Does Skill Abundance Still Matter?

The Evolution of Comparative Advantage in the 21st Century

Shin Kikuchi, MIT

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Skill Abundance and Comparative Advantage

- Skill Abundance: Central for comparative advantage (**Heckscher–Ohlin**)
  - Skill-abundant countries specialize in skill-intensive sectors
  - e.g. Electronics in the US v.s. Textiles in India

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- **This paper: What about the 21st century?**

At a Glance: Skill Abundance and Comparative Advantage

G10's Revealed Comparative Advantage (RCA) in Skill Intensive Sectors:

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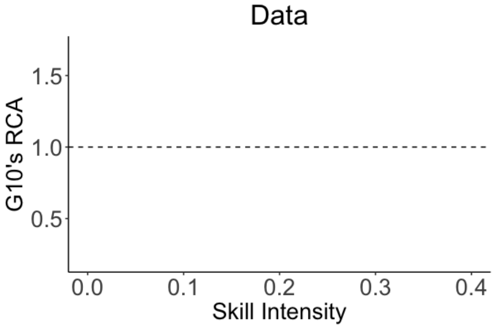

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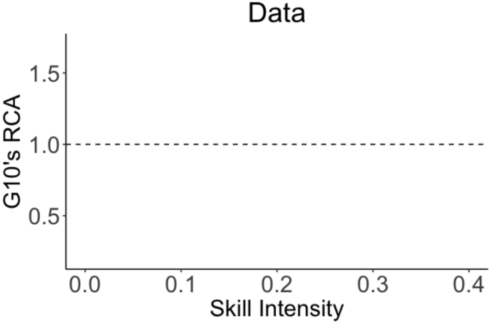

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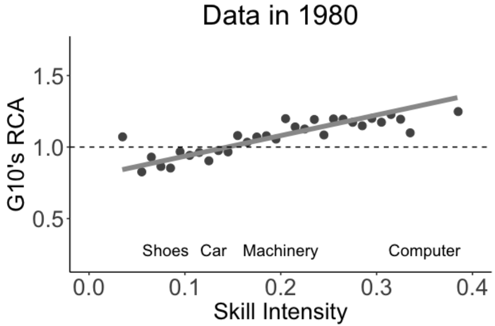

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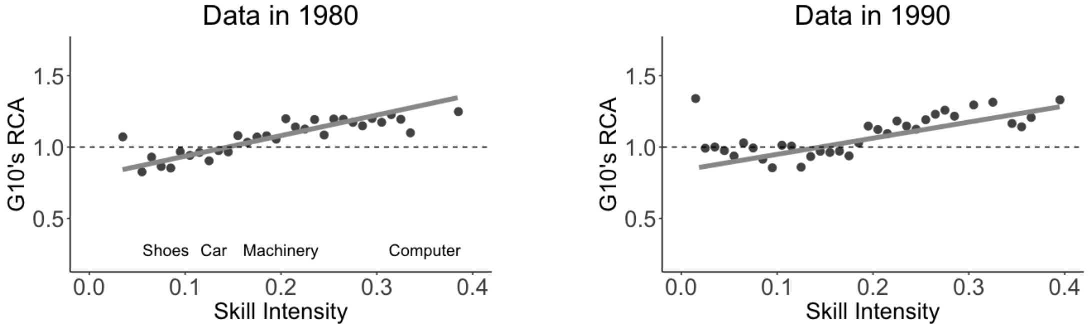

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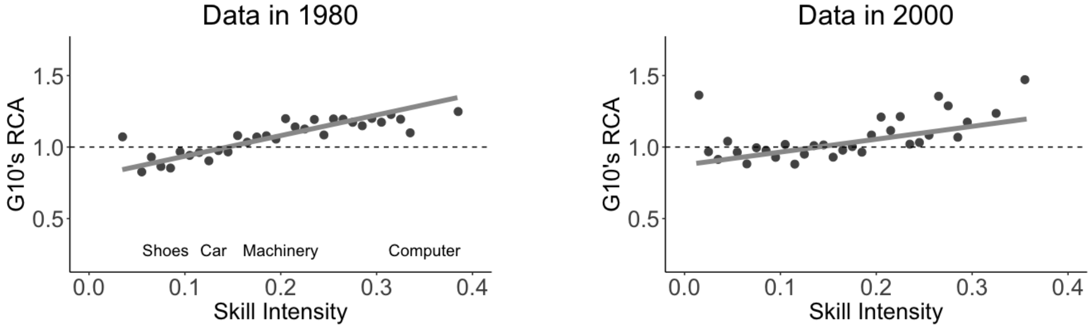

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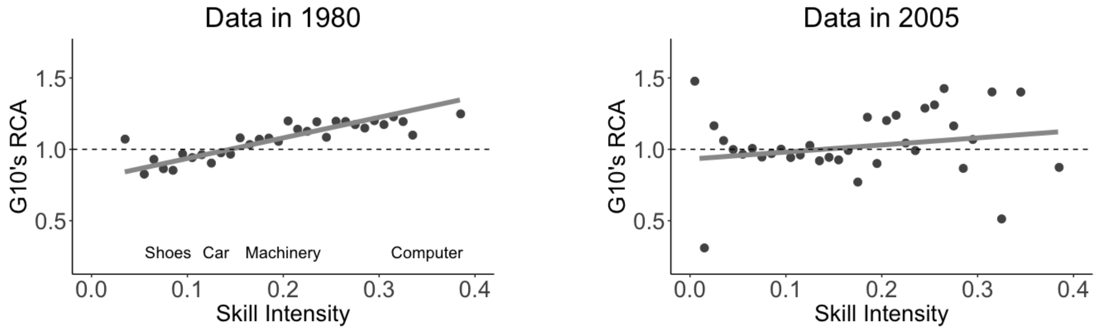

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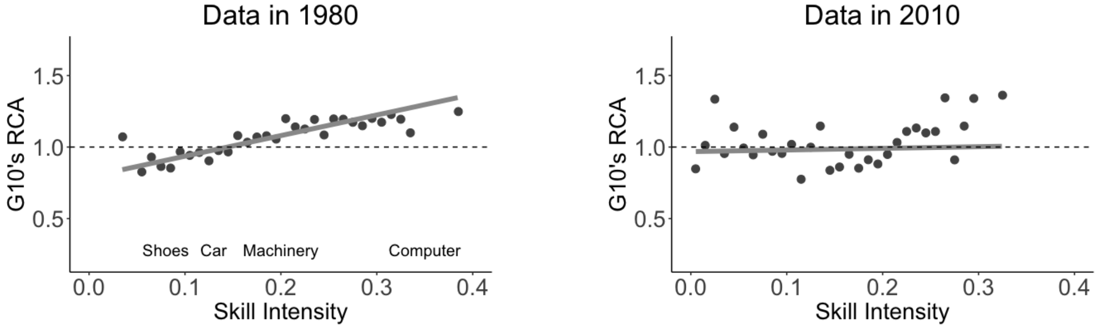

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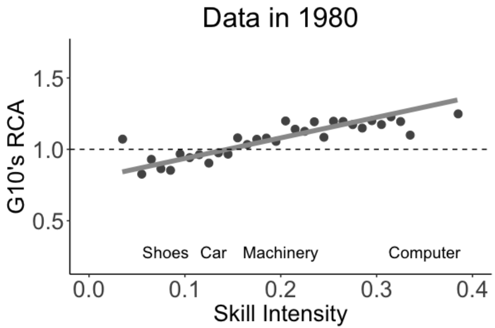

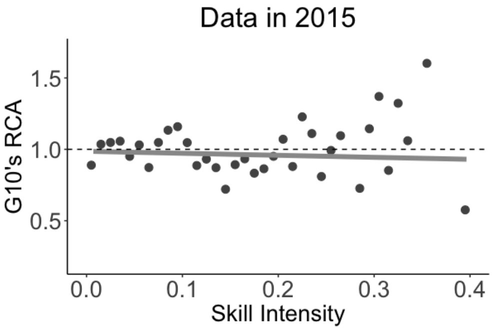

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This Paper

- Does skill abundance *systematically* matter for comparative advantage?
  - Yes and stable until 1990, No after 2000
- What can empirically and quantitatively explain the change in the pattern?
  - Automation, not offshoring
- What are the macro implications?
  - Manufacturing shifts to North; Inequality expands within & across countries

Preview (1/2) New Facts on Comparative Advantage

- Follow the literature's state-of-the-art specification
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  - No such heterogeneity from offshoring

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- **Conditional on automation, HO-like predictions still survive**

Preview (2/2) Automation Explains the Change

- Quantitative analysis: Eaton-Kortum model with automation & offshoring
  - Task framework: Acemoglu & Restrepo + Grossman & Rossi-Hansberg
  - Low-skill labor can be replaced by machines or foreign labor

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- **Automation, not offshoring, explains the empirical facts**
- Implications of automation
  - Shifts of manufacturing from South to North
  - Increases in skill premia in North and welfare everywhere

Key Contributions

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   - **HO:** Leamer (1980, 1984), Bowen et al (1987), Trefler (1993, 1995), Harrigan (1997), Davis & Weinstein (2001), Schott (2001), **Romalis (2004)**, Morrow (2010), **Chor (2010)**

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$\rightarrow$ **Skill abundance matter in 1980s; Not anymore post-2000.**

Key Contributions

1. New Facts on the sources of comparative advantage:
2. **Consequences of technology and globalization on inequality:**
    - **Technology:** Katz & Murphy (1992), Berman et al (1994), Acemoglu (2002), Autor et al (2003), Acemoglu & Autor (2011), Autor & Dorn (2013), **Acemoglu & Restrepo (2018,2022)**
    - **Offshoring: Feenstra & Hanson (1997, 1999, 2001), Grossman Rossi-Hansberg (2008, 2012)**, Hummels et al (2014), Boehm et al (2020)
    - **Interaction of Tech and Trade:** Xu (2001), Acemoglu (2002), Thoenig & Verdier (2003), Burstein et al (2013), Parro (2013), Burstein & Vogel (2017), Morrow & Trefler (2022)
    - **Automation and Trade:** Freud et al (2022), Artuc et al (2023), Fontagné et al (2024)

$\rightarrow$ **Automation $\Rightarrow$ Comparative Advantage and Inequality**

FACTS: SKILL ABUNDANCE NO LONGER MATTERS

Identifying Comparative Advantage: Refresher

- Multi-sector Eaton-Kortum Model (Chor (2010), Costinot et al (2012))

Exporter i, Importer j, Sector s: $\ln \text{Export}_{i,j,s} = -\underbrace{\theta}_{\text{Trade Elas.}} \underbrace{\ln c_{i,s}}_{\text{Unit Cost}} + \underbrace{\tilde{\eta}_{i,j} + \tilde{\eta}_{j,s}}_{\text{FEs}}$

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- If (log) relative wage is log-linear in Skill Abundance$_i$, $\ln(H_i/L_i)$,

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Canonical specification to identify the source of comparative advantage

Skill Abundance as a Source of Comparative Advantage

Do skill-abundant countries export more skill-intensive goods?

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Expect $\beta > 0$: Skill-abundant countries export skill-intensive goods more

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Skill Abundance $\Rightarrow$ CA in Skill-Intensive Sectors?

