Adoption of industrial robots and fertility

Anna Matysiak

University of Warsaw

LabFam

Labour force participation (LFP) and fertility

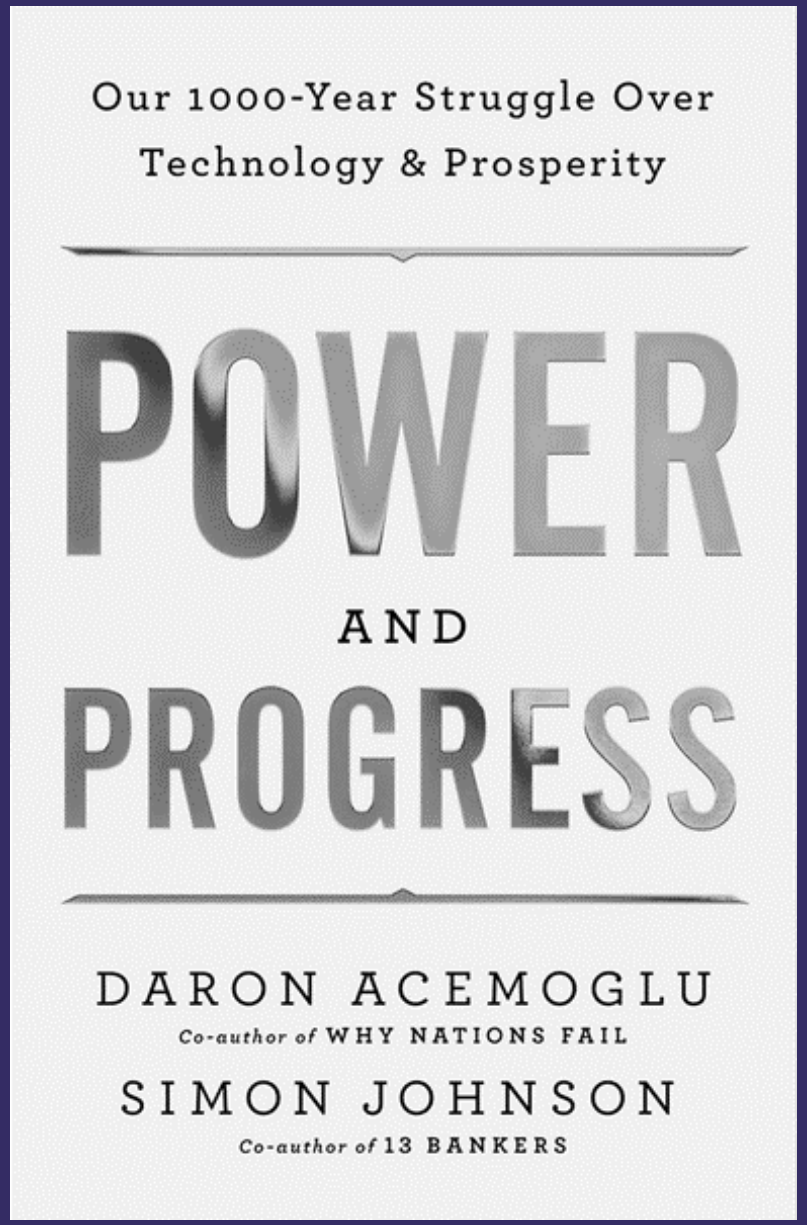
- source of income
- opportunity costs / work-family conflict
- social context: family policies, social norms

LabFam

?

- Labour augmenting / displacing effects?

LabFam



- Technological innovations facilitate development but may lead to substantial social inequalities

- Labour augmenting or displacing
  - Marginal productivity of workers
  - Institutions

LabFam

Labour augmenting effects

Labour augmenting effects

complementing human labour

↓

marginal productivity of workers ↑

↓

output ↑

↓

labour demand & wages ↑

Electric assembly line

- Reduction in production time and costs
- Production tripled
- Larger demand for lower skilled workers
- Working hours declined from 9 to 8 hours
- Wages doubled
- Better working condings (safety and health)
- Expansion of trade unions

LabFam

Labour displacing effects?

