Female Promotions and the Academic Pipeline: Evidence from a Natural Experiment

Manuel Bagues
Warwick

Milan Makany
Erasmus

Giulia Vattuone
Stockholm

Natalia Zinovyeva
Warwick

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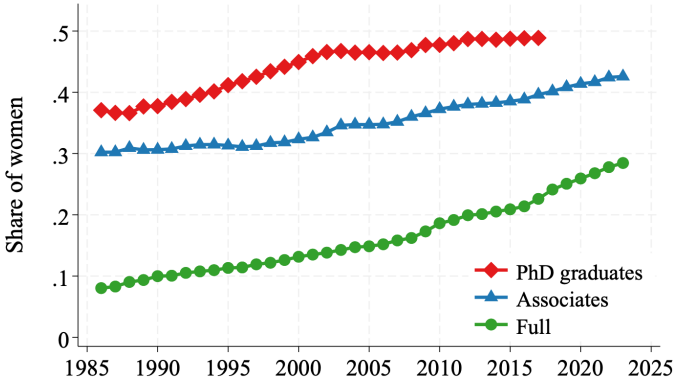
Few women reach top academic positions

- In Europe, women represent (European Commission, 2024):
  - ◇ 48% of PhD Graduates
  - ◇ 42% of Associate Professors
  - ◇ 30% of Full Professors
    - → Engineering and technology: 20%
    - → Natural sciences: 24%
    - → Medical sciences: 33%
    - → Social sciences: 35%
    - → Humanities: 38%

- In Economics, the share of women among full professors is:
  - ◇ **23%** in Europe (Auriol et al., 2020)
  - ◇ **18%** in the US (Tesar, 2025)

Women's presence in academia is growing, but progress is slow

Proportion of women in academia in Spain, by rank



- Decline from early career stages to full professorship.
- 'Leaking pipeline' (Lundberg and Stearns, 2019).

Why are there few women in top academic positions?

Beyond discrimination, two explanations dominate the debate.

1. **The structure of academic careers may be particularly costly for women**
   - ◇ Tenure-track careers are 'greedy' (Goldin, 2014, 2021).
   - ◇ Long hours and sustained effort over many years, with high uncertainty about payoff.
   - ◇ Career decisions coincide with binding family constraints, which fall more heavily on women.
   - ◇ The cost of a setback may be thus higher for women.

2. **Scarcity of senior women itself may slow progress**
   - ◇ Mentoring and role models (Ginther et al., 2020; Bettinger and Long, 2005),
   - ◇ More inclusive environment (Boustan and Langan, 2019; AEA, 2019),
   - ◇ Less bias in hiring (mixed: Moss-Racusin et al. 2012; Bagues et al. 2017; Card et al. 2020),
   - ◇ Shared research interests (Dolado et al., 2012; Belot et al., 2023; Bello et al., 2025).

This paper

Question 1: What is the cost of failing to obtain tenure? Is it larger for women?

Question 2: When women do get tenure, does the pipeline for women change?

- **Setting**: Spain, 2002–2008. *Habilitación* promotion system.
  - Promotion to Associate and Full Professor required passing a national qualification exam.
  - Highly competitive. Qualification almost always meant immediate promotion.
- **Identification**: exogenous variation in obtaining qualification.
  - Evaluation committees were randomly assigned.
  - Academic connections increased candidates' success chances (Zinovyeva and Bagues, 2015).
- **Empirical strategy**:
  - Compare candidates exogenously qualified with those who were not; trace careers.
  - Compare departments with vs. without exogenous qualifications; trace promotions.

Preview of findings

(1) **Failing to obtain tenure is more costly for women.**

- 10 years later: unsuccessful women are 83 p.p. less likely to be tenured (men: 38 p.p.).
- 15 years later: the gap is still 57 p.p. for women (men: 29 p.p.).
- Marginally unsuccessful women less likely to reapply and reduce research activity more.

Preview of findings

(2) **When a woman gets tenure, trickle-down effects are large.**

- Over the next 15 years: 1.5 more women promoted to Associate Professor.
- Over the next 10 years: 6 more female PhDs; 4 stay research-active; 1 reaches tenure.
- No corresponding effects of men or for men.

Preview of findings

- Is it gender or research orientation?
  - We estimate the effects of promoting candidates working in female-intensive areas, regardless of their gender.
  - **Research orientation** has comparable effects **for faculty outcomes**.
  - **Gender** has stronger effects **for PhD outcomes**.

Contribution

1. Literature on the **gender differences in inputs to promotions**.
2. Literature on **trickle-down effects** of senior female representation on junior women.
3. Literature on **why senior representation matters** and **what it implies for policy**.
4. Literature on **gender and organisations**.

Contribution

1. Literature on the **gender differences in inputs to promotions**.
   - ◇ Antecol et al. (2018); Sarsons et al. (2021); Card et al. (2020); Koffi (2021, 2025).
   - ◇ **Our paper**: how the academic career is structured may itself affect women differently.
2. Literature on **trickle-down effects** of senior female representation on junior women.
3. Literature on **why senior representation matters** and **what it implies for policy**.
4. Literature on **gender and organisations**.

Contribution

1. Literature on the **gender differences in inputs to promotions**.
2. Literature on **trickle-down effects** of senior female representation on junior women.
   - ◇ Boustan and Langan (2019); Hofstra et al. (2022).
   - ◇ **Our paper**: we provide the first large-scale causal evidence.
3. Literature on **why senior representation matters** and **what it implies for policy**.
4. Literature on **gender and organisations**.

Contribution

1. Literature on the **gender differences in inputs to promotions**.
2. Literature on **trickle-down effects** of senior female representation on junior women.
3. Literature on **why senior representation matters** and **what it implies for policy**.
   - ◇ Neumark and Gardecki (1998); Bettinger and Long (2005); Hilmer and Hilmer (2007); Carrell et al. (2010); Dolado et al. (2012); Bagues et al. (2017); Gaule and Piacentini (2018); Ginther et al. (2020); Epifanio and Troeger (2020); Porter and Serra (2020); Folke and Rickne (2022); Adams-Prassl et al. (2024); Deschamps (2024); Rossello et al. (2024); Bello et al. (2025); Belot et al. (2023).
   - ◇ **Our paper**: we add causal evidence on the role played by research orientation.
4. Literature on **gender and organisations**.

Contribution

1. Literature on the **gender differences in inputs to promotions**.
2. Literature on **trickle-down effects** of senior female representation on junior women.
3. Literature on **why senior representation matters** and **what it implies for policy**.
4. Literature on **gender and organisations**.
   - ◇ Kunze and Miller (2017); Azmat and Boring (2020); Folke and Rickne (2022); Cullen and Perez-Truglia (2023).
   - ◇ **Our paper**: we focus on academia and have a long-run perspective.

Habilitación system, 2002–2008

1. **National qualification exam**
   - Field-level exams for Associate/Full Professor: 30,000 applicants; 3,000 qualifications.
   - Candidates applied *before the committee was announced*.
   - Committee members were randomly assigned.
   - No conflict rules: connected candidates (one third) were 4 p.p. more likely to qualify (Zinovyeva and Bagues, 2015).
2. **University promotion**
   - Only qualified candidates could be promoted.
   - More than 90% of qualified candidates were promoted.
   - Qualification ≈ promotion. Go

Data sources

1. **Doctoral theses**: TESEO registry, years 1977–2020. Go
   - Build PhD class compositions, trace PhD graduations.
2. **Qualification exams**: Ministry of Education, years 2002–2008. Go
   - Full list of candidates and potential evaluators
   - Committee-composition lottery outcomes
   - Lists of qualified candidates
3. **Research production**: OpenAlex, Scopus, Dialnet. Go
   - Measure research output, career trajectories, and topic specialisation.
4. **Promotions to Associate and Full Prof.**: State Bulletin (BOE), 1985–2023. Go
   - Build department-year panels, track faculty composition , trace promotions.
   - Department is university $\times$ field.

Departments

4,000 participating departments

75% of all Spanish public university departments

	Pre-exam mean	Pre-exam Share of women
Associate Professors	9	34%
Full Professors	3	15%
PhD graduations	2	46%

Participation | Stocks and flows | Size distribution | Associate Professor stocks over time

Empirical strategy

- **Individual level**: does qualification change the candidate's own career?
  - Compare candidates exogenously qualified by the committee draw with those who were not.
  - Random variation in qualification comes from the lottery surprise in committee connections.

- **Department level**: what happens after a department exogenously qualifies a woman?
  - Compare depts where the lottery induced a female qualification with those where it did not.

Empirical strategy: Individual level

$$P_{i,e,t+k} = \beta_0 + \beta_1 \widehat{Q}_{i,e,t} + \beta_2 \mathbb{E}[C_{i,e}] + \beta_3 X_{i,e} + \mu_e + \lambda_t + \eta_{i,e,t+k} \tag{1}$$

- i: candidate; e: exam.
- t: results year; k: horizon after qualification (0–15).
- $\widehat{Q}_{i,e,t}$: qualification indicator (instrumented).
- $X_{i,e}$: predetermined candidate characteristics.

Instrument: committee-draw surprise (Borusyak and Hull, 2023)

$$Z_{i,e} = C_{i,e} - \mathbb{E}[C_{i,e}]$$

- $C_{i,e}$: connections with the actual committee.
- $\mathbb{E}[C_{i,e}]$: connections expected from the evaluator pool.
- Borusyak–Hull point: random shocks are not enough if exposure is non-random.

