Automation, Economic Shocks, and Infant Mortality: Evidence from Mexico

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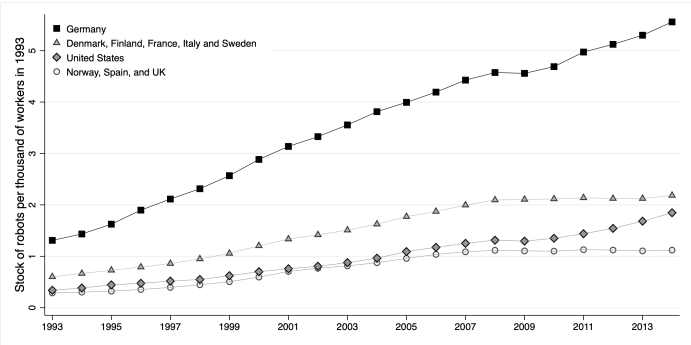
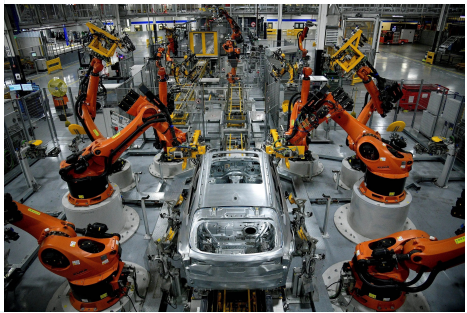
Motivation

- There has been an increase in the usage of industrial robots in the United States: it has quadrupled since 1990.



Stock of robots



Automotive assembly plant

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- The adoption of robots in the U.S. has negative spillovers on labor markets in developing countries (Faber, 2020; Kugler et al., 2020; Stemmler, 2023).
  - Plant *reshoring* has been found to be the main mechanism.

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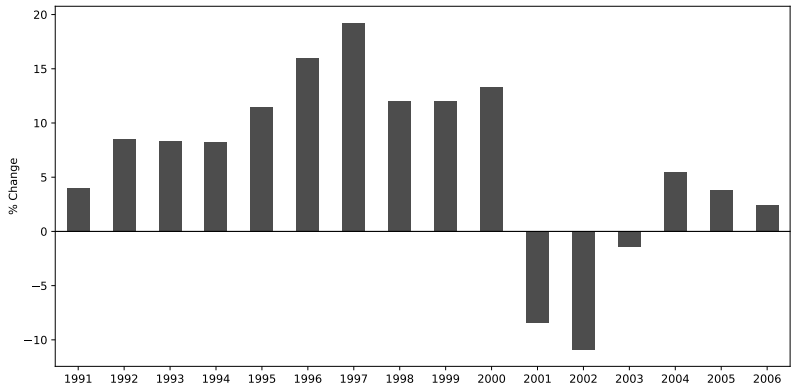

Percentage change in *Maquiladora* employment 1990-06

Motivation

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- **Research question**: Does U.S automation have effects on infant health in Mexico?

- Mexico is an ideal setting:
  1. Proximity with the US
  2. Nearly 80% of Mexican exports are US bound.
  3. Women-intensive labor in *Maquiladoras*.

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- I use a Shift-Share IV strategy exploiting historical *maquiladora* employment patterns and international robot stocks.

- I find:
  1. An increase in IMR in areas more exposed to automation.
  2. The channel is likely linked to household income losses and lower access to health services.

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- **Income effect** can reduce spending of inputs to child health inputs: nutritious foods, prenatal care.
- During unemployment spells parents may increase their time to benefit children's health outcomes: breastfeeding, taking children to the doctor (**substitution effect**).
- It may also affect the composition of births by the mothers' characteristics (**selectivity**).

Contribution to the literature

- Income shocks and infant health.
  - Pro-cyclical (Dehejia and Lleras-Muney, 2004; Ruhm, 2000)
  - Counter-cyclical (Baird et al., 2011; Bhalotra, 2010; Arceo-Gómez, 2010)

- Impacts of robots on health outcomes.
  - Mental health (O'Brien et al., 2022).
  - Work-related accidents (Gihleb et al., 2022).

