The Careers of Women Inventors

EEA-ESEM

Mimosa Distefano[1] **Klea Ibrahimi**[2] Simon Janssen[3] Alice Kügler[2] Linh Tô[4]

27 August 2024

[1] London School of Economics [2] **Central European University** [3] Institute for Employment Research
[4] Boston University

Germany is a leader in innovation

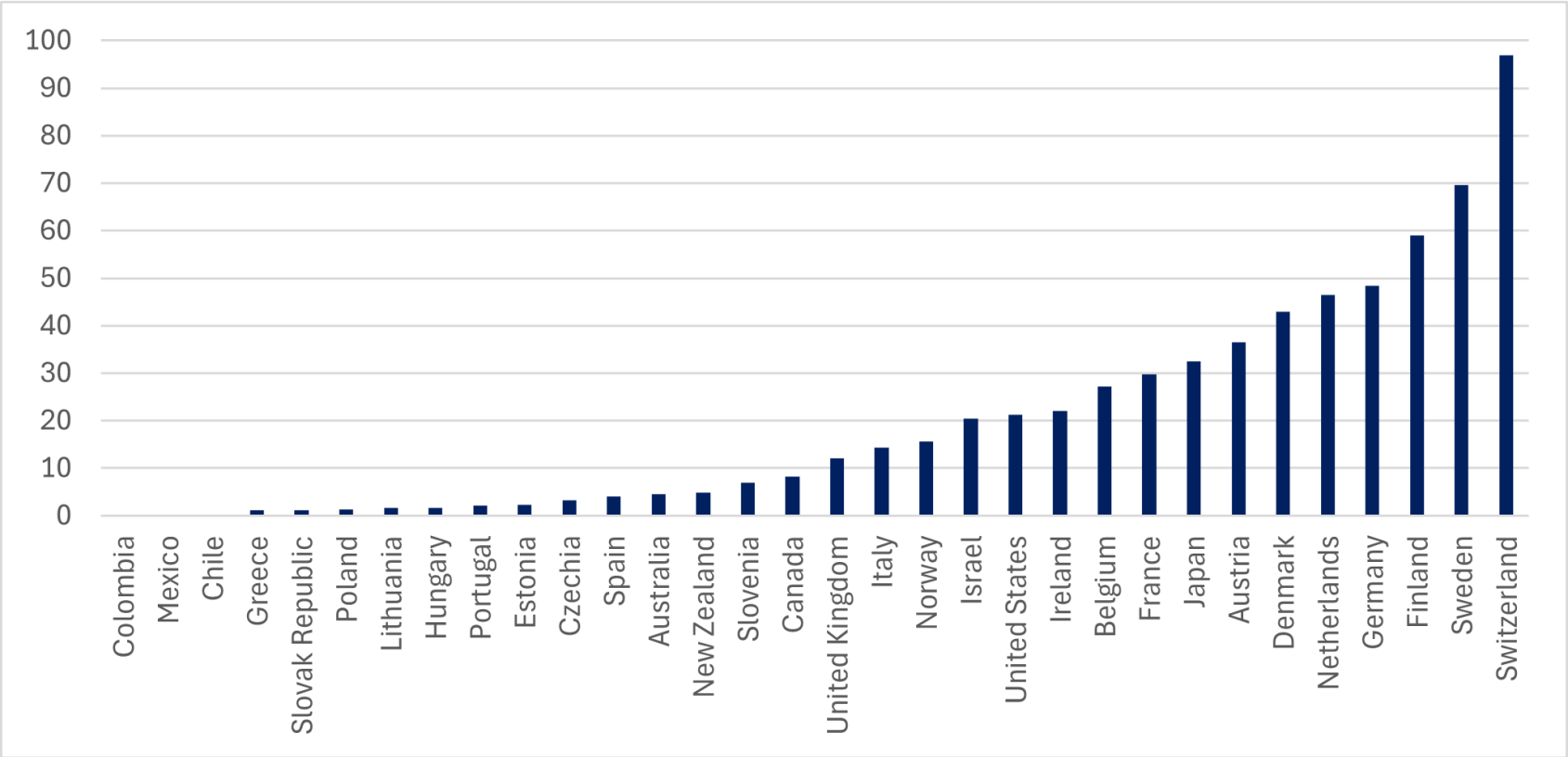


Figure 1: Number of (granted) patents by 1000 workers by country in 2019.
Source: European Patent Office