Identifying assumptions and interpretation

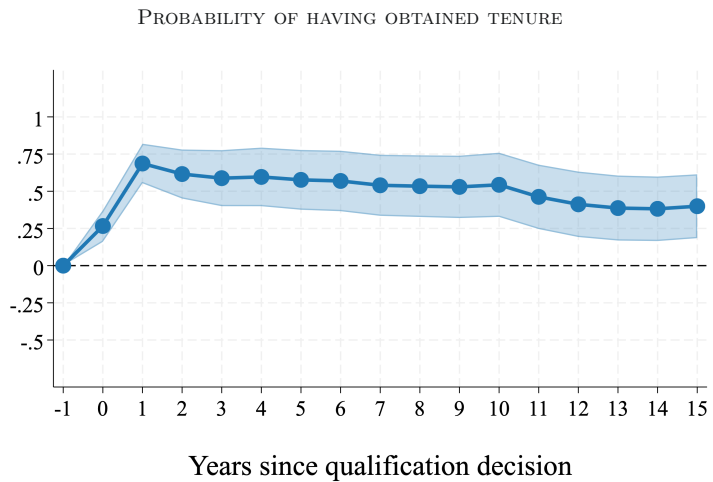
Assumptions:

1. *Exogeneity*: committee composition unrelated to candidate characteristics.
   Randomization
2. *Exclusion*: committees affect promotion only through qualification.
   - National evaluation has no formal role in hiring.
   - Promotion largely mechanical (>90% within 2 years).
3. *Monotonicity*: connections do not reduce qualification probabilities.
   - Defiers unlikely (prevailing academic norms and risks of reputational costs).
4. *Relevance*: strong first stage. 1st Stage

Interpretation: LATE. Effect of qualification on promotion for compliers.

Compliers Alternative instruments

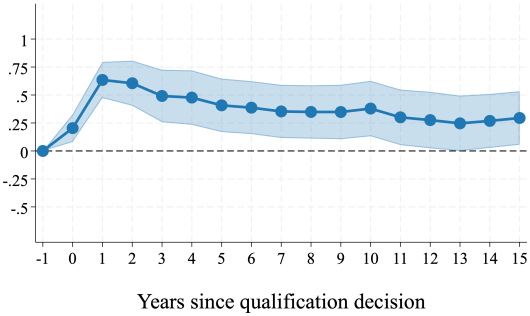
2SLS: Impact of qualifications on promotions



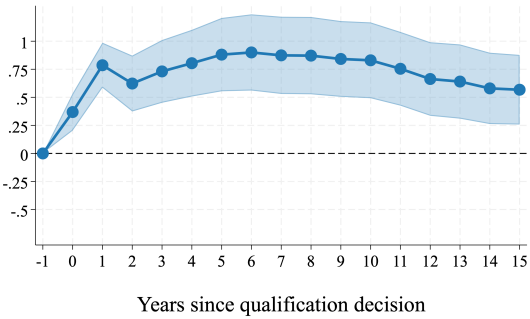
Full Professorships

2SLS: Impact of qualification on obtaining tenure, by gender

Men



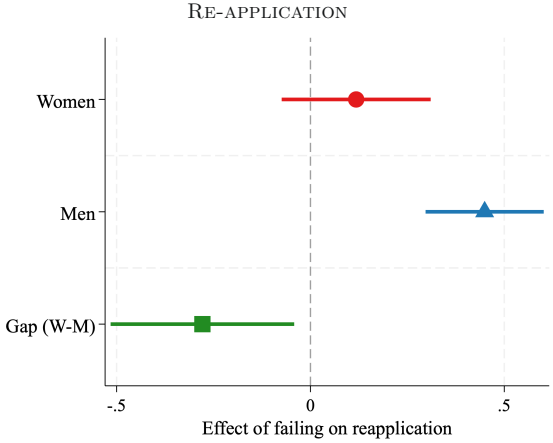
Women



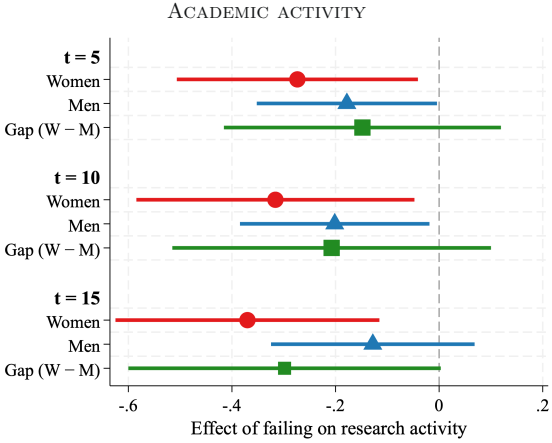
- Persistence is more pronounced for women. At $t = 10$, the difference in promotion probability is:
  - 83 p.p. (s.e. = 17) for women & 38 p.p. (s.e. = 13) for men.
  - difference is marginally significant (p-value = 0.051).

Full Professorships

2SLS: Impact of failing tenure on re-application and academic activity



p-value (gap=0): 0.021



p-value (gap=0): t=5 0.277 t=10 0.186 t=15 0.052

Empirical strategy: Department level

Impact of female and male qualifications on departmental outcomes (2SLS)

$$Y_{j,e,t+k} = \delta_0 + \delta_1 \widehat{Q}^f_{j,e,t} + \delta_2 \widehat{Q}^m_{j,e,t} + \delta_3 \mathbb{E}[C^f_{j,e,t}] + \delta_4 \mathbb{E}[C^m_{j,e,t}] + \theta' W_{j,e,t} + \mu_e + \lambda_t + u_{j,e,t+k} \quad (2)$$

- j: department; e: exam; t: qualification year; $k \in [0, 15]$.
- $\widehat{Q}^g_{j,e,t}$: number of qualified candidates, $g \in \{f, m\}$, instrumented.
- $W_{j,e,t}$: predetermined department characteristics.

Instruments

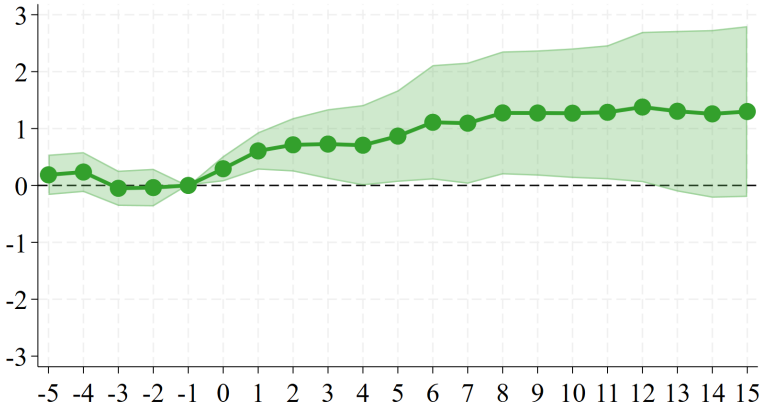
$$Z^g_{j,e} = \frac{1}{N^g_{j,e}} \sum_{i=1}^{N^g_{j,e}} (C_{i,e} - \mathbb{E}[C_{i,e}])$$

- Average deviation of realized from expected connections, for each gender
- Aggregates individual quasi-random shocks to the department level

1st Stage Randomization

Department Level Analysis - Impact on female faculty

Impact of a woman qualifying for Assoc. Prof. on cumulative number of female promotions to Assoc. Prof.

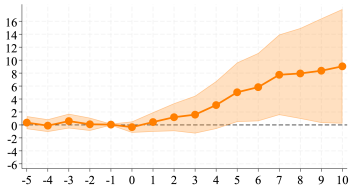


No impact on male promotions | No impact of men | Excluding own candidate | Critical mass

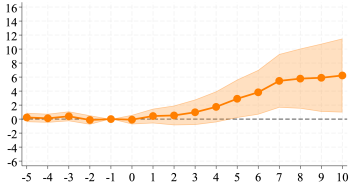
Department Level Analysis - Impact on PhD graduates

Impact of a woman qualifying for Assoc. Prof. on cumulative number of PhD graduates

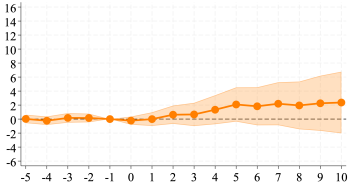
All graduates



Female graduates



Male graduates

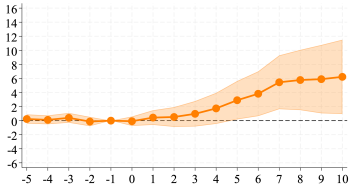


No impact of men

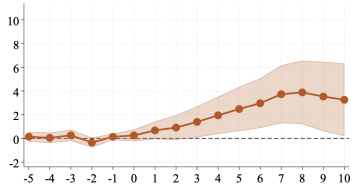
Department Level Analysis - Impact on female graduates

Impact of a woman qualifying for Assoc. Prof. on departments' female PhD students

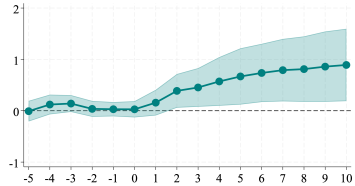
Female PhD Graduates



Female future academics



Female future associate profs



- Future academics are PhDs who keep publishing five years after graduation (55% for female PhDs in the sample).
- Future associate professor promotions are within ten years of graduations (6% for female PhDs in the sample).