- Heterogeneous impacts of negative income shocks by gender:
  - Labor outcomes (Autor et al., 2019; Acemoglu and Restrepo, 2020; Anukriti and Kumler, 2019).

Context

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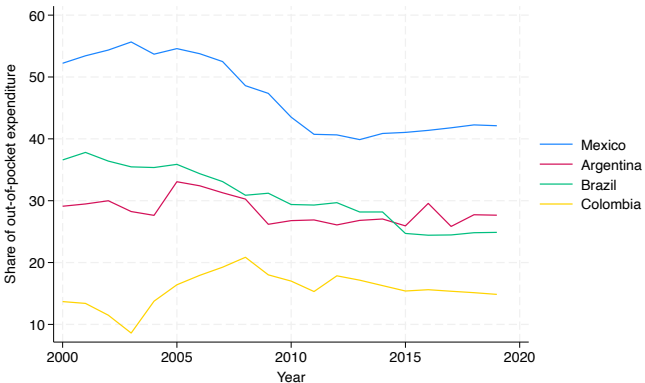
  - Social norms: more tolerant to repetitive tasks, greater manual activity, less likely to unionize (Fussell, 2000; Villarreal and Yu, 2007).

- Workers are low-skilled, who earn less than then average manufacturing worker across the wage distribution (Estefan, 2022).

Mexico's health system



- Public-private hybrid system; many workers rely on employer-linked insurance (IMSS, ISSSTE).
- Health coverage is strongly tied to formal employment.

Data and empirical strategy

Data

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- Exposure to U.S. robots and IV from 2000 to 2015.
  - Baseline *maquiladora* employment (1990) (CEPAL, 1994).
  - Industry-level robot stock from International Federation of Robotics (IFR).

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  - Industry level variation for the period 2000-2015 ▸ IFR robots
- Treatment definition follows Faber (2020) ▸ Geographic distribution :

$$\underbrace{\Delta robots^{US}_{c,t}}_{\text{U.S robot exposure in Mexico}} = \sum_{i \in I}^{I} \underbrace{\frac{L^{f}_{c,i,1990}}{L_{c,1990}}}_{\text{Employment shares}} \underbrace{\left(\frac{(R^{US}_{i,t_1} - R^{US}_{i,t_0}) O_{i,1992}}{L^{f}_{i,1990}/1,000} \right)}_{\text{Robots per thousand workers}}$$

- $\frac{L^{f}_{c,i,1990}}{L_{c,1990}}$ is the share of *maquiladora* employment in industry i and CZ c in 1990.
- $R^{US}_{i,t}$ is the stock of U.S. robots in industry i at t.
- $O_{i,1992}$ is the share of Mexican imports to U.S. output.
- $L^{f}_{i,1990}$ is the industry-level employment in *maquiladoras*.

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- OLS estimates are potentially biased (e.g. U.S. internalizes Mexico's labor market outcomes when deciding when to use robots).

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- $R_{i,t}^{EUR-9}$ is the stock of robots for: Denmark, Finland, France, Germany, Italy, Norway, Spain, Sweden, and the United Kingdom.

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- Exogenous variation comes from the shares (Goldsmith-Pinkham et al., 2020)

▸ Balance tests

Estimating equation

- I estimate the 2SLS system of equations for the period t =2000-2015 as follows:

$$\begin{cases} \Delta robots^{US}_{c,(t_0,t_1)} = b_0 + \lambda_r + b_1 IV\Delta robots^{US}_{c,(t_0,t_1)} + \mathbf{X}'_{c,2000}\gamma + \Delta Y'_{c,2000-98}\rho + \epsilon_{c,t} \\ \Delta Y_{c,(t_0,t_1)} = \alpha + \theta_r + \beta\Delta\widehat{robots^{US}_{c,(t_0,t_1)}} + \mathbf{X}'_{c,2000}\varphi + \Delta Y'_{c,2000-98}\omega + \varepsilon_{c,t} \end{cases} \tag{1}$$

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  - Standard errors are clustered at the state level.

