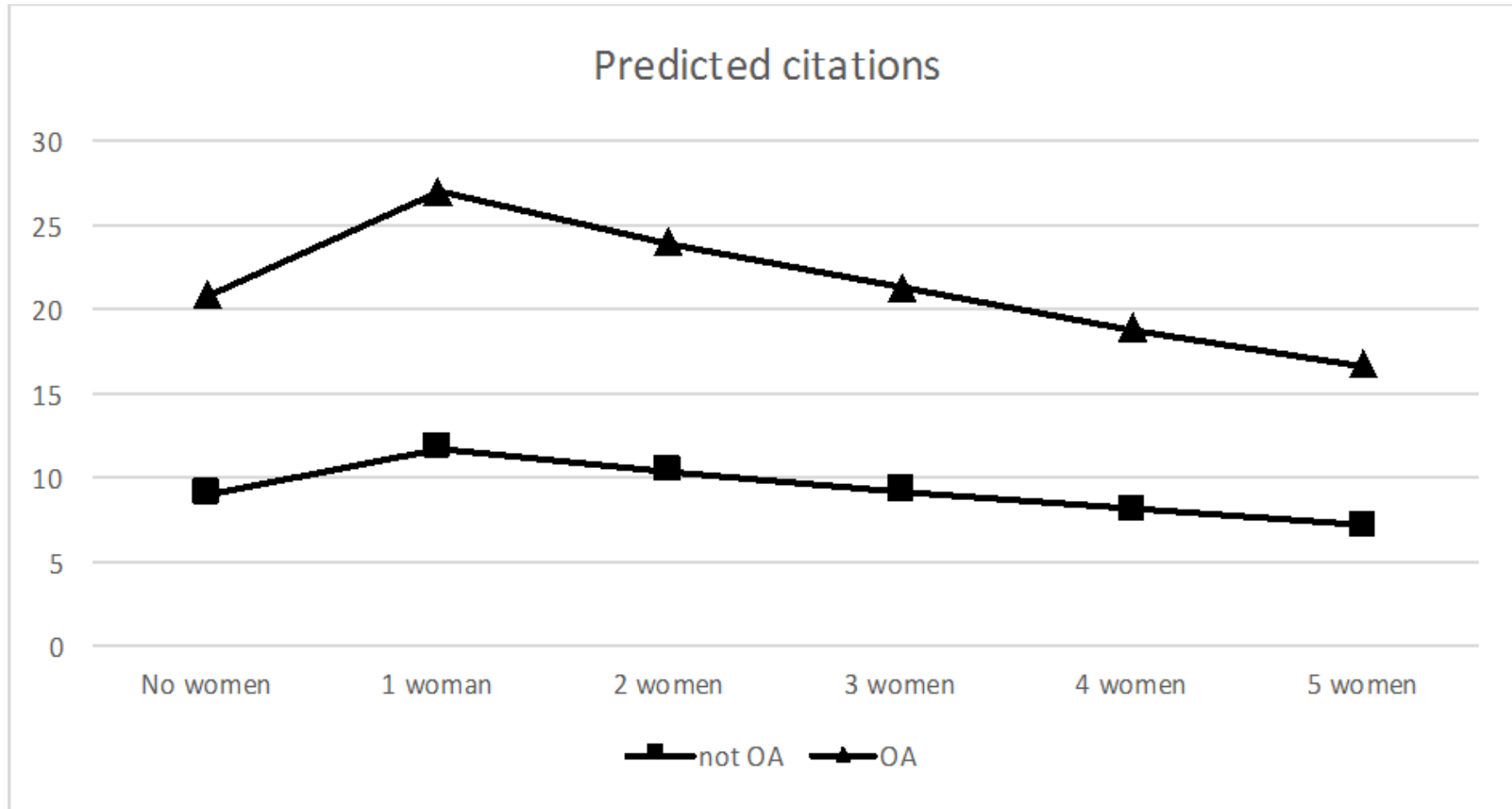


Other factors to consider





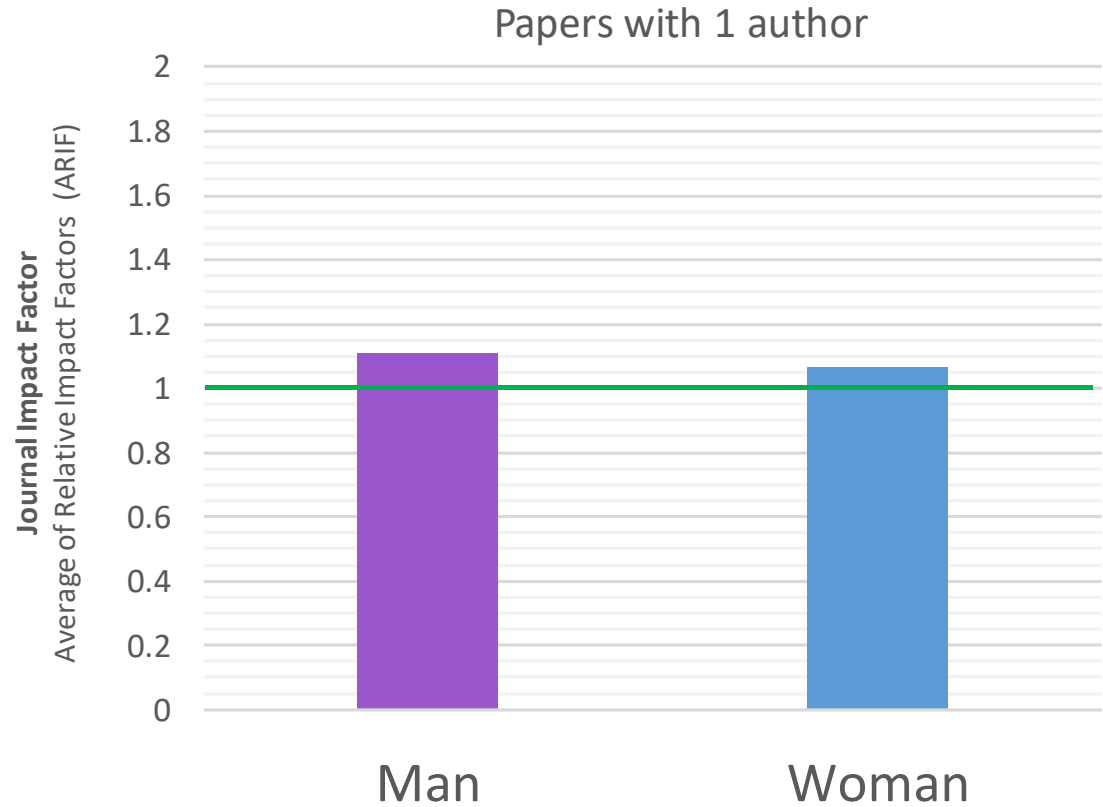