No impact on men | No impact of men | By supervisor gender

Is professors' gender or research topics that matters?

- Belot et al. (2023): Women thrive when working in male-dominated fields; departments want to hire women but do not revise topic priorities.
- Bello et al. (2025): research similarity bias in male-dominated environments can limit both gender diversity and diversity in research agendas.

→ Could promoting researchers in female-intensive fields, regardless of gender, have similar long-run effects on gender diversity?

Department Level Analysis - Mechanisms

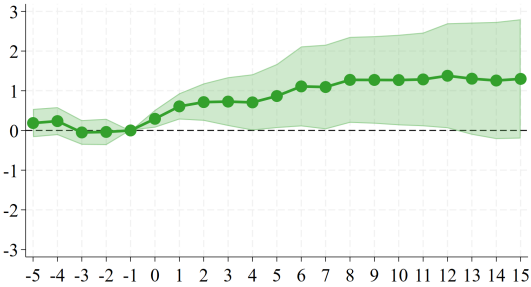
Research orientation as a complementary channel

- **Topic feminisation**: for each topic-year, the share of female authors in that topic over the previous five years, excluding the current year. Examples in 2000:
  - *Early Childhood Education and Development*: 0.60.
  - *Evolutionary Game Theory and Cooperation*: 0.22.
- Candidate index: average topic feminisation across pre-exam publications.
- Candidates are in **female-intensive** areas if their index is **above mean within field**.
- Gender and research orientation overlap, but **only partly**.
  - **37%** of candidates in female-intensive areas are women, vs **28%** in male-intensive areas.
  - Distributions | Construction of index

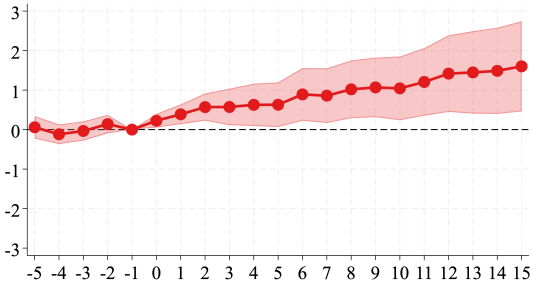
Department level - mechanisms

Impact of a female-intensive-topic applicant qualifying for Assoc. Prof. on cumulative female promotions

Gender-based promotion



Topic-based promotion

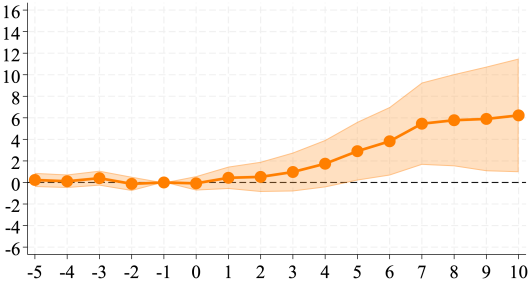


- Promoting a researcher in a female-intensive area also increases female faculty.
- Horse Race

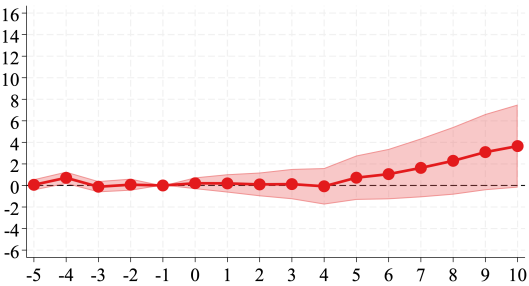
Department level - mechanisms

Impact of a female-intensive-topic applicant qualifying for Assoc. Prof. on cumulative female graduates

Gender-based promotion



Topic-based promotion



- Topic-based promotion also raises female PhD outcomes, but less than promoting a woman.

Horse Race | Impact on academic activity and promotions

Conclusions

- Academic career setbacks have lasting consequences, especially for women.
  - 15 years after failing, 59% of women still had not obtained tenure (men: 29%).
  - Women who fail are less likely to reapply and to remain active in research.
- Promoting a woman generates long-run spillovers within her department.
  - **+1.5 female Associate Professors**, **+6 female PhD graduates**, **+4 female future academics**, and **+1 female future Associate Professor**.
- Research topics also matter for attracting women.
  - Diversifying topics can help, especially when search costs are high or explicit gender policies are not feasible.
- But topics matter less for PhD outcomes.
  - Gender-specific mechanisms play an additional and substantial role.

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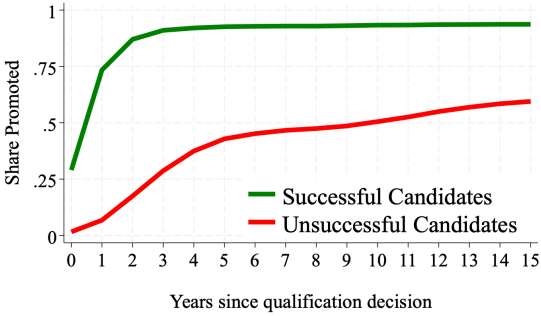
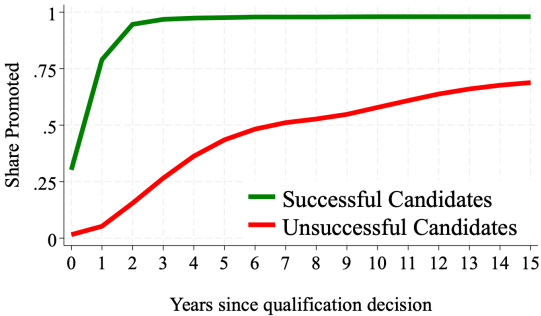
Appendix

Promotion rates by qualification outcome and years since exam

Application to Associate Professorships



Application to Full Professorships



Back

PhD graduate data

Back

- **TESEO**: mandatory official registry.
  - Analysis sample: $\sim 204,000$ public-university PhD graduates, 1990–2017.
  - Retain those with complete gender, uni, field, year, and advisor records (8% dropped).
  - Research topics classified using UNESCO Thesaurus (fine-grained classification).
    - → 24 broad two-digit fields (e.g., 53: *Economics*).
    - → 250 four-digit categories (e.g., 5302: *Econometrics*).
    - → 2,153 six-digit subfields (e.g., 530205: *Time Series Analysis*).

- Basic facts about the sample:
  - 47% women, 5 years to graduate, 53% stay in academia, 10% reach tenure. Go
  - Female advisors are substantially more likely to supervise female students. Go
  - Female and male PhD graduates tend to work on different research topics. Go
  - 74% obtained their prior degrees at the same institution (INE survey data). Go

Qualification Exams and Connections

Back

- Qualification exams
  - **967** exams; **31k** applications
  - Full list of candidates and potential evaluators
  - Committee-composition lottery outcomes
  - Lists of qualified candidates
  - Descriptives

- Following Zinovyeva and Bagues (2015), we construct applicant–evaluator connections.
  - We consider three types of connection: PhD advisor, coauthor, colleague.
    - → **35%** in FP exams
    - → **29%** in ASP exams
  - Descriptives T-tests Algorithm

Publication Data

Back

- Combined data from OpenAlex, Scopus, and Dialnet.
- **6 million** publication records. Linked to individuals in our sample.
- Research topics classified using OpenAlex taxonomy
  - Multiple levels of aggregation (fields, subfields, topics). 4,500 research topics.
- **Use**: Measure research output, career trajectories, and topic specialisation.

Records Productivity Topics

Promotion data

Back

- **Source**: BOE announcements of promotions to Associate and Full Professor.
  - Name, university, and research field.
  - ∼**68,000** promotions, 1986–2023; **48** universities; **188** fields. Flows by year
- **Faculty stock**: BOE records are incomplete before 1986.
  - Add official rosters of eligible Associate and Full Professors from 2002–2008 exams.
  - Rosters include appointment dates; coverage is about 85% of FP and 70% of ASP.
- **Use**: build department-year panels (university × field).
  - Track faculty composition by rank and gender.
  - Count promotions by department, year, rank, and gender.
  - Link qualification outcomes to later promotions.

