Escaping the Losses from Trade: The Impact of Heterogeneity and Skill Acquisition

Axelle Ferriere[1] **Gaston Navarro**[2] **Ricardo Reyes-Heroles**[2]

[1]Paris School of Economics, CNRS & CEPR

[2]Federal Reserve Board

February 2024

Motivation

- Trade shocks affect economic agents unevenly

  Autor, Dorn & Hanson (2013), Pierce & Schott (2016), Burstein & Vogel (2017),...

  - Potential losses from greater import competition
  - *Current* workers' industries, regions, occupations, firms, *skills*...

Motivation

- Trade shocks affect economic agents unevenly

  Autor, Dorn & Hanson (2013), Pierce & Schott (2016), Burstein & Vogel (2017),...

  - Potential losses from greater import competition
  - *Current* workers' industries, regions, occupations, firms, *skills*...

- Several margins of adjustment to overcome *initial* losses

  - Regional migration Caliendo, Dvorkin & Parro (2019), Dix-Carneiro & Kovak (2018),...
  - Switching industries and/or occupations ACM (2010), Traiberman (2019), Dix-Carneiro et al. (2023), ...

Motivation

- Trade shocks affect economic agents unevenly

  Autor, Dorn & Hanson (2013), Pierce & Schott (2016), Burstein & Vogel (2017),...

  - Potential losses from greater import competition
  - *Current* workers' industries, regions, occupations, firms, *skills*...

- Several margins of adjustment to overcome *initial* losses
  - Regional migration Caliendo, Dvorkin & Parro (2019), Dix-Carneiro & Kovak (2018),...
  - Switching industries and/or occupations ACM (2010), Traiberman (2019), Dix-Carneiro et al. (2023), ...

- What about the new generations of workers?

This paper

- Skill acquisition as a margin of adjustment
  - + College enrollment

This paper

- Skill acquisition as a margin of adjustment
  - + College enrollment
- Two questions:
  - + Do trade shocks affect college decisions?
  - + What are the welfare consequences in the short- and long-run?

What we do

- **Evidence:** effects of trade shocks on college enrollment
  - Effects on labor market outcomes for college/non-college
  - Effects on college enrollment for future workers

What we do

- **Evidence:** effects of trade shocks on college enrollment
  - + Effects on labor market outcomes for college/non-college
  - + Effects on college enrollment for future workers
- Dynamic trade **model** with heterogeneous households
  - + Multi-region open economy model with HO-type comparative advantage
  - + Aiyagari-OLG structure with *costly education choice*
  - + Costly switching across local labor markets

What we find

- **Evidence:**
  - + Trade shocks are more detrimental for less educated workers
  - + Younger cohorts respond by increasing college enrollment...
    - - Effect driven by families with enough wealth

What we find

- **Evidence:**
  - + Trade shocks are more detrimental for less educated workers
  - + Younger cohorts respond by increasing college enrollment...
    - Effect driven by families with enough wealth
- **Model:**
  - + Short-run:
    - Higher college premium and increased college enrollment ... for wealthy hh
    - Uneven welfare gains/losses determined by region, sector, and wealth
  - + Long-run:
    - Higher college enrollment mitigates the initial increase in the college premium
    - Endogenous skill acquisitions makes long-run welfare gains more equal

Related literature

- Trade shocks and labor market adjustment
  - Autor, Dorn & Hanson (2013), Pierce & Schott (2016), Artuç, Chaudhuri, & McLaren (2010), Dix-Carneiro (2014), Traiberman (2020), Caliendo, Dvorkin & Parro (2019), Dix-Carneiro et al. (2023)...
- Trade (spatial), human capital, and inequality
  - Findlay & Kierzkowski (1983), Blanchard & Willmann (2016), Danziger (2017), Kleineberg & Eckert (2021), Ghose (2023),
  - Atkin (2016), Greenland & Lopestri (2016), Blanchard & Olney (2018), Thukuri (2021)
  - Katz and Murphy (1992), Autor, Katz and Kearney (2008), Keane and Wolpin (1997), Huggett, Ventura and Yaron (2011), Guner, Ruggieri and Tybout (2022)
  - Helpman et al. (2010, 2017), Antràs et al. (2017), Burstein et al. (2016), Burstein & Vogel (2017)
- Macroeconomics and skill acquisition
  - Charles, Hurst & Notowidigdo (2016)
  - Abbott, Gallipoli, Meghir & Violante (2019), Daruich (2022)
  - Adao, Beraja & Pandalai-Nayar (2020)
- *Heterogeneous-agent trade-spatial macro models*
  - Lyon & Waugh (2018, 2019), Carroll & Hur (2020,2022), Giannone et al. (2023), Greeney (2023), Waugh (2023), Dvorkin (2023)

Evidence

Measuring trade shocks

- Import penetration in region (market) r in period t

  Autor, Dorn, & Hanson (2013)

$$\Delta IPW_{rt} = \sum_i \frac{L_{rit}}{L_{rt}} \frac{\Delta M_{it}}{L_{it}}$$

i: sector, M_{it}: Chinese imports, L_{rit}: workers sector i and region r,

$$L_{rt} = \sum_i L_{rit}, \text{ and } L_{it} = \sum_r L_{rit}$$

Measuring trade shocks

- Import penetration in region (market) r in period t

  Autor, Dorn, & Hanson (2013)

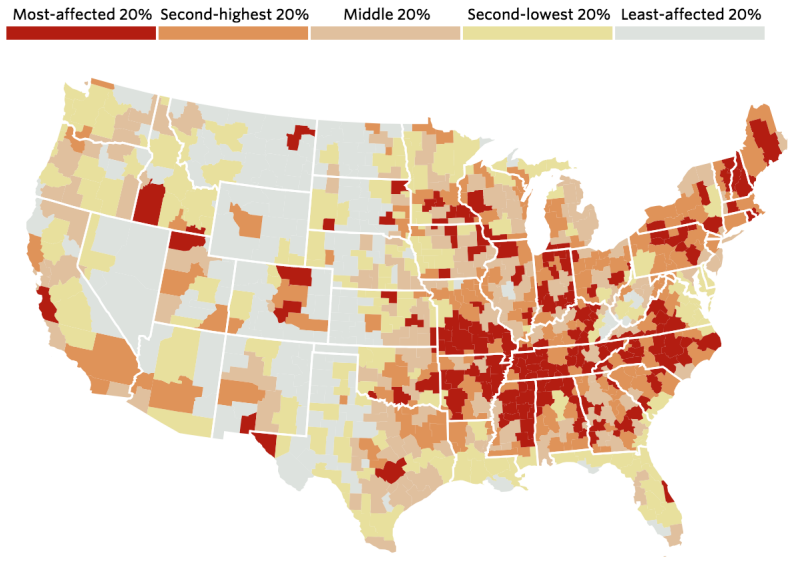
$$\Delta IPW_{rt} = \sum_i \frac{L_{rit}}{L_{rt}} \frac{\Delta M_{it}}{L_{it}}$$

  i: sector, M_{it}: Chinese imports, L_{rit}: workers sector i and region r,

$$L_{rt} = \sum_i L_{rit}, \text{ and } L_{it} = \sum_r L_{rit}$$

- Data overview: 722 commuting zones (regions), two waves
  - + Period 1990-2000: ΔIPW_{rt} *Median*: ≈$1,000, *IQR*: $600
  - + Period 2000-2007: ΔIPW_{rt} *Median*: ≈$2,000, *IQR*: $1,500

Measuring trade shocks



Estimating regional effect of trade shocks

- Effect of *import competition* on variable y_{it}

$$\Delta y_{rt} = \gamma_t + \beta \Delta IPW_{rt} + \delta X_{rt} + e_{rt}$$

  - y_{rt}: labor income, employment,...