However the majority of inventors are men

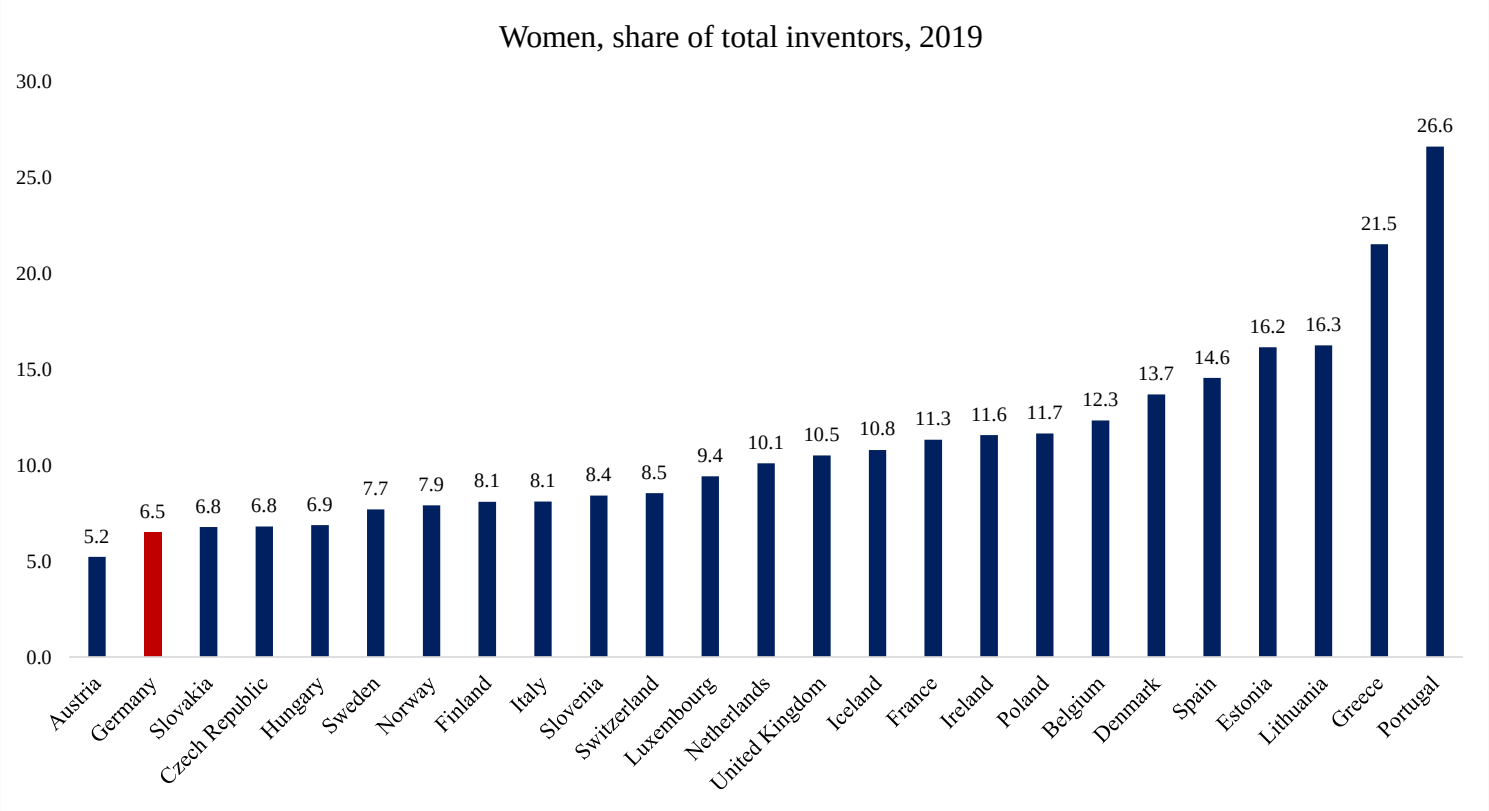


Figure 2: Share of women inventors in 2019. Source: OECD

This paper

How and why the careers of men and women inventors do differ?

- The role of **children** in women inventors' careers
- The role of **sector** in men and women career divergences
- **Empirical strategy**:
  - Estimate child penalties for labor market and patent outcomes.
  - Show how the life cycles of men and women inventors differs.
- **Data**: The complete work history of inventors with at least one patent between 1999 and 2011 in Germany and the firms they worked for

Literature and Contribution

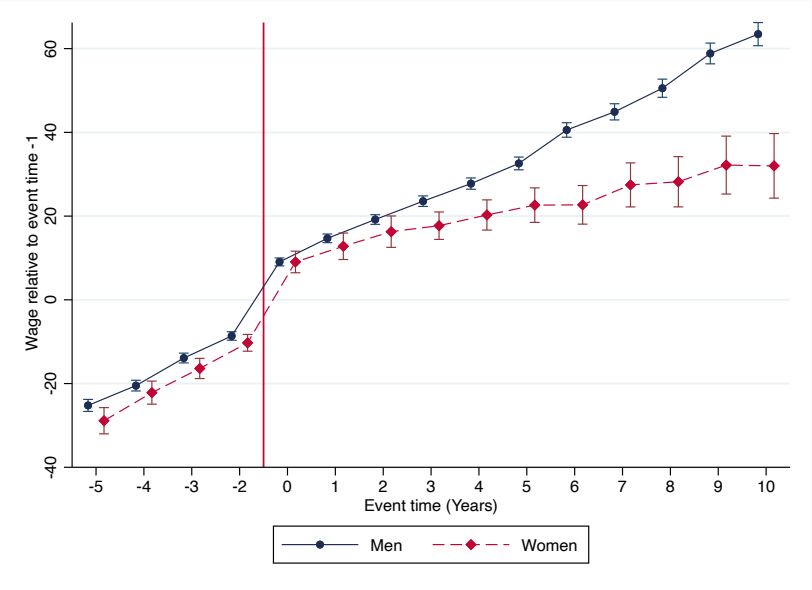
- The **role of motherhood in labor market outcomes of females**: Kleven et al., 2019; Raute, 2019; Boelmann et al., 2020; Bonke et al., 2022
- **Gender disparities in science and innovation**: Kim and Moser 2021; Akcigit and Goldschlag, 2023; Hochberg et al., 2023; Waldinger et al., 2022
- **The inefficient allocation of talent**: Hsieh et al., 2019; Brouillette, 2021

Stylized facts

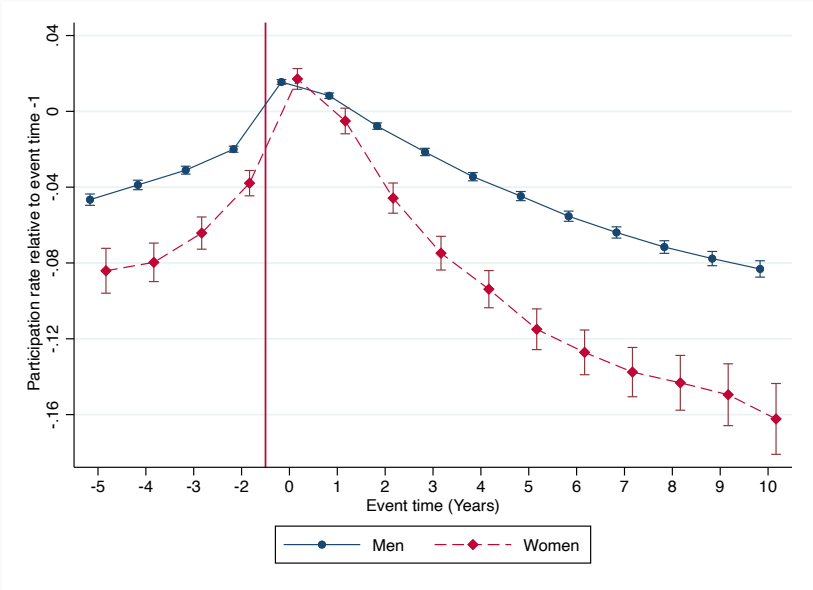
- The average women inventor earns double than the average STEM worker but half of the average men inventor Earnings
- The average men inventor has 3.2 patents while woman inventor only 2.3 patents over their lifetime Patenting
- Men are more likely to work in engineering while women in Chemistry Occupations
- Women are more likely to work in smaller firms that pay less on average, and work in bigger teams

Women benefit less from patenting compared to men

Wages



Participation rates



What is the role of children?

Child penalties: Methodology

- We run the following **event study** as in Kleven et al., 2018:

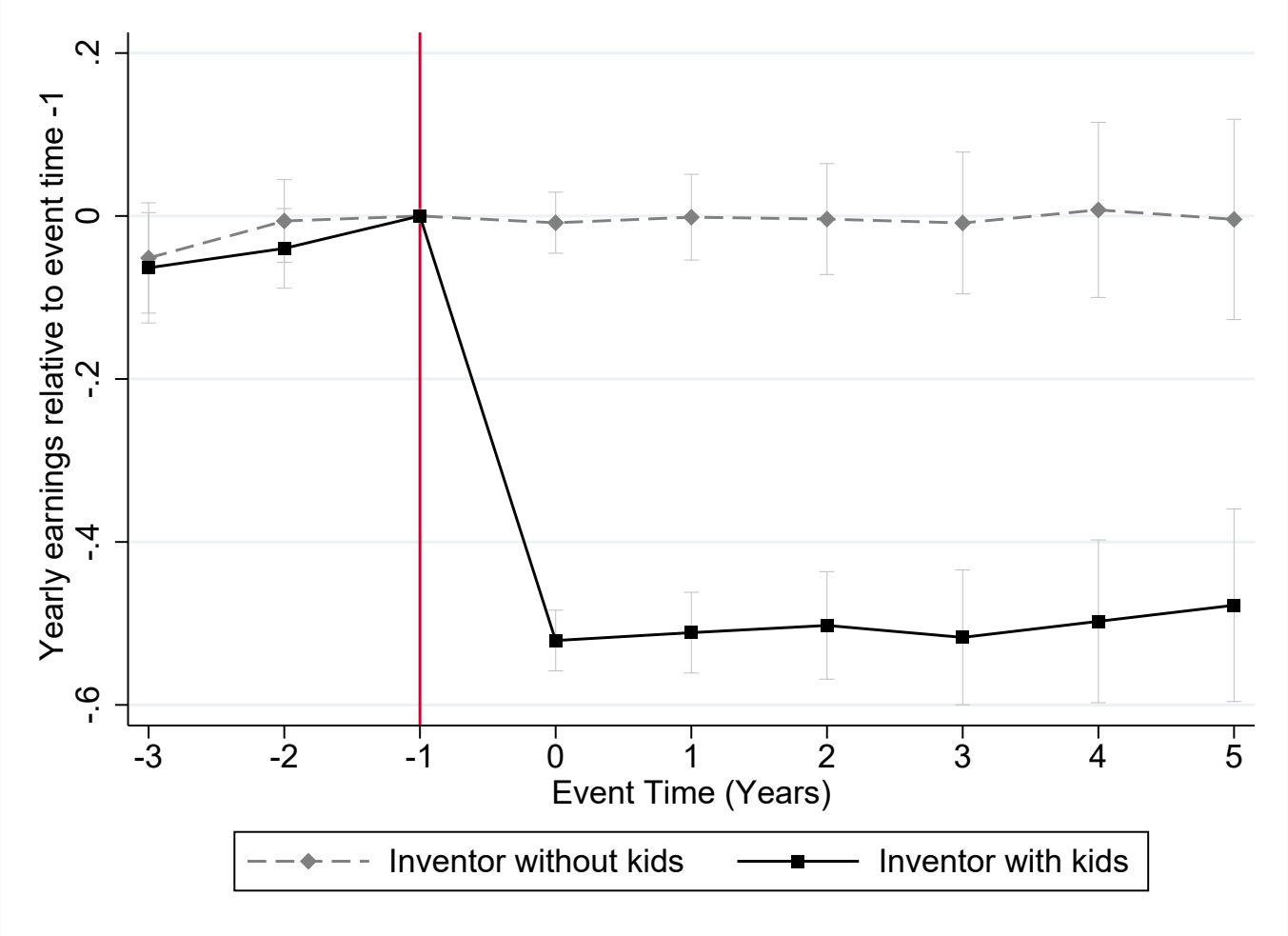
$$Y_{\text{ist}} = \sum_{j \neq -1} \alpha_j \cdot I[j = t] + \sum_k \beta_k \cdot I[k = age_{\text{is}}] + \sum_y \gamma_y \cdot I[y = s] + \nu_{ist}$$

  where i refers to individual, s to year, t to the time from the event of child-birth, and Y_{ist} is the outcome variable

- Then we predict the **counterfactual outcome** by running the same event study without including event dummies
- The **child penalty effect** in percentages is calculated as follows:

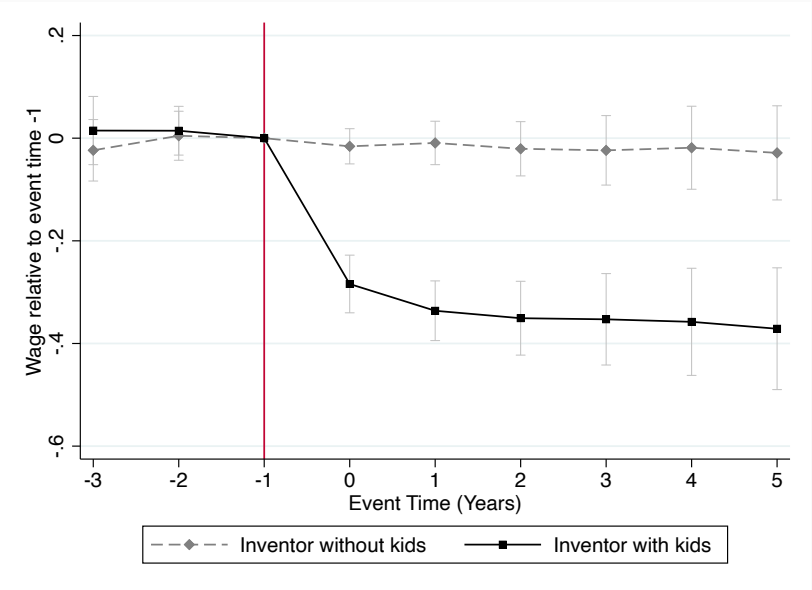
$$P_t = \hat{\alpha}_t / \mathbb{E}[\widetilde{Y}_{\text{ist}} | t]$$