PhD graduate data: sample

Back

	Overall	Men	Women	Women–Men	SE
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall [N= 203,542]					
Female Student	0.47				
Share Female Supervisors	0.21	0.16	0.27	0.11***	0.00
Years to Graduate	5.16	5.14	5.19	0.06***	0.01
Staying in Academia	0.53	0.54	0.52	-0.02***	0.00
Promoted ASP	0.10	0.12	0.08	-0.04***	0.00

Notes: The unit of observation is a PhD graduate from a Spanish public university between 1990 and 2017. Column (1) reports unconditional means. Columns (2) and (3) report means separately for women and men. Column (4) reports the difference in means (women minus men) and Column (5) the corresponding standard error. *** $p < .01$, ** $p < .05$, * $p < .1$

PhD graduate data: same-sex preference

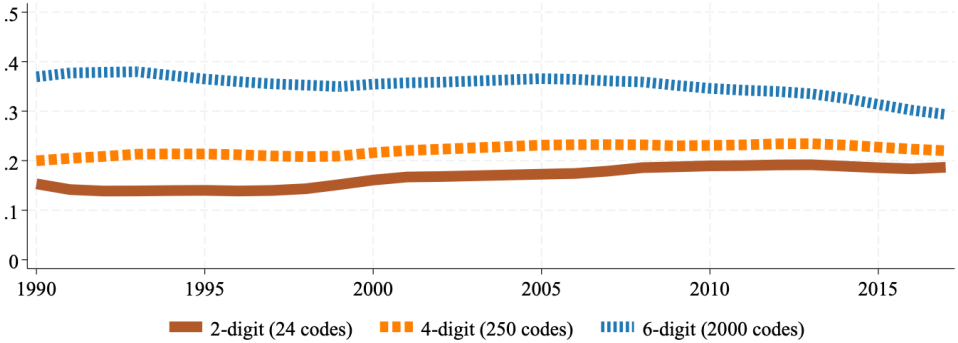
Back

	Female student			
	(1)	(2)	(3)	(4)
Female Advisor	0.099***		0.092***	0.098***
	(0.004)		(0.004)	(0.005)
Advisor's research feminisation (std)		0.039***	0.032***	0.038***
		(0.003)	(0.003)	(0.003)
Observations	126156	126156	126156	126156
Number of departments	4006	4006	4006	4006
Baseline	0.43	0.43	0.43	0.43
R^2	0.122	0.119	0.124	0.320
Year FE	✓	✓	✓	
Department FE	✓	✓	✓	
Department × Year FE				✓

Notes: Notes: OLS estimates. The unit of analysis is a PhD student. The sample period is 1990-2017. Departments are university-field interactions. Standard errors clustered at department level. *Advisor's Research Feminization* is based on pre-graduation publications, and it is standardised to have zero mean and unit standard deviation.
*** p < .01, ** p < .05, * p < .1

PhD graduate data: research topic segregation

Duncan segregation index



- Stagnant segregation since the 1990s.

Back

INE survey: additional support

- 2006 INE Survey on Human Resources in Science and Technology.
- 12,625 doctorate holders; survey weights represent about 83,000 people.
- PhDs completed in 1990–2006; 46% women.

	Share
Prior degree and PhD at same university	74%
Doing research in 2006	69%
Main job in higher education	43%

Financing Back

INE survey: PhD financing

	Overall %	Men %	Women %
Spanish scholarship	37.9	34.0	42.5
Other/foreign scholarship	4.1	3.7	4.5
Teaching/research assistant work	10.9	11.4	10.2
Other job	25.8	28.9	22.2
Private/family/self-finance	16.7	17.2	16.2
Employer reimbursement	0.4	0.4	0.3
Other	4.2	4.4	4.0

INE support Back

Qualification Exams

Back

	All	FP	ASP
Candidates			
N per exam	32.31	26.78	38.28
	(27.22)	(17.74)	(33.68)
N qualified per exam	3.69	2.88	4.57
	(3.57)	(1.79)	(4.64)
% Female	33.39	26.67	40.64
	(18.34)	(15.45)	(18.47)
Evaluators			
N eligible FP	7,955	7,644	7,799
N selected FP	3,969	2,741	1,228
N eligible ASP	21973		21973
N selected ASP	1,764		1,764
Observations	967	502	465

Notes: The table shows descriptive statistics for the 967 qualification exams that took place between 2002 and 2006. The second and third columns provide statistics relative to exams for Full (FP) and Associate Professorships (ASP), respectively.

Qualification Exams and Connections

Back

	Applications to Full Professorships				
	Male	Female	Diff. (Male - Female)	s.e.	obs.
Qualifications					
% Qualified	0.11	0.09	0.02***	(0.01)	13444
Nr Exams per candidate	2.09	2.00	0.10***	(0.04)	6540
% with strong ties	0.35	0.35	0.00	(0.01)	13444
Strong ties	0.515	0.476	0.039**	(0.017)	13444
	Applications to Associate Professorships				
	Male	Female	Diff. (Male - Female)	s.e.	obs.
Qualifications					
% Qualified	0.12	0.11	0.01**	(0.00)	17799
Nr Exams per candidate	1.84	1.70	0.13***	(0.03)	10031
% with strong ties	0.30	0.29	0.01	(0.01)	17799
Strong ties	0.407	0.378	0.029***	(0.011)	17799

Notes: The table reports descriptive statistics on applications to Full Professorships (FP) and Associate Professorships (ASP). The top panel refers to FP applications, while the bottom panel refers to ASP applications. The dataset includes $13,444$ FP applications submitted by $6,540$ candidates and $17,799$ ASP applications submitted by $10,031$ candidates. Candidates can apply simultaneously in several related research fields, and multiple times in case of examination failure.

Qualification Exams and Connections

Back

	Full Professor Exams			Associate Professor Exams		
	Mean	SD	N	Mean	SD	N
A. *Potential connections of candidates*						
Connected eligible evaluators	4.40	4.61	6540	12.63	15.74	10031
- Colleagues	3.89	4.52	6540	11.98	15.65	10031
- Co-authors	1.01	1.37	6540	1.43	2.20	10031
- Ph.D. advisors	0.22	0.42	6540	0.39	0.57	10031
B. *Actual connections in exam applications*						
Strong ties	0.35	0.48	13444	0.29	0.45	17799
- Colleague	0.32	0.47	13444	0.27	0.45	17799
- Coauthor	0.07	0.26	13444	0.04	0.19	17799
- Ph.D. advisor/advisee	0.03	0.18	13444	0.02	0.15	17799

Notes: The table reports the mean and standard deviation of the number of connections between candidates and evaluators. Panel A shows statistics for the average candidate, while Panel B shows the proportion of actual strong ties observed in exam applications. Columns 1–3 correspond to Full Professor exams, while Columns 4–6 correspond to Associate Professor exams. Connection types – colleague, co-author, and advisor/advisee – are not mutually exclusive. The sample sizes in Columns 3 and 6 refer to the number of unique candidates (Panel A) or exam applications (Panel B) for each exam type.

Committee assignment: random draw

- For each exam-field, the Ministry built the list of eligible evaluators.
  - Public institution in Spain; minimum research-quality threshold based on *sexenios*.
- Committees had seven members.
  - Full Professor exams: 7 Full Professors.
  - Associate Professor exams: 3 Full Professors + 4 Associate Professors.
- Evaluators were drawn at random, with one ball per eligible evaluator.
- The longest-tenured member became president; exam took place at the president's uni.
- A reserve committee was also drawn; replacements were rare, about 2%.
- Two constraints: at most one CSIC researcher and at most one emeritus professor.
  - If a second person in either group was drawn, the draw was repeated.

Back

Expected connectedness: algorithm

1. Start from the list of eligible evaluators in the exam field.
2. For each candidate, mark which eligible evaluators are connected to them.
3. Apply the same random-draw rules used by the Ministry.
   - Full Professor exams: draw 7 Full Professors.
   - Associate Professor exams: draw 3 Full Professors and 4 Associate Professors.
   - At most one CSIC researcher and at most one emeritus professor.
4. For each possible committee, count how many members are connected to the candidate.
5. Average this number across all possible committees.

Expected connectedness is this average number of connected committee members.

Candidates applied before committees were announced, so this measure is fixed before the committee is known.

Back

Expected connectedness: Full Professor exams

All seven committee members are drawn from the pool of eligible Full Professors.

Let R, E, and P denote the number of CSIC researchers, emeritus professors, and other eligible professors. Then:

$$p_R = 1 - \frac{\binom{R}{0}\binom{P+E}{7}}{\binom{P+E+R}{7}}, \qquad p_E = 1 - \frac{\binom{E}{0}\binom{P+R}{7}}{\binom{P+E+R}{7}}.$$

$$\begin{aligned}\mathbb{E}[C_{i,e}] = {} & p_R p_E (c_R + c_E + 5c_P) + p_E(1-p_R)(c_E + 6c_P) \\ & + p_R(1-p_E)(c_R + 6c_P) + (1-p_R)(1-p_E)\cdot 7c_P.\end{aligned}$$

c_j denotes candidate i's number of connections with members of group $j \in \{R, E, P\}$.

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Expected connectedness: Associate Professor exams

Three evaluators are drawn from eligible Full Professors and four from eligible Associate Professors. The probabilities p_R^{FP}, p_E^{FP}, p_R^{AP}, and p_E^{AP} are computed analogously, separately for each pool.

$$\begin{aligned}\mathbb{E}[C_{i,e}] = &\left[p_R^{FP} p_E^{FP}(c_R^{FP} + c_E^{FP} + c_P^{FP}) + p_E^{FP}(1 - p_R^{FP})(c_E^{FP} + 2c_P^{FP})\right. \\ &\left. + p_R^{FP}(1 - p_E^{FP})(c_R^{FP} + 2c_P^{FP}) + (1 - p_R^{FP})(1 - p_E^{FP}) \cdot 3c_P^{FP}\right] \\ &+ \left[p_R^{AP} p_E^{AP}(c_R^{AP} + c_E^{AP} + 2c_P^{AP}) + p_E^{AP}(1 - p_R^{AP})(c_E^{AP} + 3c_P^{AP})\right. \\ &\left. + p_R^{AP}(1 - p_E^{AP})(c_R^{AP} + 3c_P^{AP}) + (1 - p_R^{AP})(1 - p_E^{AP}) \cdot 4c_P^{AP}\right].\end{aligned}$$

c_j^k denotes candidate i's number of connections with members of group $j \in \{R, E, P\}$ in pool $k \in \{FP, AP\}$.