Estimating regional effect of trade shocks

- Effect of *import competition* on variable y_{it}

$$\Delta y_{rt} = \gamma_t + \beta \Delta IPW_{rt} + \delta X_{rt} + e_{rt}$$

  - y_{rt}: labor income, employment,...
  - Effect on different groups
    - working age 30-55 $\rightarrow$ by education levels
    - education decisions for ages 18-25
  - Data from *American Community Survey* (IPUMS)

Estimating regional effect of trade shocks

- Effect of *import competition* on variable y_{it}

$$\Delta y_{rt} = \gamma_t + \beta \Delta IPW_{rt} + \delta X_{rt} + e_{rt}$$

  - y_{rt}: labor income, employment,...
  - Effect on different groups
    - working age 30-55 $\rightarrow$ by education levels
    - education decisions for ages 18-25
  - Data from *American Community Survey* (IPUMS)

- Instrument ΔIPW_{it} by Chinese imports in other high-income countries

Effect on labor market opportunities: Income

Labor income decreases

Δy_{rt}: log change in labor income by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.92^{**}				
	(0.40)				

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average labor income by 0.92%

Effect on labor market opportunities: Income

Labor income decreases more for less educated workers

Δy_{rt}: log change in labor income by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.92^{**}	-1.41^{***}	-0.55^{*}		
	(0.40)	(0.45)	(0.35)		

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average labor income by 0.92%
  - + Larger decline for less educated workers

Effect on labor market opportunities: Income

Labor income decreases more for less educated workers

Δy_{rt}: log change in labor income by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.92^{**}	-1.41^{***}	-0.55^{*}	-0.45	-0.36
	(0.40)	(0.45)	(0.35)	(0.63)	(0.40)

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A \$1,000 increase in imports
  - + Decreases average labor income by 0.92%
  - + Larger decline for less educated workers
  - + No effect for workers with bachelor degree or more

Effect on labor market opportunities: Employment

Employment decreases

Δy_{rt}: change in fraction of pop employed by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.73^{**}				
	(0.20)				

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average employment by 73bps

Effect on labor market opportunities: Employment

Employment decreases more for less educated workers

Δy_{rt}: change in fraction of pop employed by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.73^{**}	-1.06^{***}	-0.46^{***}		
	(0.20)	(0.30)	(0.13)		

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average labor income by 73bps
  - + Larger decline for less educated workers

Effect on labor market opportunities: Employment

Employment decreases more for less educated workers

Δy_{rt}: change in fraction of pop employed by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.73^{**}	-1.06^{***}	-0.46^{***}	-0.45^{**}	-0.31^{**}
	(0.20)	(0.30)	(0.13)	(0.18)	(0.12)

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average labor income by 73bps
  - + Larger decline for less educated workers
  - + Smallest effect for workers with bachelor degree or more

Effect on education: Dealing with migration

- Individuals age 18-25 migrate often, especially to attend college
  - $\rightarrow$ $\approx 50\%$ of freshmen in colleges $>$ 100 mi away from perm home (HERI at UCLA)
  - $\Longrightarrow$ Two strategies to deal with migration:

Effect on education: Dealing with migration

- Individuals age 18-25 migrate often, especially to attend college
  - $\rightarrow \approx 50\%$ of freshmen in colleges $>$ 100 mi away from perm home (HERI at UCLA)
  - $\Longrightarrow$ Two strategies to deal with migration:

1. Link to previous commuting zone $\rightarrow$ measure of migration migration
   - $\rightarrow$ Ages 18-25 currently enrolled in college

Effect on education: Dealing with migration

- Individuals age 18-25 migrate often, especially to attend college
  - $\rightarrow \approx 50\%$ of freshmen in colleges $>$ 100 mi away from perm home (HERI at UCLA)
  - $\Longrightarrow$ Two strategies to deal with migration:

1. Link to previous commuting zone $\rightarrow$ measure of migration migration
   - $\rightarrow$ Ages 18-25 currently enrolled in college

     No information on the household

Effect on education: Dealing with migration

- Individuals age 18-25 migrate often, especially to attend college
  - $\rightarrow \approx 50\%$ of freshmen in colleges $>$ 100 mi away from perm home (HERI at UCLA)
  - $\Longrightarrow$ Two strategies to deal with migration:

1. Link to previous commuting zone $\rightarrow$ measure of migration migration
   - $\rightarrow$ Ages 18-25 currently enrolled in college
   - No information on the household

2. Consider individual level PSID data $\rightarrow$ can follow individuals over time
   - $\rightarrow$ High school graduates enrolled in college

Effect on education: Dealing with migration

- Individuals age 18-25 migrate often, especially to attend college
  - $\rightarrow \approx 50\%$ of freshmen in colleges $>$ 100 mi away from perm home (HERI at UCLA)
  - $\Longrightarrow$ Two strategies to deal with migration:

1. Link to previous commuting zone $\rightarrow$ measure of migration migration
   - $\rightarrow$ Ages 18-25 currently enrolled in college
     No information on the household

2. Consider individual level PSID data $\rightarrow$ can follow individuals over time
   - $\rightarrow$ High school graduates enrolled in college
     Can link individuals to household

College enrollment increases in response to a trade shock

- Strategy 1: Link to previous CZ using ACS data

College enrollment increases in response to a trade shock

- Strategy 1: Link to previous CZ using ACS data

Δy_{rt}: change in enrolled in any year of college ages 18-25

	Enrollment$_t$	Enrollment$_{t+1}$
ΔIPW_{rt}	0.88^{**}	
	(0.19)	

Notes: $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A \$1,000 increase in imports
  - + Increases college enrollment by 88 bps

College enrollment increases in response to a trade shock

- Strategy 1: Link to previous CZ using ACS data

Δy_{rt}: change in enrolled in any year of college ages 18-25

	Enrollment$_t$	Enrollment$_{t+1}$
ΔIPW_{rt}	0.88^{**}	1.30^{*}
	(0.19)	(0.4)

Notes: $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A \$1,000 increase in imports
  - + Increases college enrollment by 88 bps
  - + Significantly strong delayed effect on enrollment of 130 bps

College enrollment increases in response to a trade shock

- Strategy 1: Link to previous CZ using ACS data

Δy_{rt}: change in enrolled in any year of college ages 18-25

	Enrollment$_t$	Enrollment$_{t+1}$
ΔIPW_{rt}	0.88^{**}	1.30^{*}
	(0.19)	(0.4)

Notes: $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A \$1,000 increase in imports
  - + Increases college enrollment by 88 bps
  - + Significantly strong delayed effect on enrollment of 130 bps
- Consistent with results for high school completion in Greenland & Lopresti (2016)

Effect on education by wealth level

- Strategy 2: individual level regressions with PSID data

Effect on education by wealth level

- Strategy 2: individual level regressions with PSID data

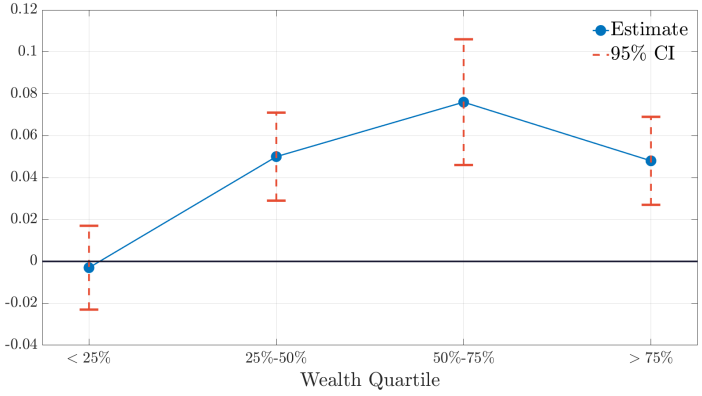
Linear prob model on college enrollment, $e_{nrt} \in \{0, 1\}$

$$e_{nrt} = \sum_q \beta^q \mathbb{I}_{\{Y_{h(n)rt} \in q\}} \Delta IPW_{rt} + \theta_Y Y_{h(n)rt} + \theta_e e^p_{h(n)rt} + \delta X_{rt} + u_{nrt}$$

+ Quartiles by households' wealth Y_{nrt}:
  - groups: $< 25\%$, $25\% - 50\%$, $50\% - 75\%$, $> 75\%$
+ controls: family wealth + HH's head education + regional-level

College enrollment increases for wealthy families only

College enrollment by wealth quartiles β^q

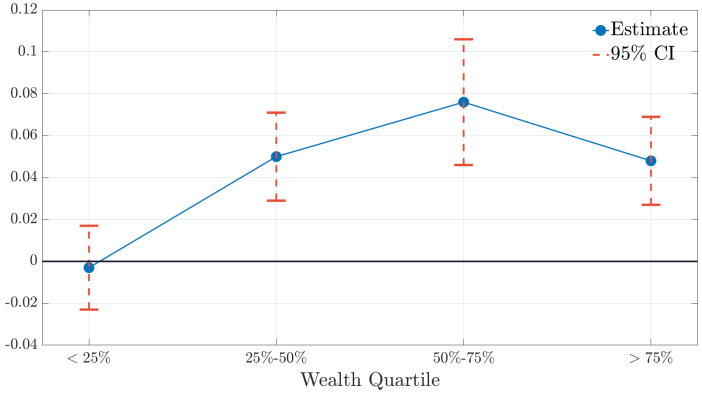


- Enrollment increases for top-wealth households, decreases for bottom-wealth.