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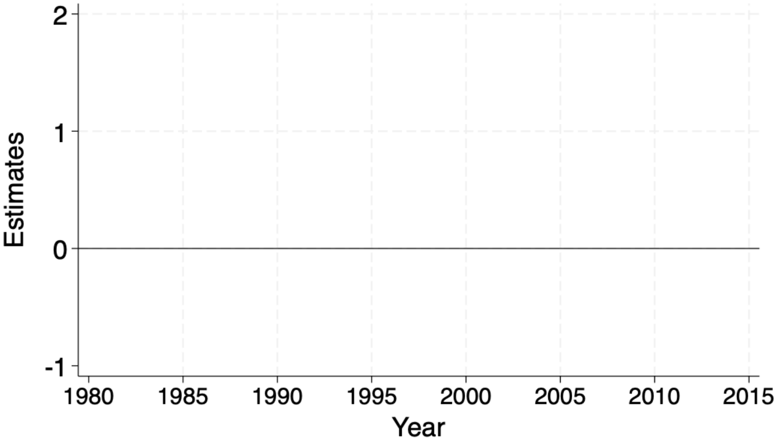

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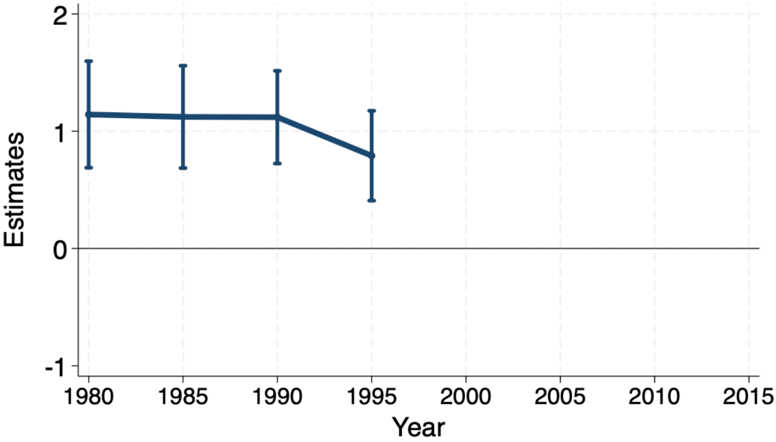

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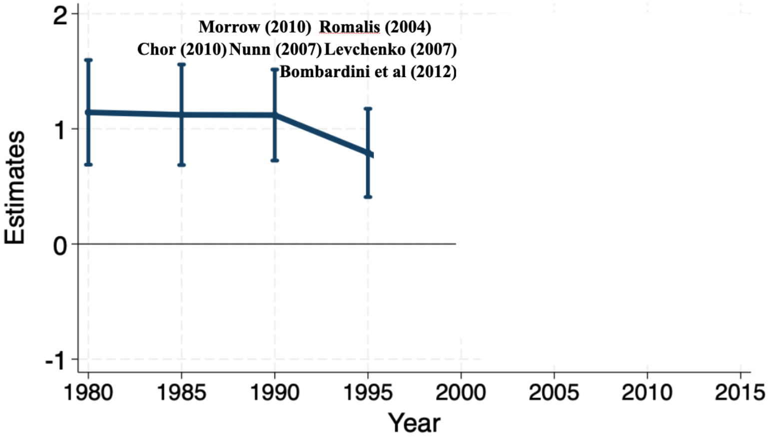

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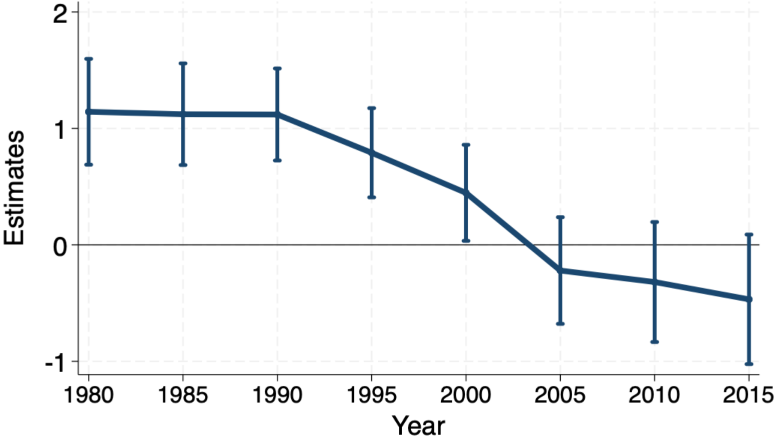

Change in Patterns of CA Comes from Exports

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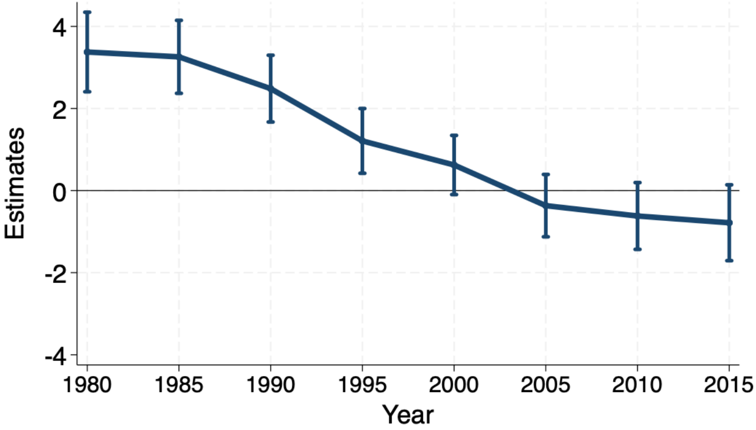
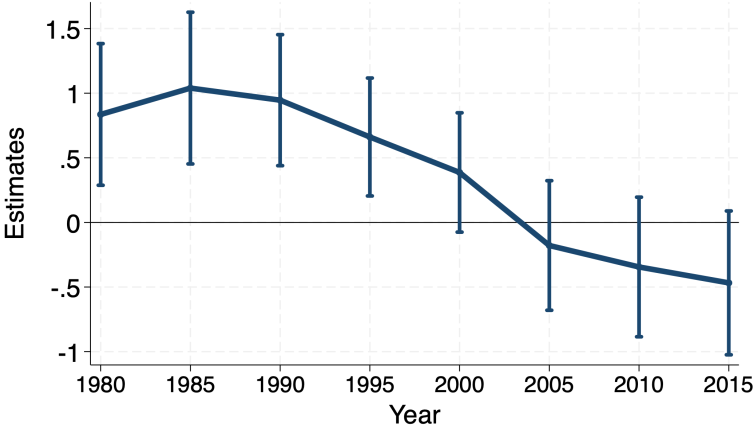


NOT Driven by Attenuating Skill Measurement

$$\ln \text{Exports}_{i,j,s,t} = \beta_t \left[\text{Skill Intensity}_{s,\mathbf{2015}} \times \text{Skill Abundance}_{i,\mathbf{2015}}\right] + \eta_{i,j,t} + \eta_{j,s,t},$$



Robustness Checks

- Other sources of comparative advantage? ‣ Capital ‣ Institution
- Driven by small countries? ‣ Weighted
- Some exporter-sector unobserved het., or IRS? ‣ Pool years and i-s FEs
- Different skill measures? ‣ High School ‣ Predicted by Demographics
- Total exports, instead of bilateral exports (Romalis 2004, Nunn 2007,...) ‣ go
- Different measures of sectoral factor intensity (Chor 2010)
  - $\ln(H_S/L_S)$, instead of α_S^H($\equiv$ Skilled Payroll Share to Value-Added) ‣ go
- Including service sectors (WIOD, later in this presentation)

POTENTIAL HYPOTHESES:
AUTOMATION AND OFFSHORING

Potential Hypotheses: Automation and Offshoring

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Potential Hypotheses: Automation and Offshoring

- What can make domestic skill abundance less relevant for CA after the 1990s?
- Two massive technical progress, replacing low-skill labor
  - Automation: Replace low-skill labor with machines
  - Offshoring: Replace low-skill labor with foreign inputs
- This section: Explore heterogeneous effects across countries and sectors
  - Descriptive analysis for heterogeneous effects (for now)
  - Causal analysis using the model (later)

Specification for Heterogeneous Effects: Automation

$$\ln \text{Exports}_{i,j,s,t} = \underbrace{\beta_t^0 \left(1 + \beta_t^A HA_{i,s}\right)}_{=\beta_t} \cdot \left[\text{Skill Intensity}_{s,t} \times \text{Skill Abundance}_{i,t}\right] + \eta_{i,j,t} + \eta_{j,s,t},$$

- $HA_{i,s}$: High-automation dummy (below/above the median robot adoption)
  - Robot adoption: Robot stock per workers from IFR & WIOD

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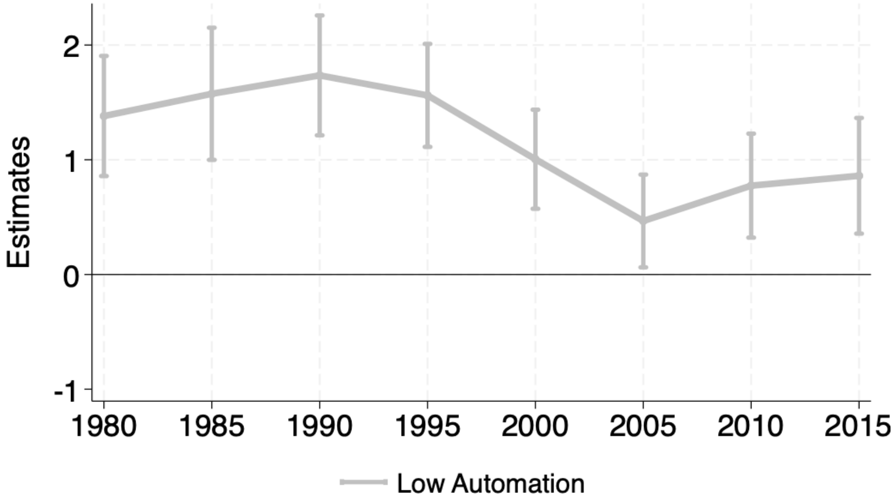
- $HA_{i,s}$: High-automation dummy (below/above the median robot adoption)
  - Robot adoption: Robot stock per workers from IFR & WIOD
- Expect β_t^A to decrease if there is a relationship btw change & automation

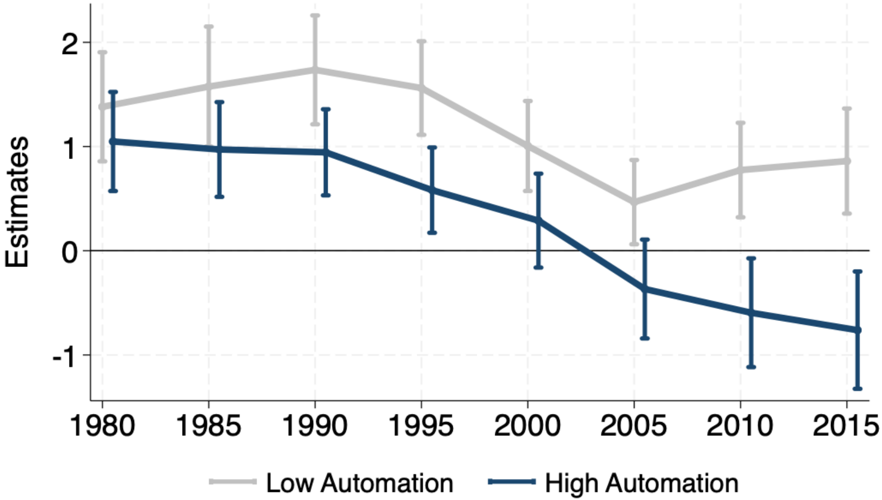
Skill Abundance Still Matters Absent Automation

