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An econometric investigation of the productivity gender gap in Mexican research

… and a simulation study of the effects on scientific performance of policy scenarios to promote gender equality

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The productivity puzzle, gender gap or gender bias

- **“Productivity puzzle”** (Cole and Zuckerman 1984): The publication productivity of female scientists is found to be lower than male publication productivity in almost all scientific fields

- Although many studies in the economic, education and sociology literature have documented the gender gap or gender bias, relatively few of them have actually focused on analyzing the likely underlying causes

- Surprisingly, the puzzle remains…

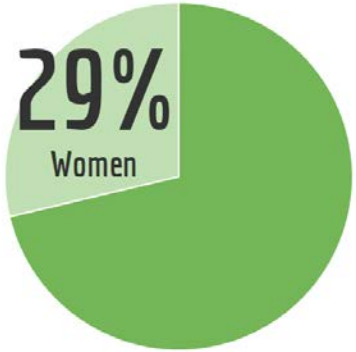
Mexican National Researchers' System - SNI

- *"The SNI is a policy instrument of the Mexican State created in 1984 to identify, recognise, and stimulate economically, based on a merit scheme, the production of high quality scientific and technological knowledge"* (Dr. Enrique Cabrero Mendoza, CONACYT Director General)

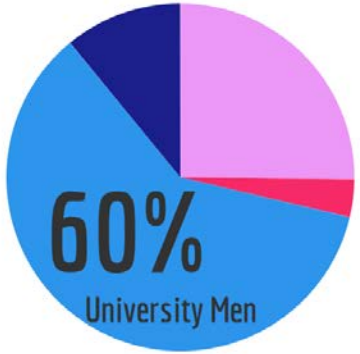
- International reference for the creation of similar systems in Latin America
  - National Researchers' System of Uruguay
  - Incentives Programme for Research and Innovation of Venezuela
  - National Incentives Programme for researchers of Paraguay

Data

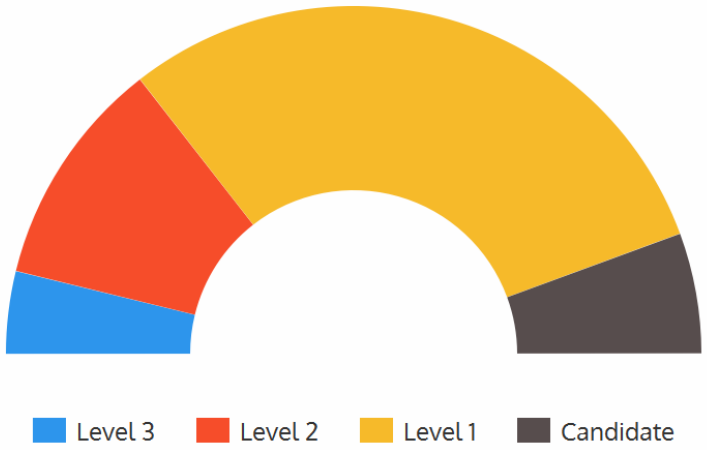
- Researchers SNI members in 2013
- ISI WoS publications between 1990-2014: 44,535 publications
- SNI Ranking history in period 2002-2013
- Focus on ‘Hard Sciences’
  - SNI Knowledge Area I: Physics, Mathematics, Astronomy and Astrophysics, and Earth Sciences
  - Area II: Chemistry
  - Area III: Health Sciences, Medicine and Human Pathology
  - Area VI: Agronomy
  - Technology Sciences
- 2,481 researchers
- 41 public universities, and 18 public research centres



Number of researchers by gender and affiliation



The SNI Levels



- Focus on academic (quantity and) quality, relevance and impact of research and the training of human resources
- Research: journal articles, books, book chapters, patents, innovation, technology transfer
- Training: Supervision of postgraduate students, teaching, training of researchers and research teams
- Candidate. PhD level (with exceptions)
- Level 1. + training participation S&T evaluation committees, communication and diffusion of S&T activities
- Level 2. + develop/establish a line of research/academic specialisation
- Level 3. + leadership in the Mexican scientific community, national and international recognition