Labour displacing

effects

Certain job and work tasks get replaced by machines

↓

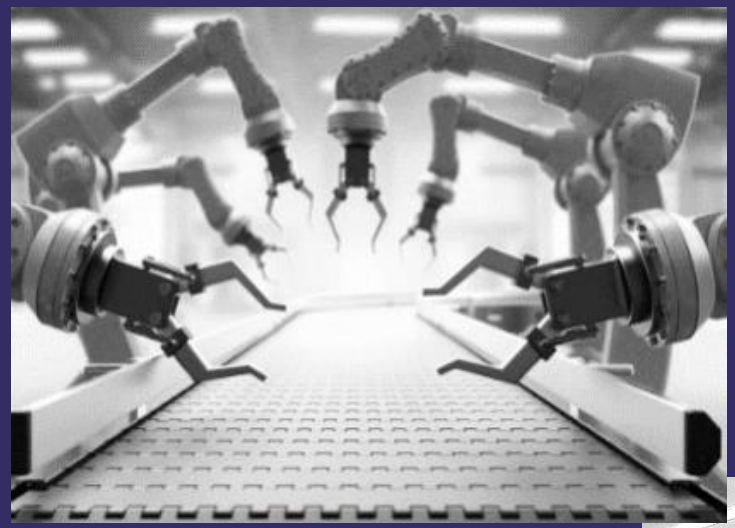
production costs ↓

average productivity ↑

marginal productivity of workers ↓

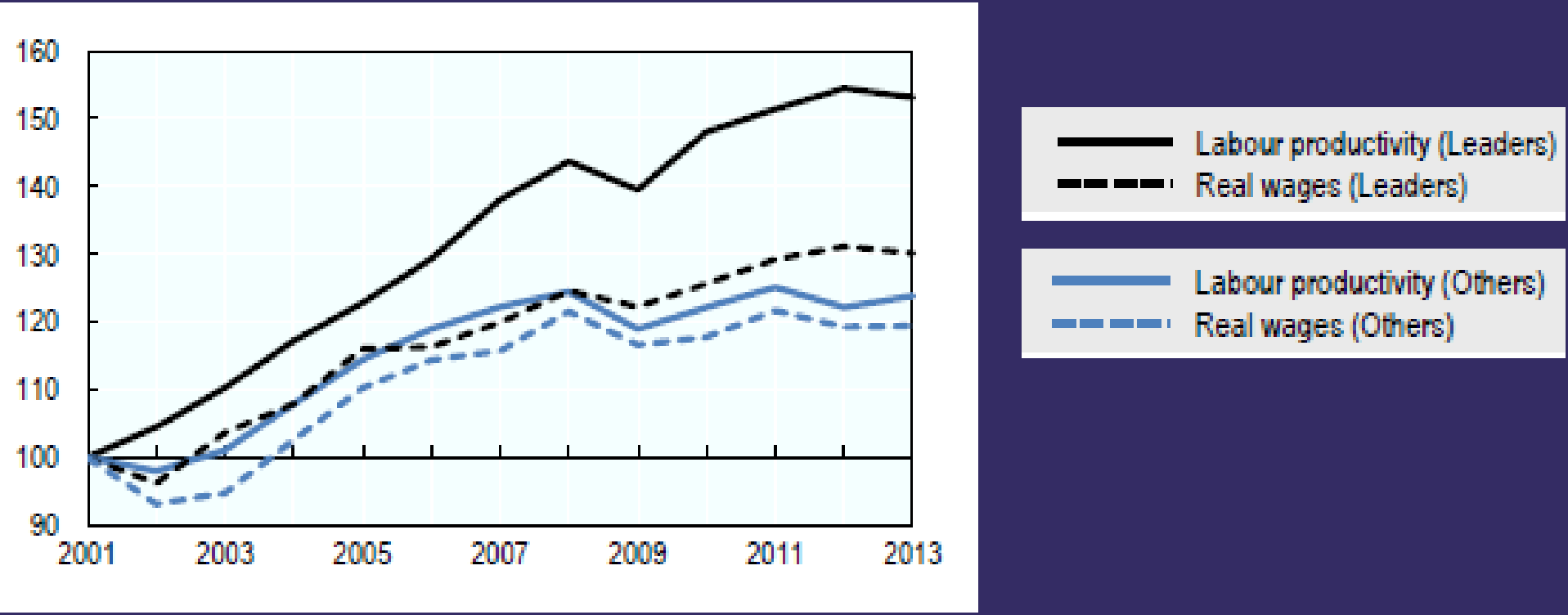
↓

Output? Labour demand? Wages?



LabFam

Wages have decoupled from productivity in technologically advanced firms...



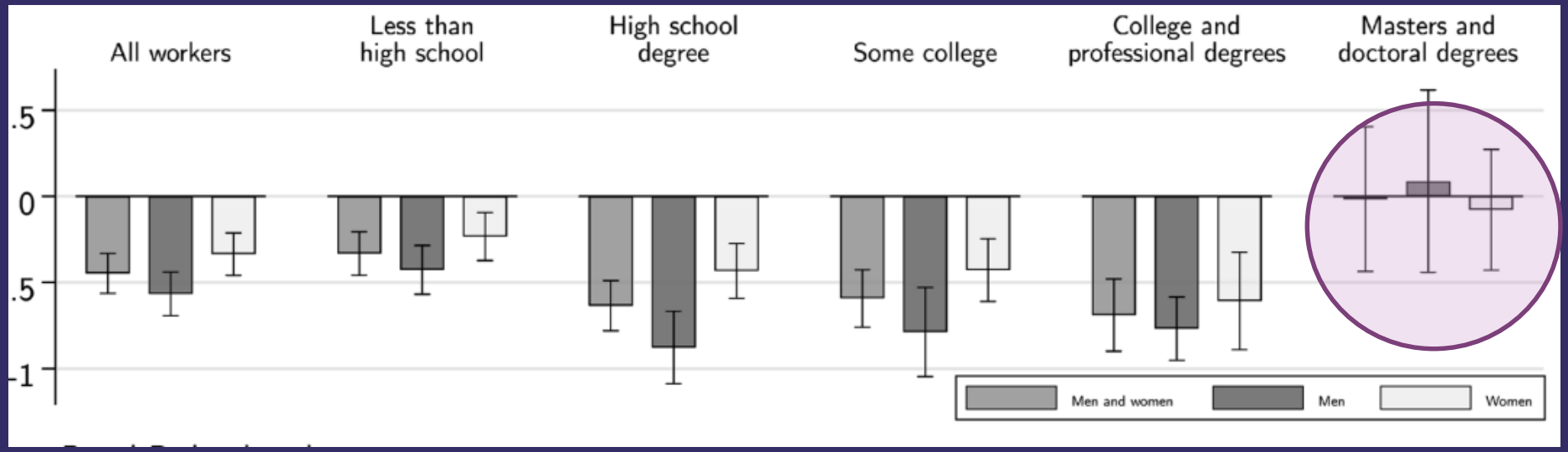
Countries: Belgium, Denmark, Germany, Ireland, Japan, Korea, Sweden, UK, US

Source: OECD Employment Outlook 2018

LabFam

Automation and employment

- **US:** 1 robot / 1000 workers reduces the employment rate by 0.2 pp. and wages by about 0.42% (Acemoglu and Restrepo 2020)



Source: Acemoglu and Restrepo 2020

- **Europe:** null overall effect, but negative effects on employment of low and middle educated workers (Graetz and Michaels 2018)