- Regressions are weighted by the start of the period population.

Results

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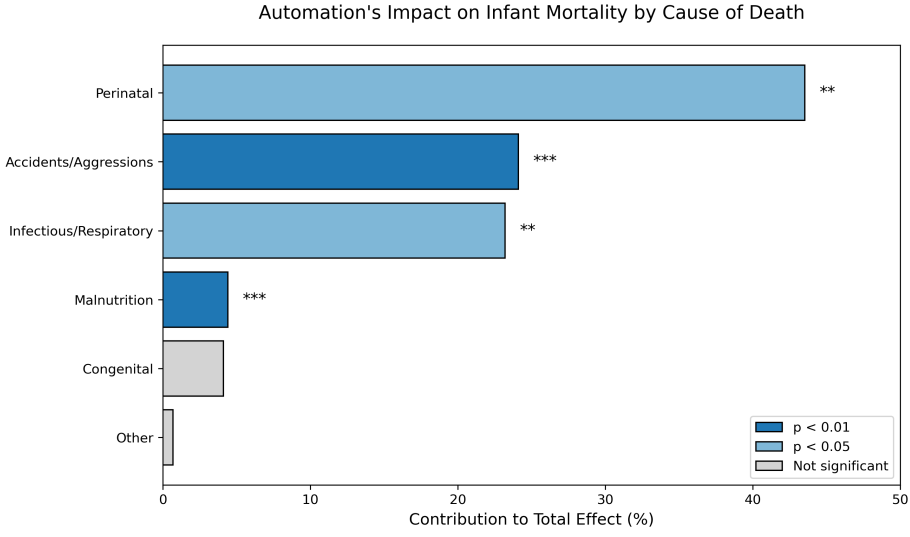
Table: Effect of robot penetration on the change of infant mortality rate (2000- 15)-2SLS.

	(1)	(2)	(3)	(4)
Panel A. 2SLS				
$\Delta robots^{US}$	1.505**	1.493***	1.384***	1.358***
	(0.629)	(0.565)	(0.528)	(0.511)
Kleibergen-Paap F-stat	48.05	48.17	57.41	68.02
Panel B. First Stage				
$IV\Delta robots^{US}$	0.100***	0.100***	0.102***	0.100***
	(0.014)	(0.014)	(0.013)	(0.012)
Observations	1805	1805	1805	1805
Mean dep var	14.02	14.02	14.02	14.02
Region FE/industry shares	✓	✓	✓	✓
Outcome trends		✓	✓	✓
Demographic trends			✓	✓
Contemporary shocks				✓

Causes of death



Robustness checks

- Accounting only for positive employment in *maquiladoras*.
- Treatment outliers.
- Permutation test.

Mechanisms

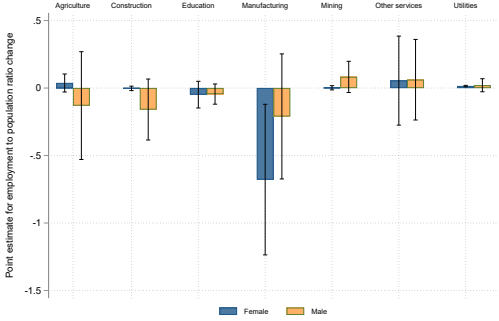
1 Substitution effects

- Job displacements can cause women to spend more time with their children.
- However, cash-constrained women may need to look for additional sources of income (e.g. informally).

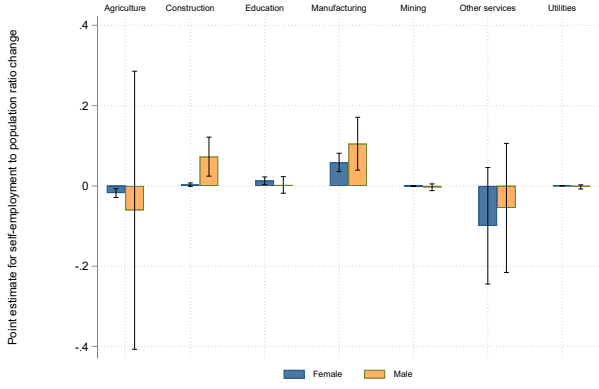
1.1 Labor adjustments to U.S. robots

Table: Effect of robot penetration on changes of labor market outcomes (2000-2015)-2SLS.