Promotion from Low Ranks to High Ranks by affiliation and gender

	Public Universities			Public Research Centres		
	Men			Men		
	Last rating in period			Last rating in period		
First rating in period	Low Rank	High Rank	Total	Low Rank	High Rank	Total
Low Rank	1013	299	1312	151	84	235
High Rank	0	186	186	0	36	36
Total	1013	485	1498	151	120	271
	Women			Women		
	Last rating in period			Last rating in period		
First rating in period	Low Rank	High Rank	Total	Low Rank	High Rank	Total
Low Rank	524	68	592	75	9	84
High Rank	0	33	33	0	3	3
Total	524	101	625	75	12	87

Average productivity of researchers by discipline and gender

	Researchers		Average productivity (average yearly papers)	
Discipline	**Men**	**Women**	**Men**	**Women**
Mathematics	40	7	1,10	2,43
Astronomy and Astrophysics	21	4	2,38	2,25
Medicine and Human Pathology	122	84	2,36	2,10
Technology sciencies	340	100	2,20	1,73
Physics	281	45	1,79	1,69
Earth Sciences	138	45	1,82	1,64
Agronomy	232	68	1,95	1,63
Health Sciences	14	17	1,93	1,53
Chemistry	151	82	2,13	1,46
Life Sciences	430	260	2,10	1,43
Total	**1769**	**712**	**2,03**	**1,62**

Method of Analysis

- Adapted version of the method by Mairesse and Pezzoni (2015), and Rivera León et al. (forthcoming)

We explore three interrelated issues

Selectivity

Probability of occurrence of non-publishing spells

Promotion

Probability of advances in SNI levels, interpreted as career achievements: changes from 'Low Ranks' to 'High Ranks'