Multivariate analysis





Scientific Impact of women and men

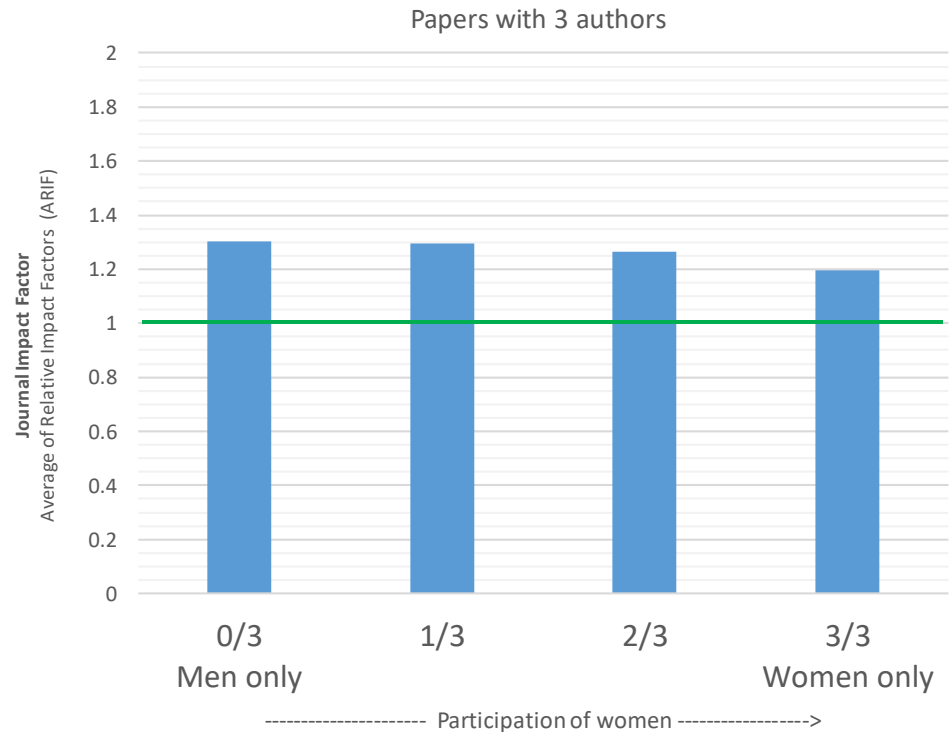
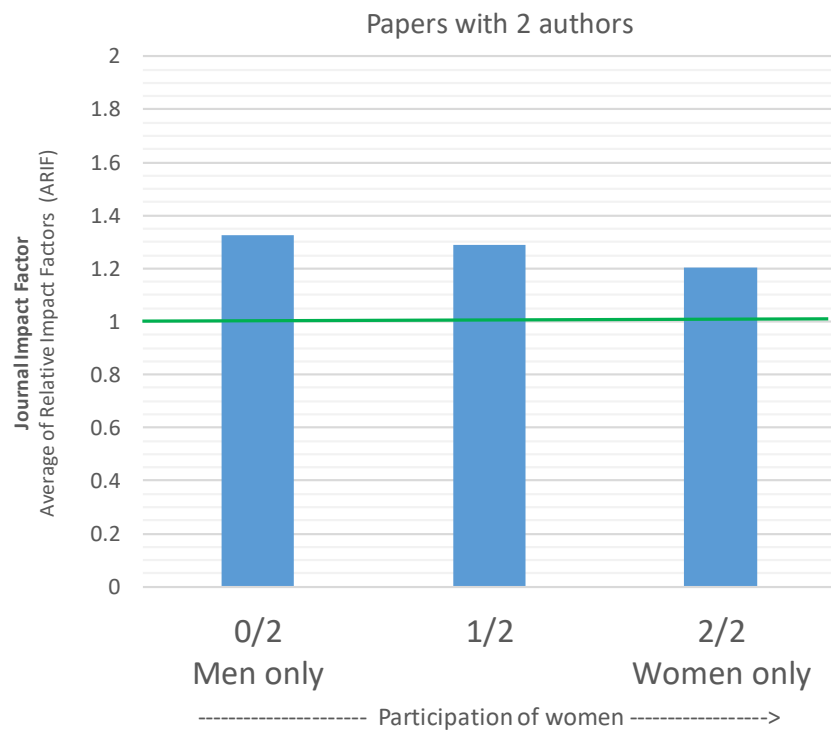
In papers with a **single author**, the average of journal impact factors is slightly higher for men