Child penalties: Earnings

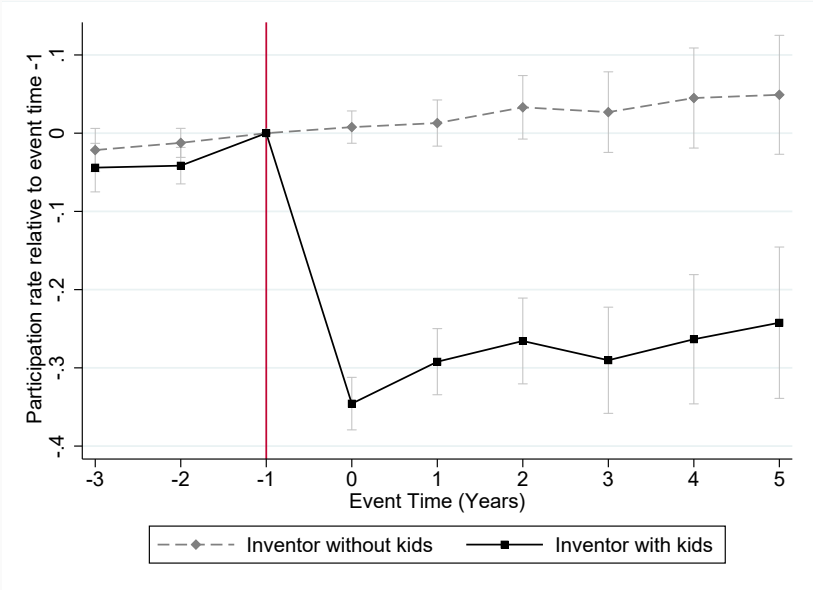


Child penalties: Wages and Participation rates

Wages

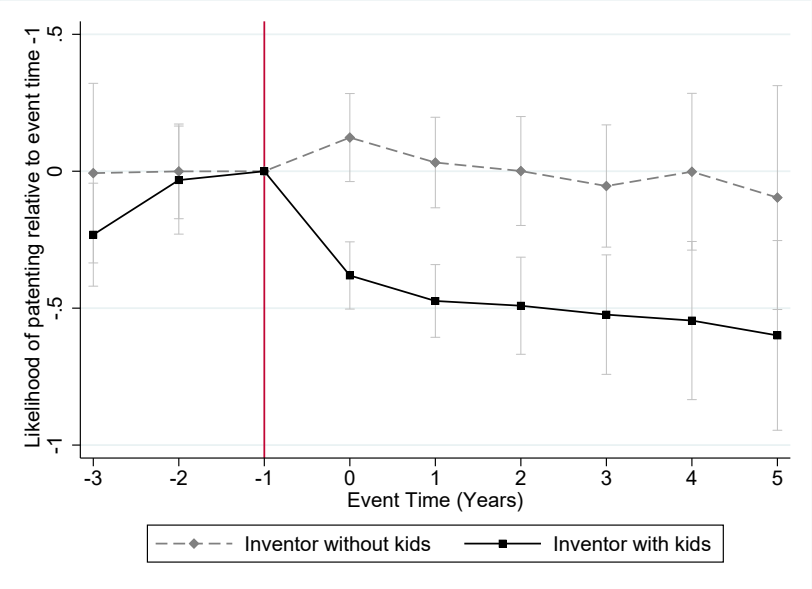


Participation rates

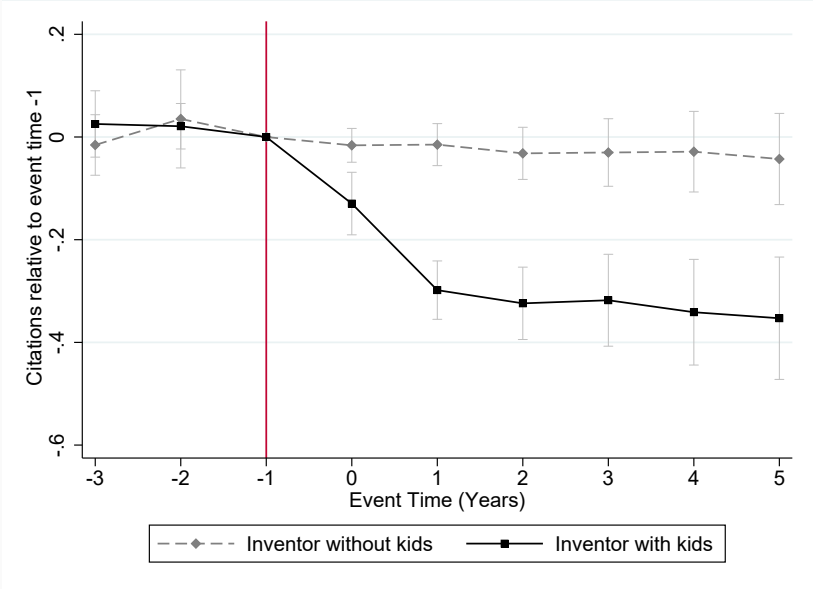


Child penalties: Patent outcomes

Likelihood of patenting



Citations



Are the gaps persistent over the lifecycle?

Life Cycles: Methodology

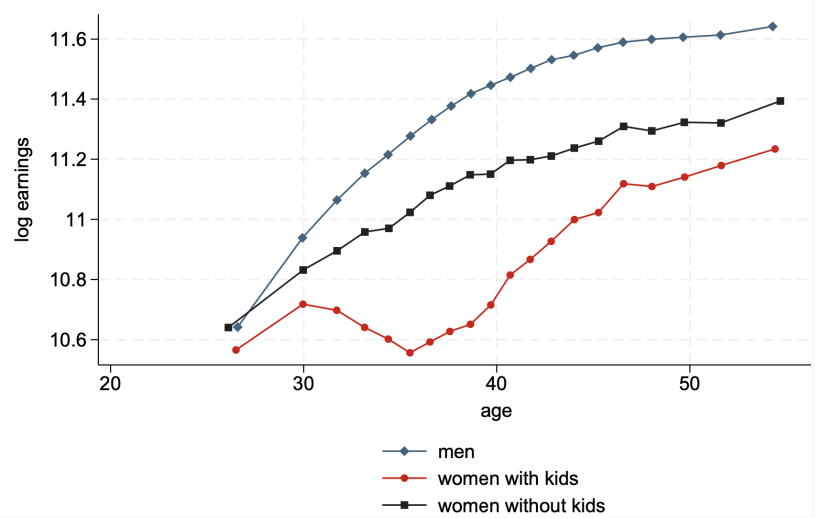
- We run the following regression:

$$Y_{it} = \sum_k \beta_k \cdot I[k = age_{it}] + X_{it} + \nu_{it}$$

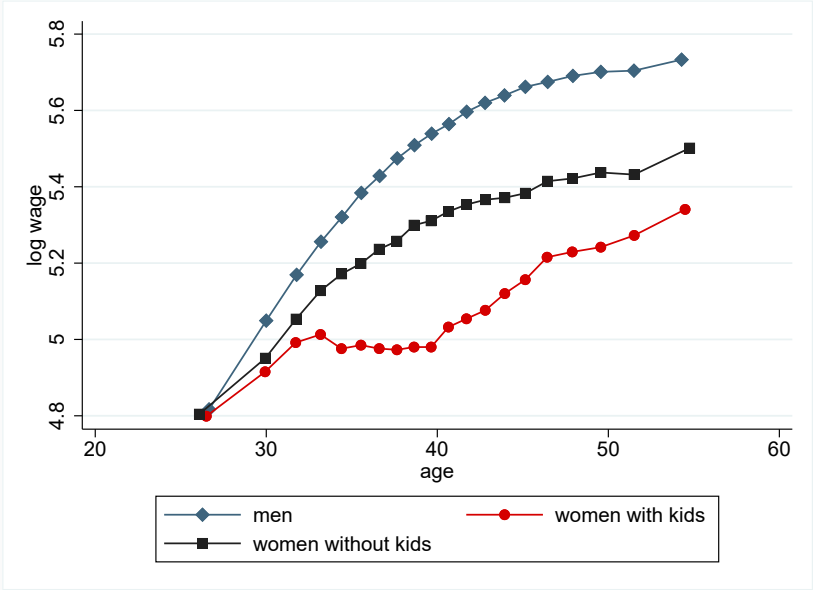
- where i refers to individual, t to year and Y_{it} is the outcome variable
- X_{it} includes controls such as education, occupation and sector

Life cycle graphs: Annual Earnings and Wages

Annual Earnings



Log Wages



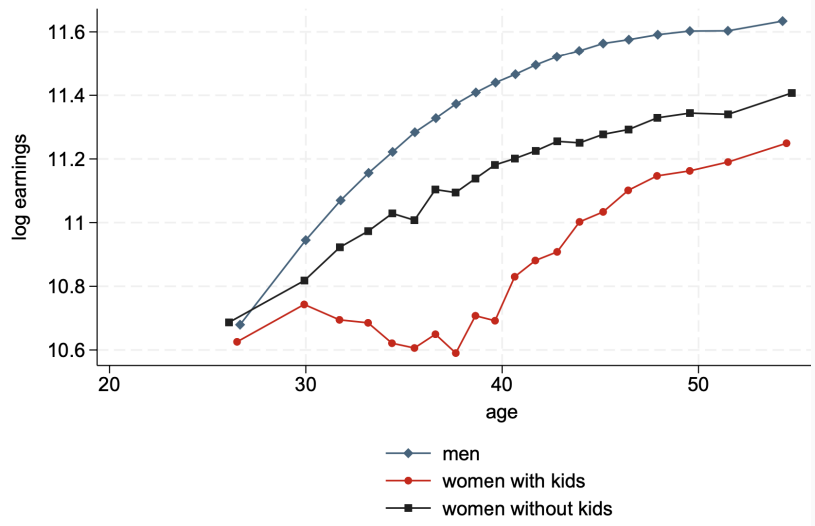
controlling for education and occupation