▸ CPS (income)

College enrollment increases for wealthy families only

College enrollment by wealth quartiles β^q



- Enrollment increases for top-wealth households, decreases for bottom-wealth.
- A \$1,000 increase in ΔIPW increases enrollment ≈ 4 p.p

▸ CPS (income)

Evidence - main takeaways

1. Trade shocks detrimental labor market outcomes
   $\rightarrow$ especially for less educated workers

2. Young individuals adjust by enrolling into college

3. Enrollment increase driven by the middle/top of the wealth distribution

Model

Trade model with heterogeneous HHs and skill acquisition

→ OE with multiple regions trading goods and assets within and across borders

Trade model with heterogeneous HHs and skill acquisition

→ OE with multiple regions trading goods and assets within and across borders

+ Technologies: two sectors, services and manufacturing
  - o Intermediate goods → Tradable
    - Inputs: college workers & non-college workers
  - o Final goods → Non-tradable
    - Inputs: domestic region-specific & imported intermediate goods

Trade model with heterogeneous HHs and skill acquisition

→ OE with multiple regions trading goods and assets within and across borders

+ Technologies: two sectors, services and manufacturing
  - o Intermediate goods → Tradable
    - Inputs: college workers & non-college workers
  - o Final goods → Non-tradable
    - Inputs: domestic region-specific & imported intermediate goods

+ Households/Workers: continuum & finitely-lived
  - o Education: one-time decision at age $j = 1$ → utility cost + preference shock
  - o Sector-Region (LLM): switch at any age → utility cost + preference shock
  - o Intervivos transfer to kid at age $j = J_k$ → bequest motive
  - o Idiosyncratic labor risk, save in bonds return r^*, retire at J_R

Intermediate goods – tradable – sector $i = s, m$

$$\max_{L_{cri}, L_{nri}} p_{ri} z_{ri} \left(\gamma_{ri} L_{cri}^{\frac{\sigma-1}{\sigma}} + (1-\gamma_{ri}) L_{nri}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} - w_{cri} L_{cri} - w_{nri} L_{nri}$$

+ L_{cri} and L_{nri} denote college and non-college labor in region r and sector i
+ w_{cri} and w_{nri} denote college and non-college wages
+ z_{ri} sector productivity

Intermediate goods – tradable – sector $i = s, m$

$$\max_{L_{cri}, L_{nri}} p_{ri} z_{ri} \left(\gamma_{ri} L_{cri}^{\frac{\sigma-1}{\sigma}} + (1 - \gamma_{ri}) L_{nri}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} - w_{cri} L_{cri} - w_{nri} L_{nri}$$

+ L_{cri} and L_{nri} denote college and non-college labor in region r and sector i
+ w_{cri} and w_{nri} denote college and non-college wages
+ z_{ri} sector productivity

Key assumptions:

- college and non-college workers are substitutes: $\sigma > 1$
- Service is more intensive in college workers: $\gamma_{rs} > \gamma_{rm}$ (Cravino and Sotelo, 2018)

Decline in manufacturing *w.r.t.* services $\rightarrow$ lower demand for non-college *w.r.t.* college workers

Final goods – non-tradable – sector $i = s, m$

+ Technology: $Q_{ri} = \left[\omega^{\frac{1}{\eta_i}} D_{ri}^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} (D_{ri}^*)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$

  → D_i composite of domestic intermediates and D_i^* imported one

$$D_{ri} = \left(\sum_{r' \in \mathcal{R}} \alpha_{rr'}^{\frac{1}{\omega}} d_{rir'}^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}}$$

+ Profits $\max_{\{d_{rir'}\}_{r'}, D_{ri}^*} \left\{ q_{ri} Q_{ri} - \sum_{r' \in \mathcal{R}} \tau_{rir'} p_{r'i} d_{rir'} - p_i^* \tau_i^* D_{ri}^* \right\}$

  → price of final good $q_{ri} = \left[\omega \bar{p}_{ri}^{1-\eta} + (1-\omega) \left(\tau_i^* p_i^* \right)^{1-\eta} \right]^{\frac{1}{1-\eta}}$

  → $\bar{p}_{ri}$ ideal price index for the domestic Armington aggregator

+ $\tau_i^* \geq 1$ iceberg cost → control *trade openness*

Households

→ Dynastic framework with three stages: pre-education, education and working

Households

→ Dynastic framework with three stages: pre-education, education and working

Value of a worker at age j in labor market $\ell = (r, i)$

$$V_j(a, x, \ell, e) = \max_{c_s, c_m, a'} \left\{ U(c) + \mathbb{E}\left[\max_{\ell'} \left\{ \epsilon_{\ell'} - \psi_{je}(\ell, \ell') + \beta V_{j+1}(a', x', \ell', e) \right\} \right] \right\}$$

$$q_r c + q_a a' \leq w_{e\ell} x \bar{h} + (1 + r^*) q_a a, \qquad a' \geq \underline{a}_{j,e}$$

- consumption $c = \mathcal{C}(c_s, c_m)$, price index $q_r = \mathcal{Q}(q_{rs}, q_{rm})$.
- $\epsilon_{\ell'}$ realized and ℓ' choice at end of period → after c and a' chosen

  Artuc, Chaudhuri, and McLaren (2010), Caliendo, Dvorkin, and Parro (2020)
- education e is fixed

Households

→ Dynastic framework with three stages: pre-education, education and working

Value of a worker at age j in labor market $\ell = (r, i)$

$$V_j(a, x, \ell, e) = \max_{c_s, c_m, a'} \left\{ U(c) + \mathbb{E} \left[\max_{\ell'} \left\{ \epsilon_{\ell'} - \psi_{je}(\ell, \ell') + \beta V_{j+1}(a', x', \ell', e) \right\} \right] \right\}$$

$$q_r c + q_a a' \leq w_{e\ell} x \bar{h} + (1 + r^*) q_a a, \qquad a' \geq \underline{a}_{j,e}$$

- consumption $c = \mathcal{C}(c_s, c_m)$, price index $q_r = \mathcal{Q}(q_{rs}, q_{rm})$.
- $\epsilon_{\ell'}$ realized and ℓ' choice at end of period → after c and a' chosen

  Artuc, Chaudhuri, and McLaren (2010), Caliendo, Dvorkin, and Parro (2020)
- education e is fixed

Households

→ Dynastic framework with three stages: pre-education, education and working

Value of going to college $e = c$ at age $j = 1, 2$

$$V_j(a, x, \ell, c) = \max_{c_s, c_m, a'} \left\{ U(c) + \mathbb{E} \left[\max_{\ell'} \left\{ \epsilon_{\ell'} - \psi_{je}(\ell, \ell') + \beta V_{j+1}(a', x', \ell', c) \right\} \right] \right\}$$

$$q_r c + q_a a' + q_{rs} \kappa \leq w_{n\ell} x \frac{\bar{h}}{2} + (1 + r^*) q_a a, \qquad a' \geq \underline{a}_{j,c}$$

- κ cost college
- work part-time and receive non-college wage
- looser borrowing limit for college $\underline{a}_{j,c}$

Newborns and transfers

→ Dynastic framework with three stages: pre-education, education and working

+ Value to a newborn who receives a transfer Φ

$$\mathcal{V}_0(\Phi, x, \ell_p, e_p) = \mathbb{E}\left[\max_e \left\{-\phi \mathbb{I}_{e=c} + \mathbb{E}\left[\max_\ell \{\epsilon_\ell - \psi_0(\ell_p, \ell) + V_1(\Phi, x, \ell, e)\}\right]\right\}\right]$$

where $\phi \sim F_e(e_p)$, with e_p the parental state

Newborns and transfers

→ Dynastic framework with three stages: pre-education, education and working

+ Value to a newborn who receives a transfer Φ

$$\mathcal{V}_0(\Phi, x, \ell_p, e_p) = \mathbb{E}\left[\max_e \left\{-\phi \mathbb{I}_{e=c} + \mathbb{E}\left[\max_\ell \{\epsilon_\ell - \psi_0(\ell_p, \ell) + V_1(\Phi, x, \ell, e)\}\right\}\right]\right]$$

where $\phi \sim F_e(e_p)$, with e_p the parental state

+ Transfer at age $j = J_k$

$$\max_{\Phi \geq 0} \left\{V_{J_k}(a - \Phi, x_p, \ell_p, e_p) + \hat{\beta}\mathbb{E}\left[\mathcal{V}_0(\Phi, x, \ell_p, e_p)|x_p\right]\right\}$$

where $x \sim F_x(x_p)$, with x_p the parental state

Calibration

Calibration - key nationwide parameters

- Household: period $=$ 2 years, $J_k = 15$, $J_R = 25$
  - $\beta = 0.98 \rightarrow$ wealth/income $\approx$ 3.5-4
  - $\hat{\beta} = 0.35 \rightarrow$ intervivo transfers $\approx \$30{,}000$ per child
  - CRRA preferences with curvature $\sigma = 2$