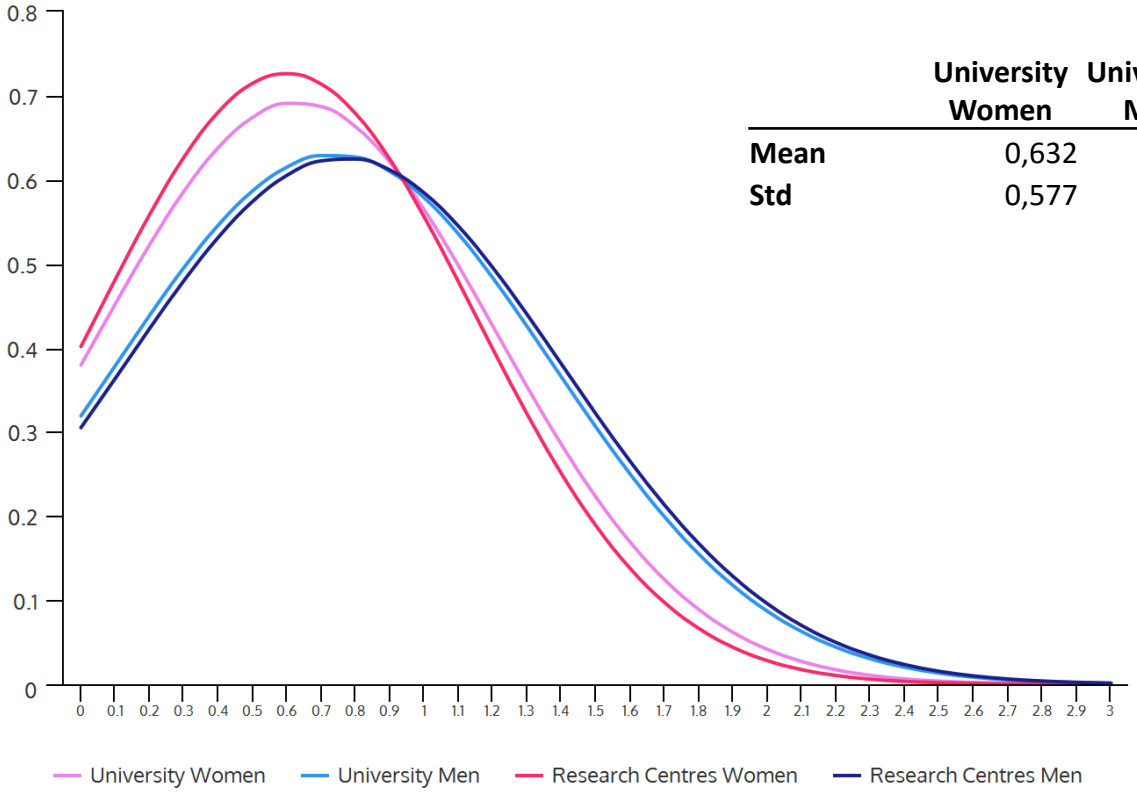
Productivity

Understanding of the determinants of scientific productivity accounting for the interrelated differences between female and male researchers, rank status and non-publishing spells

Average productivity of researchers with and without non-productive years

	Public universities			Public Research Centres		
Researchers	Women	Men	W/M (or W-M in logs)	Women	Men	W/M (or W-M in logs)
Including non-publishing years						
Mean	1,24	1,59	0,78	1,14	1,65	0,69
Median	1	1	1,00	1	1	1,00
Std Dev	1,47	1,98		1,39	1,86	
Obs.	6525	18389		917	3703	
Excluding non-publishing years						
Mean	2,00	2,37	0,84	1,84	2,42	0,76
Median	2	2	1,00	1	2	0,50
Std Dev	1,40	2,00		1,35	1,78	
Obs.	4049	12338		567	2516	

Distribution of observed log-productivity for female and male researchers



	University Women	University Men	Research Centres Women	Research Centres Men
Mean	0,632	0,739	0,598	0,764
Std	0,577	0,633	0,549	0,638

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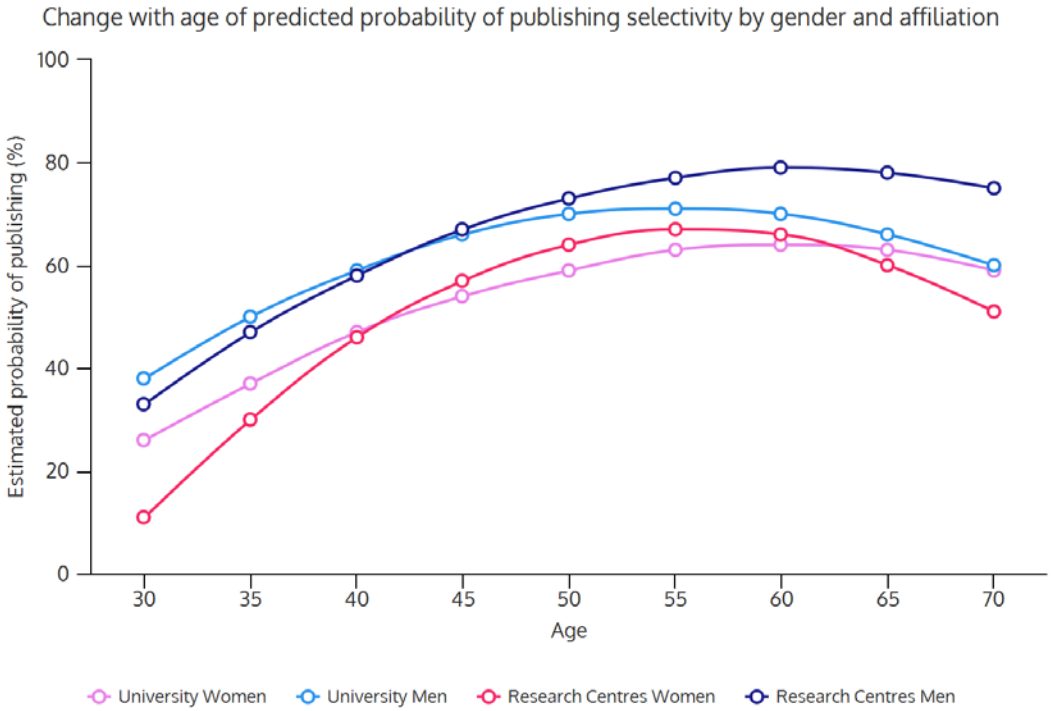
Publishing year selection probit equation for university and PRC researchers