Plot $\widehat{\beta}_t^0$



Skill Abundance Still Matters Absent Automation

Plot $\widehat{\beta}_t^0$ and $\widehat{\beta}_t^0 + \widehat{\beta}_t^A$



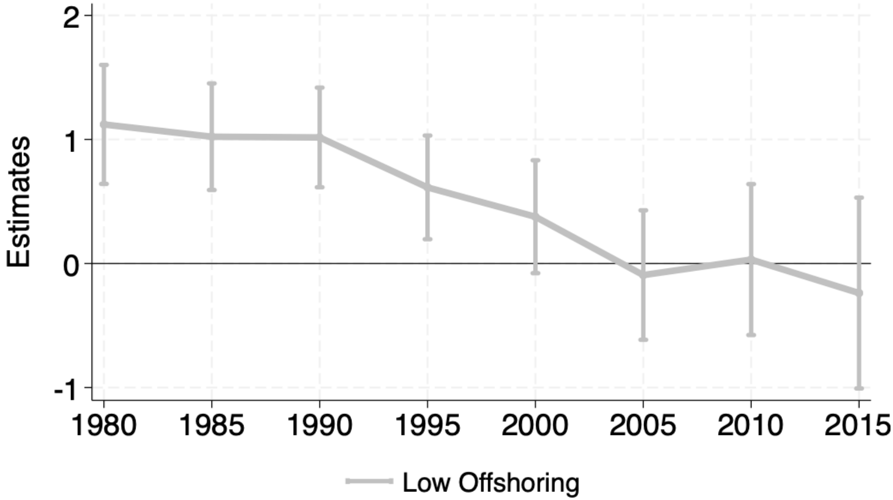
Specification for Heterogeneous Effects: Offshoring

$$\ln \text{Exports}_{i,j,s,t} = \underbrace{\beta_t^0 \left(1 + \beta_t^O HO_{i,s}\right)}_{=\beta_t} \cdot \left[\text{Skill Intensity}_{s,t} \times \text{Skill Abundance}_{i,t}\right] + \eta_{i,j,t} + \eta_{j,s,t},$$

- $HO_{i,s}$: High-offshoring dummy (below/above the median offshoring)
  - Offshoring share: (Intermediate imports) / (Total intermediates) from WIOD
- Expect β_t^O to decrease if there is a relationship btw change & offshoring

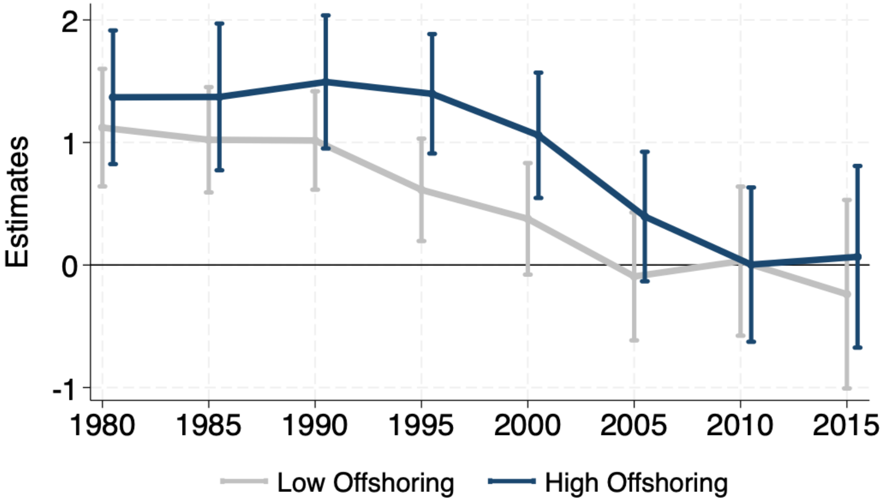
Skill Abundance does not Matter Even Absent Offshoring

Plot $\widehat{\beta}_t^0$



Skill Abundance does not Matter Even Absent Offshoring

Plot $\widehat{\beta}_t^0$ and $\widehat{\beta}_t^0 + \widehat{\beta}_t^O$



Same Results from Continuous Measures

$$\ln \text{Exports}_{i,j,s,t} = \beta_t^0 \left(1 + \beta_t^A \text{Auto}_{i,s} + \beta_t^O \text{Ofs}_{i,s}\right) \cdot \left[\text{Skill Int.}_{s,t} \times \text{Skill Abd.}_{i,t}\right] + \eta_{i,j,t} + \eta_{j,s,t}$$

	1995	2010	1995	2010
Skill Intensity x Abundance	1.26	-0.33		
	(0.23)	(0.28)		
x Automation (log robot stock)				
x Offshoring Share ($\times$100)				

Same Results from Continuous Measures

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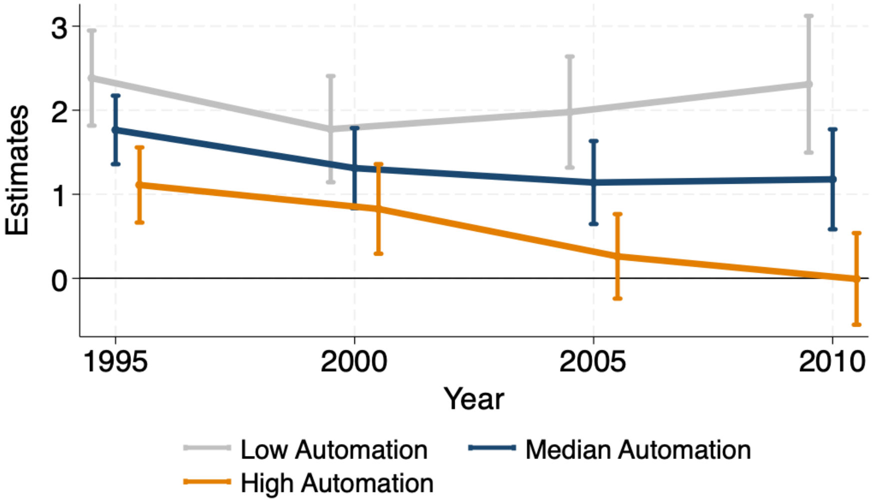
	1995	2010	1995	2010
Skill Intensity x Abundance	1.26	-0.33	3.00	**3.49**
	(0.23)	(0.28)	(0.41)	(0.57)
x Automation (log robot stock)			-0.19	**-0.35**
			(0.05)	(0.06)
x Offshoring Share (×100)			0.04	0.05
			(0.05)	(0.07)

Note: Automation measure: 12.2 for German cars, 2.3 for Indian textiles

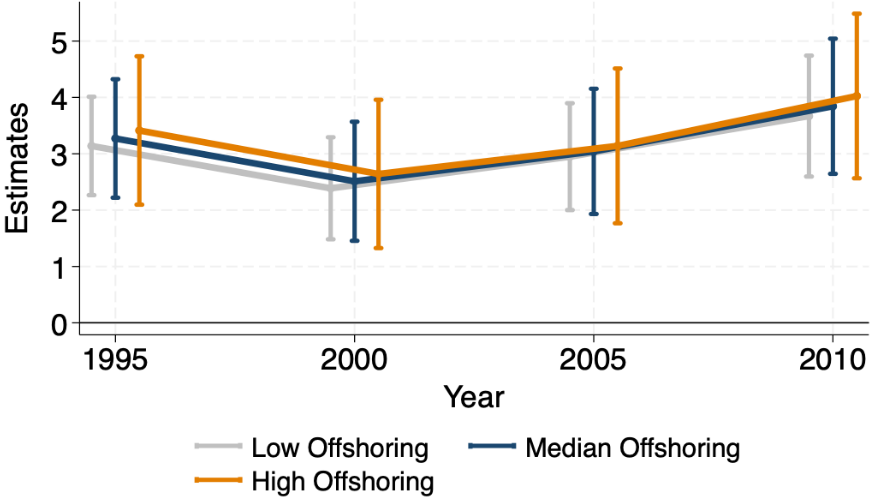
Skill Abundance Still Matters Absent Automation

Fitted values for groups with automation of 10th, 50th, and 90th percentiles



Offshoring Seems Unrelated to Change in Pattern

Fitted values for groups with offshoring of 10th, 50th, and 90th percentiles



Controlling China Shock does not Change Results

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x Automation (log robot stock)				
x Offshoring Share ($\times$100)				
x China's RCA				

Controlling China Shock does not Change Results

	1995	2010	1995	2010
Skill Intensity x Abundance	1.26	-0.33	2.43	**3.51**
	(0.23)	(0.28)	(0.45)	(0.46)
x Automation (log robot stock)			-0.15	**-0.31**
			(0.05)	(0.05)
x Offshoring Share (×100)			0.03	0.11
			(0.05)	(0.06)
x China's RCA			0.20	**0.34**
			(0.12)	(0.13)

Takeaway: **China shocks strengthen the Heckscher-Ohlin force**

Summary of Empirical Facts

- **Skill abundance becomes less important in comparative advantage** over time
  - Less important with higher **automation**
  - Offshoring has surprisingly no relationship

MODEL: TRADE WITH AUTOMATION AND OFFSHORING

Overview

- Multi-sector Eaton-Kortum model with input-output linkages

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  - Labor: $H_{i,s}$ (high-skilled), $L_{i,s}$ (low-skilled)

Overview

- Multi-sector Eaton-Kortum model with input-output linkages
  - **New: Task framework for automation and offshoring**

- Primary factors:
  - Labor: $H_{i,s}$ (high-skilled), $L_{i,s}$ (low-skilled)

- Additional production factors (produced using outputs: roundabout)
  - Automation Capital: $A_{i,s}$
  - Intermediate: $X_{i,s}$ (domestic), $O_{i,s}$ (foreign, offshored)
    - ⋆ including non-automation capital (buildings, land)

Demand: Standard Multi-Sector Eaton Kortum Model

- Country i, j, Sector s
- Preference across sectors: Cobb-Douglas with expenditure share of $\mu_{j,s}$

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- Country i, j, Sector s
- Preference across sectors: Cobb-Douglas with expenditure share of $\mu_{j,s}$
- Trade share (gravity equation) within sectors:

$$\pi^F_{i,j,s} = \frac{(c_{i,s} \cdot \tau_{i,j,s})^{-\theta}}{\sum_l^{\mathcal{J}} (c_{l,s} \cdot \tau_{l,j,s})^{-\theta}}$$

  - Unit cost: $c_{i,s}$—endogenously determined from production processes (next)
  - Trade cost: $\tau_{i,j,s}$
  - Trade elasticity $\theta > 0$

Supply 1/2: Task Framework in Production

- Extend Grossman & Rossi-Hansberg (2008), Acemoglu & Restrepo (2022)

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$$Y_{i,s}(\omega) = z_{i,s}(\omega) \cdot (H_{i,s}(\omega))^{\alpha_s^H} \cdot (T_{i,s}(\omega))^{1-\alpha_s^H}.$$

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- Production function for each task ($\psi_{i,s}^f(x)$ task-specific tech)

$$T_{i,s}(x) = \underbrace{\psi_{i,s}^A(x)A_{i,s}(x)}_{\text{Automation Capital}} + \underbrace{\psi_{i,s}^L(x)L_{i,s}(x)}_{\text{Production Labor}} + \underbrace{\psi_{i,s}^X(x)X_{i,s}(x)}_{\text{Domestic Input}} + \underbrace{\psi_{i,s}^O(x)O_{i,s}(x)}_{\text{Foreign Input}}$$

Suppl 2/2: Task Allocation $\mathcal{T}^f_{i,s}$, Task Share $\Gamma^f_{i,s}$

- Task production cost using factor f: $c^f_{i,s}(x) \equiv w^f_{i,s} / (\psi^f_{i,s}(x))$ for $f \in \{A, L, X, O\}$