	Men				Women				
	(1) Employment	(2) Self-employment	(3) Unemployment	(4) OLF	(5) Employment	(6) Self-employment	(7) Unemployment	(8) OLF	(9) Household income
$\Delta robots^{US}$	-0.354*	0.120	0.000	0.054	-0.612***	-0.030	0.020***	0.353*	-0.017**
	(0.184)	(0.213)	(0.016)	(0.145)	(0.220)	(0.067)	(0.004)	(0.193)	(0.008)
Observations	1804	1804	1804	1804	1804	1804	1804	1804	1804
Mean dep var	50.717	20.730	1.190	19.430	23.383	7.630	0.325	64.206	
Region FE/industry shares	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outcome trends	✓	✓	✓	✓	✓	✓	✓	✓	✓
Demographic trends	✓	✓	✓	✓	✓	✓	✓	✓	✓
Contemporary shocks	✓	✓	✓	✓	✓	✓	✓	✓	✓



(b) Employment



(c) Self-employment

#2 Income effects

- Income shocks affect household's ability to afford nutritious foods, pre/post-natal care services.
- Can induce stress and prompt risky behaviors and complicate pregnancies (Bozzoli and Quintana-Domeque, 2014).
- Can change the structure of power within household (Majlesi, 2016).

2.1 Access to healthcare and infant mortality

Table: Effect of robot penetration on the change of health insurance coverage for women (2000-15)-2SLS.

	(1) All	(2) Wage employment	(3) Self-employment
$\Delta robots^{US}$	-0.405**	-0.465***	0.015
	(0.179)	(0.146)	(0.069)
Observations	1804	1804	1804
Region FE/industry shares	✓	✓	✓
Demographic trends	✓	✓	✓
Contemporary shocks	✓	✓	✓

Table: Effect of robot penetration on the change of infant mortality rate by insurance status (2000-15)-2SLS.

	(1) All	(2) Insured	(3) Uninsured
$\Delta robots^{US}$	1.358***	0.279	1.153**
	(0.511)	(0.229)	(0.481)
Observations	1805	1805	1805
Region FE/industry shares	✓	✓	✓
Outcome trends	✓	✓	✓
Demographic trends	✓	✓	✓
Contemporary shocks	✓	✓	✓

2.2 Risky behaviors

- I used ENSA and ENSANUT and ran main analysis from 2002 to 2012 on women between 20-45.

	(1) Drinks alcohol	(2) Smokes	(3) Diabetes
Panel A. All			
$\Delta robots^{US}(2002-2012)$	-0.502 (0.449)	0.631 (0.429)	0.166*** (0.057)
Observations	31	31	31
Mean dep var	61.35	14.99	2.050
Panel B. Insured			
$\Delta robots^{US}(2002-2012)$	-0.981** (0.469)	0.248 (0.271)	0.286** (0.132)
Observations	31	31	31
Mean dep var	62.53	18.49	2.919
Panel C. Uninsured			
$\Delta robots^{US}(2002-2012)$	0.916** (0.396)	0.814* (0.422)	0.264* (0.140)
Observations	31	31	31
Mean dep var	60.57	13.56	2.397

3 Selection

- Income shocks may induce changes in fertility among groups (Dehejia and Lleras-Muney, 2004).
  - For example, low-skilled women tend to avert fertility in harsh times.
- Income shocks may induce stillbirths and fetal deaths.
- Income shocks may increase population flows (migration)

3.1 Selective fertility

Table: Effect of robot penetration on fetal deaths and birth rates (2000- 15)-2SLS.