- The probability of publishing is lower on average for university females than for a university male;
- These differences are less on average among researchers in PRCs, although the gap between men and women increases with age
- Probabilities of publishing increase for researchers, regardless of the affiliation, that are more persistent in publishing in the three previous years than those who are less persistent or not publishing

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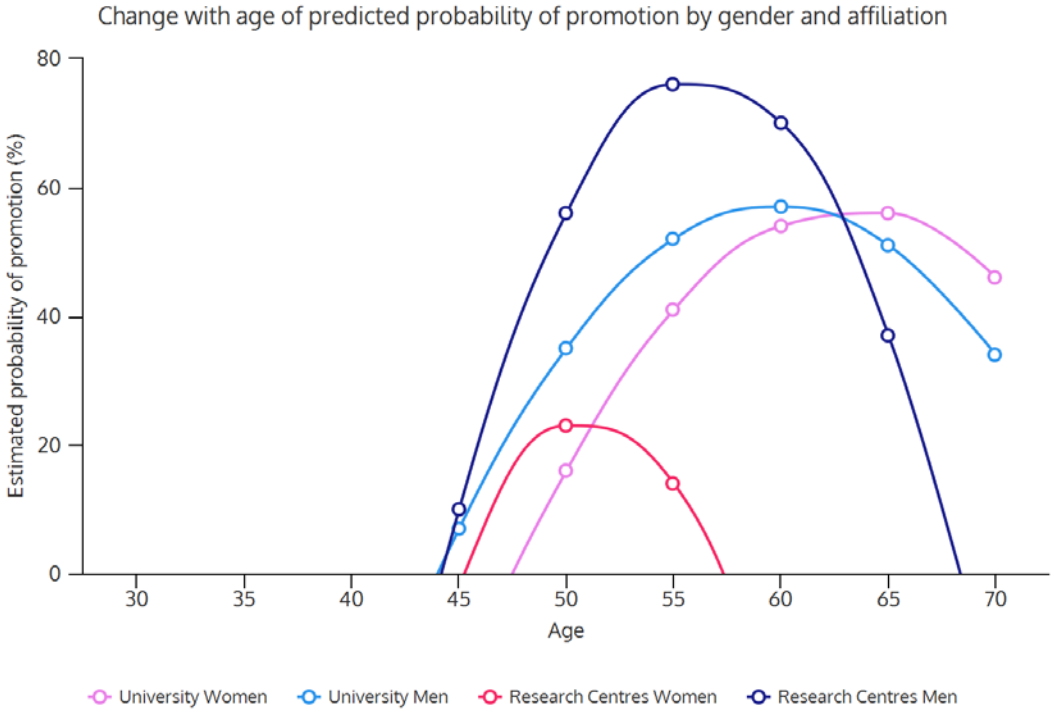
Promotion probit equation for university and PRC researchers

- The probability of being promoted to high rank is much lower for female researchers than for their male colleagues, “everything else equal”
- This probability increases with age for both university and PRC researchers, much less rapidly for female researchers in PRCs
- Numbers of past publication are a major determinants of promotion