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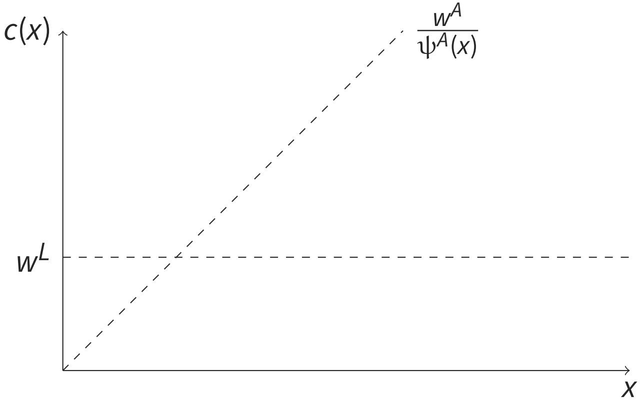
- Cost minimization $\Rightarrow$ Task Allocation and Task Share

$$\mathcal{T}^f_{i,s} = \left\{ x : f = \text{argmin}_{f'} c^{f'}_{i,s}(x) \right\}, \quad \to \Gamma^f_{i,s} : \text{ measure of } \mathcal{T}^f_{i,s}, \quad \text{for} \quad f \in \{A, L, X, O\}$$

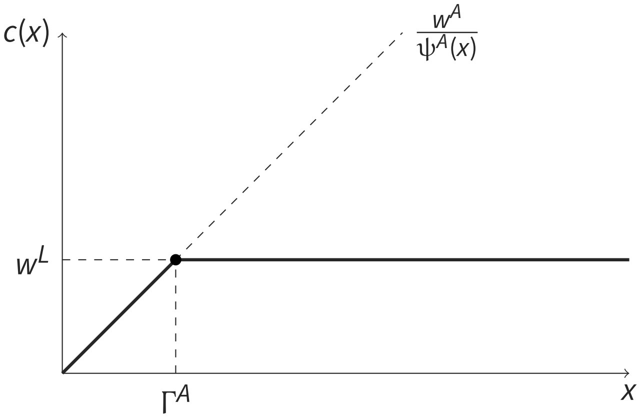
At Glance: Task Allocation and Task Share

- Suppose no intermediate and constant labor productivity $\psi^L(x) = 1$.



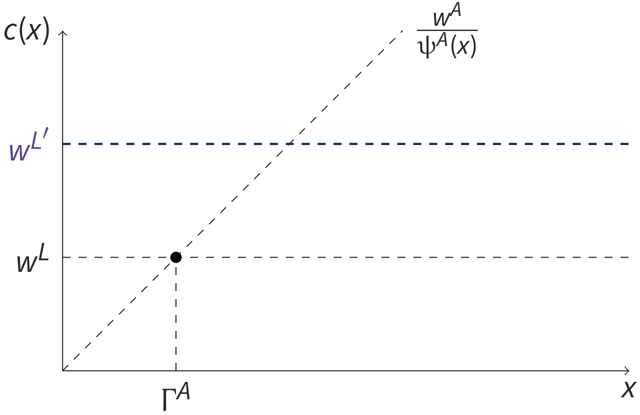
At Glance: Task Allocation and Task Share

- Suppose no intermediate and constant labor productivity $\psi^L(x) = 1$.
- Cost minimization (task allocation) $\Rightarrow$ Automation share $\Gamma_i^A = \Gamma^A$



At Glance: Task Allocation and Task Share

- Suppose no intermediate and constant labor productivity $\psi^L(x) = 1$.
- Suppose wage increases to $w^{L'}$



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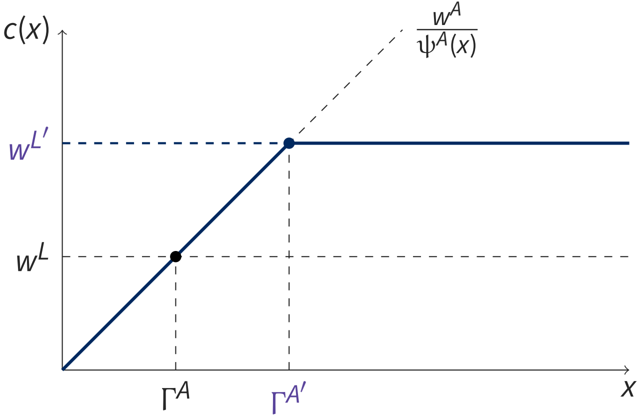
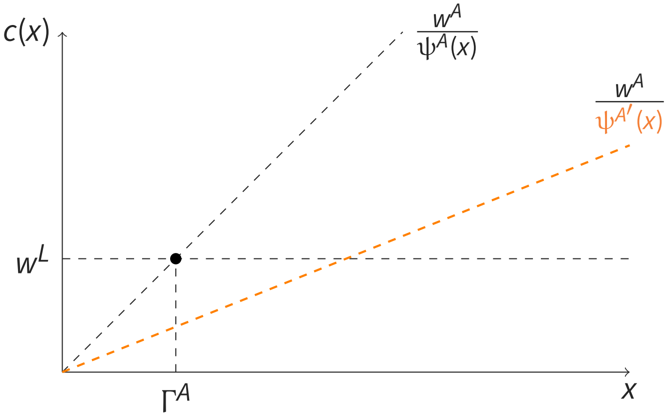


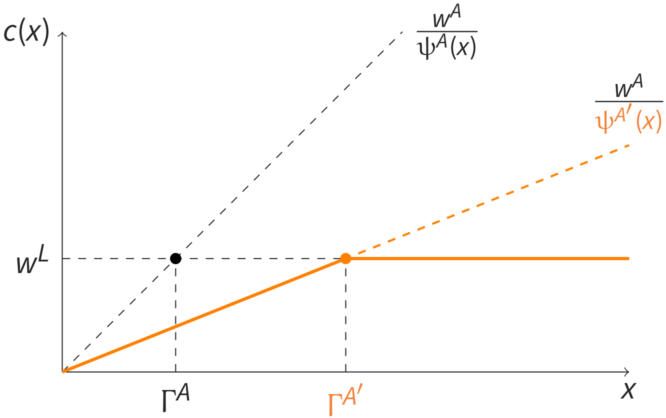
At Glance: Task Allocation and Task Share

- Suppose no intermediate and constant labor productivity $\psi^L(x) = 1$.
- Now, consider automation shock $\psi^A(x)$ from $\psi^{A'}(x)$



At Glance: Task Allocation and Task Share

- Suppose no intermediate and constant labor productivity $\psi^L(x) = 1$.
- Automation share increases to $\Gamma^{A'}$



Suppl 2/2: Task Allocation $\mathcal{T}_{i,s}^{f}$, Task Share $\Gamma_{i,s}^{f}$

- Task production cost using factor f: $c_{i,s}^{f}(x) \equiv w_{i,s}^{f} / (\psi_{i,s}^{f}(x))$ for $f \in \{A, L, X, O\}$

- Cost minimization $\Rightarrow$ Task Allocation and Task Share

$$\mathcal{T}_{i,s}^{f} = \left\{ x : f = \text{argmin}_{f'} c_{i,s}^{f'}(x) \right\}, \quad \rightarrow \Gamma_{i,s}^{f} : \text{ measure of } \mathcal{T}_{i,s}^{f}, \quad \text{for} \quad f \in \{A, L, X, O\}$$

- Unit cost of production:

$$c_{i,s} = \Lambda_s \cdot (w_i^H)^{\alpha_s^H} \cdot \left[\left(\frac{w_{i,s}^A}{\Gamma_{i,s}^A} \right)^{\Gamma_{i,s}^A} \cdot \left(\frac{w_i^L}{\Gamma_{i,s}^L} \right)^{\Gamma_{i,s}^L} \cdot \left(\frac{w_{i,s}^X}{\Gamma_{i,s}^X} \right)^{\Gamma_{i,s}^X} \cdot \left(\frac{w_{i,s}^O}{\Gamma_{i,s}^O} \right)^{\Gamma_{i,s}^O} \right]^{1-\alpha_s^H}$$

Equilibrium Conditions ▸ Two Country

Given factor endowments $\{H_i, L_i\}$, an equilibrium is a set of wages $\{w_i^H, w_i^L\}$

- Consumers maximize utility by choosing from which countries to buy
  $\rightarrow$ trade share $\pi_{i,j,s}$, as a function of unit cost $\{c_{i,s}\}$

- Unit cost, $c_{i,s}$, as a function of $\{w_i^H, w_i^L\}$
  - $\{w_{i,s}^A, w_{i,s}^X, w_{i,s}^O\}$ are functions of $\{w_i^H, w_i^L\}$ with IO coef.

- Goods and Labor Markets Clear

QUANTIFICATION

Quantitative Analysis: Effects of Automation and Offshoring

- Two Exercises:
  1. Can changes in $\Gamma^{A}_{i,s,t}$ (automation) and $\Gamma^{O}_{i,s,t}$ (offshoring) explain $\widehat{\beta}_t$?
  2. Using the same model, what are the macro implications?

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  - $\Gamma^A_{i,s,t}$ (automation, constructed)

$$p^A_{i,s,t}A_{i,s,t} = \underbrace{p^K_{i,s,t0}K_{i,s,t0}}_{\text{Capital Income}} \cdot \underbrace{\frac{p^M_{US,s,t0}M_{US,s,t0}}{p^K_{US,s,t0}K_{US,s,t0}}}_{\text{Machine-Capital Ratio}} \cdot \underbrace{\frac{p^R_{i,s,t}R_{i,s,t}}{p^R_{i,s,t0}R_{i,s,t0}}}_{\text{Increases in Robots}} .$$

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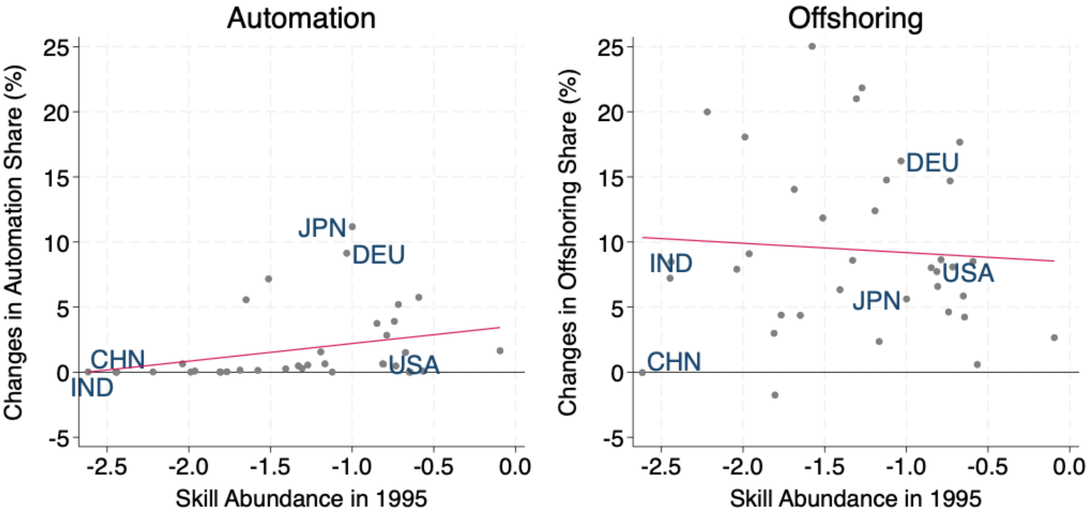
  - Adjust $\Gamma^{L}_{i,s,t}$ (low-skilled labor share) to make $\sum_{F=L,A,X,O} \Gamma^{F}_{i,s,t} = 1$

Data: More Automation in Skill-Abundant Countries



Calibration

Description	Parameter	Value & Source
Panel A: Time-Invariant Parameters (fixed in 1995)		
Trade Elas.	θ	4 (Standard)
Expenditure Share	$\mu_{i,s}$	Data (WIOT)
Factor Endowment	H_i, L_i	Data (WIOT)
Factor Share	$\alpha^H_{i,s}$	Data (WIOT)
Input-Output Coef.	$\alpha^X_{i,r,s}, \alpha^A_{i,r,s}$	Data (WIOT) & Ding (2023)
Panel B: Time-Variant Shocks		
Automation Productivity	$\widehat{\overline{\psi^A_{i,s}}}$	Match $\widehat{\Gamma^A_{i,s}}$
Offshoring Cost	$\widehat{\overline{\tau^X_{i,s}}}$	Match $\widehat{\Gamma^O_{i,s}}$

RESULTS: CHANGES IN COMPARATIVE ADVANTAGE

1. Automation and Offshoring on Changes in $\widehat{\beta}$

- Question: How much can $\Gamma^{A}_{i,s,t}$ and $\Gamma^{O}_{i,s,t}$ explain the path of $\widehat{\beta}_t$?