Abbott, Gallipoli, Meghir & Violante (2019), Daruich (2022)

Calibration - key nationwide parameters

Households

- Household: period $= 2$ years, $J_k = 15$, $J_R = 25$
  - $\beta = 0.98 \rightarrow$ wealth/income $\approx$ 3.5-4
  - $\hat{\beta} = 0.35 \rightarrow$ intervivo transfers $\approx \$30{,}000$ per child
  - CRRA preferences with curvature $\sigma = 2$

- College decision
  - $\kappa \rightarrow$ cost of college $\approx \$6{,}000$ per year
  - $\phi(.) \rightarrow \approx 32\%$ of college graduates, inter-generational education persistence ≈ 0.69
  - $\underline{a}_c \rightarrow$ borrow up to $\approx \$23{,}000$ (for 14 years)

Abbott, Gallipoli, Meghir & Violante (2019), Daruich (2022)

Calibration - key nationwide parameters

Sectors

- Sectors: $\psi_{je}(\ell, \ell') = \psi_r + \psi_i$
  - $\varepsilon_\ell \sim Gumbel(-\rho\gamma, \gamma)$
  - ψ_i: sector persistence $\approx$ 97% Artuc, Chaudhuri, & McLaren (2010)
  - ψ_r: migration rate $\approx 2.50\%$ Kaplan & Schulhofer-Wohl (2017)
  - $\psi_c^{j=0}$: 25% migration upon college ?

Calibration - key nationwide parameters

- Sectors: $\psi_{je}(\ell, \ell') = \psi_r + \psi_i$
  - $\varepsilon_\ell \sim Gumbel(-\rho\gamma, \gamma)$
  - ψ_i: sector persistence $\approx$ 97% Artuc, Chaudhuri, & McLaren (2010)
  - ψ_r: migration rate $\approx 2.50\%$ Kaplan & Schulhofer-Wohl (2017)
  - $\psi_c^{j=0}$: 25% migration upon college ?

- Skill intensity by sector: $\gamma_s = 0.55$, $\gamma_m = 0.45$
  - $\rightarrow$ wage bill to college workers by sector

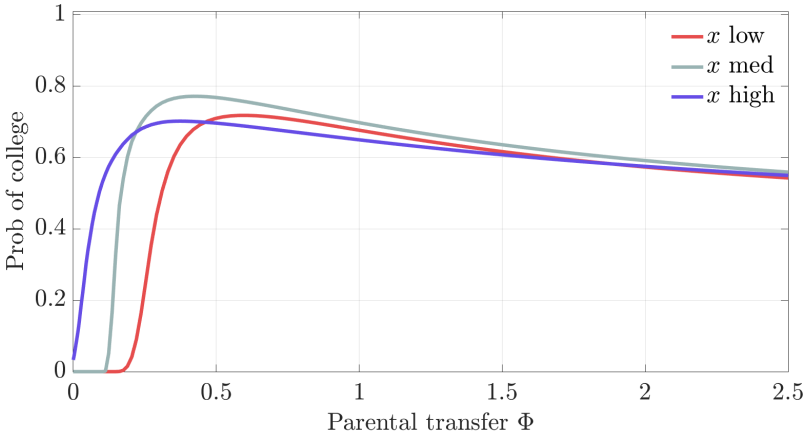
Calibration - key nationwide parameters

- Sectors: $\psi_{je}(\ell, \ell') = \psi_r + \psi_i$
  - $\varepsilon_\ell \sim Gumbel(-\rho\gamma, \gamma)$
  - ψ_i: sector persistence $\approx$ 97% Artuc, Chaudhuri, & McLaren (2010)
  - ψ_r: migration rate $\approx 2.50\%$ Kaplan & Schulhofer-Wohl (2017)
  - $\psi_c^{j=0}$: 25% migration upon college ?

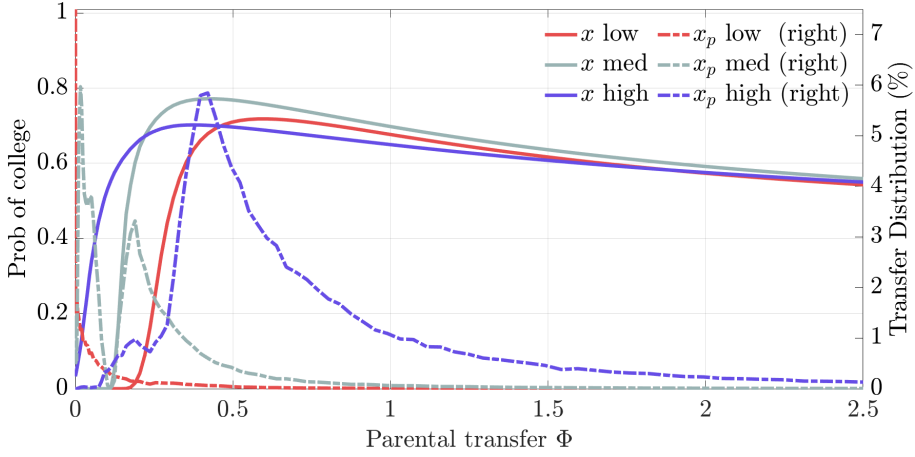
- Skill intensity by sector: $\gamma_s = 0.55$, $\gamma_m = 0.45$
  - $\rightarrow$ wage bill to college workers by sector

- Consumption bundle:
  - $c = \left(\sum_i \nu_i^{\frac{1}{\rho}} c_i^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}$, with $\rho = 0.5$, $\nu_s = 0.81$ and $\nu_m = 0.19$
  - $\rightarrow$ aggregate labor share by sector

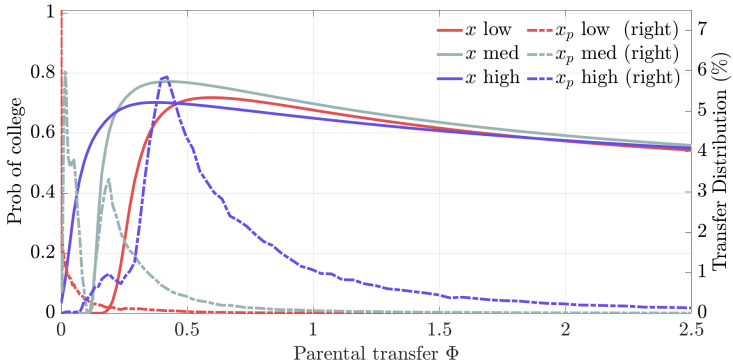
Education Policy



Education Policy



Education Policy



College Graduation Rates					
	Q1	Q2	Q3	Q4	Q5
Data	0.13	0.18	0.27	0.39	0.55
Model	0.07	0.18	0.29	0.45	0.59

Source: Vardishvili (2023), NLSY 1997

Calibration - three regions

+ Three regions
  - differ only in productivities z_{rs} and z_{rm}

+ Match employment share + population mass by region in 1990
  - West $\rightarrow$ low exposure (low manufacturing labor share)
  - Midwest $\rightarrow$ high exposure (high manufacturing labor share)
  - North-East $\rightarrow$ mid exposure (average manufacturing labor share)

  $\rightarrow$ choose z_{rs} and z_{rm} keeping income per-worker across regions approx constant

+ Choose domestic trade costs, $\tau_{rmr'}$, to match domestic trade shares (CFS for 1993)

Modeling trade openness - nationwide

Main Exercise:

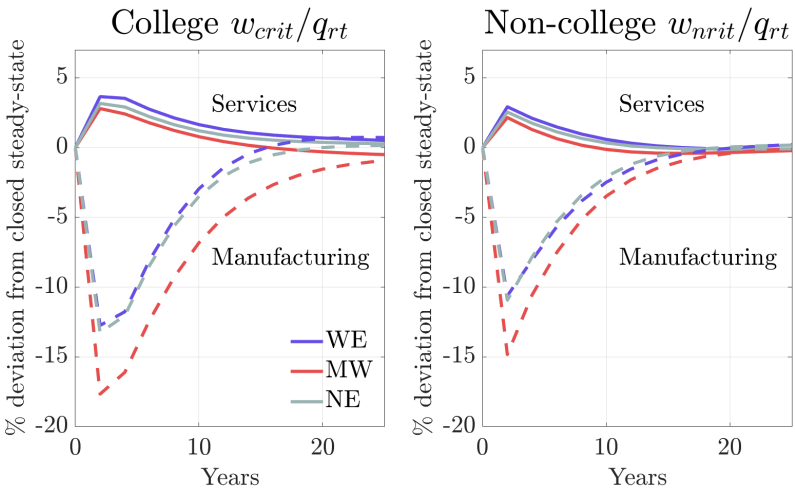
- At $t = 0$ the economy is at a steady state with high τ_m^*, and τ_s^*
  - + "Closed economy" calibrated to the 1990s
  - + Home-bias: services $\approx$ 98%, and manuf $\approx$ 90%

- At $t = 1$, τ_m^* unexpectedly decrease (τ_s^* as well)
  - + Large decline in the cost of importing manufacturing goods
  - + A sudden and permanent shock
  - + The economy slowly converges to the new steady-state
  - + "Open economy" calibrated to the 2010s $\rightarrow$ manuf h-b $\approx 75\%$

The effects of trade openness

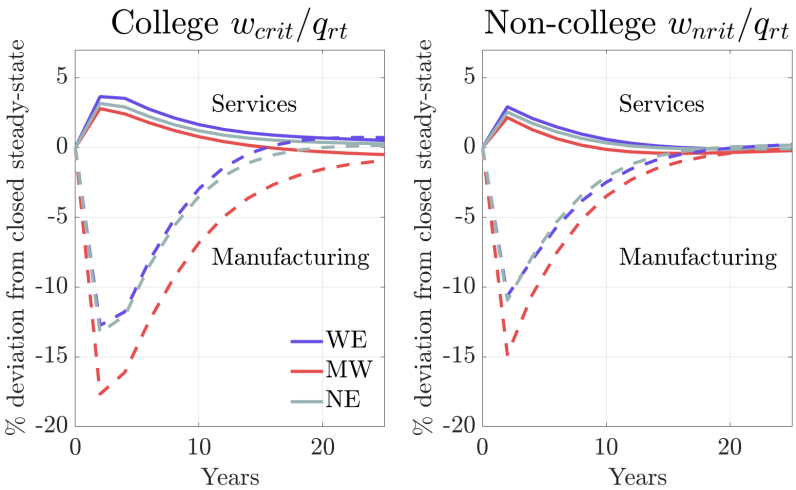
1. Transitional dynamics
2. Model vs data
3. Who goes more to college and welfare consequences
4. Skill acquisition as margin of adjustment

Evolution of real wages



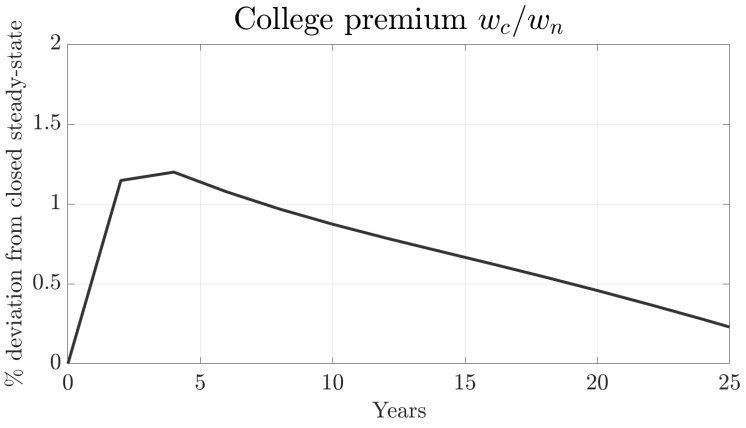
- Services expand and manufacturing contracts
- Wages respond accordingly

Evolution of real wages



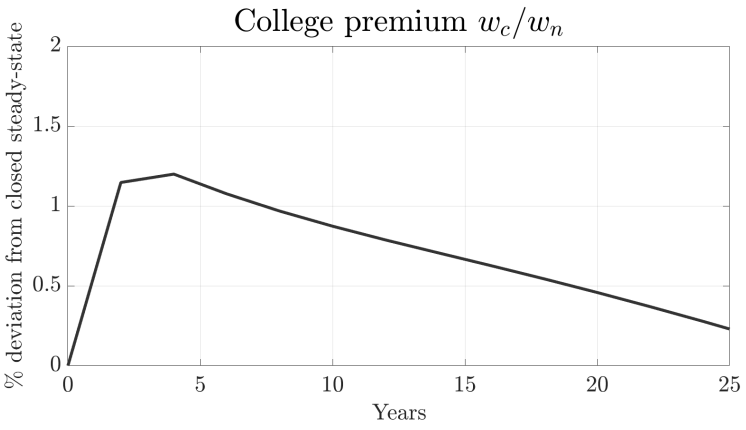
- Services expand and manufacturing contracts
- Wages respond accordingly
- Effect depends on exposure to the shock

Returns to college increase...



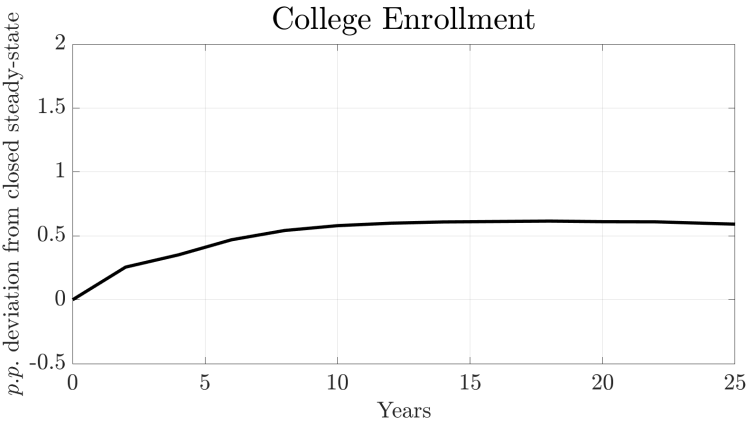
- Expansion in services leads to higher college wage premium

Returns to college increase...



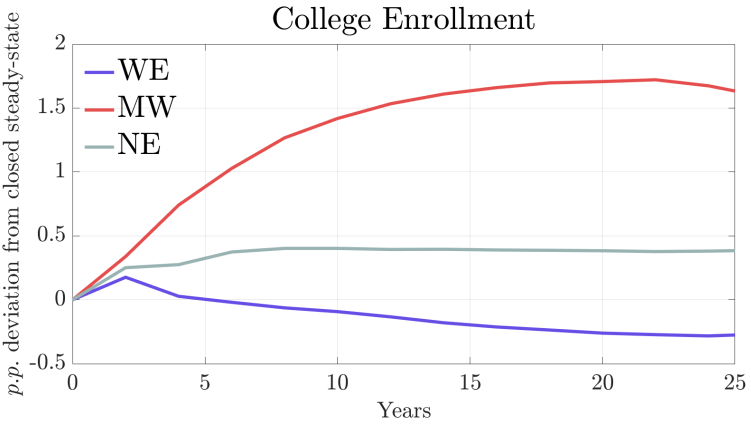
- Expansion in services leads to higher college wage premium
- Larger increase on impact than in the long-run

... and college enrollment increases as well



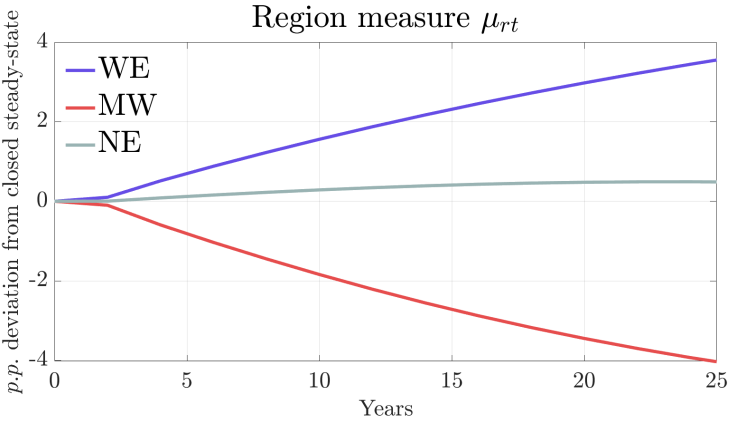
- Increased return to college leads to higher college enrollment