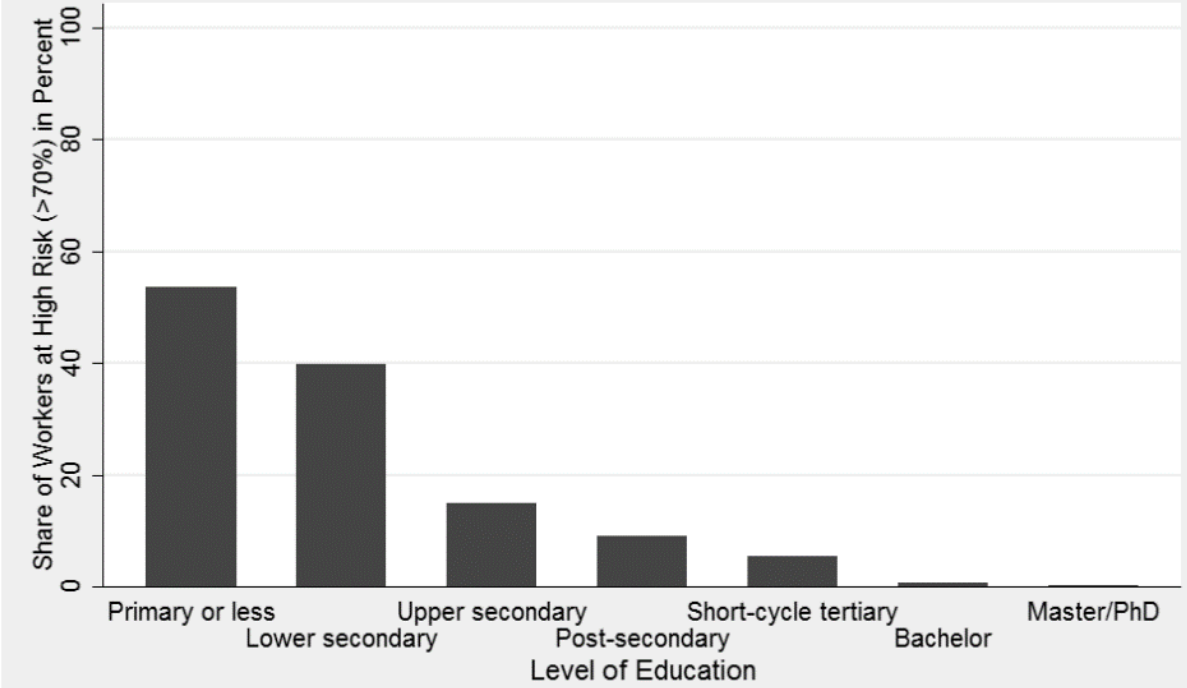
LabFam

Automation and employment

- 9-14% of jobs at high risk of full automation (more than 70% of tasks automatable)
- 25-32% jobs at medium risk (50-70% of tasks automatable)

Source: Arntz et al. (2017), Nedelkoska and Quinitini (2018)

Figure 6. **Share of Workers with High Automatibility by Education**



Source: Authors' calculation based on the Survey of Adult Skills (PIAAC) (2012)

LabFam

?

- Labour augmenting / displacing effects
- Changing structure of the labour demand / growing disparities between high and low-to-middle skilled
- Effects on wages, employability, stability and certainty of employment
- Structural LM change (not cyclical!)

LabFam

Past research

?

Anelli et al. (2021):

- regional study (commuting zones in the US)
- adoption of industrial robots → more cohabitation and divorce, decline in marital fertility, increase in non-marital fertility

LabFam

?

MACRO-LEVEL STUDY

Co-authors: D. Bellani & H. Bogusz

Countries: DE, IT, FR, UK, PL & CZ

Period: 1993-2017

MICRO-LEVEL STUDY

Co-authors: L. Andersson, W. Hardy

Countries: Sweden

Period: 1993-2017

LabFam

MACRO-LEVEL STUDY

Co-authors: D. Bellani & H. Bogusz

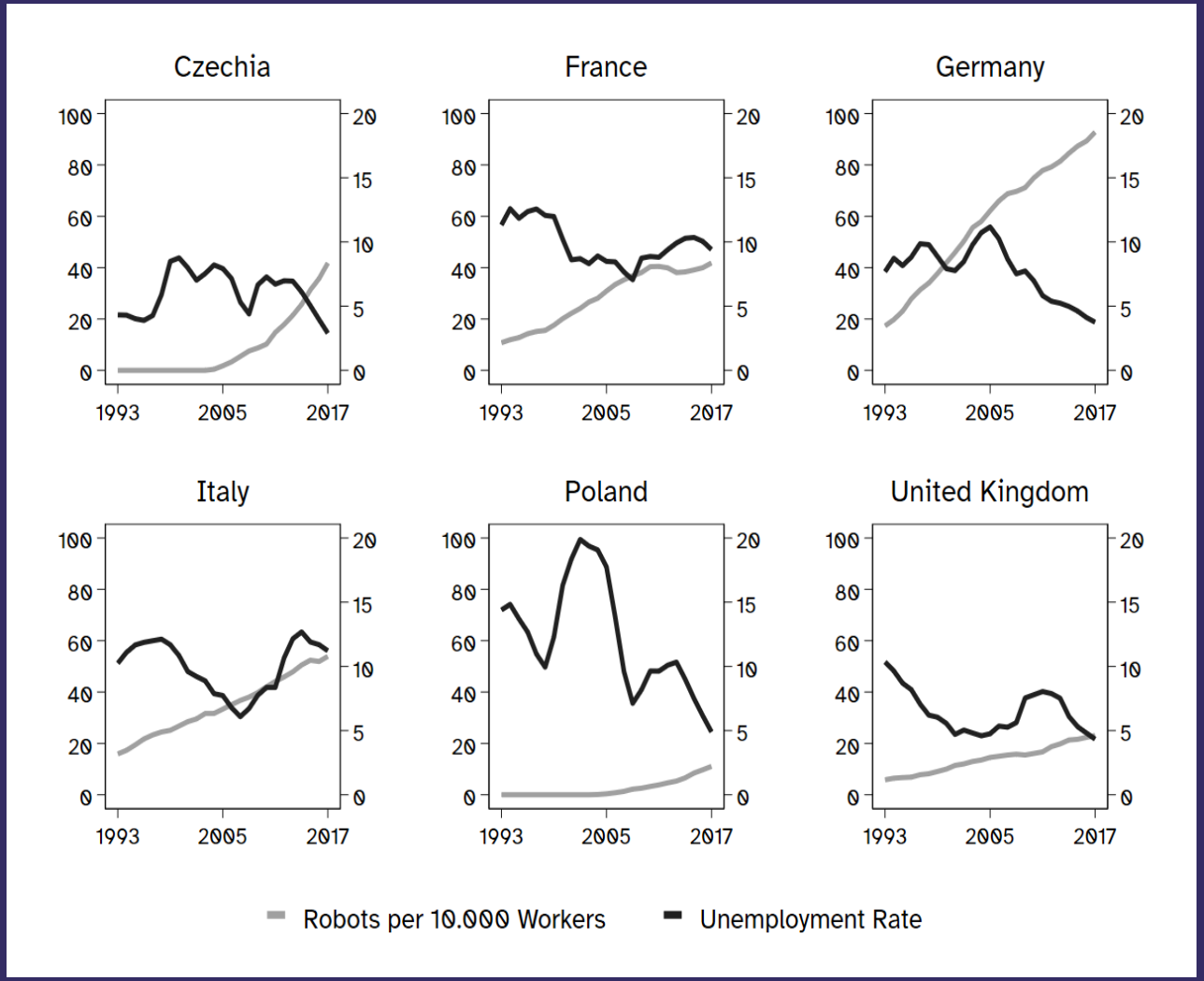
Countries: DE, IT, FR, UK, PL & CZ

Period: 1993-2017

Fertility effects of automation less pronounced in regions with:

H1: better educated populations

H2: more technologically advanced



MACRO LEVEL STUDY: Data (1993-2017)

EUROSTAT:

- Regional NUTS-2 fertility rates (total and age-specific)
- Regional employment structures by industry (NACE 2-digit)

INTERNATIONAL FEDERATION OF ROBOTICS (IFR)

- Robot stocks (country and industry-specific) at 3-digit since 1993

fully autonomous machines that do not require a human operator

LabFam

MACRO LEVEL STUDY: Measurement

$$Exposure\ to\ robots_{r,t} = \sum_{i=1}^{N} \frac{empl_{r,i,t_0}}{empl_{r,t_0}} \left(\frac{robots_{i,t}}{empl_{i,t_0}}\right)$$

distribution of intitial employment at t0 across regions

replacement of initial employment (at t0) in industry i by robots

LabFam

Source: Acemoglu and Restrepo (2020)

MACRO LEVEL STUDY: Modelling

$$fertility_{r,t} = \alpha \cdot Exposure\ to\ robots_{r,t-2} +$$

$$+ \beta \cdot Controls_{r,t-1} + \eta_r + \upsilon_t + \varepsilon_{r,t}$$

Controls:

- population age structure
- % highly educated
- ratio highly educated women to men
- women's economic activity rate

Regional fixed effects

Year fixed effects

LabFam

MACRO LEVEL STUDY: Modelling

$$fertility_{r,t} = \alpha \cdot Exposure\ to\ robots_{r,t-2} +$$

$$+ \beta \cdot Controls_{r,t-1} + \eta_r + \nu_t + \varepsilon_{r,t}$$

$$\sum_{i=1}^{N} \square \frac{empl_{r,i,t_0}}{empl_{r,t_0}} \left(\frac{robots^{c}_{i,t}}{empl_{i,t_0}} \right)$$

Overidentified IV model:

- Robot stocks instrumented with robots in {Germany, France, UK, Italy, Spain, Sweden, Norway and Finland} excluding the studied country
- In models for Czechia and Poland we additionally use US as an intstrument

MACRO LEVEL STUDY: Modelling

$$fertility_{r,t} = \alpha \cdot Exposure\ to\ robots_{r,t-2} + \quad x\ Moderator_{r,t\text{-}1}$$

$$+ \beta \cdot Controls_{r,t-1} + \eta_r + \nu_t + \varepsilon_{r,t}$$

Fertility effects less pronounced if:

Moderators:

H1: better educated populations → % highly educated

H2: region more technologically advanced → % empl in techn and knowledge sector

LabFam

MACRO-LEVEL STUDY: Results

Country	TFR	FR 20-24	FR 25-29	FR 30-34	FR 35-39	FR 40-44	FR 45+
Germany	**ns**	ns	ns	ns	-0.00011***	-0.00005***	ns
France	**ns**	ns	ns	ns	ns	ns	ns
Italy	**-0.00118***	ns	-0.00090***	ns	ns	ns	ns
UK	**ns**	ns	ns	ns	ns	0.00039*	ns
Czechia & Poland	**ns**	ns	ns	ns	0.00025*	ns	ns

*** 1% ** 5% * 10%. Sample sizes: 680 observations for Germany, 440 for France, 400 for Italy, 700 for the UK, and 240 for Poland and Czechia jointly.

LabFam

MACRO-LEVEL STUDY: Results

% highly educated

Country	TFR *main effect*	TFR *interaction effect*
Germany	-0.0016***	0.00005***
France	0.0015**	-0.00058**
Italy	-0.00292*	0.0001
UK	ns	ns
Czechia & Poland	ns	ns

*** 1% ** 5% * 10%. Sample sizes: 680 observations for Germany, 440 for France, 400 for Italy, 700 for the UK, and 240 for Poland and Czechia jointly.

LabFam

MACRO-LEVEL STUDY: Results
empl in technology and knowledge sectors

Country	**TFR** *main effect*	**TFR** *interaction effect*
Germany	ns	ns
France	ns	ns
Italy	-0.00116*	0.000005
UK	ns	ns
Czechia & Poland	ns	ns

*** 1% ** 5% * 10%. Sample sizes: 680 observations for Germany, 440 for France, 400 for Italy, 700 for the UK, and 240 for Poland and Czechia jointly.