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1. Calibrate the model to 1995 and shock the economy
2. Construct counterfactual trade flow: $(X_{i,j,s,t})'$
   - Data (World Input-Output Database, incl. Service)
   - Case 1. Only Automation: Change $\Gamma^{A}_{i,s,t}$
   - Case 2. Only Offshoring: Change $\Gamma^{O}_{i,s,t}$

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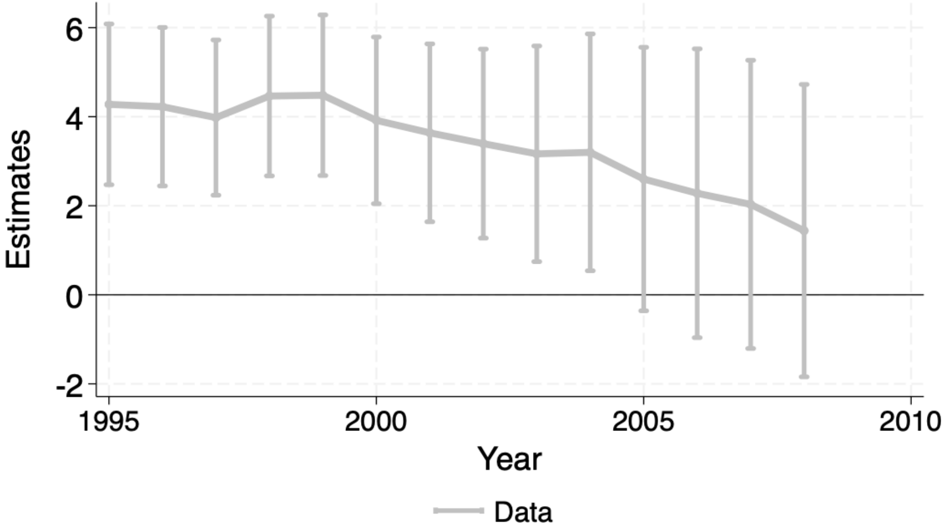
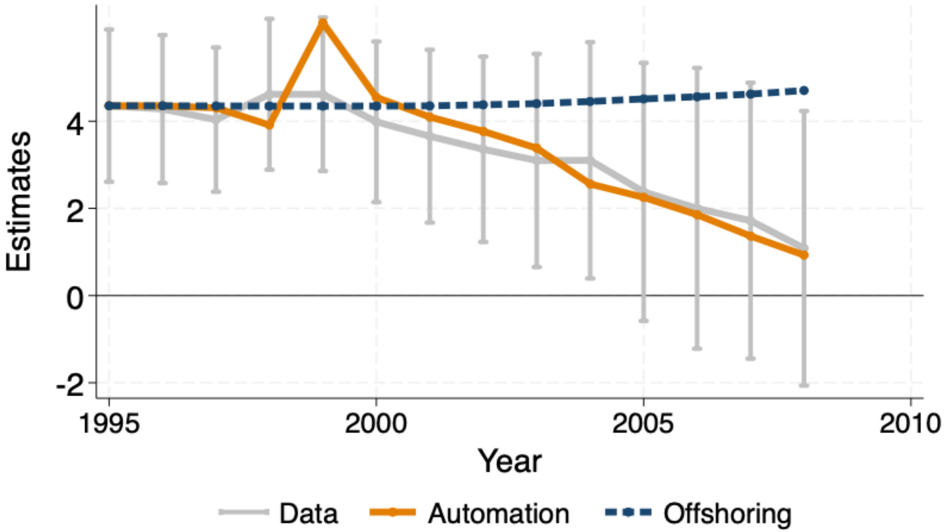
   - Case 1. Only Automation: Change $\Gamma^{A}_{i,s,t}$
   - Case 2. Only Offshoring: Change $\Gamma^{O}_{i,s,t}$
3. Run the same regression as in data but for counterfactual economies

$$\ln(X_{i,j,s,t})' = \beta_t \left[\alpha^{H}_{s,t_0} \times \ln\left(\frac{H_{i,t_0}}{L_{i,t_0}}\right)\right] + \eta_{i,j,t} + \eta_{j,s,t} + \varepsilon_{i,j,s,t}.$$

$\widehat{\beta}_t$ Decreases Even Using WIOD



Automation, Not Offshoring, Causes the Decline



Why Automation?

- Sizes of automation are smaller than offshoring
- Why does automation, not offshoring, matter?

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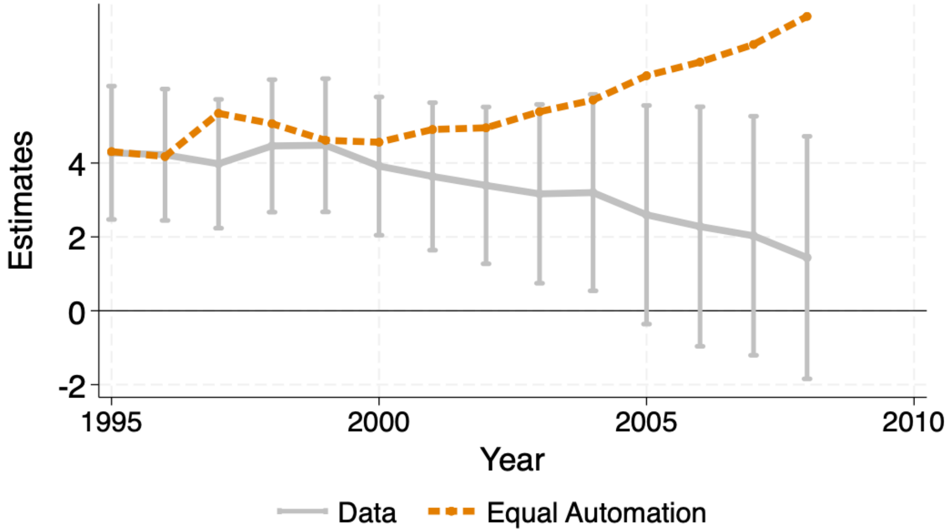
- Why does automation, not offshoring, matter?
- One observation: Automation happens disproportionately in L– scarce countries
- Experiment: Suppose all the countries increase automation equally...

Equal Automation Cannot Explain the Decline

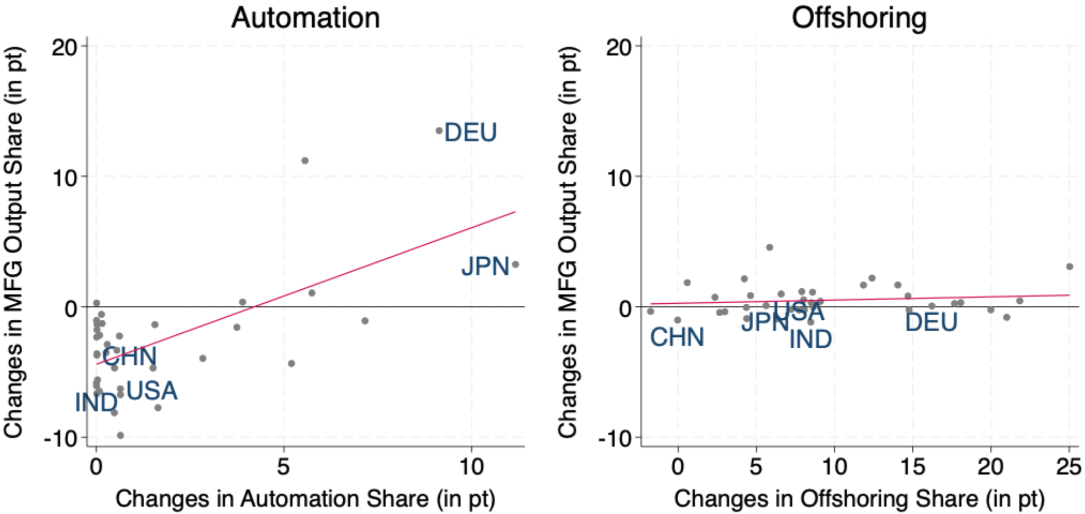


RESULTS: MACRO IMPLICATIONS OF AUTOMATION AND OFFSHORING

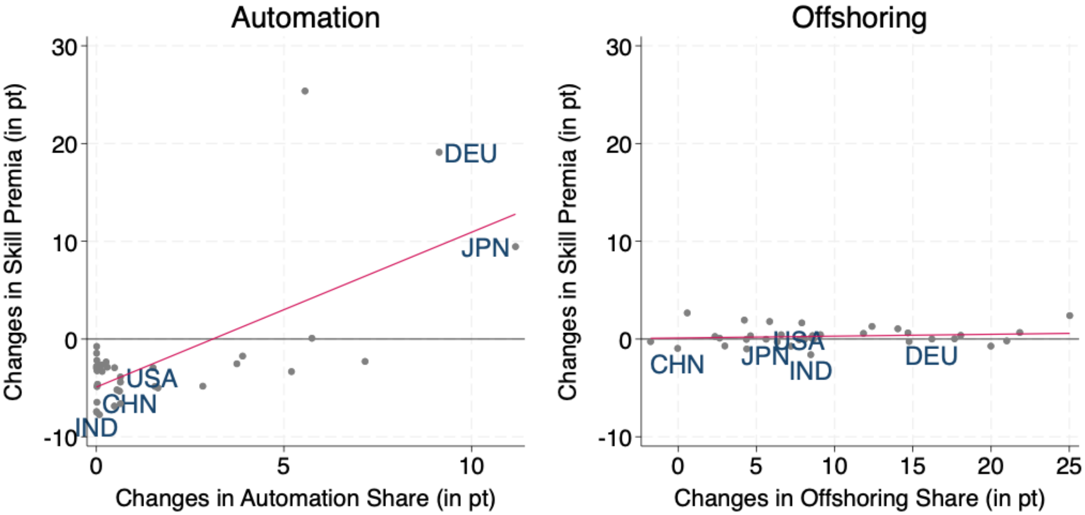
Macro Implications of Automation and Offshoring

- Through the lens of the same model, what is the causal effect of automation and offshoring?
- Three macro variables
  - Output share of manufacturing (sectoral share within a country)
  - Skill premium (inequality within a country
  - Welfare (inequality across countries)