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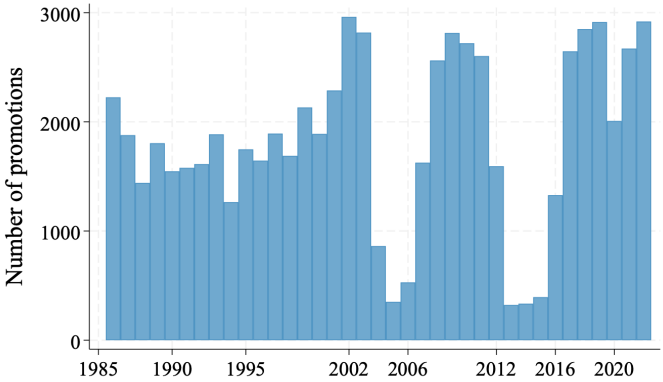
Promotions



- 2002-2003: large number of promotions in anticipation of the new system.
- 2005-2006: few promotions as many qualifications exams were still under way.
- 2013-2015: freezing of promotions due to the public finance crisis.

Back

Departments: participation

Back

	Count	Percent
Departments in Spain	4730	
Departments with any Candidate in Habilitación	4000	100%
Panel A: Full professor exams		
Departments with:		
a candidate	2642	66%
a successful candidate	955	24%
a female candidate	1159	29%
a successful female candidate	286	7%
a male candidate	2304	58%
a successful male candidate	791	20%
Panel B: Associate professor exams		
Departments with:		
a candidate	3330	83%
a successful candidate	1224	31%
a female candidate	2080	52%
a successful female candidate	564	14%
a male candidate	2550	64%
a successful male candidate	866	22%

Notes: The table shows the distribution of Spanish public university departments by participation and success in *habilitación* exams. The sample includes all departments with at least one Full Professor and one Associate Professor. Percentages are computed relative to the 4,000 departments with at least one candidate. Panel A reports counts for Full Professor exams and Panel B for Associate Professor exams. "Departments with a candidate" denotes at least one applicant to the relevant exam; "departments with a successful candidate" denotes at least one qualified applicant. Gender-specific rows indicate the presence of at least one female or male candidate, and at least one successful female or male candidate, respectively.

Departments: exam characteristics

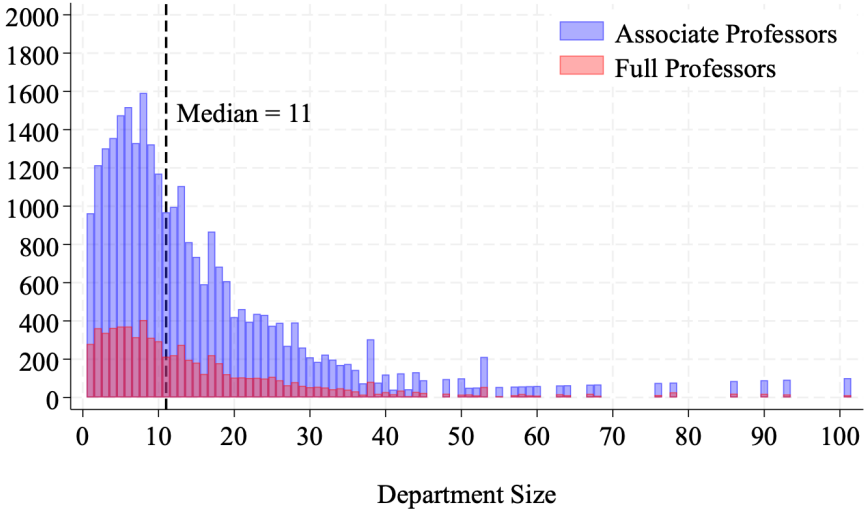
Back

	FP exams	ASP exams
Pre-exam levels		
Associate Professors	9.58	8.31
Female share	34.72	33.85
Full Professors	2.96	2.66
Female share	14.17	14.78
PhD graduations	2.12	1.92
Female share	45.72	45.47
Totals over 10 years post exam		
Promotions to ASP	3.34	3.85
Women	1.36	1.49
Men	1.98	2.36
Promotions to FP	2.45	1.81
Women	0.71	0.48
Men	1.74	1.33
PhD graduations	29.04	27.09
Women	14.12	12.82
Men	14.92	14.26
Number of department-exam	6485	6733
Number of departments	2642	3330

Notes: The table reports department-exam level averages for departments in Spanish public universities with at least one faculty member applying to a national qualification exam. The first and second columns refer to departments participating in Full Professor and Associate Professor exams, respectively. Pre-exam levels are measured one year before the exam. Female shares are expressed in percentage points. Promotions and PhD graduations are cumulative totals over the ten years following the exam. *FP* and *ASP* denote Full and Associate Professors.

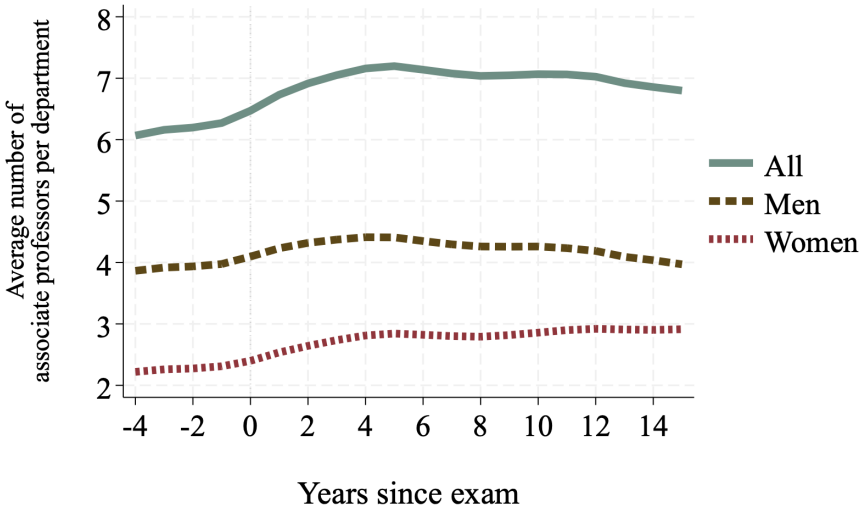
Departments: size distribution

Back



Departments: Associate Professor stocks around exams

Back



Data: Publication records

Back

	Total	Health Sciences	Life Sciences	Physical Sciences	Social Sciences	% Spanish
Number of publications	6,430,173	26.56%	18.65%	33.52%	21.28%	34.98%
Number of publications by type						
Journal articles	4,567,444	26.89%	18.88%	32.29%	21.94%	30.48%
Books/Book chapters	1,098,931	13.78%	13.57%	39.67%	32.98%	74.12%
Conference proceedings/other	763,798	29.58%	19.02%	41.36%	10.03%	5.60%
Number of publications by source						
OpenAlex	3,220,647	28.03%	20.10%	30.35%	21.53%	23.81%
Scopus	1,607,887	23.10%	15.45%	50.75%	10.71%	3.60%
Dialnet	1,601,639	16.85%	8.32%	16.15%	58.68%	88.96%

Notes: The table reports descriptive statistics for publication records, after deduplication across OpenAlex, Scopus, and Dialnet. Column 1 shows the total number of unique entries. Columns 2–5 present the distribution across four broad research domains, following OpenAlex's research topic taxonomy. Column 6 reports the share of publications in Spanish.

- Scopus tops up with Physical and Health Sciences records, while Dialnet with Spanish-language records.

Data: Research output of candidates

Back

	Overall	Men	Women	Women–Men	SE
	(1)	(2)	(3)	(4)	(5)
Panel A: Applications for Full Professor [N= 13,444]					
Female Candidate	0.27				
Qualified	0.11	0.11	0.09	-0.02***	0.01
Papers	33	0.05	-0.13	-0.18***	0.02
Papers in Web of Science	17	0.02	-0.05	-0.07***	0.02
Books	3	0.05	-0.13	-0.18***	0.02
Chapters	7	0.04	-0.11	-0.15***	0.02
Total AIS	17	0.02	-0.05	-0.07***	0.02
Average AIS	0.83	0.01	-0.03	-0.04*	0.02
Panel B: Applications for Associate Professor [N= 17,799]					
Female Candidate	0.40				
Qualified	0.12	0.12	0.11	-0.01**	0.00
Papers	17	0.10	-0.15	-0.25***	0.01
Papers in Web of Science	8	0.07	-0.11	-0.17***	0.01
Books	1	0.06	-0.09	-0.15***	0.01
Chapters	3	0.02	-0.03	-0.05***	0.01
Total AIS	10	0.06	-0.10	-0.16***	0.01
Average AIS	0.87	0.03	-0.05	-0.08***	0.02

Notes: The unit of observation is an application to the *habilitación* qualification system. Panel A reports applicants to Full Professor positions; Panel B reports applicants to Associate Professor positions. Column (1) reports overall means. Columns (2) and (3) report means by gender, where productivity measures are standardized at the exam level. Column (4) reports the difference in means (women minus men) and Column (5) the corresponding standard error.