LabFam

MICRO-LEVEL STUDY

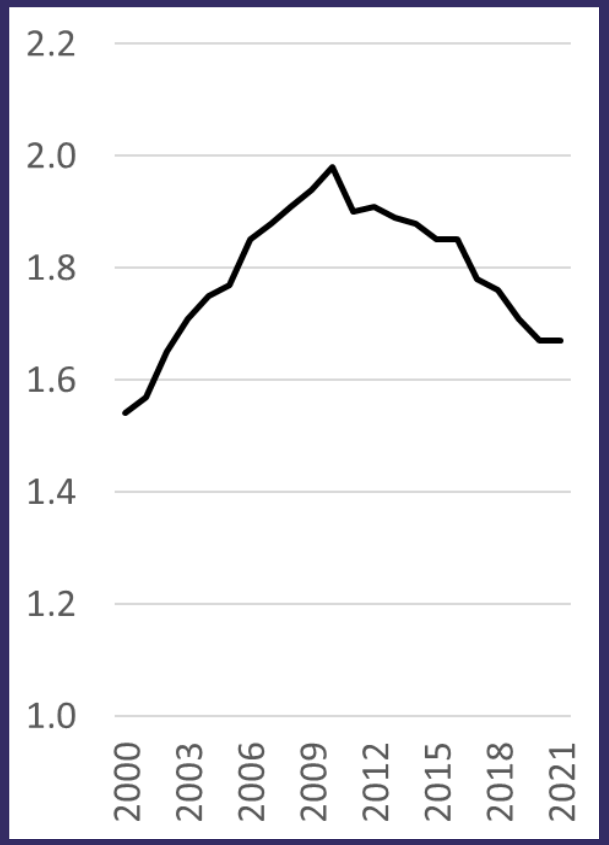
Co-authors: L. Andersson, W. Hardy

Countries: Sweden

Period: 1993-2017

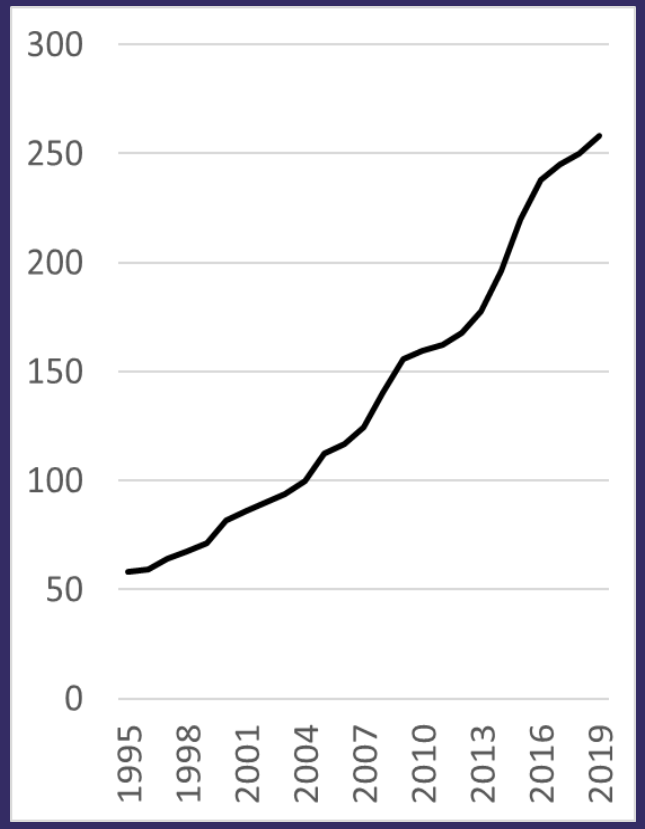
?

Total fertility rate



Robot density

Number of inustrial robots per 10,000 workers in manufacturing



LabFam

MICRO-LEVEL STUDY: Data and Method

?

Data:

- Swedish register data
- IFR robot stocks (industry-specific) at 3 digit since 1993

Period: 1993-2017

Method:

- Event history models

Events:

- Marriage
- 1st, 2nd, 3rd birth
- Divorce

LabFam

MICRO-LEVEL STUDY: Data and Method

?

Measure:

- Exposure to robots

$$Exposure\ to\ robots_{i,t} = \frac{robots_{i,t}}{empl_{i,t_0}}$$

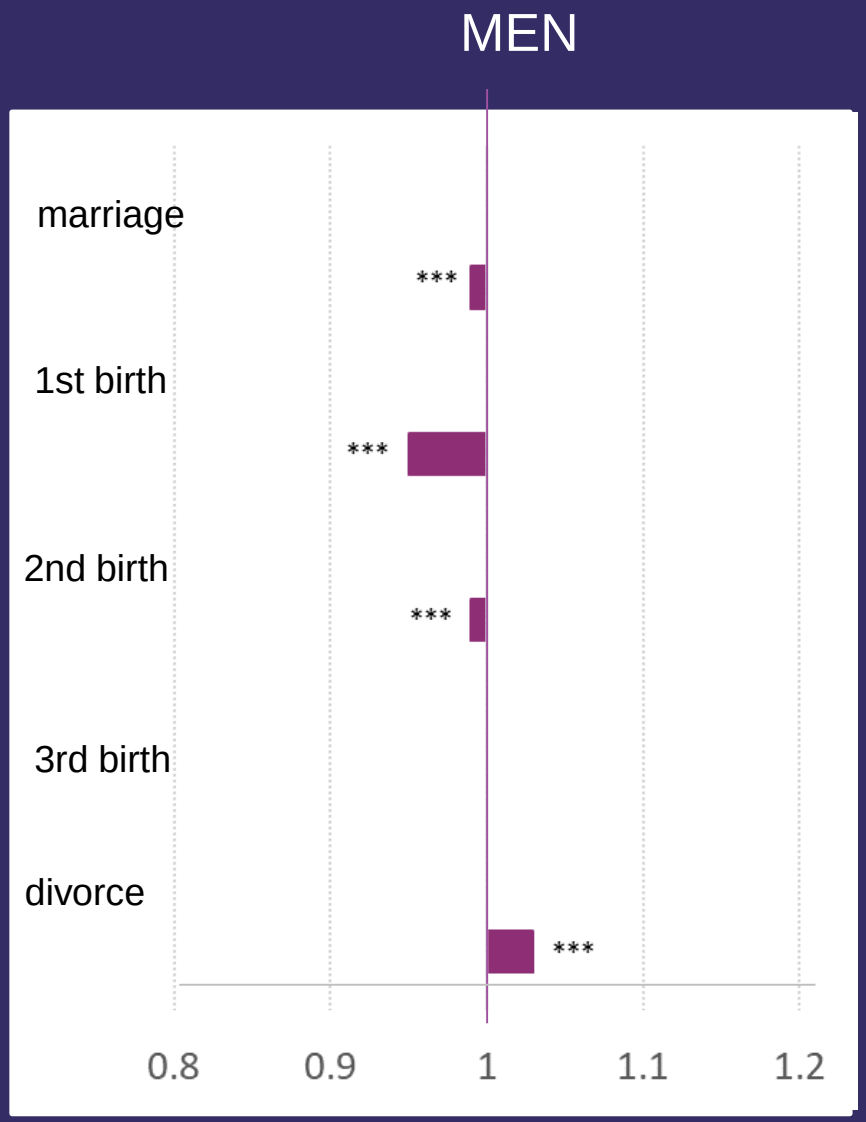
IV: Using stock of robots in other countries which are similarly (Finland, Denmark)