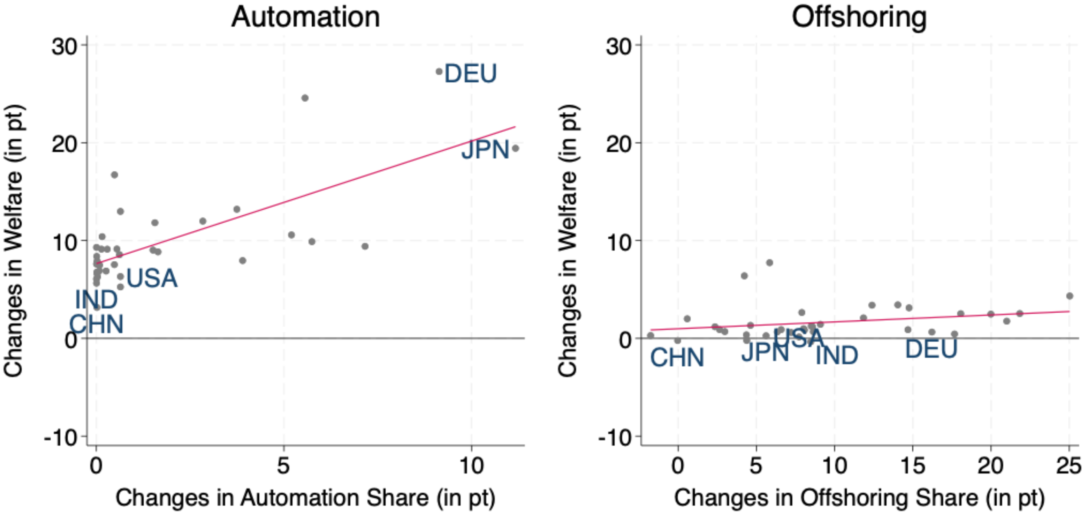
Manufacturing Shifts to High-Automation Countries



Skill Premia Increases Only in High-Automation Countries



Welfare Increases Everywhere



CONCLUSION

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Conclusion

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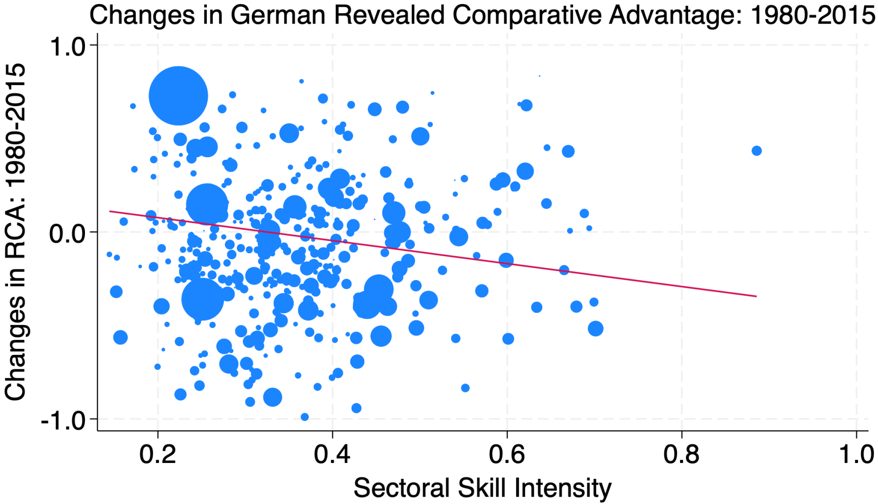
  - **It did.** Skill abundance no longer matters for comparative advantage
  - **Automation** causes the decline; Offshoring has small effects
- Automation relocates manufacturing from South to North
  - Inequality within & across countries increases
- Work in progress:
  - Does a robot tax *import* China shocks and backfire in an open economy?
  - Does automation facilitate reshoring and reduce the costs of decoupling?
  - Will clean technology erode the comparative advantage of oil-rich countries?

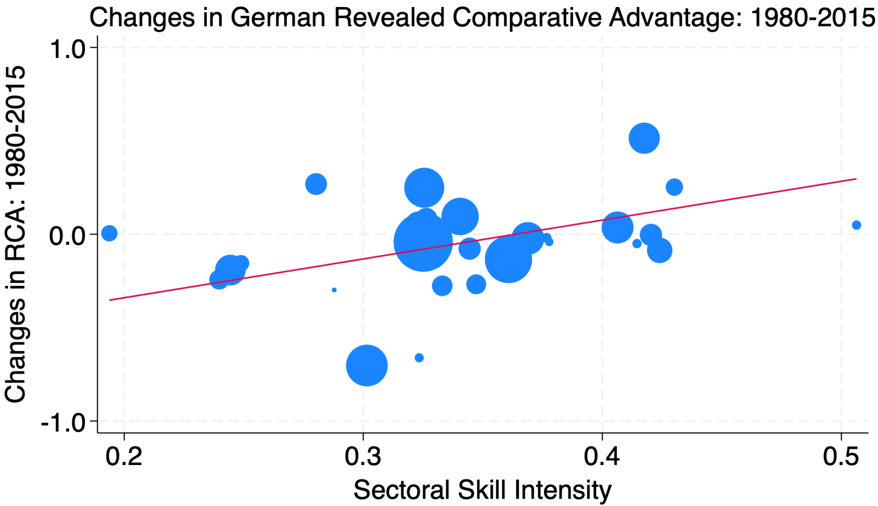
APPENDIX

FACTS

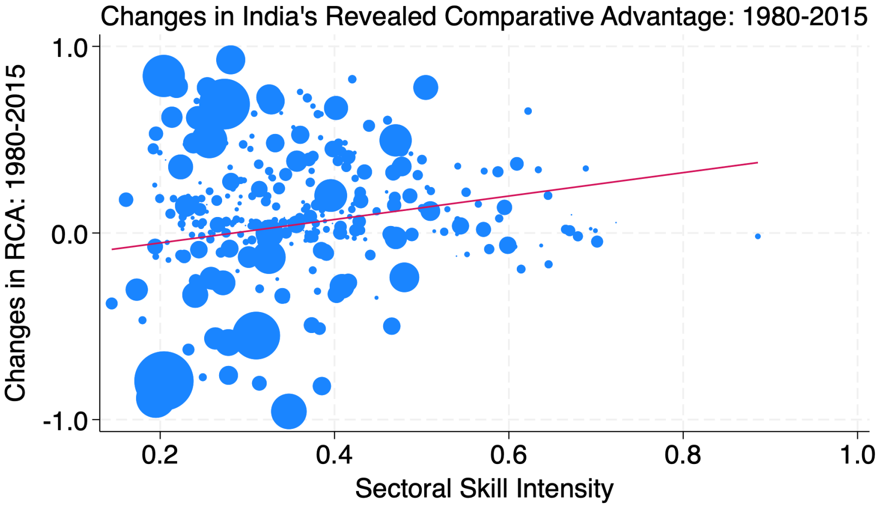
Germany ▸ back



Germany (Low-Automation) ▸ back

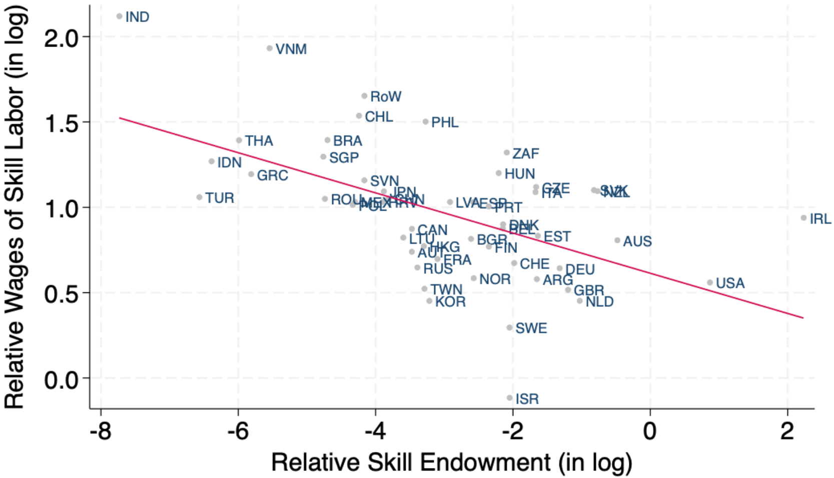


India ▸ back



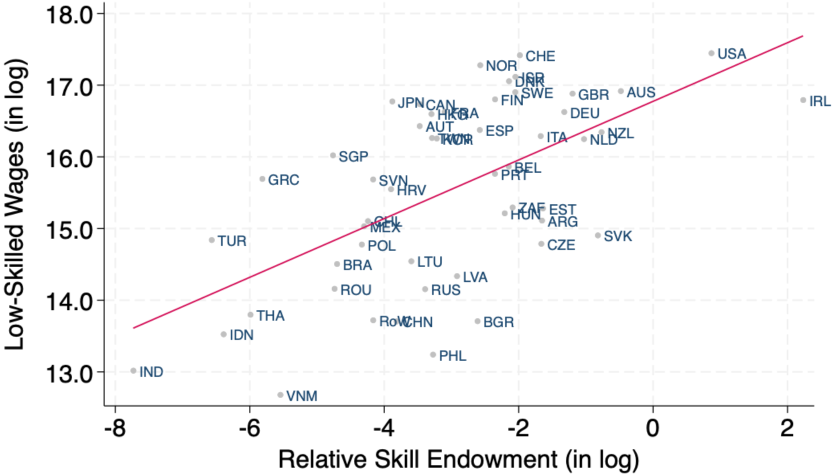
Changes in India's Revealed Comparative Advantage: 1980-2015
Changes in RCA: 1980-2015
1.0
0.0
-1.0
0.2
0.4
0.6
0.8
1.0
Sectoral Skill Intensity

Relative Skilled Wages Decreasing in Skill Endowment ▸ back



Note: Data from GTAP, 2004

Unskilled Wages Increasing in Skill Endowment ▸ back



Note: Data from GTAP, 2004

REGRESSION

Simplified Structural Interpretation

- Gravity Equation + Unit Production Cost

$$X_{i,j,s} = \left((c_{i,s}\tau_{i,j}\tau_{j,s})\right)^{1-\sigma} \cdot (P_{j,s})^{\sigma-1} X_{j,s}, \quad \ln X_{i,j,s} = (1-\sigma) \cdot \ln c_{i,s} + \mu_{i,j} + \mu_{j,s}$$

$$c_{i,s} = (w_i^H)^{\alpha_s^H} (w_i^L)^{1-\alpha_s^H}, \quad \ln c_{i,s} = \underbrace{\frac{d \ln(w^H/w^L)}{d \ln(H/L)}}_{\equiv \epsilon^W\text{: Rel. Wage Elas.}<0} \cdot \alpha_s^H \cdot \ln\left(\frac{H_i}{L_i}\right) + \ln w_i^L$$