Research topic classification

Back

- OpenAlex, for the same record, provides both *topics* and *concepts*.
  - Topics come from the OpenAlex taxonomy.
  - Concepts come from the Microsoft Academic Graph (MAG)
- Scopus, Dialnet, and Teseo come with *concepts*.
  - MAG text classifier on titles/abstracts (Wang et al., 2019; Hafner and Hedtrich, 2024).
- Inference method:
  - Estimate $P(\text{topic}|\text{concept})$ using OpenAlex records.
  - Project this mapping to Scopus, Dialnet, and Teseo.

Topic Assignment Procedure

- From OpenAlex *work-topic-concept* triples:
  - Keep concepts with score ≥ 0.4.
  - Aggregate topic scores within concept-topic pairs:

$$P(t \mid c) \;=\; \frac{\sum_{w \in \mathcal{W}_{c,t}} \text{topic score}_{w,t}}{\sum_{t'} \sum_{w \in \mathcal{W}_{c,t'}} \text{topic score}_{w,t'}}$$

- For each work i:

$$\widetilde{p}_{i,t} \;=\; \sum_{c \in \mathcal{C}_i} s_{i,c}\, P(t \mid c), \qquad p_{i,t} \;=\; \frac{\widetilde{p}_{i,t}}{\sum_{t'} \widetilde{p}_{i,t'}}$$

$$\widehat{t}_i \;=\; \arg\max_t p_{i,t}$$

OpenAlex Taxonomy

Back

Health Sciences	Life Sciences
- Dentistry	- Agricultural and Biological Sciences
- Health Professions	- Biochemistry, Genetics and Molecular Biology
- Medicine	- Immunology and Microbiology
- Nursing	- Neuroscience
- Veterinary	- Pharmacology, Toxicology and Pharmaceutics
Physical Sciences	**Social Sciences**
- Chemical Engineering	- Arts and Humanities
- Chemistry	- Business, Management and Accounting
- Computer Science	- Decision Sciences
- Earth and Planetary Sciences	- Economics, Econometrics and Finance
- Energy	- Psychology
- Engineering	- Social Sciences
- Environmental Science	
- Materials Science	
- Mathematics	
- Physics and Astronomy	

Notes: The table lists 26 research fields, each mapped into one of four broad research domains defined by the OpenAlex taxonomy.

Source: https://api.openalex.org/topics.

Research Feminisation Indices

Construction

1. Assign publications by faculty and exam candidates to around 4,500 OpenAlex topics.
2. For records not directly indexed in OpenAlex, map MAG concept labels to the OpenAlex taxonomy.
3. For each topic-year, compute the share of female authors in that topic over the preceding five years, excluding the current year.
   - The index captures the gender composition of a research area, not the author's own gender.
4. Aggregate topic-level values to papers, then to authors using pre-event publications.
5. For PhD theses, apply the same five-year logic to TESEO/Thesauro thesis topics.

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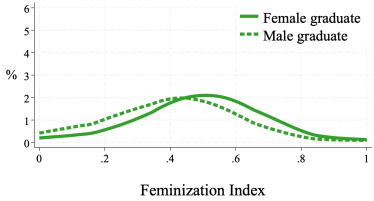
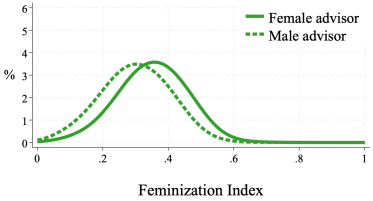
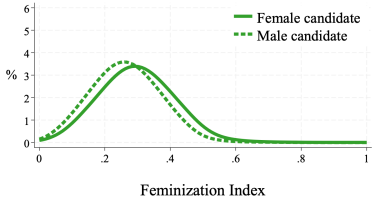
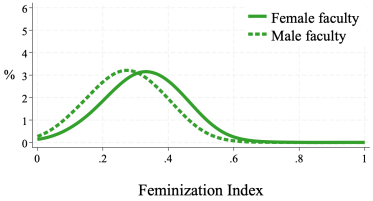
Research Feminisation Indices

Distributions









Construction Back

Randomization Check

Back

Panel A.	Not controlling for expected connections			
	Papers	Books	Chapters	AIS
	(1)	(2)	(3)	(4)
Strong ties	0.004	-0.011	-0.022***	0.008
	(0.007)	(0.007)	(0.007)	(0.007)
Panel B.	Controlling for expected connections			
	Papers	Books	Chapters	AIS
	(1)	(2)	(3)	(4)
Strong ties	-0.000	-0.004	-0.000	0.000
	(0.010)	(0.010)	(0.010)	(0.011)

Notes: The table reports OLS estimates from eight separate regressions using a sample of 31,243 applications to Associate and Full Professor positions. The top panel presents coefficients from regressions of various productivity measures on the number of strong ties between the candidate and committee members. The bottom panel includes the expected number of connections. All regressions cluster standard errors at the exam level. The outcome variables in columns (1)-(3) are the number of journal articles, books, and book chapters published by the candidate up to the year of the exam. Column (4) reports the number of citations received by pre-exam journal articles as of 2024. All dependent variables are standardized at the exam level with zero mean and unit standard deviation.

First stage estimates - individual level analysis

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	Full Professor Exams				Associate Professor Exams			
Outcome: Qualified	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All candidates		Men	Women	All candidates		Men	Women
Strong Connections	0.052***	0.052***	0.055***	0.040***	0.064***	0.064***	0.068***	0.061***
	(0.005)	(0.005)	(0.006)	(0.009)	(0.006)	(0.006)	(0.007)	(0.008)
Productivity controls:								
- Journal Articles		0.025***	0.023***	0.027***		0.037***	0.036***	0.040***
		(0.005)	(0.005)	(0.009)		(0.004)	(0.005)	(0.007)
- Total AIS		0.025***	0.029***	0.013*		0.008**	0.004	0.019***
		(0.004)	(0.005)	(0.007)		(0.004)	(0.005)	(0.007)
- Book Chapters		0.014***	0.012***	0.024***		0.014***	0.011***	0.019***
		(0.003)	(0.004)	(0.006)		(0.003)	(0.004)	(0.005)
- Books		0.001	-0.001	0.008		0.001	-0.004	0.007
		(0.003)	(0.003)	(0.007)		(0.003)	(0.003)	(0.005)
Observations	13439	13439	9802	3594	17762	17762	10687	7069
KP rk Wald F-stat	120.147	126.545	96.741	19.264	129.455	131.548	97.152	52.409

Notes: The table reports first-stage estimates of Equation 1. All regressions include the number of expected connections, and cluster standard errors at the exam level. Productivity controls include the number of journal articles, books, and book chapters published by the candidate up to the year of the exam, as well as the number of citations received by pre-exam journal articles as of 2024. All productivity variables are standardized at the exam level with zero mean and unit standard deviation.

2SLS: Impact of qualifications on promotions

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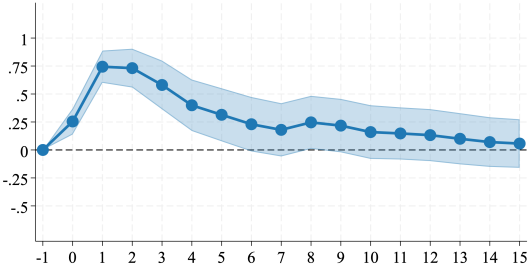
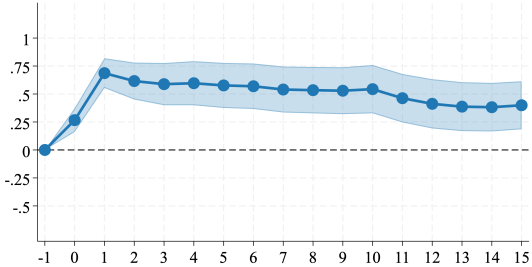
Promotions to Full Professorships



Promotions to Associate Professorships



2SLS: Impact of qualifications on promotions

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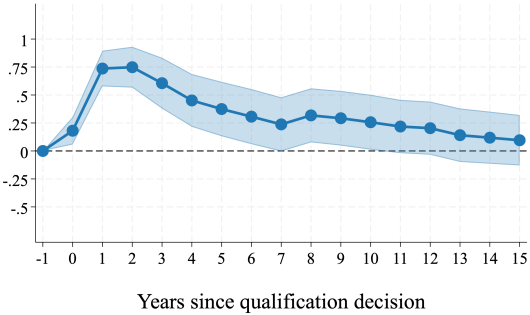
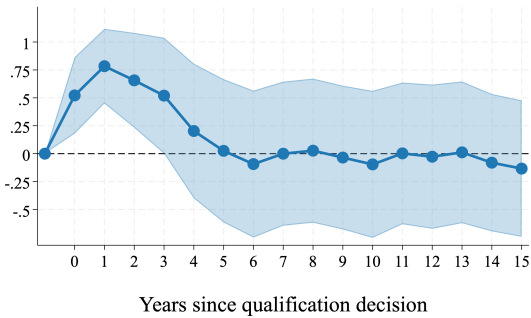
Applications to Full Professorships

Promotions to Full Professorships - Men



Promotions to Full Professorships - Women



IV subpopulations, by gender

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Sub-population	Share	Papers	Citations	AIS
Panel A: Female candidates				
Compliers	6.9%	0.06	-0.05	0.11
Always-takers	9.1%	0.17	0.18	0.15
Never-takers	84.0%	-0.20	-0.11	-0.12
Panel B: Male candidates				
Compliers	8.4%	0.14	0.17	-0.05
Always-takers	9.8%	0.47	0.41	0.38
Never-takers	81.7%	0.02	-0.02	0.01

Notes: The table profiles IV sub-populations based on whether the committee draw assigned a candidate more connection intensity than expected from the evaluator pool, $1\{C_{i,e} > \mathbb{E}[C_{i,e}]\}$. Estimates are computed within terciles of expected connection intensity and pooled by gender. *Papers* is the number of journal articles published up to the exam; *Citations* is citations to pre-exam journal articles as of 2024; *AIS* is total Article Influence Score of pre-exam journal articles. Productivity measures are standardized at the exam level.