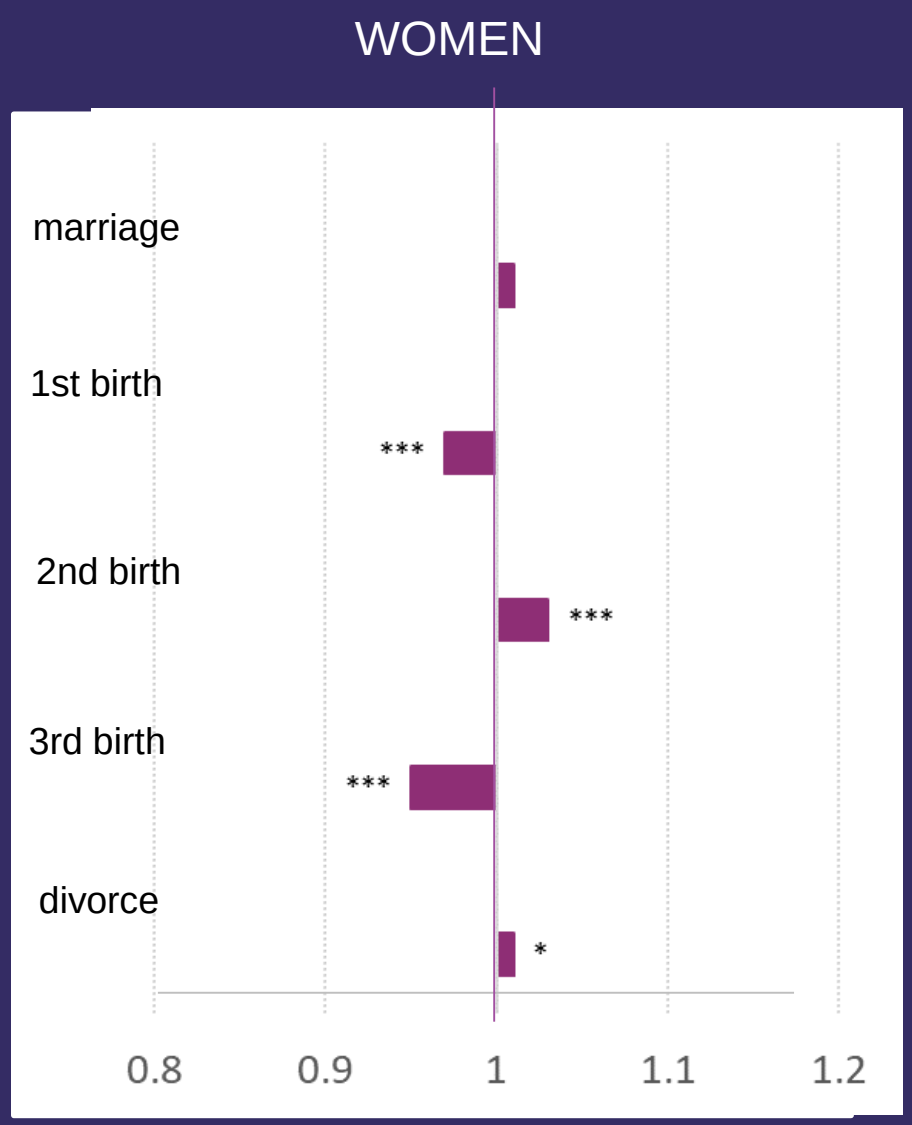
Controls:

- Age
- (Age of the previous child)
- Calendar year
- Education
- Employment status (works in a sector with / without robotisation, no work)
- Firm size
- Seniority status

LabFam

MICRO-LEVEL STUDY: Results





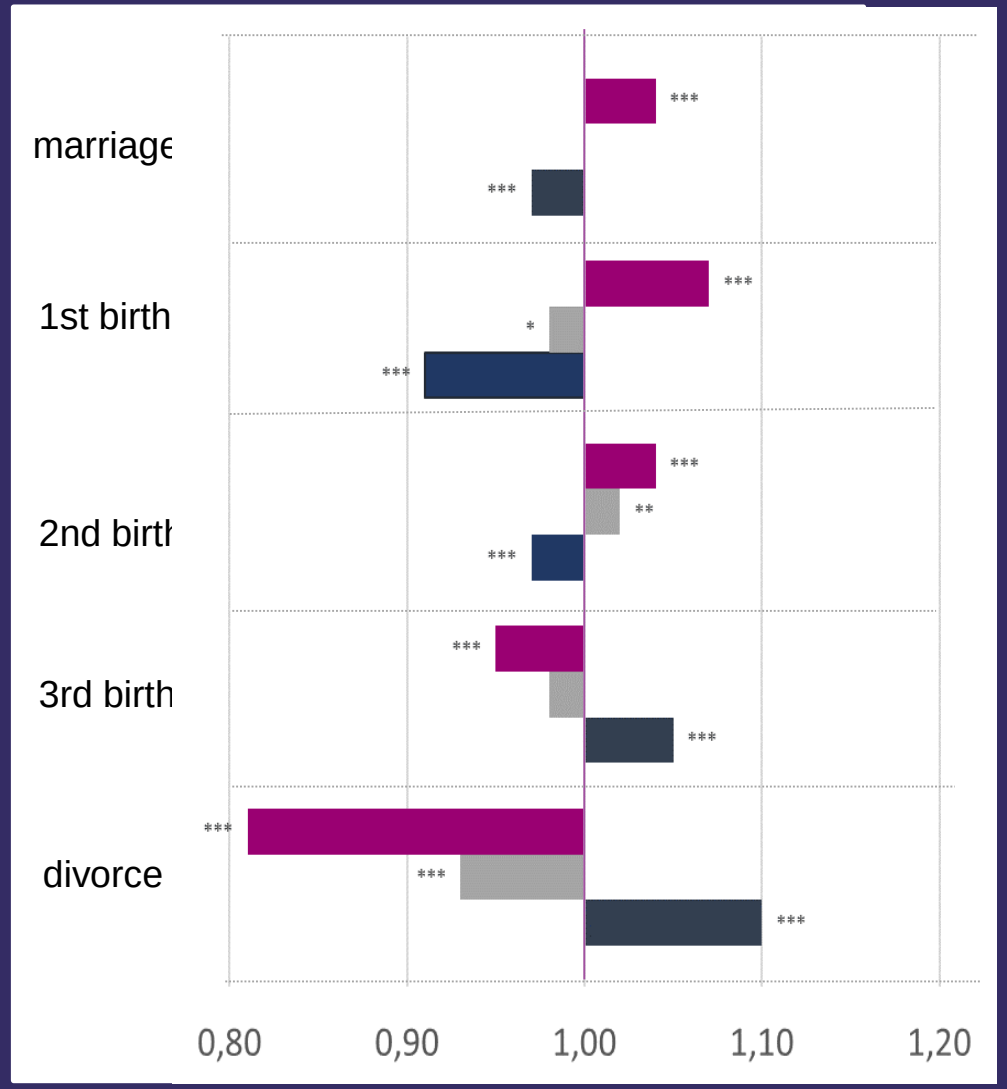
Note: A change in the risk of an event due to an increase in robot adoption in an industry by one standard deviation