- Regression

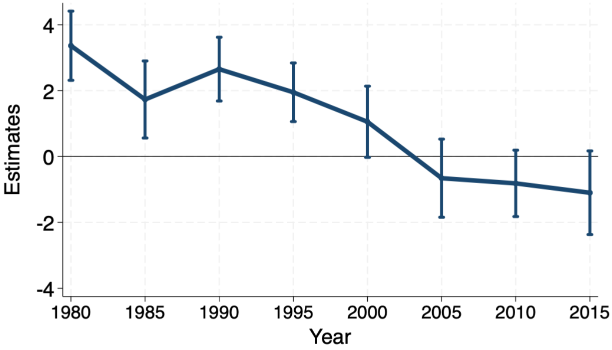
$$\ln X_{i,j,s} = (1-\sigma)\epsilon^W \left[\alpha_s^H \times \ln\left(\frac{H_i}{L_i}\right)\right] + \mu_{i,j} + \mu_{j,s} + \ln w_i^L$$

back

ROBUSTNESS

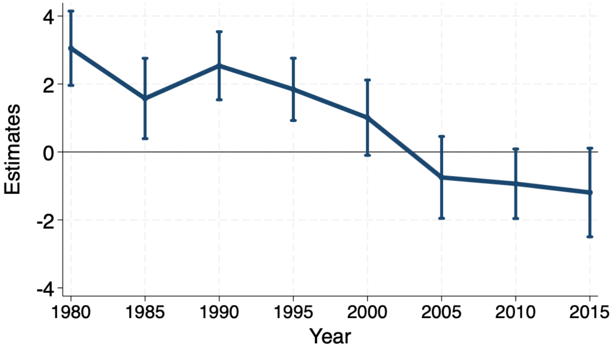
Controlling Capital Intensity ▸ back

$$\ln X_{i,j,s,t} = \beta_t \left[\alpha^H_{s,t} \times \ln\left(\frac{H_{i,t}}{L_{i,t}}\right)\right] + \beta^K_t \left[\alpha^K_{s,t} \times \ln\left(\frac{K_{i,t}}{L_{i,t}}\right)\right] + \eta_{i,j,t} + \eta_{j,s,t}$$

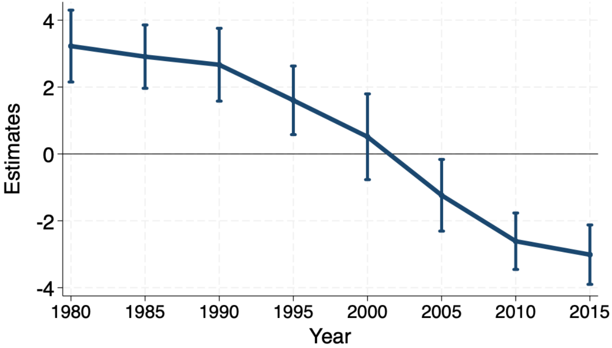


Controlling Capital Intensity and Institutions ‣ back

$$\ln X_{i,j,s,t} = \beta_t \left[\alpha^H_{s,t} \times \ln\left(\frac{H_{i,t}}{L_{i,t}}\right)\right] + \sum_{f\in\{K,I\}} \beta^F_t \left[\alpha^F_{s,t} \times \ln\left(\frac{F_{i,t}}{L_{i,t}}\right)\right] + \eta_{i,j,t} + \eta_{j,s,t}$$

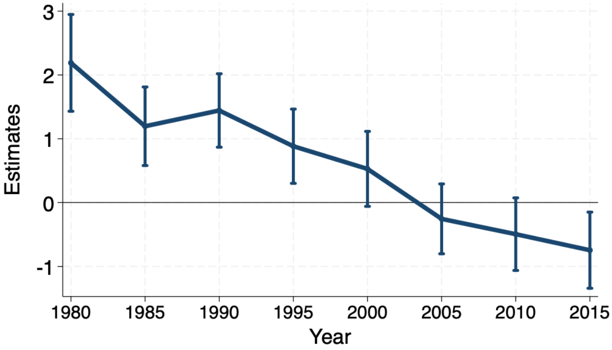


Weighted by Country Export ▸ back



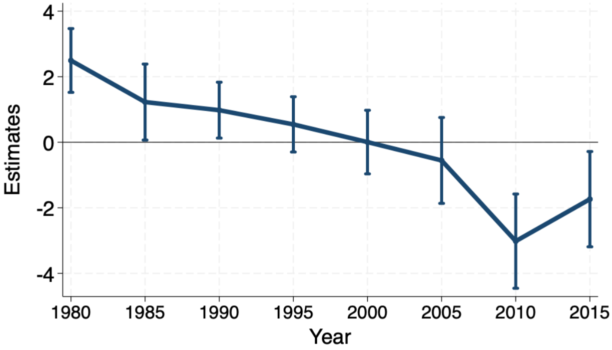
Pool and control Origin-Sector FEs ▸ back

$$\ln X_{i,j,s,t} = \beta_t \left[\alpha^H_{s,t} \times \ln \left(\frac{H_{i,t}}{L_{i,t}} \right) \right] + \eta_{i,s} + \eta_{i,j,t} + \eta_{j,s,t}$$



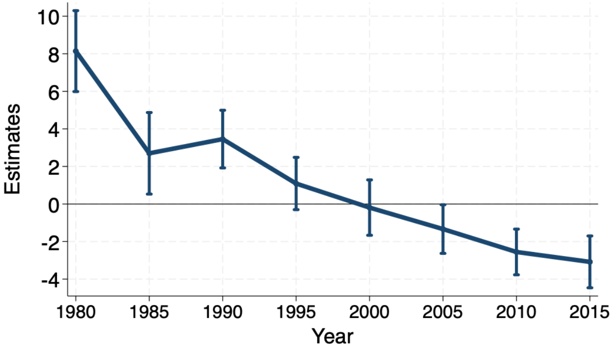
High-school Graduates as Skilled ‣ back

$$\ln X_{i,j,s,t} = \beta_t \left[\alpha^H_{s,t} \times \ln \left(\frac{HS_{i,t}}{NHS_{i,t}} \right) \right] + \eta_{i,j,t} + \eta_{j,s,t}$$



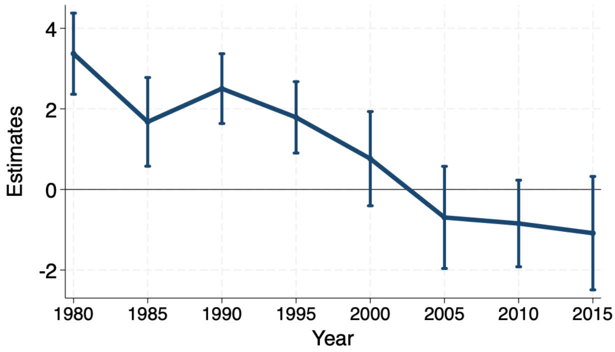
Instrument Skill Endowment by Cohort IV ▸ back

$$\ln X_{i,j,s,t} = \beta_t \left[\alpha^H_{s,t} \times \ln \left(\frac{H_{i,t}}{L_{i,t}} \right) \right] + \eta_{i,j,t} + \eta_{j,s,t}$$



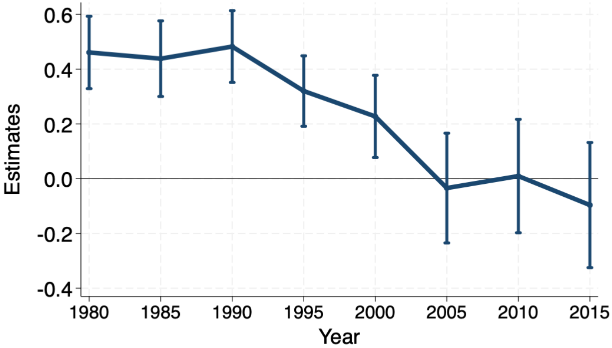
Romalis (2004): Total Export ‣ back

$$\ln X_{i,s,t} = \beta_t \left[\alpha^H_{s,t} \times \ln\left(\frac{H_{i,t}}{L_{i,t}}\right)\right] + \eta_{i,t} + \eta_{s,t}$$



Chor (2011): Num of Workers as Factor Intensity ▸ back

$$\ln X_{i,j,s,t} = \beta_t \left[\ln\left(\frac{H_{s,t}}{L_{s,t}}\right) \times \ln\left(\frac{H_{i,t}}{L_{i,t}}\right) \right] + \eta_{i,j,t} + \eta_{j,s,t}$$

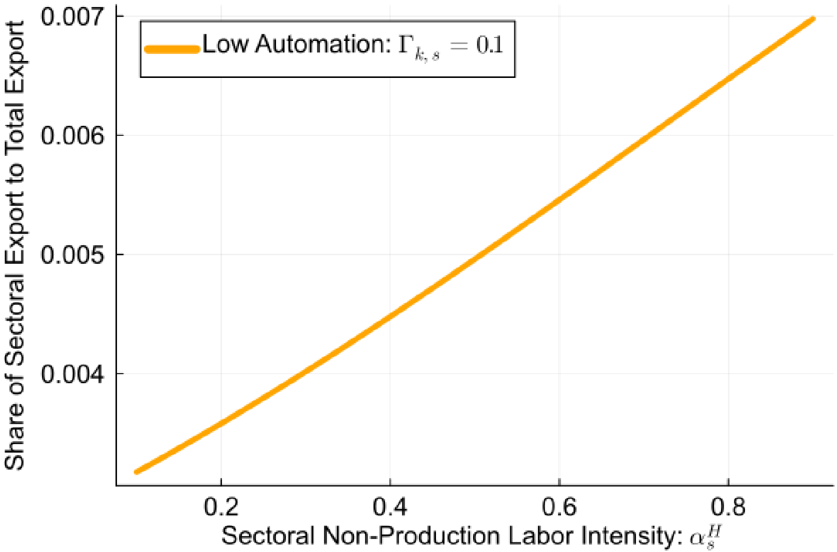


TWO COUNTRY ILLUSTRATION: AUTOMATION

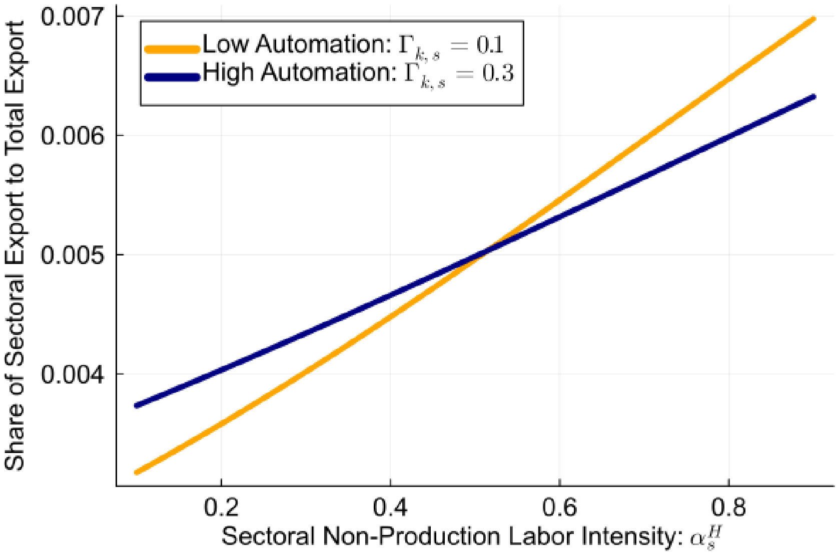
Two Country Illustration: Automation

- North (40% are H) and South (25% are H)
- Actual factor intensity across 397 SIC sectors
- Set $\alpha_s^G = \alpha_s^M = 0$ (focus on value-added)
- Exogenous changes in factor intensity common across sectors & countries
  - Automation: Increase $\Gamma_{i,s}^K = 0.1$ to 0.3
- Show export share of each sector in North against α_s^H – Slope is β^H