Scientific Impact of women and men

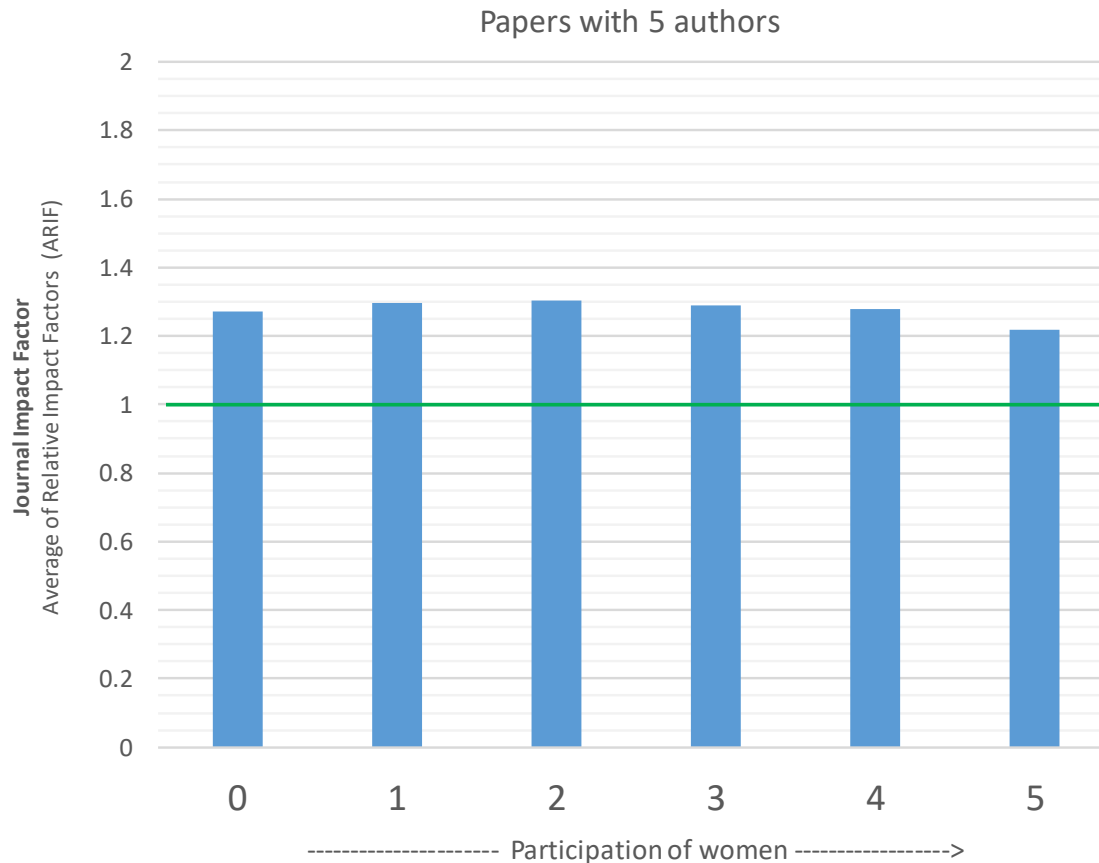
With 2 or 3 authors, the journal impact factor decreases with the participation of women





Scientific Impact of women and men

In papers with more than 3 authors, the highest impact factors are associated with mix-gender teams





Conclusion

- **The proportion of women in scientific papers is still smaller than that of men in most fields of research and in most countries**
- **The proportion of women is increasing rapidly**
- **Generally, women are less cited and publish in lower-quality journals**
- **International collaboration and open access are two important factors to explain the lower impact of women**
- **But even when controlled for the subfield of research, international collaboration and availability in open access, the proportion of women in the group of authors appears to be inversely correlated to scientific impact**
- **Mix-gender team publish on average in higher impact journals**



Future work – other factors to examine

- **Age** of researcher (leaking pipeline & lag before the proportion of women in senior researchers increase)
- Research **networks** and gender
- Research **topics** and gender

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Thank you!