MICRO-LEVEL STUDY: Results

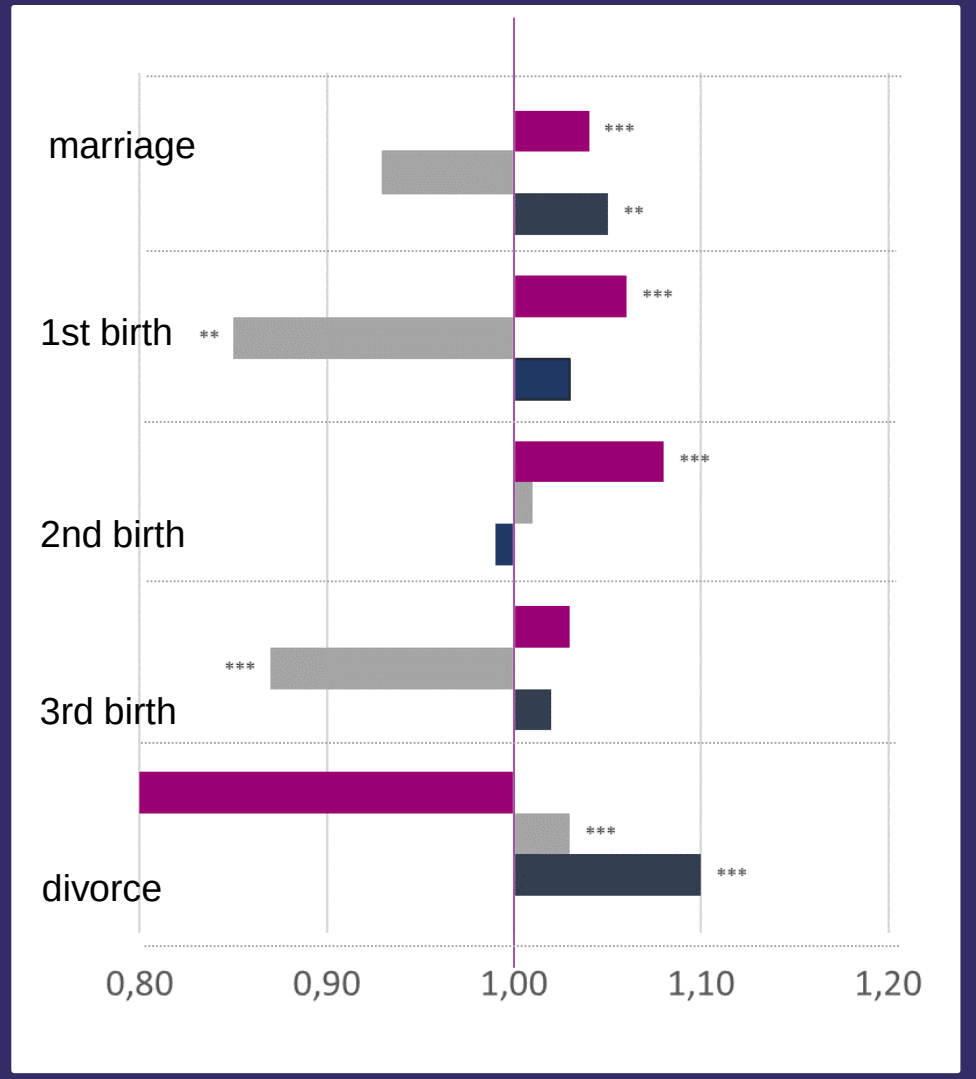
Note: A change in the risk of an event due to an increase in robot adoption in an industry by one standard deviation