... and college enrollment increases as well



- Increased return to college leads to higher college enrollment
- Effect is larger for the highly exposed region

Midwest contracts while other regions expand

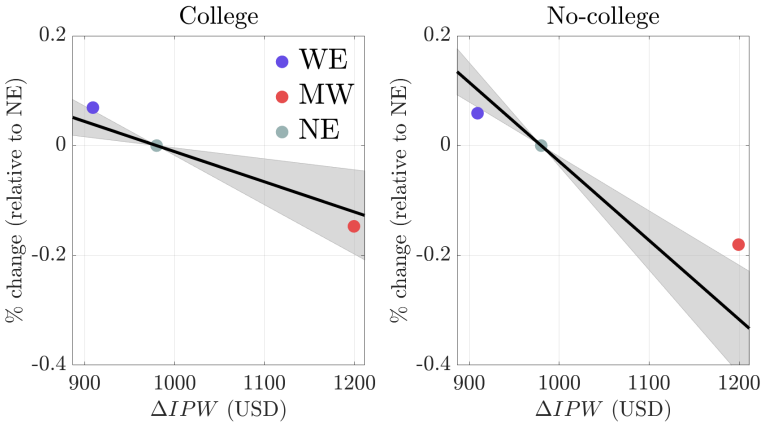


- Workers leave the Midwest as the manufacturing sector contracts...
- ...and they relocate to other regions as services expand

The effects of trade openness

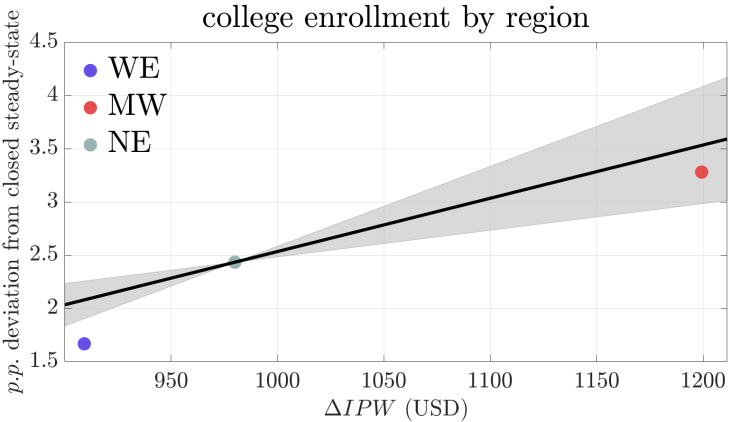
1. Transitional dynamics
2. Model vs data
3. Who goes more to college and welfare consequences
4. Skill acquisition as margin of adjustment

Model vs data: Labor earnings (30-55)



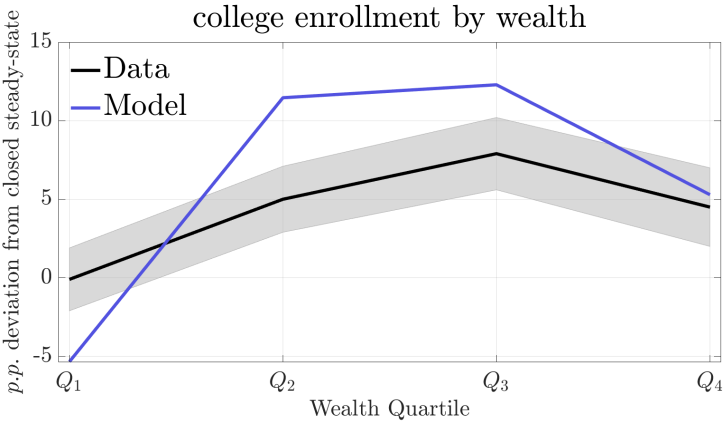
- Model delivers similar results to regressions for labor earnings

Model vs data: College enrollment



- Model predictions for college enrollment are in line with evidence

Model vs data: College enrollment across wealth



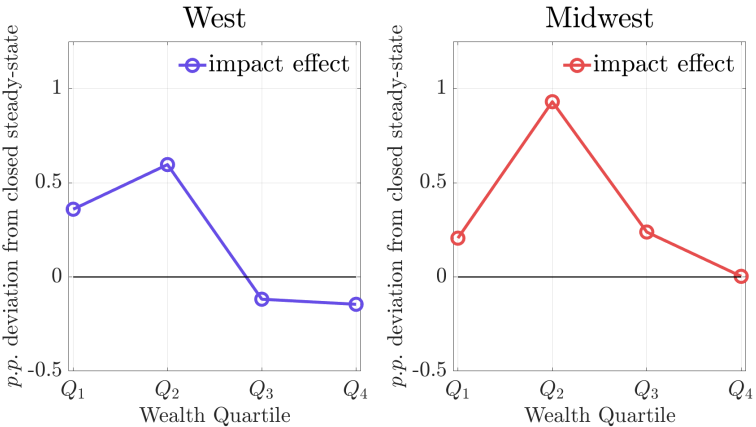
- Model predictions for college enrollment across wealth distribution are broadly consistent with the data

The effects of trade openness

1. Transitional dynamics
2. Model vs data
3. Who goes more to college and welfare consequences
4. Skill acquisition as margin of adjustment

Who goes more to college?

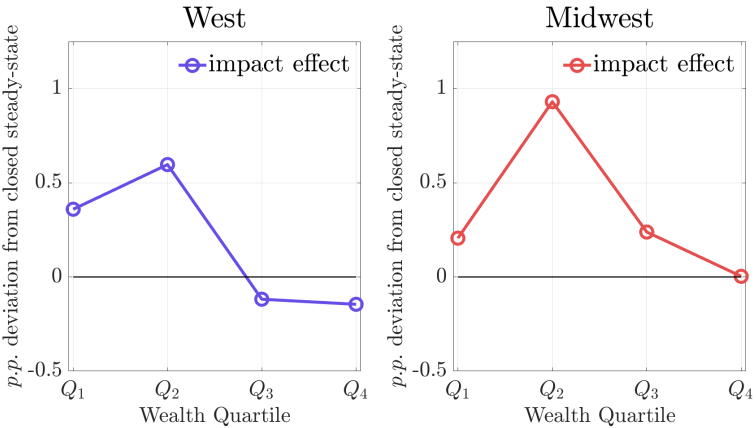
College enrollment across regions



- College enrollment increases most in high exposure region

Who goes more to college?

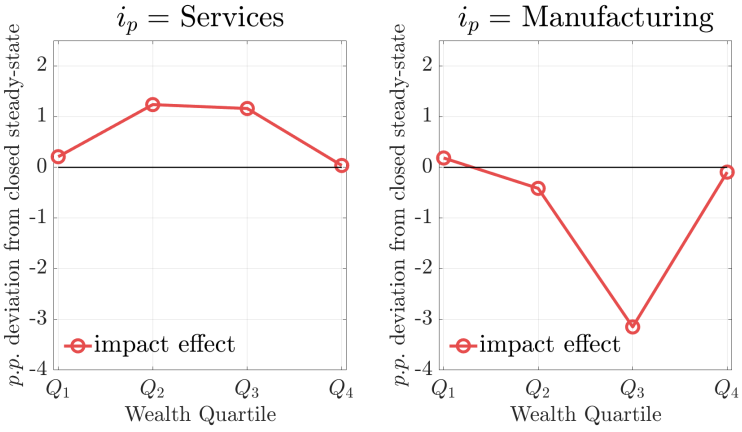
College enrollment across regions



- College enrollment increases most in high exposure region
- As in data, increase is concentrated in middle of wealth distribution

Who goes to college more?