Innovation sectors in Germany

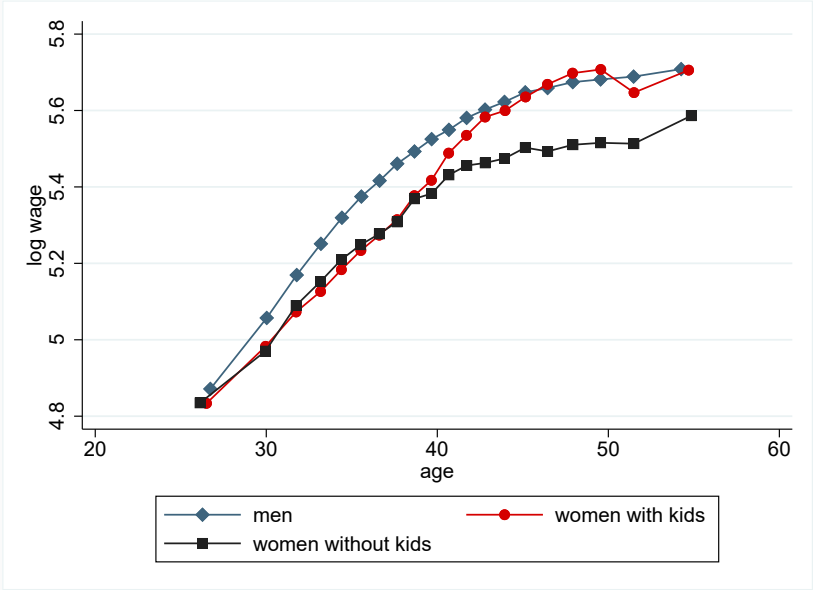
- Five main industries: Manufacturing 74%, Business activities 16%, Wholesale and retail trade 5%, Education 4% and Health 1%
- 75% of Men and 59% of Women Inventors work in Manufacturing
- The Lowest share of Women Inventors is in Manufacturing (6 women per 100 men inventors)
- The Highest share of women inventors is working in the field of Health (1 women per 3 men inventors)

Life cycle graphs: The importance of sector

Annual Earnings



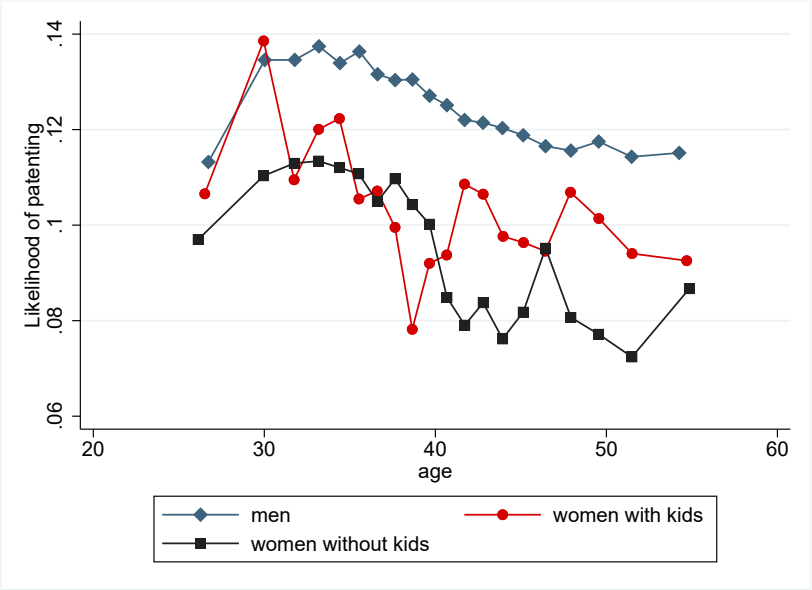
Log Wages



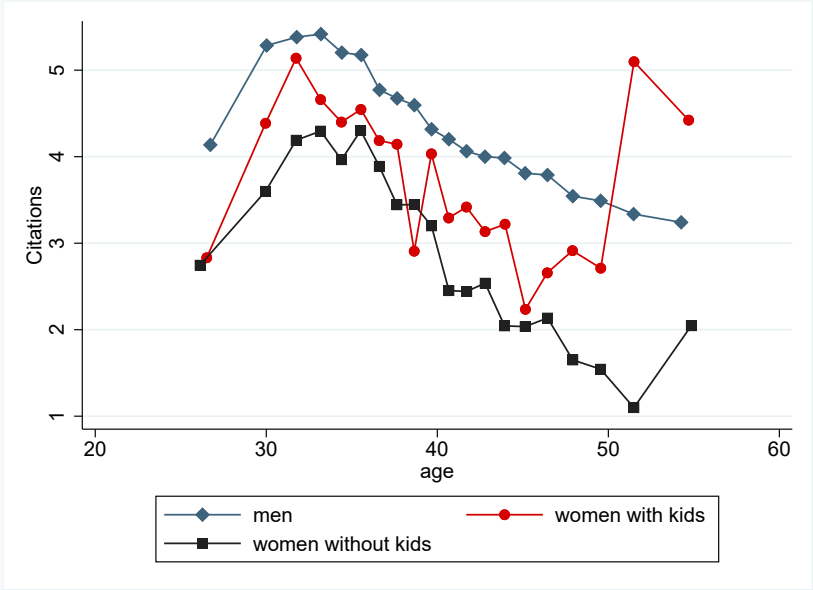
controlling for education, occupation and sector