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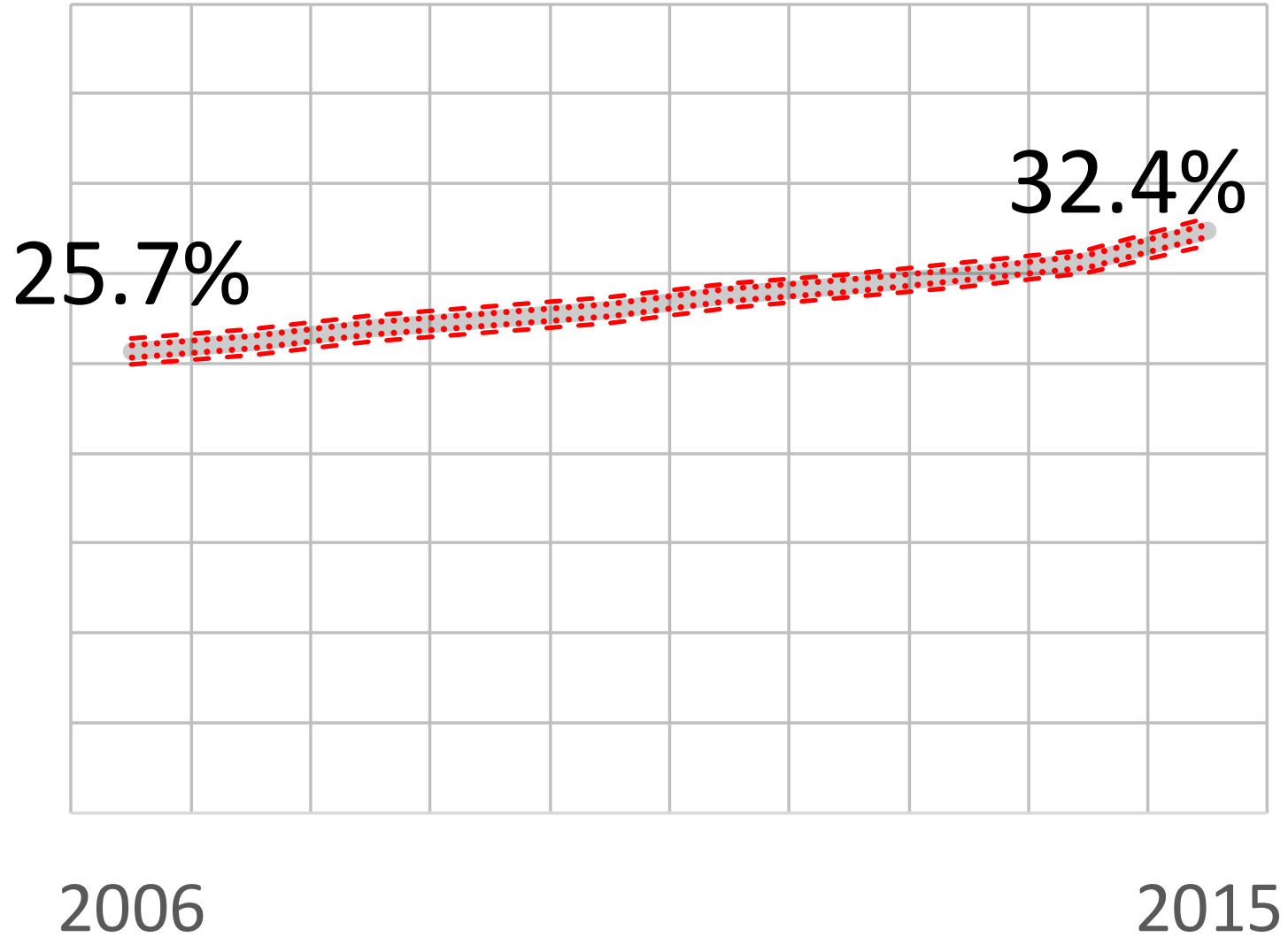
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Trend in the U.S.





Subfields with highest proportions of women

Highest proportions of women (all fields)

Subfield	Pw
Gender Studies	76%
Nursing	74%
Social Work	60%
Family Studies	60%
Developmental & Child Psychol.	58%
Public Health	53%
Drama & Theater	53%
Gerontology	53%
Rehabilitation	52%
Languages & Linguistics	48%

Highest proportions of women (natural & applied sciences)

Subfield	Pw
Food Science	42%
Veterinary Sciences	42%
Medical Informatics	37%
Biotechnology	37%
Plant Biology & Botany	36%
Medicinal & Biomol. Chemistry	36%
Dairy & Animal Science	36%
Environmental Sciences	35%
Analytical Chemistry	35%
Marine Biology & Hydrobiology	35%



Subfields with lowest proportions of women

Lowest proportions of women

(all fields)

Subfield	Pw
Economic Theory	15%
Computer Hardware & Architect	16%
Fluids & Plasmas	17%
Nuclear & Particles Physics	18%
Mathematical Physics	18%
Distributed Computing	19%
Acoustics	19%
Orthopedics	20%
Astronomy & Astrophysics	21%
Finance	21%

Lowest proportions of women

(Arts, humanities, health & social sciences)

Subfield	Pw
Orthopedics	20%
Philosophy	21%
Religions & Theology	24%
Surgery	25%
Urology & Nephrology	26%
Respiratory System	27%
Cardiov. System & Hematol.	27%
International Relations	27%
Microscopy	27%
Nuclear Med. & Med. Imaging	28%



Future work – improving the accuracy

- Gender identification using **email**
- Disambiguation of **researchers' portfolios** of publications to resolve unassigned cases
- Gender tagging using **image-based Gender-Recognition**