College enrollment by sector - Midwest (high exposure) region

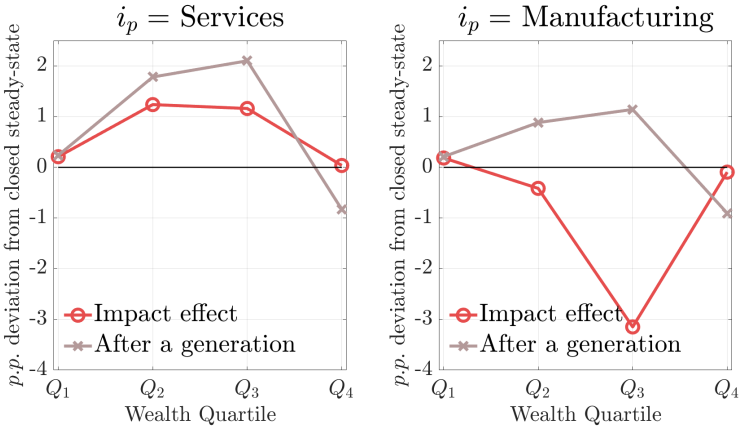


- Decline concentrated in manuf households in middle of wealth distribution
- Sectoral differences (as in data)...

▸ CPS (income)

Who goes to college more?

College enrollment by sector - Midwest (high exposure) region

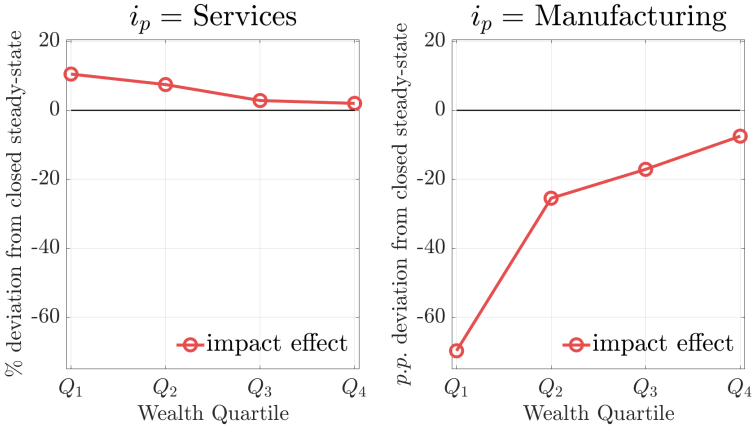


- Decline concentrated in manuf households in middle of wealth distribution
- Sectoral differences (as in data)...
- ...dissipate after a generation.

▸ CPS (income)

The role of parental transfers

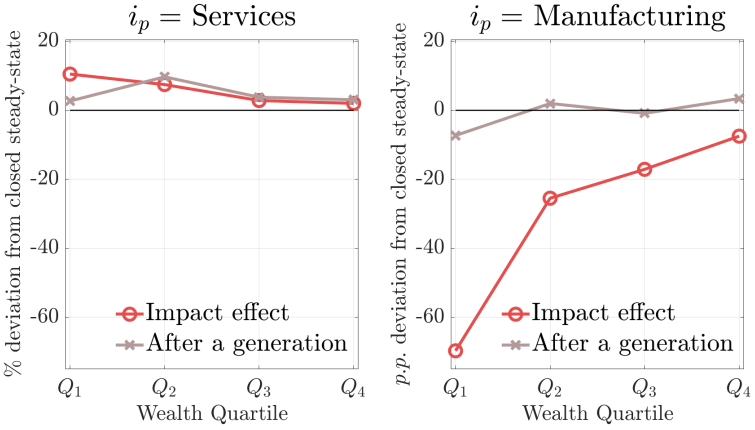
Transfers by sector - Midwest (high exposure) region



- Transfers decline sharply in manufacturing
- Explains the differential in college enrollments

The role of parental transfers

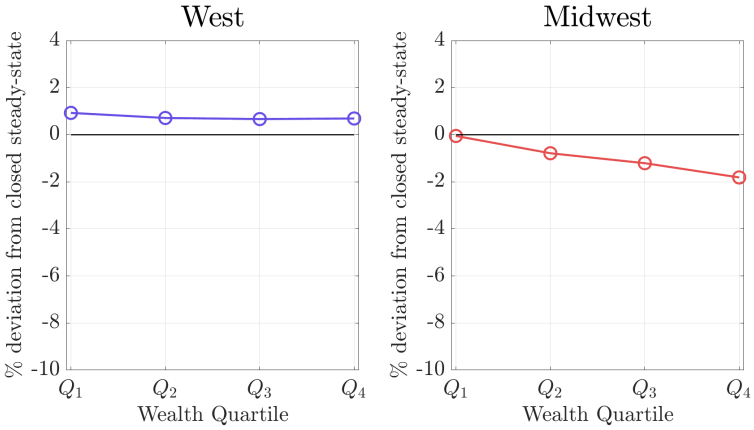
Transfers by sector - Midwest (high exposure) region



- Transfers decline sharply in manufacturing
- Explains the differential in college enrollments
- Reverts after a generation.

Uneven welfare consequences

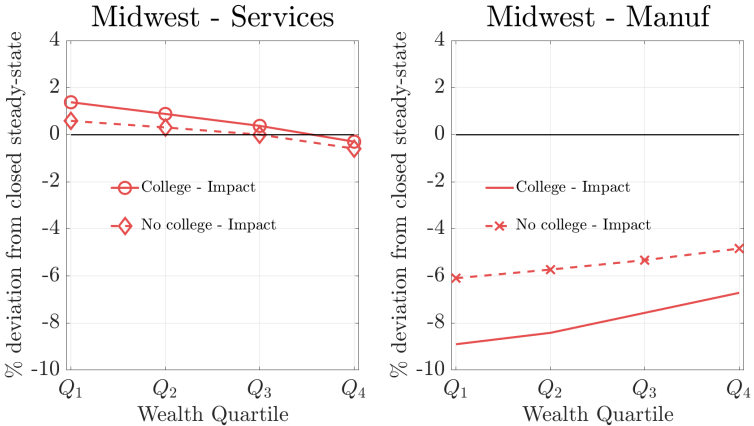
Consumption equivalents by region



- Welfare gains in the West and losses in the Midwest
- Welfare losses in the Midwest concentrated in wealthy households

Uneven welfare consequences

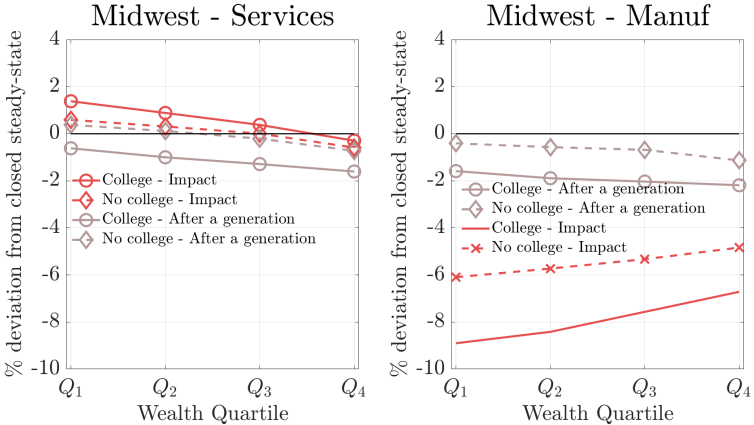
Consumption Equivalents - Midwest (high exposure) region



- Heterogeneity across sectors and education levels
- Welfare losses concentrated in manufacturing wokers

Uneven welfare consequences

Consumption Equivalents - Midwest (high exposure) region



- Heterogeneity across sectors and education levels
- Welfare losses concentrated in manufacturing wokers

The dynamic effects of trade openness

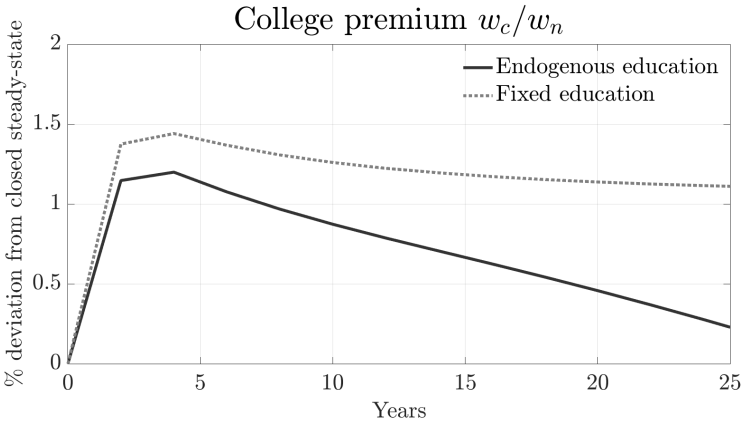
1. Cross-regional differences
2. Who goes to college more?
3. The welfare consequences of trade openness
4. Skill acquisition as margin of adjustment