Life cycle graphs: Patenting and Citations

Likelihood of patenting



Citations

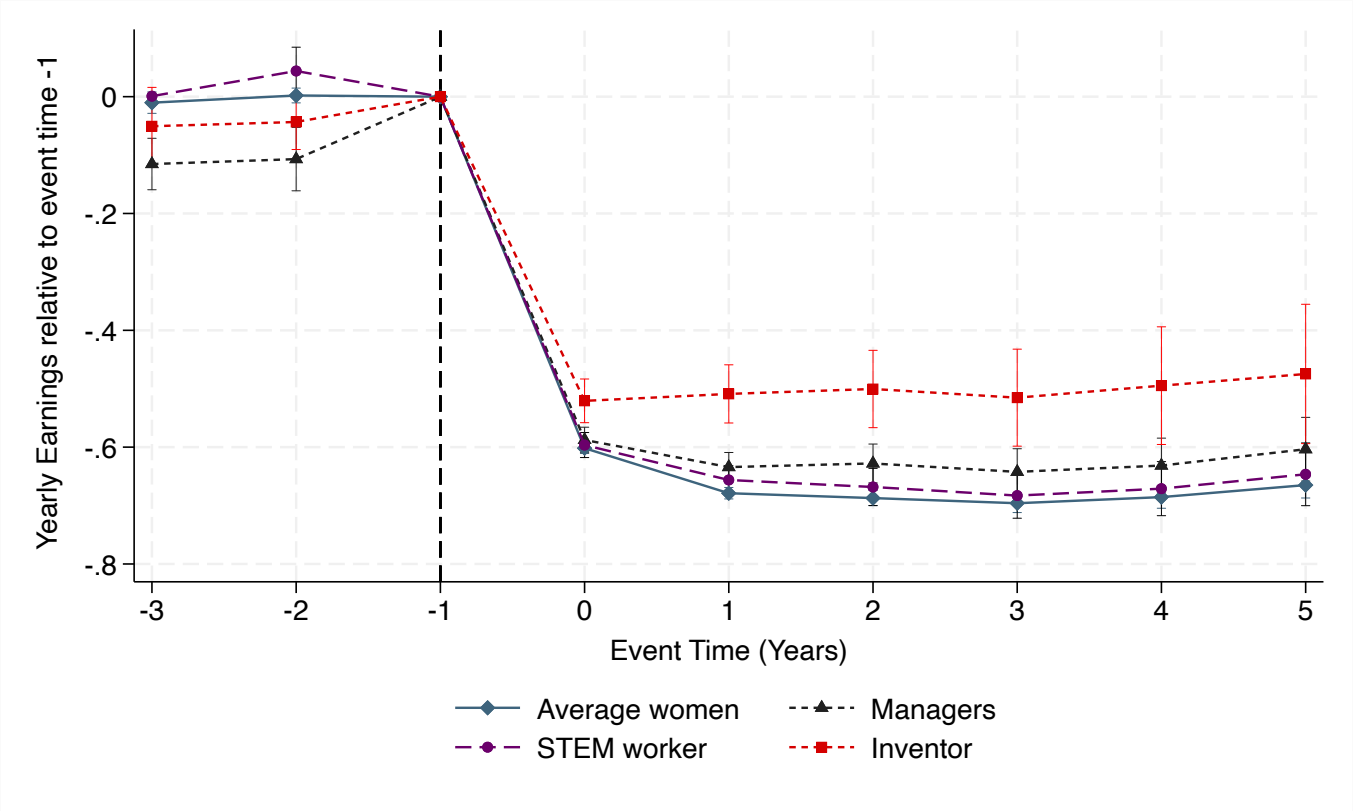


controlling for education, occupation and sector

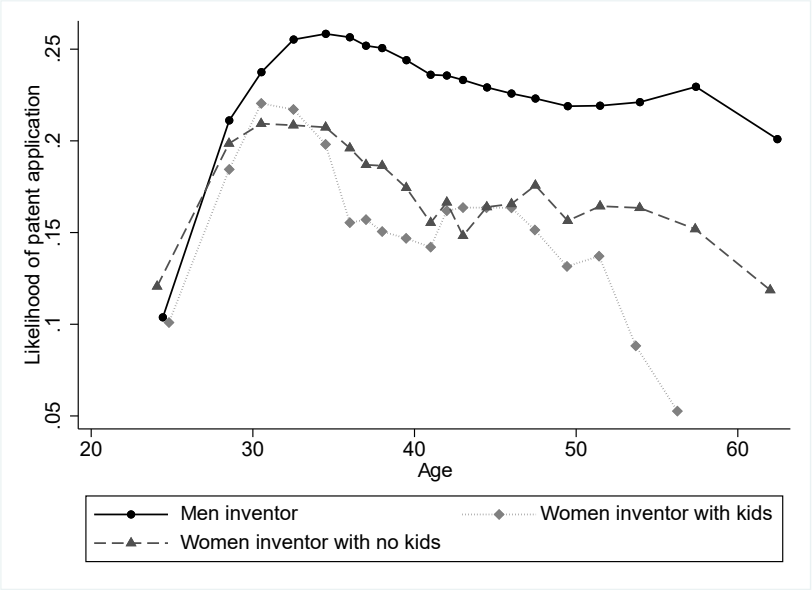
Conclusions

- In Germany, significant gender disparities persist in innovation, with women comprising only 6-7%.
- Women inventors face a 40% long-term penalty on wages and 22% participation penalty after having children
- The childhood penalty extends to likelihood of patenting and citations
- Main contributors to the gender gaps in innovation is the participation and the role of sector

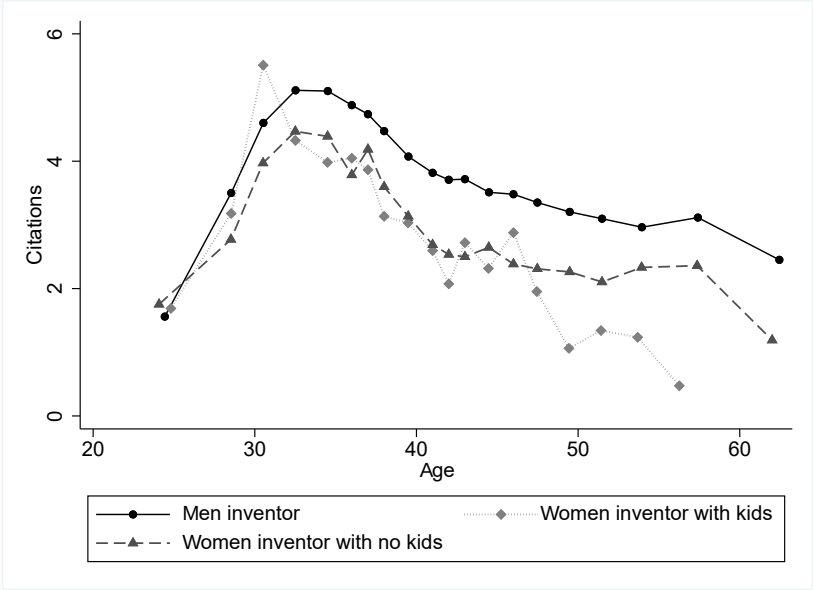
Child penalties: Different Categories of Women