Alternative instrument definitions

Back

	Binary	Count	Separate	Intensity
Outcome: Qualified	(1)	(2)	(3)	(4)
At Least One Strong Tie	0.088***			
	(0.009)			
Strong Ties		0.063***		
		(0.006)		
PhD Advisors			0.124***	
			(0.023)	
Colleagues			0.048***	
			(0.006)	
Coauthors			0.095***	
			(0.021)	
Strong Tie Intensity				0.064***
				(0.006)
Observations	17762	17762	17762	17762
KP rk Wald F-stat	105.046	97.754	47.922	131.548

Notes: The table reports first-stage estimates of candidate qualification on connections with the evaluation committee, using four alternative instrument definitions. Column (1) includes an indicator for having at least one connected evaluator in the evaluation committee; column (2) includes the count of strongly connected evaluators; column (3) includes the count of connected evaluators, separately by tie type (shared affiliation, PhD supervision, and coauthorship); and column (4) considers a composite index equal to the number of tie types per evaluator, summed across evaluators. All specifications control for expected connections and candidate productivity (journal articles, total AIS, book chapters, and books), and include exam and result-year fixed effects. The sample consists of applications for Associate Professor positions. Standard errors are clustered at the exam level.
*** p < .01, ** p < .05, * p < .1

First-stage estimates, departmental level

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	Qualified	Women Qualified	Men Qualified	Feminised Qualified	Not Feminised Qualified
	(1)	(2)	(3)	(4)	(5)
Panel A. Applications to Associate Professor positions					
Strong Connections	0.151***				
	(0.014)				
Female Strong Connections		0.135***	0.020*		
		(0.020)	(0.011)		
Male Strong Connections		0.004	0.143***		
		(0.006)	(0.018)		
Feminised Strong Connections				0.130***	0.004
				(0.017)	(0.006)
Not Feminised Strong Connections				0.031***	0.108***
				(0.010)	(0.019)
Observations	6732	6732	6732	6177	6177
KP rk Wald F-stat	116.501	34.303	34.303	18.573	18.573
KP rk LM statistic	103.181	67.370	67.370	33.519	33.519
SW F-stat	125.424	61.266	70.905	56.025	38.285

Notes: The unit of observation is a department–exam. Panel A includes applications to Associate Professor positions, while Panel B to Full Professor positions. Column (1) reports department-level first-stage estimates where the outcome is the total number of qualified candidates. Columns (2) and (3) report first-stage estimates where the outcomes are the number of qualified female and male candidates, respectively. Columns (4) and (5) report first-stage estimates from the feminised-equivalent version first-stage regression. *Strong connections* measures the average number of connections between candidates in a given department–exam and committee evaluators, with female-, male-, feminised- and not-feminised-specific variants defined analogously for the respective subgroups. All specifications include controls listed in the text. Standard errors are clustered at the department level. The table reports F-statistics for weak and underidentification of the instrumental variables.
*** $p < .01$, ** $p < .05$, * $p < .1$

Randomization check, departmental level

Back

Panel A.	Not controlling for expected connections				
	Candidates	Papers (z)	AIS (z)	Chapters (z)	Books (z)
Strong ties	0.504**	0.792***	0.638***	0.568***	0.493***
	(0.219)	(0.110)	(0.117)	(0.107)	(0.109)
Panel B.	Controlling for expected connections				
	Candidates	Papers (z)	AIS (z)	Chapters (z)	Books (z)
Strong ties	-0.313	-0.092	-0.096	-0.050	0.003
	(0.194)	(0.099)	(0.103)	(0.096)	(0.099)
Observations	13,215	13,215	13,215	13,215	13,215

Notes: The table reports OLS estimates at the department–exam level for applications to Associate and Full Professor positions. The dependent variables are the number of candidates in each department–exam cell and department-level standardised measures of productivity at the time of the exam. The main explanatory variable is the average number of strong ties between candidates and committee members. Panel A excludes controls for expected connections; Panel B includes them. All specifications control for the number of Associate and Full Professors in the department one year prior to the exam, as well as examination and year fixed effects. Standard errors are clustered at the department level. *** p < .01, ** p < .05, * p < .1

Randomization check, departmental level. By gender

Back

Panel A.	Not controlling for expected connections					
	Female candidates	Male candidates	Papers (z)	AIS (z)	Chapters (z)	Books (z)
Female strong ties	4.268***	-3.124***	0.793***	0.616***	0.361**	0.317*
	(0.276)	(0.179)	(0.182)	(0.191)	(0.177)	(0.187)
Male strong ties	-1.733***	1.704***	0.503***	0.430***	0.477***	0.353***
	(0.098)	(0.179)	(0.119)	(0.130)	(0.121)	(0.121)
Joint F-test [p-value]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.005]
Panel B.	Controlling for expected connections					
	Female candidates	Male candidates	Papers (z)	AIS (z)	Chapters (z)	Books (z)
Female strong ties	0.052	0.045	-0.067	-0.020	-0.365*	-0.032
	(0.272)	(0.201)	(0.200)	(0.207)	(0.193)	(0.188)
Male strong ties	-0.132	-0.337*	-0.070	-0.111	0.123	0.045
	(0.084)	(0.174)	(0.126)	(0.137)	(0.127)	(0.131)
Joint F-test [p-value]	[0.293]	[0.153]	[0.777]	[0.695]	[0.140]	[0.937]
Observations	13,215	13,215	13,215	13,215	13,215	13,215

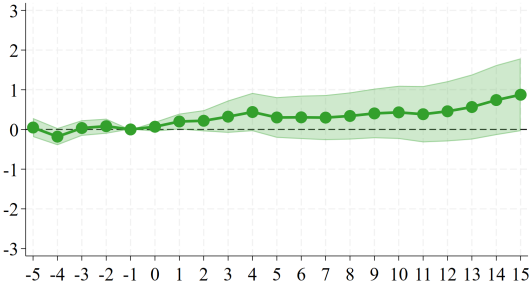
Notes: The table reports OLS estimates at the department–exam level for applications to Associate and Full Professor positions, separately by candidate gender. The dependent variables are the number of female and male candidates in each department–exam cell and department-level standardised measures of productivity at the time of the exam. The main explanatory variables are the average number of strong ties between female and male candidates and committee members. Panel A excludes controls for expected connections; Panel B includes them. All specifications control for the number of female and male Associate and Full Professors in the department one year prior to the exam, as well as examination and year fixed effects. The joint F-test tests whether both instruments are simultaneously zero. Standard errors are clustered at the department level.
*** p < .01, ** p < .05, * p < .1

Department Level Analysis - Impact of male promotions

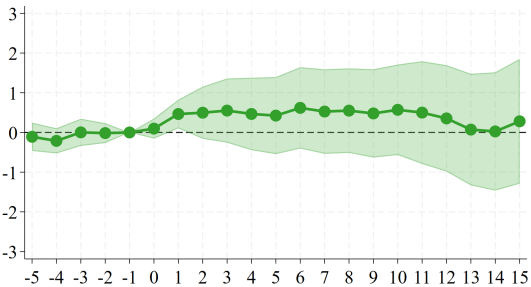
Back

Impact of a man qualifying for Assoc. Prof. on cumulative number of promotions to Assoc. Prof.

Female promotions to Associate Professor



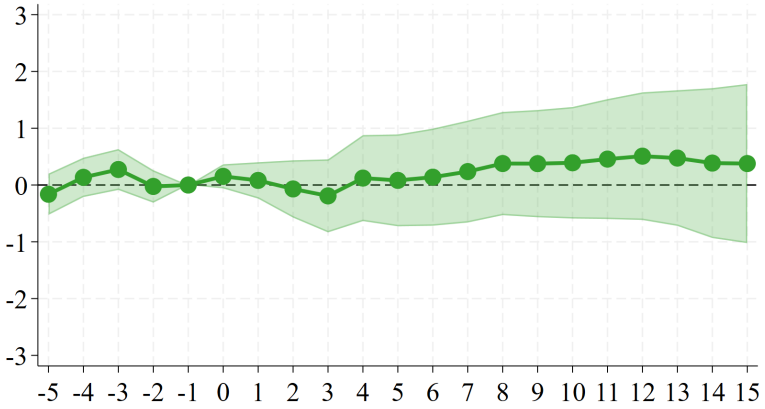
Male promotions to Associate Professor



Department Level Analysis - Impact on male faculty

Back

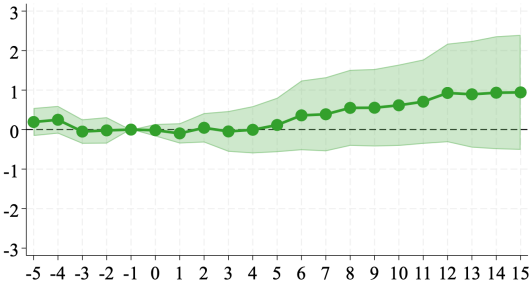
Impact of a woman qualifying for Assoc. Prof. on cumulative number of male promotions to Assoc. Prof.