MICRO-LEVEL STUDY: IV Results

MEN



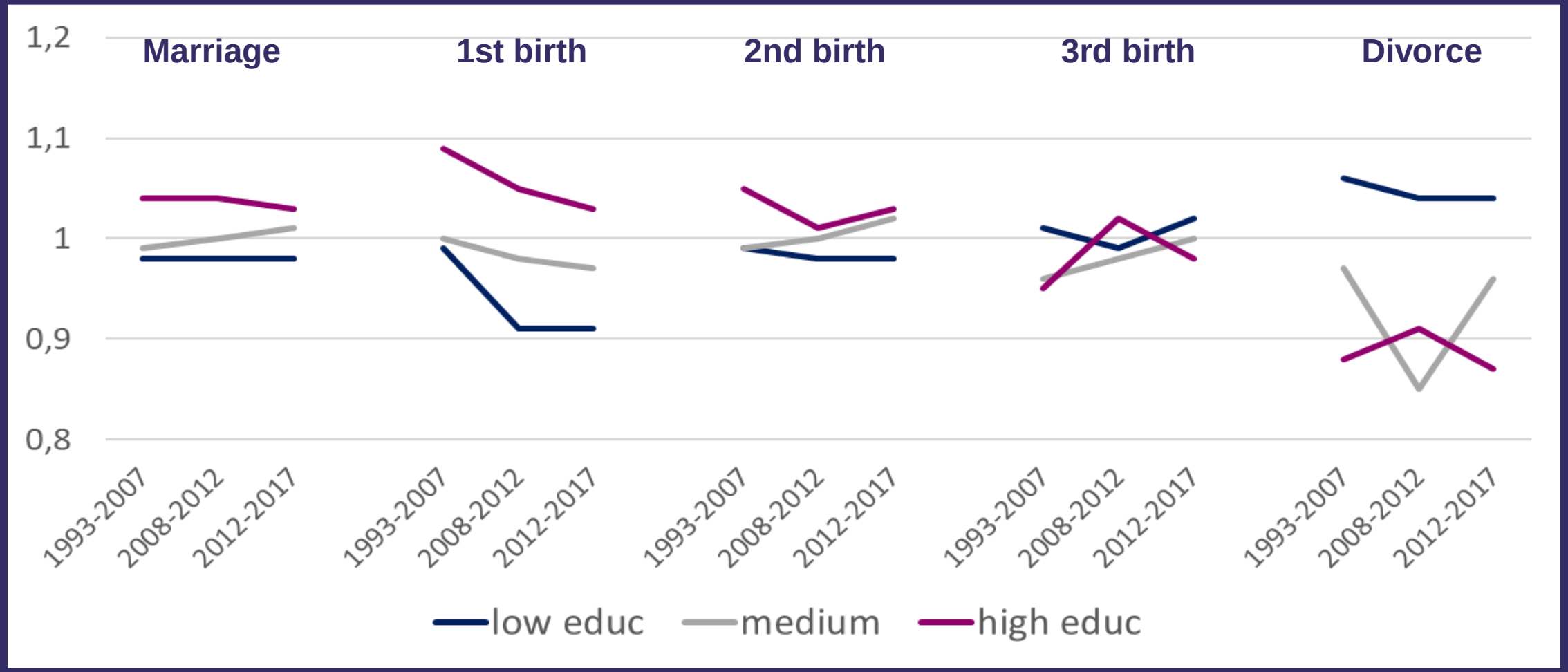
WOMEN



Note: A change in the risk of an event due to an increase in robot adoption in an industry by one standard deviation

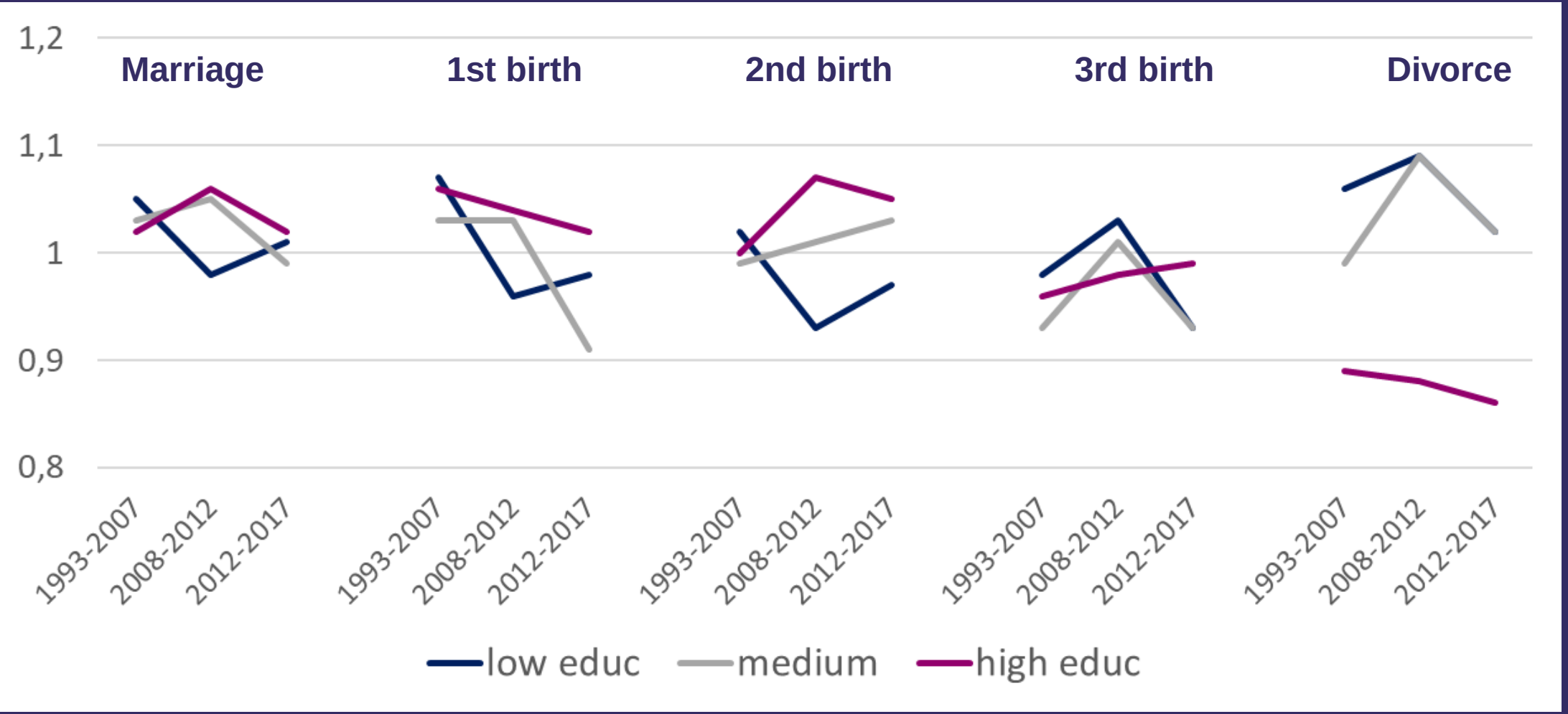
MICRO-LEVEL STUDY: Results

Change in the risk of the event due to an increase in automation by 1 st dev., MEN



MICRO-LEVEL STUDY: Results

Change in the risk of the event due to an increase in automation by 1 st dev.,WOMEN



Conclusions

- Rather weak overall effects of robot adoption on fertility / family formation and its stability
- Clear edu differences
  - Negative effects on fertility more pronounced in regions with lower educated populations
  - Negative efffects on family formation and stability among low educated workers and positive among highly educated workers (Sweden)
- No intensification of the negative effects of robot adoption over time

LabFam

Outlook

- Does structural LM change / adoption of robots cause a reversal in educational gradient in fertility?

Horizon 2020
European Union funding
for Research & Innovation

UNIVERSITY OF WARSAW
Faculty of Economic Sciences

LabFam