Life-cycle of patenting



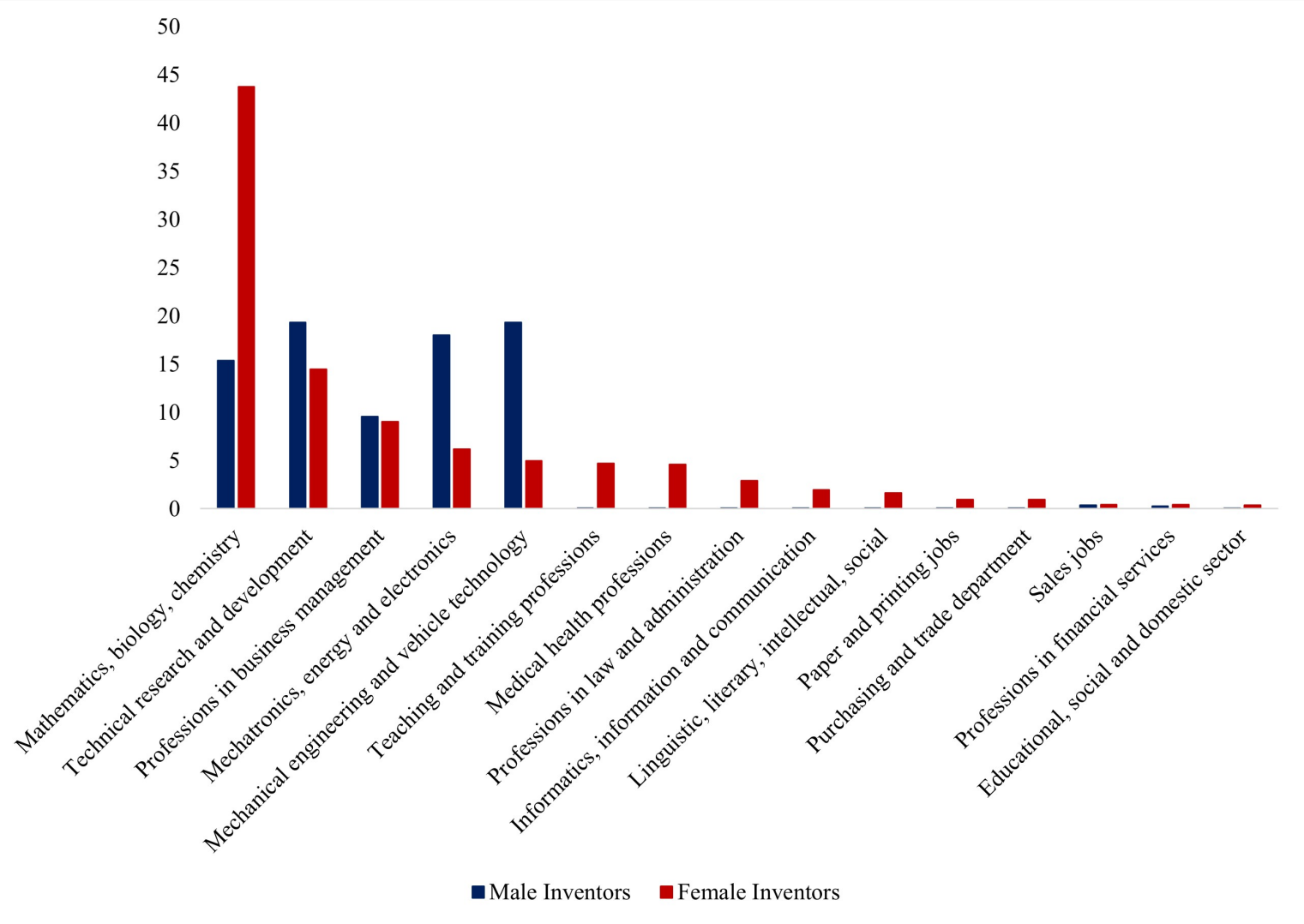
Likelihood of patent applications



Citations

go back

Share of women and men inventors by occupations



go back

Summary statistics: Labor market characteristics

	Male inventor	Female inventor		Female STEM worker	
		with kids	without kids	with kids	without kids
Daily gross wages	279.99	150.20	178.18	70.09	77.78
	(178.54)	(108.02)	(135.52)	(47.36)	(54.73)
Age	41.93	35.68	37.76	34.49	42.99
	(9.68)	(6.63)	(9.35)	(7.68)	(11.36)
Annual earnings	94,059	44,764	56,883	22,246	24,974
	(67,232)	(40,018)	(49,442)	(17,294)	(20,250)
Part-time	0.06	0.37	0.18	0.36	0.25
	(0.23)	(0.48)	(0.38)	(0.48)	(0.43)
Participation rate	0.92	0.83	0.88	0.97	0.96
	(0.27)	(0.38)	(0.33)	(0.17)	(0.19)

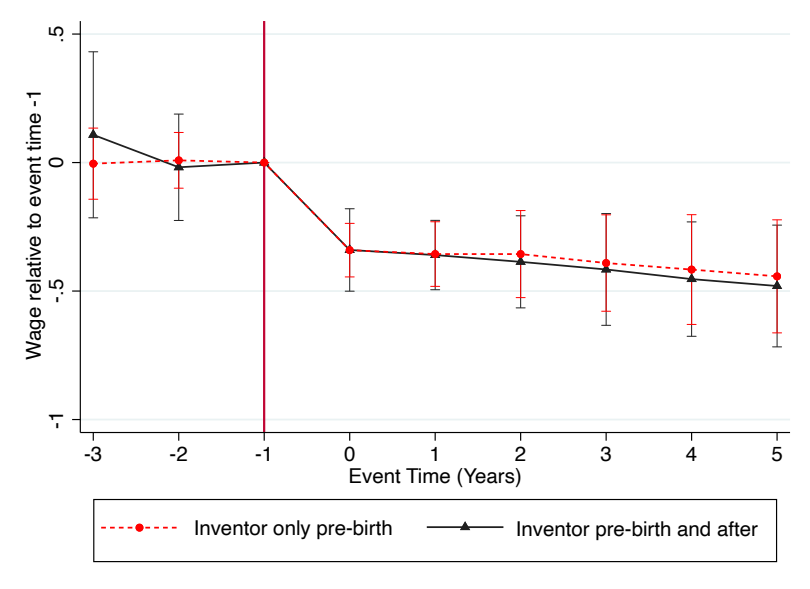
go back

Summary statistics: Patenting characteristics

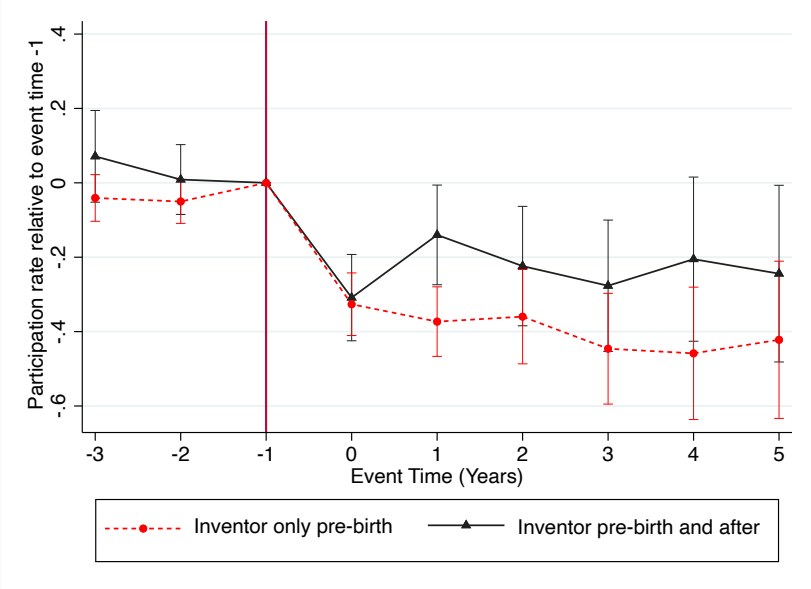
	Male inventor	Female inventor with kids	Female inventor without kids
Number of lifetime patents:			
Applications	3.15	2.28	2.24
	(6.99)	(5.15)	(5.43)
Granted	1.28	0.83	0.79
	(2.86)	(1.89)	(1.91)
Likelihood of a patent in a year:			
Applications	0.23	0.17	0.17
	(0.42)	(0.37)	(0.38)
Granted	0.11	0.08	0.08
	(0.32)	(0.27)	(0.27)
Age at first patenting:			
Application	39.66	33.98	36.06
	(8.73)	(5.66)	(8.20)
Granted	40.09	34.19	36.64
	(8.67)	(5.68)	(8.18)
Citations:			
Overall citations of past ten years	3.72	3.30	3.02
	(17.47)	(19.08)	(15.07)
Originality score	0.07	0.06	0.06
	(0.18)	(0.17)	(0.17)
Generality score	0.05	0.04	0.04
	(0.14)	(0.14)	(0.14)
Number of obs.	1,709,655	34,094	99,126