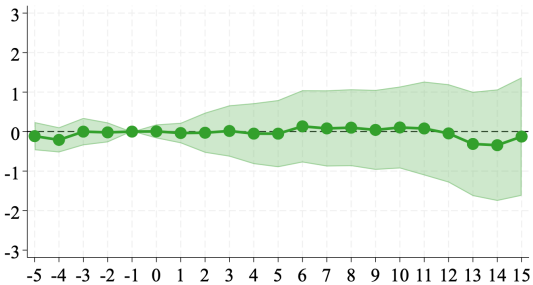
Department Level - Impact of promotions, excluding own candidate

Back

Female qualification -> female promotions



Male qualification -> male promotions



Department Level Analysis - Critical Mass

Impact of exogenous female qualification by baseline number of women

Back

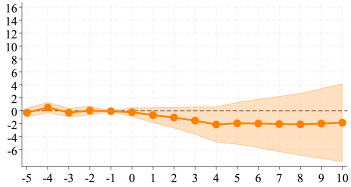
Baseline female representation	Associate Professor qualification (representation based on Full+Associate Professors)		
	Number of observations	Female promotions to Associate Professor (10 years)	Female PhD graduates (10 years)
No senior women	2013	0.116	-5.921
		(0.625)	(4.435)
Women in minority ($\leq$ men)	3786	2.037**	10.999**
		(0.849)	(4.330)
Women in majority ($>$ men)	933	1.037	6.776
		(1.246)	(4.477)
Observations		6732	6732

Department Level Analysis - Impact on PhD graduates

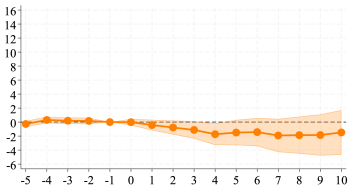
Impact of a man qualifying for Assoc. Prof. on cumulative number of PhD graduates

Back

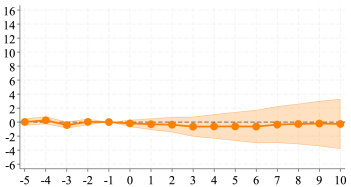
All graduates



Female graduates



Male graduates

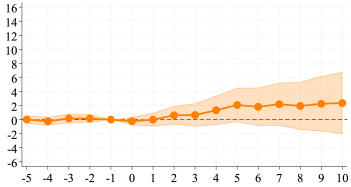


Department Level

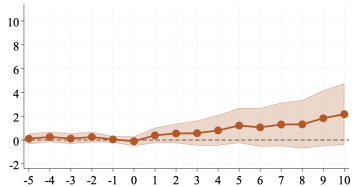
Back

Impact of a woman qualifying for Assoc. Prof. on departments' male PhD graduates

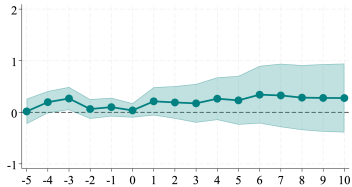
Male PhD graduates



Male future academics



Male future associate professors

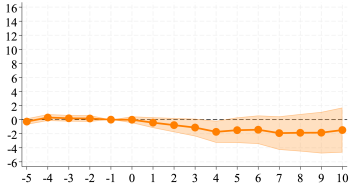


Department Level

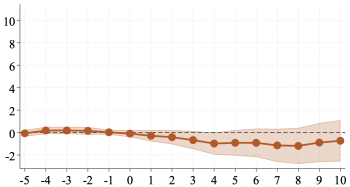
Back

Impact of a man qualifying for Assoc. Prof. on departments' female PhD graduates

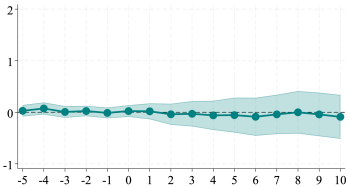
Female graduates



Research active female graduates



Female graduates promoted to ASP

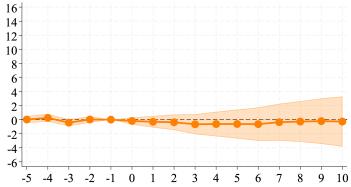


Department Level

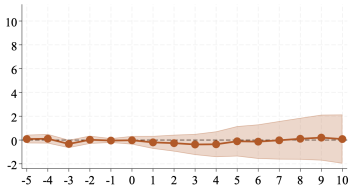
Back

Impact of a man qualifying for Assoc. Prof. on departments' male PhD graduates

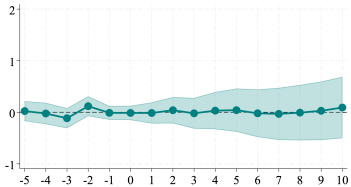
Male PhD graduates



Male future academics



Male future associate professors

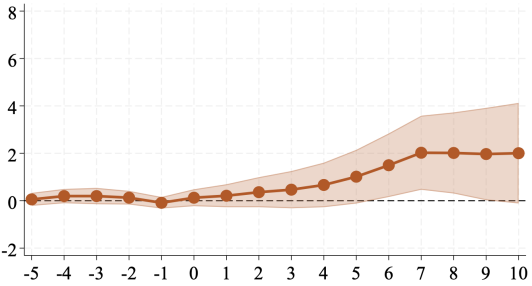


Department Level Analysis - Impact by Supervisor Gender

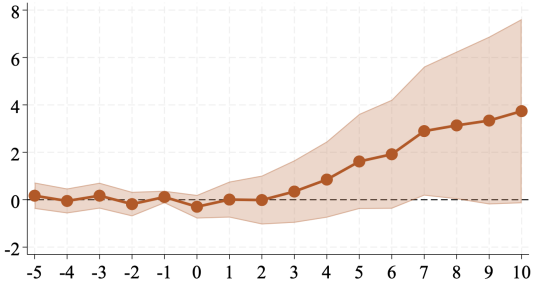
Impact of a woman qualifying for Assoc. Prof. on supervision of female PhD students

Back

Female PhDs with Female Lead Supervisor



Female PhDs with Male Lead Supervisor



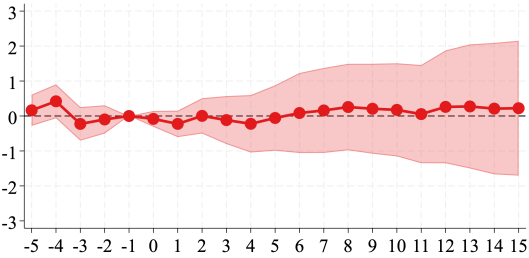
- 2/6 PhD students with female lead supervisor (sample average: 27%)

Department level - mechanisms

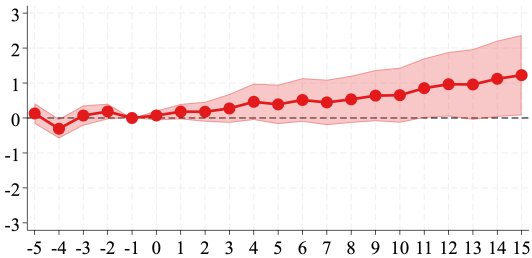
Back

Horse race between gender-based and topic-based promotion on female promotions to Associate Professor

Gender-based promotion



Topic-based promotion



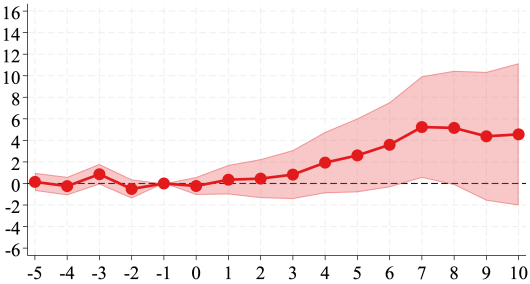
- Note: we remove own candidate.

Department level - mechanisms

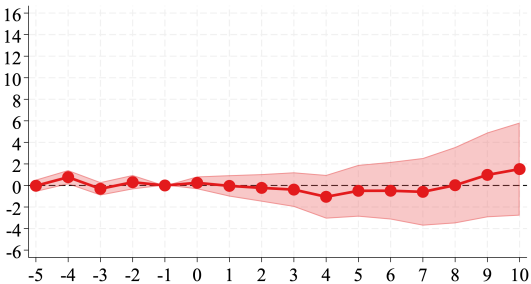
Back

Horse race between gender-based and topic-based promotion on female PhD graduates

Gender-based promotion



Topic-based promotion

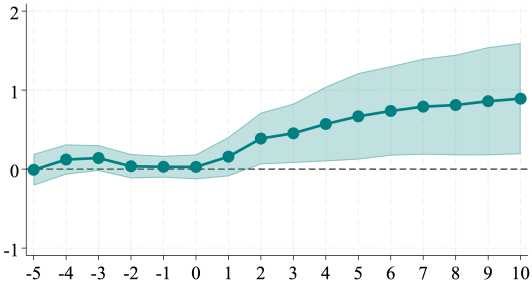


Department level - mechanisms

Back

Impact of an applicant from female-intensive topics qualifying for Assoc. Prof. on female graduates' activity and retention

Gender-based promotion



Topic-based promotion