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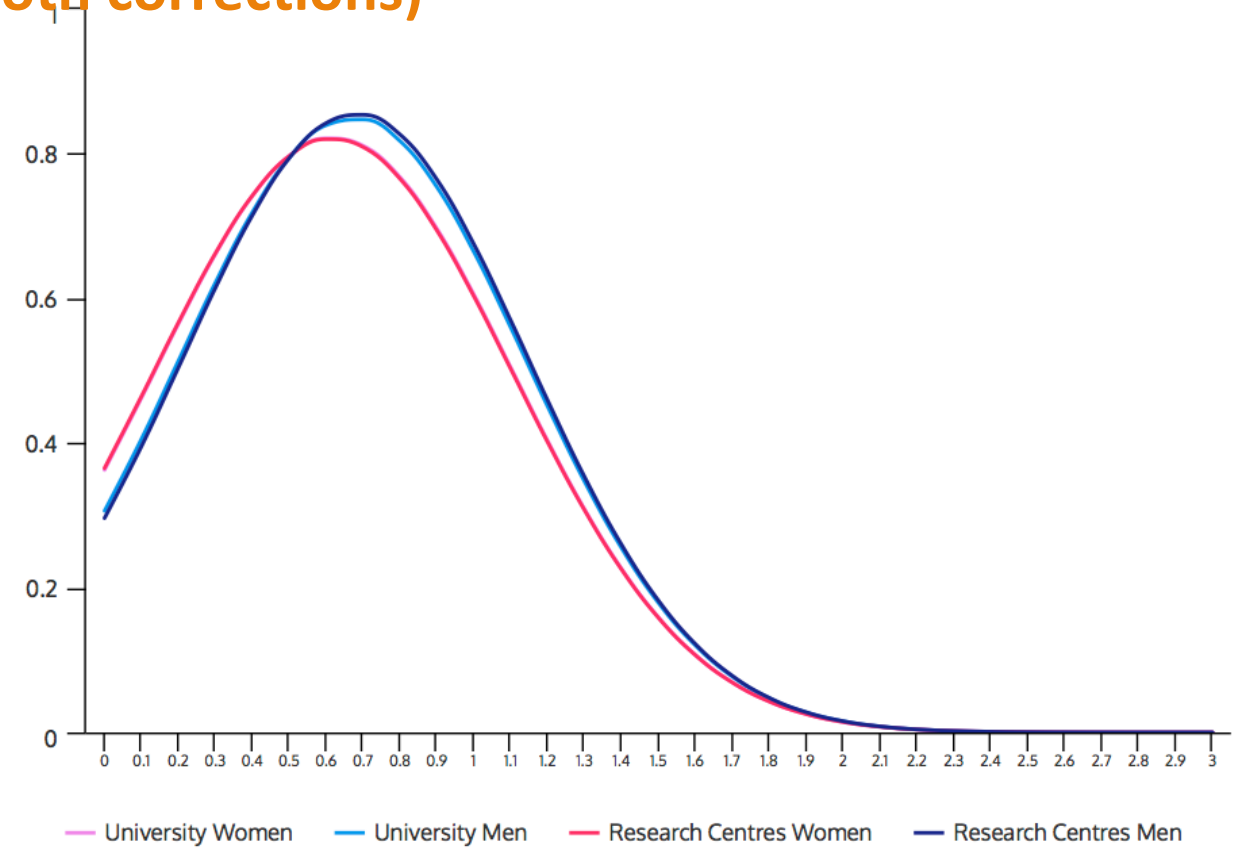
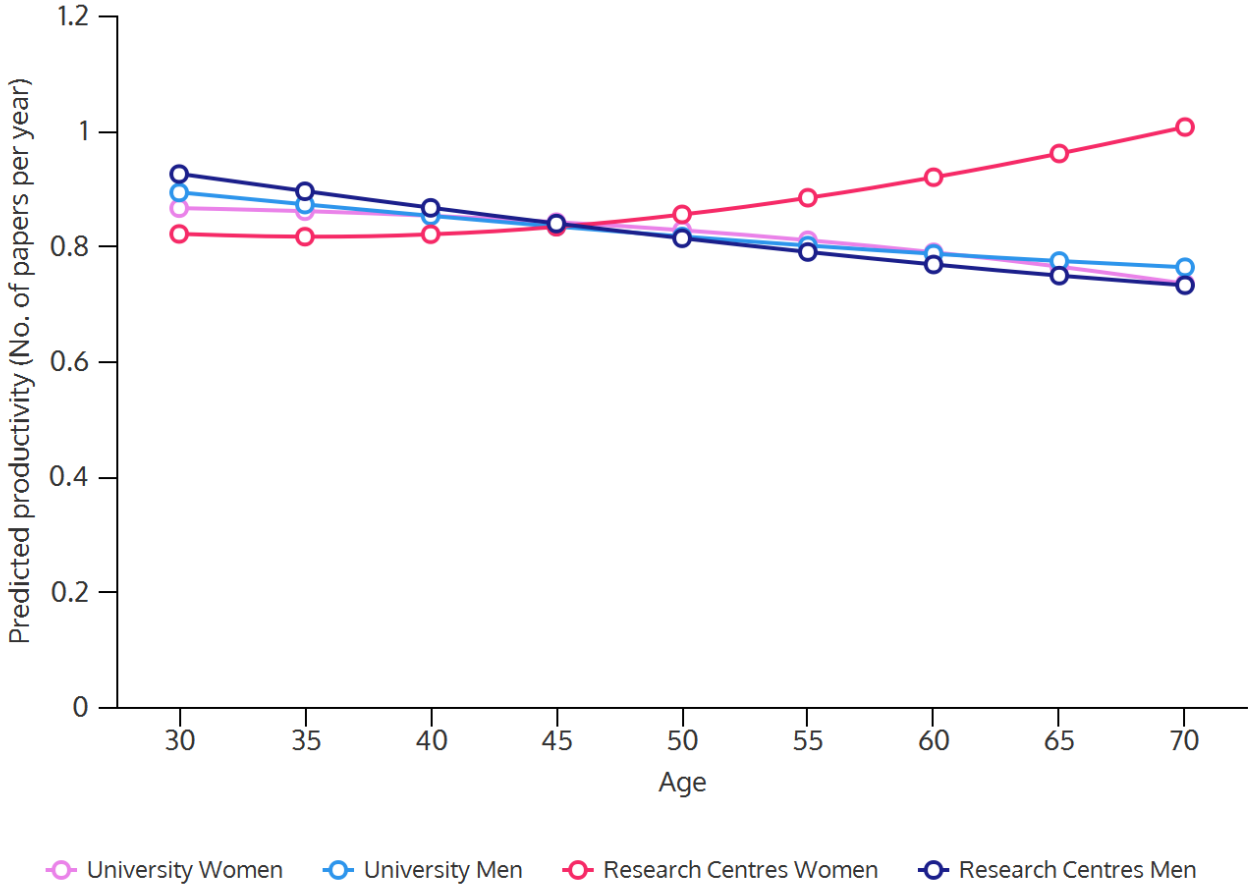
Distribution of predicted log-productivity for female and male researchers (both corrections)