go back

Timing of patenting



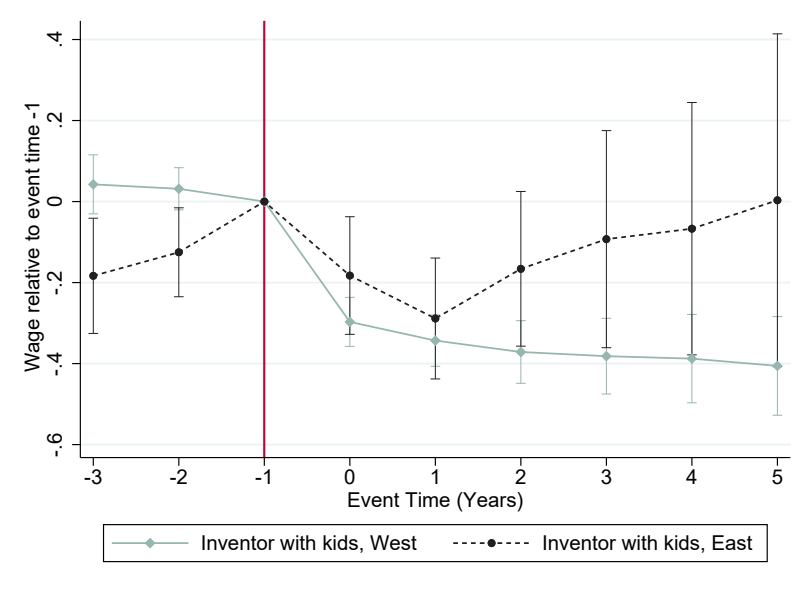
Wages



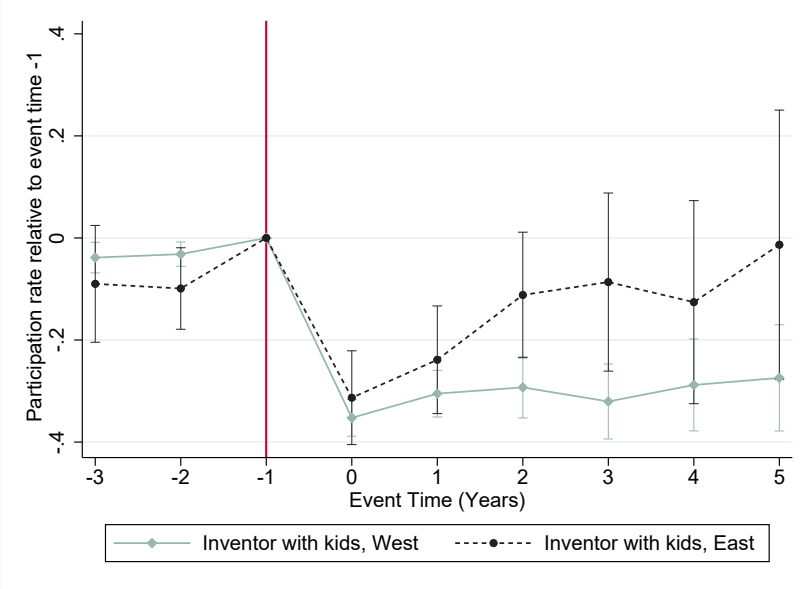
Participation rates

go back

Regions



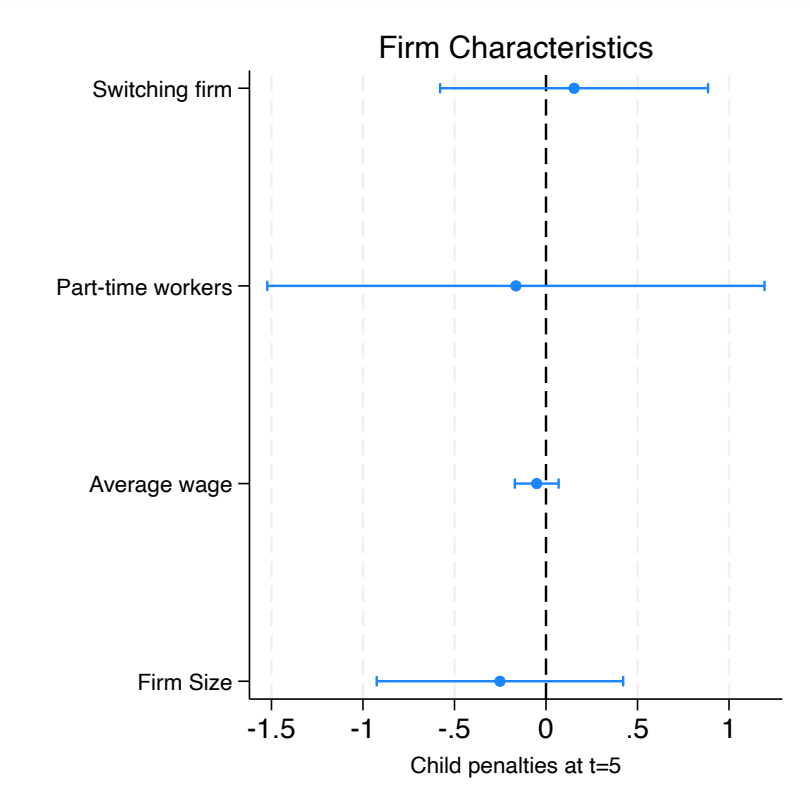
Wages

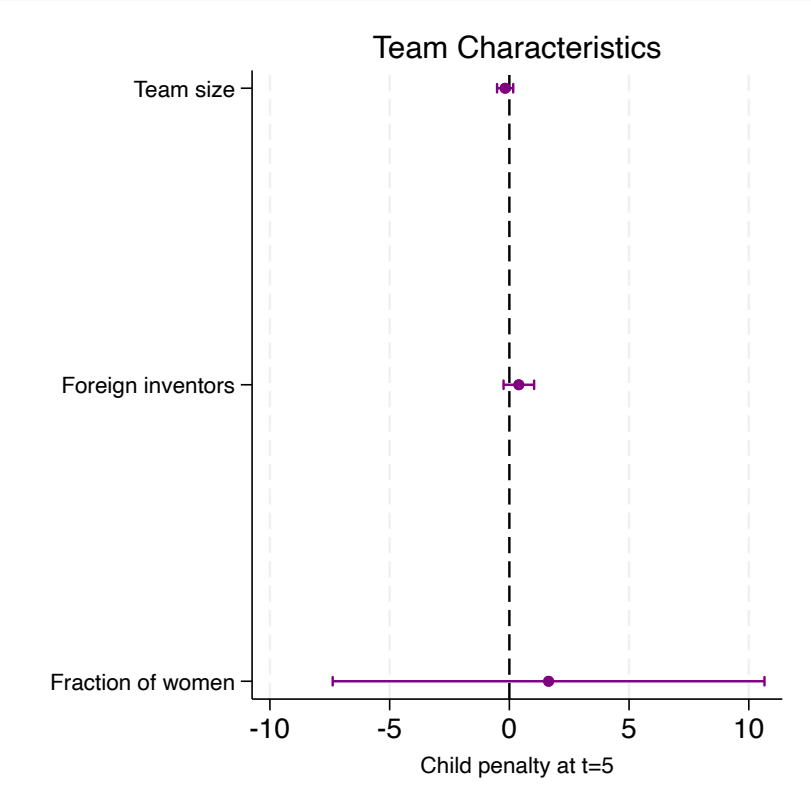


Participation rates

go back

Firm and team characteristics





go back