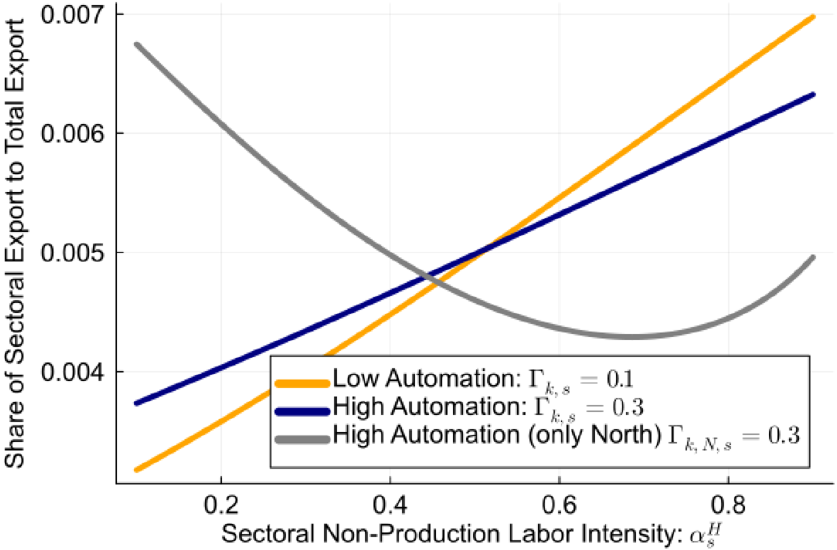
North Specialize in Skill-Intensive Sectors



Automation Makes Skills Less Important

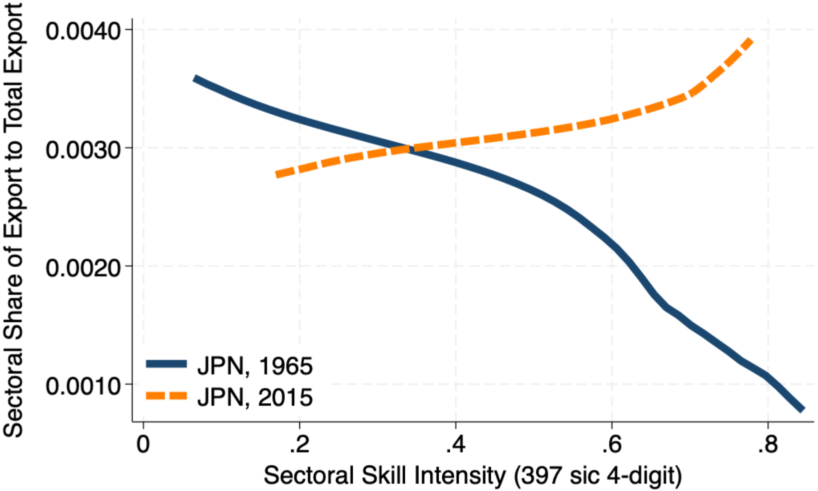


If Only North Automates, Sign Flips

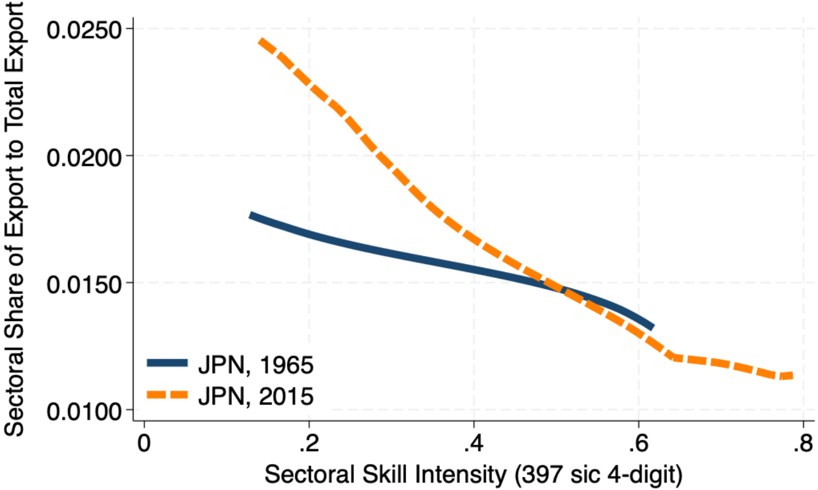


Example: Within Low-Automation Sectors, Japan Specializes in Skill Intensive Industries

▸ Back



Example: Within High-Automation Sectors, Japan Specializes in Low-Skill Intensive Industries ‣ Back



TOY MODEL: TASK AND COMPARATIVE ADVANTAGE

Model

- Small open economy with two sectors ($s = 1, 2$)
- Demand

$$q_s = (c_s)^{1-\sigma} \cdot \overline{Q_s}$$

- Production (micro-foundation = task framework)

$$Y_s = \zeta \cdot (H_s)^{\alpha_s} \left((L_s)^{\Gamma} (M_s)^{1-\Gamma} \right)^{1-\alpha_s}, \quad \alpha_1 = 1 - \alpha_2 = \alpha > 1/2$$

  - M_s: machines or foreign factors supplied at a fixed price r
- Factor market clearing

$$\sum_{s=1,2} H_s = H, \quad \sum_{s=1,2} L_s = L$$

Equilibrium

- Wages $\{w^L, w^H\}$ that satisfy

$$w^L L = \Gamma(1-\alpha)(c_1)^{1-\sigma} + \Gamma\alpha(c_2)^{1-\sigma}, \quad w^H H = \alpha(c_1)^{1-\sigma} + (1-\alpha)(c_2)^{1-\sigma}$$

- Unit cost

$$c_s = \left(w^H\right)^{\alpha_s} \left((w^L)^{\Gamma}(r)^{1-\Gamma}\right)^{1-\alpha_s}$$

Comparative Advantage

- A change in factor endowment $\widehat{H} = -\widehat{L}$ (=compare two small countries)
- Up to 1st order, CA in H-intensive sector ($s = 1$)

$$\widehat{c_2} - \widehat{c_1} = \underbrace{-(2\alpha - 1)\widehat{\omega}}_{\text{Skill Premium<0}} \underbrace{-(1 - \Gamma)(2\alpha - 1)\widehat{w^L}}_{\text{Task Displacement}}$$

- Skill premium ($\widehat{\omega} \equiv \widehat{w^H} - \widehat{w^L}$) and wages

$$\widehat{\omega} = \underbrace{-2\widehat{H}}_{\text{Labor Supply}} + \underbrace{(2\alpha - 1)(\sigma - 1)\left(\widehat{c_2} - \widehat{c_1}\right)}_{\text{GE Effect}}, \quad \widehat{w^L} = \frac{(\sigma - 1)(2\alpha - 1) - 1}{2 + (1 - \Gamma)(\sigma - 1)(2\alpha - 1)}\widehat{\omega}$$

Comparative Advantage if $\Gamma = 1$

Proposition 1: Rybczynski (1955)

An increase in skilled labor $\widehat{H} > 0$ strengthens comparative advantage in a skill-intensive sector.

$$\widehat{c}_2 - \widehat{c}_1 = \frac{2(2\alpha - 1)}{1 + (2\alpha - 1)^2(\sigma - 1)}\widehat{H}$$

Comparative Advantage if $\Gamma < 1$

Proposition 2: Acemoglu-Restrepo meets Rybczynski

An increase in skilled labor $\widehat{H} > 0$ strengthens comparative advantage in a skill-intensive sector. However, the elasticity is lower when labor share Γ is lower.

$$\widehat{c_2} - \widehat{c_1} = \frac{2(2\alpha - 1)}{\frac{1}{\eta(\Gamma)} + (2\alpha - 1)^2(\sigma - 1)}\widehat{H} \tag{1}$$

where $\eta(\Gamma) = 1 - \frac{1-(\sigma-1)(2\alpha-1)}{\frac{2}{1-\Gamma}+(\sigma-1)(2\alpha-1)} \in (0, 1)$ is increasing in Γ.

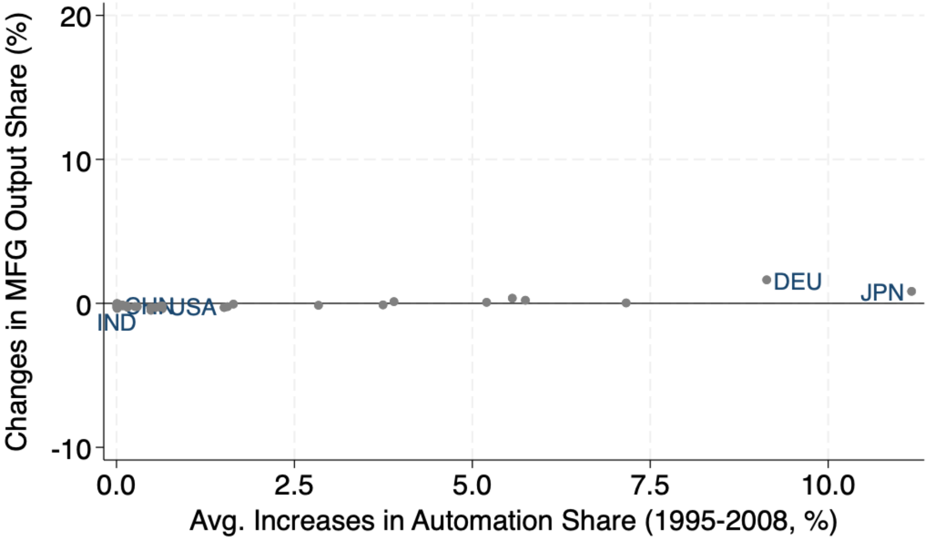
Automation, Globalization, and Inequality

- Automation $\rightarrow$ shifts MFG to High-Automation countries
- Demand for H increases in High-Automation countries
- Demand for L increases in Low-Automation countries
  - Move to Service sectors, which are more L–intensive

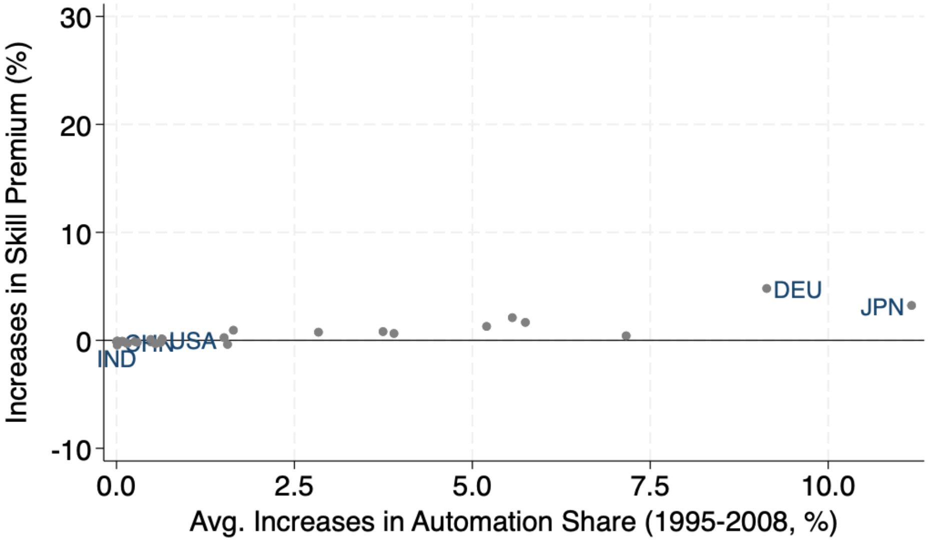
Automation, Globalization, and Inequality

- Automation $\rightarrow$ shifts MFG to High-Automation countries
- Demand for H increases in High-Automation countries
- Demand for L increases in Low-Automation countries
  - Move to Service sectors, which are more L–intensive
- Roles of Trade?
  - Now, set the trade elasticity $\theta = 1$, instead of $\theta = 4$
  - This kills sectoral reallocation via expenditure switch across countries

θ = 1: Lower Elas. Makes MFG Shifts Less



θ = 1: Skill Premia Increases Everywhere



θ = 1: Welfare Increases Everywhere, but Less