		Birth rate						
	(1) Fetal deaths	(2) All	(3) Less than primary	(4) Primary	(5) Secondary	(6) Tertiary	(7) 15-35	(8) 36-45
$\Delta robots^{US}$	0.356	-0.001	1.450***	-0.164	0.127	0.679***	-0.565	-0.164*
	(0.418)	(0.001)	(0.450)	(0.286)	(1.204)	(0.245)	(0.656)	(0.095)
Observations	1805	1804	1804	1804	1804	1804	1804	1804
Mean dep var	9.715	0.128	34.11	32.47	40.90	7.116	106.6	9.710
Region FE/industry shares	✓	✓	✓	✓	✓	✓	✓	✓
Outcome trends	✓	✓	✓	✓	✓	✓	✓	✓
Demographic trends	✓	✓	✓	✓	✓	✓	✓	✓
Contemporary shocks	✓	✓	✓	✓	✓	✓	✓	✓

3.2 Migration

Table: Effect of robot penetration on the change of the logarithm of working-age population (2000-15)-2SLS.

	(1)	(2)	(3)	(4)
$\Delta robots^{US}$	-0.019*	0.017*	0.016*	0.017*
	(0.011)	(0.009)	(0.009)	(0.009)
Observations	1804	1804	1804	1804
Region FE/industry shares	✓	✓	✓	✓
Outcome trends		✓	✓	✓
Demographic trends			✓	✓
Contemporary shocks				✓

Conclusion

- Results are consistent with a counter-cyclical pattern of infant mortality among developing countries.
- Loss of income and healthcare access are key mechanisms.
- Effects are concentrated among uninsured, low-skilled women.
- Selection and migration play a limited role.
- **Policy implication:** Social protection is essential in automation-exposed regions.

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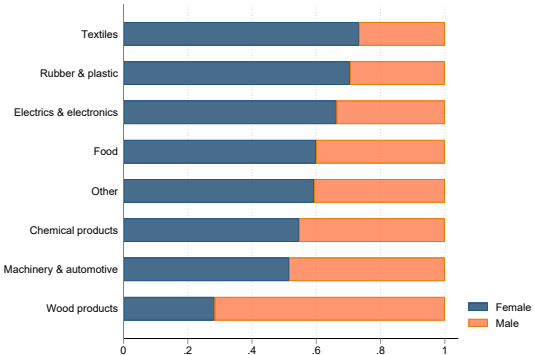
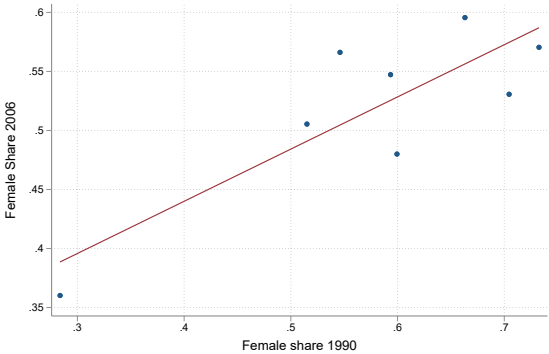
Maquiladora employment

Figure: Employment in maquiladoras ‣ Back



(a) Emp. shares by sector in 1990



(b) Persistent relationship

Figure: Change in industrial robot stock by industry, 2000-15

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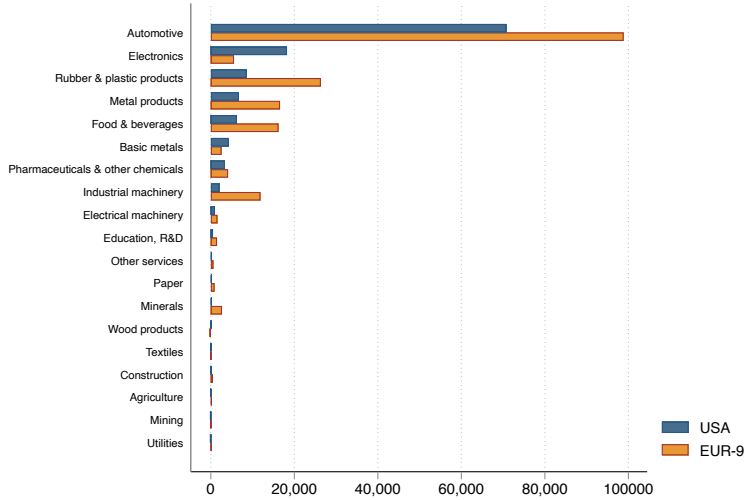