Predicted Scientific Productivity (Both Corrections)



Summary of Preliminary Findings

- Existence of publication productivity gender gaps among Mexican SNI researchers.
  - approximately 20% among university researchers and 30% in PRCs
  - gender gap is most marked and important among public research centres affiliates
  - number of non-publishing years is rather similar for men and women, and also by affiliation
- Selectivity and promotion corrections account for a large part of the observed gender productivity gap.
  - The gap is considerably reduced when controlled for promotion and non-publishing spells among researchers in public research centres (~10%), and almost disappears among researchers in universities.
- Scientific productivity declines slightly with age, with the exception of women in public research centres, for which the most productive years are after the age of 45.
  - Predicted publication productivity is almost the same for all SNI researchers at the age of 45, regardless of the gender and affiliation

Next steps

- Calibrate counterfactual simulations with the dual purpose of assessing the magnitude of macro-impacts of existing gender gaps and of illustrating the potential impacts of a range of policy scenarios
- Definition of policy scenarios
  - what would be the changes in scientific publication production and productivity overall and by large groups of disciplines, assuming that women at similar characteristics (age, discipline, etc.) than men?
  - What would be the gains in the total amount of publications/scientific productivity (and quality of the publications) if there would be no 'discrimination' against women in promotion to Higher Ranks?