Figure: Geographic distribution of US industrial robots in Mexico

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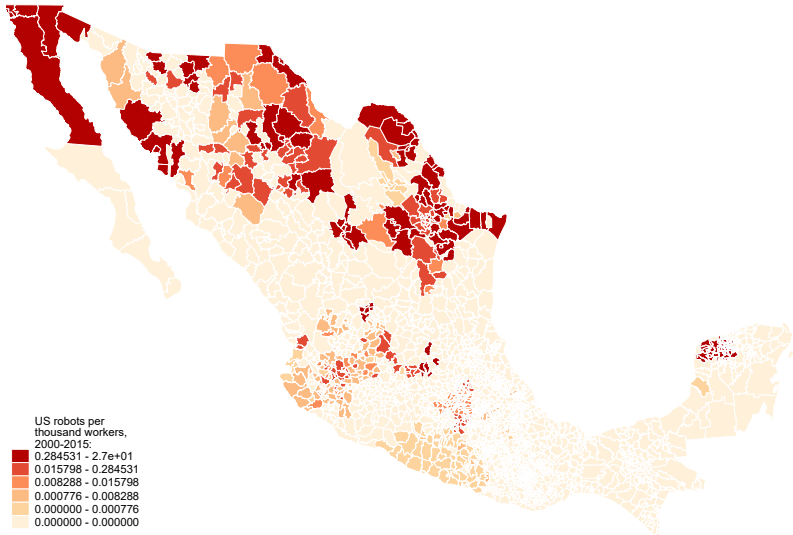

IV Balance tests

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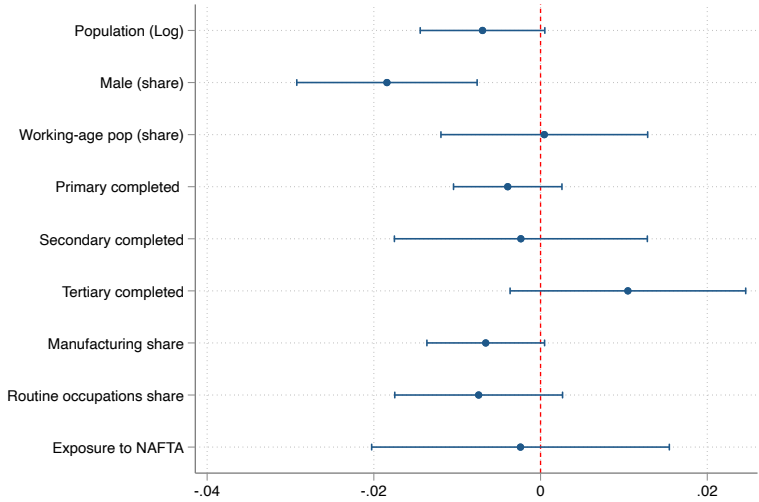
Figure: Location-level balance test



Pre-trends analysis

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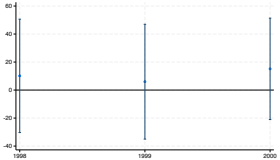
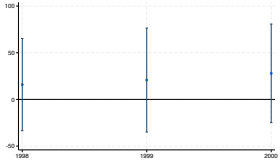
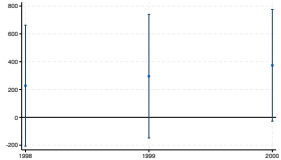
Figure: Pre-trends test



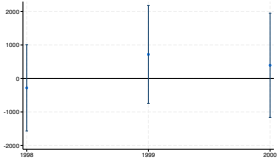
(a) Automotive



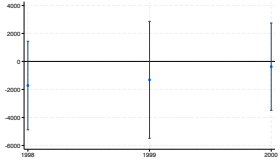
(b) Electronics



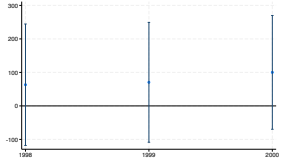
(c) Pharmaceuticals and chemicals



(d) Rubber and plastic



(e) Industrial machinery



(f) Average of all industries

Removing null employment in *maquiladoras*

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Table: Effect of robot penetration on the change of infant mortality rate (2000-2015) -2SLS.

	(1)	(2)	(3)	(4)
Panel A. 2SLS				
$\Delta robots^{US}$	1.2451**	1.2078***	0.7271**	0.7700**
	(0.5751)	(0.4426)	(0.3547)	(0.3583)
Kleibergen-Paap F-stat	50.99	52.60	99.34	168.6
Panel B. First Stage				
$IV\Delta robots^{US}$	0.0992***	0.0993***	0.1055***	0.1021***
	(0.0139)	(0.0137)	(0.0106)	(0.0079)
Observations	251	251	251	251
Mean dep var	14.74	14.74	14.74	14.74
Region FE/industry shares	✓	✓	✓	✓
Outcome trends		✓	✓	✓
Demographic trends			✓	✓
Contemporary shocks				✓

Dropping 1% of treatment distribution (right tale)

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Table: Effect of robot penetration on the change of infant mortality rate 2SLS.

	(1)	(2)	(3)	(4)
Panel A. 2SLS				
$\Delta robots^{US}$	1.8367**	1.7350**	1.6460**	1.5455**
	(0.7832)	(0.7237)	(0.7358)	(0.7366)
Kleibergen-Paap F-stat	243.0	241.9	324.3	353.3
Panel B. First Stage				
$IV\Delta robots^{US}$	0.0759***	0.0759***	0.0767***	0.0764***
	(0.0049)	(0.0049)	(0.0043)	(0.0041)
Observations	1802	1802	1801	1801
Mean dep var	14.02	14.02	14.02	14.02
Region FE/industry shares	✓	✓	✓	✓
Outcome trends		✓	✓	✓
Demographic trends			✓	✓
Contemporary shocks				✓

Permutation tests

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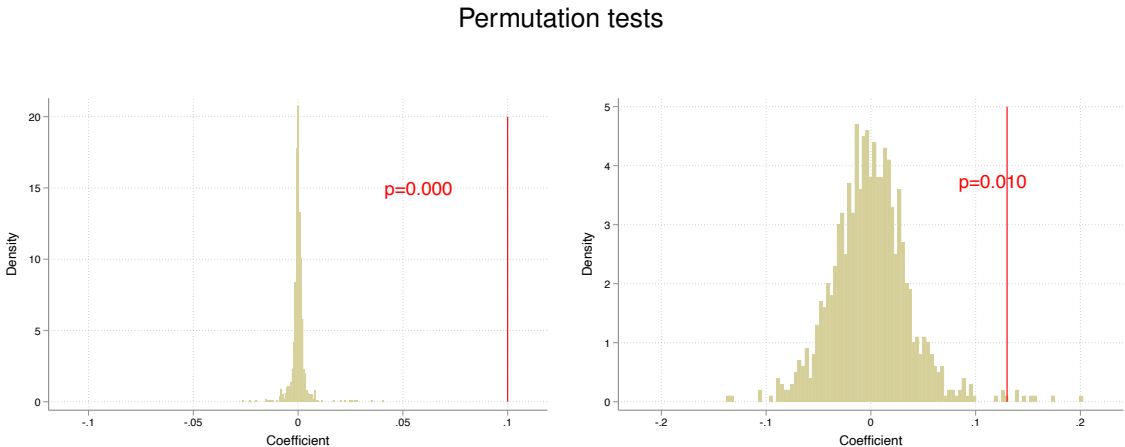
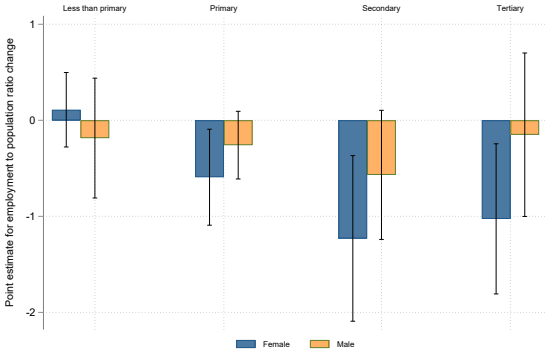


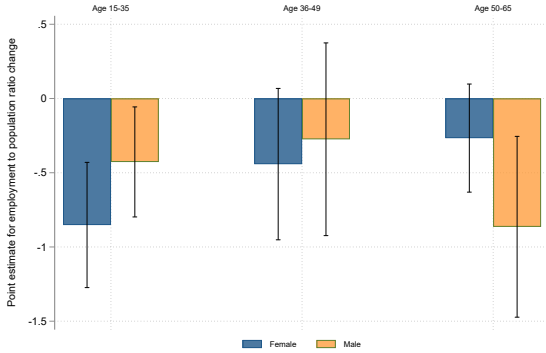
(g) First stage

(h) Reduced form

Figure: Effect of robot penetration on employment by characteristic



(a) Skill level



(b) Age

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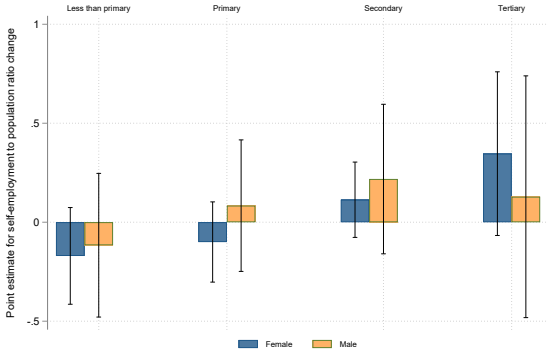
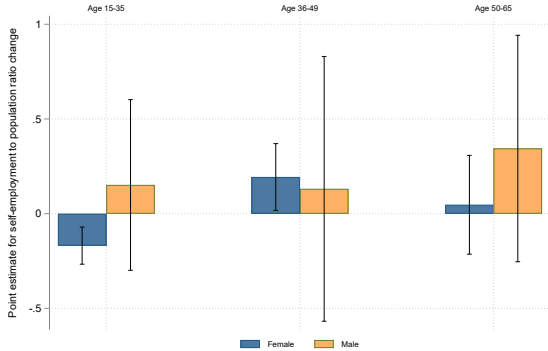
Figure: Effect of robot penetration on self-employment by characteristic



(a) Skill level



(b) Age

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Cross-country comparison

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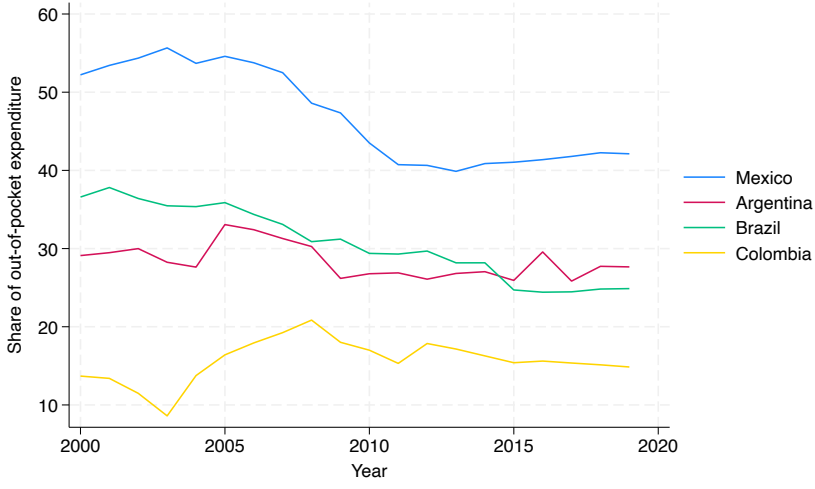

(c) Share of out-of-pocket health expenditure