A model with fixed education

- Education is a type inherited from parents
  - + Still have to pay cost of college
  - + Parents choose transfers optimally
  - + Sectoral choice as before

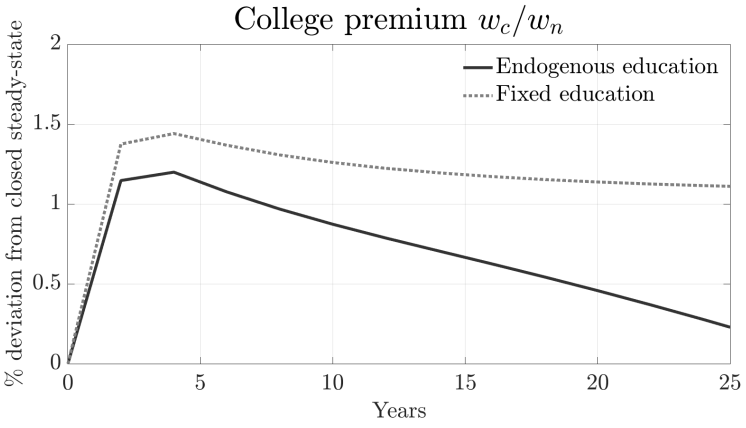
$\rightarrow$ education is not a margin of adjustment any more

Fixed Education induces a larger college premium



- The wage premium increases more on impact...

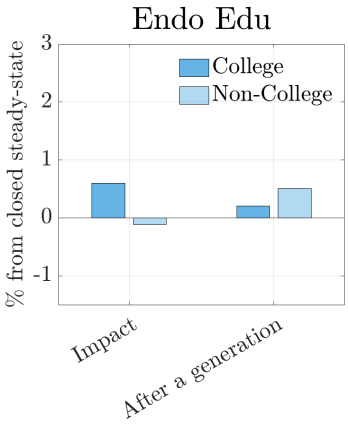
Fixed Education induces a larger college premium



- The wage premium increases more on impact...
- And remains permanently higher

Welfare gains differences persist with Fixed Education

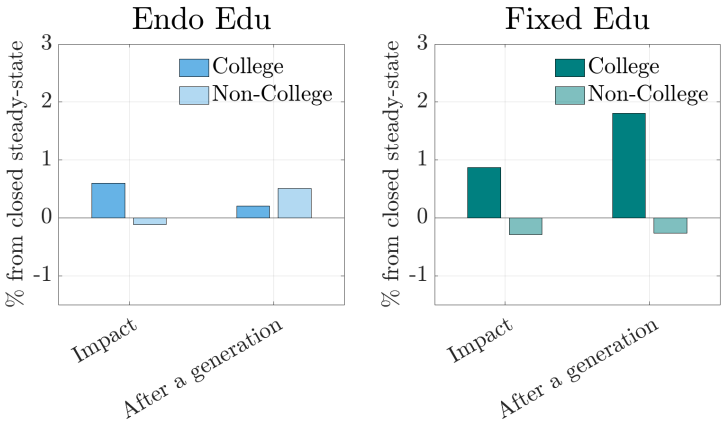
Consumption Equivalent with Endogenous and Fixed education



+ Welfare gain differentials lessen with endogenous education after a generation ...

Welfare gains differences persist with Fixed Education

Consumption Equivalent with Endogenous and Fixed education



+ Welfare gain differentials lessen with endogenous education after a generation ...
+ but they persist with fixed education

$\Rightarrow$ For new generations, the redistributive effects of endogenous education are key

Model - main takeaways

- Trade openness has very different effects across regions
- Services expand $\rightarrow$ wage premium increases $\rightarrow$ college enrollment increases
  - Effect concentrated in wealthier households and/or in services
- Welfare implications:
  - Short-run: uneven gains and losses driven by region and sector
  - Long-run: only gains, more even due to endogenous skill acquisiton

Conclusions

Next steps:

- *Evidence:*
  - What type of college? Exploit NLSY
- *Model:*
  - Calibration of steady state and transition: migration, wealth, timing of openness

Conclusions

Next steps:

- *Evidence:*
  - What type of college? Exploit NLSY
- *Model:*
  - Calibration of steady state and transition: migration, wealth, timing of openness
  - Richer decomposition of margins of adjustment: migration by age, sector
  - Policy: College subsidies vs. Trade Adjustment Assistance? Gradual openness?

Conclusions

Next steps:

- *Evidence:*
  - + What type of college? Exploit NLSY
- *Model:*
  - + Calibration of steady state and transition: migration, wealth, timing of openness
  - + Richer decomposition of margins of adjustment: migration by age, sector
  - + Policy: College subsidies vs. Trade Adjustment Assistance? Gradual openness?

- Adjustment to structural changes: automation, green transition, ...

Conclusions

Next steps:

- *Evidence:*
  - + What type of college? Exploit NLSY
- *Model:*
  - + Calibration of steady state and transition: migration, wealth, timing of openness
  - + Richer decomposition of margins of adjustment: migration by age, sector
  - + Policy: College subsidies vs. Trade Adjustment Assistance? Gradual openness?

- Adjustment to structural changes: automation, green transition, ...

Thank you!

Appendix

Measuring trade shocks – Autor, Dorn, & Hanson (2013)

- **Import penetration** in region (market) r in period t

$$\Delta IPW_{rt} = \sum_i \frac{L_{rit}}{L_{rt}} \frac{\Delta M_{it}}{L_{it}}$$

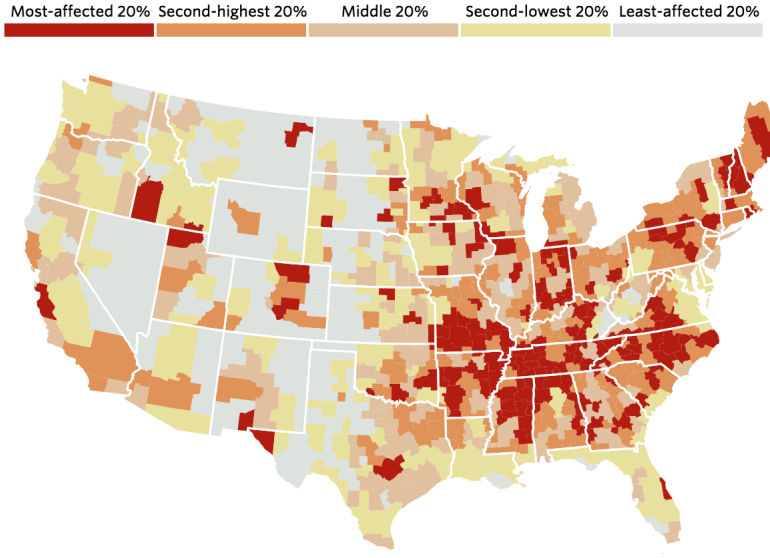
i: sector, M_{it}: Chinese imports, L_{rit}: workers sector i and region r,

$$L_{rt} = \sum_i L_{rit}, \text{ and } L_{it} = \sum_r L_{rit}$$

- Data overview:
  - + 722 commuting zones (regions)
  - + Two waves
    - Period 1990-2000: ΔIPW_{rt} *Median*: \$890, *IQR*: \$600
    - Period 2000-2007: ΔIPW_{rt} *Median*: \$2,070, *IQR*: \$1,500

map return

Measuring trade shocks – Autor, Dorn, & Hanson (2013)



return

Effect on labor market opportunities: Employment

Δy_{rt}: change in fraction of pop employed by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.73^{**}				
	(0.20)				

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average employment by 73bps

Effect on labor market opportunities: Employment

Δy_{rt}: change in fraction of pop employed by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.73^{**}	-1.06^{***}	-0.46^{***}		
	(0.20)	(0.30)	(0.13)		

Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - Decreases average labor income by 73bps
  - Larger decline for less educated workers

Effect on labor market opportunities: Employment

Δy_{rt}: change in fraction of pop employed by education, ages 30-55

	All	High School	Some Coll	2-y program	Bachelor
ΔIPW_{rt}	-0.73^{**}	-1.06^{***}	-0.46^{***}	-0.45^{**}	-0.31^{**}
	(0.20)	(0.30)	(0.13)	(0.18)	(0.12)

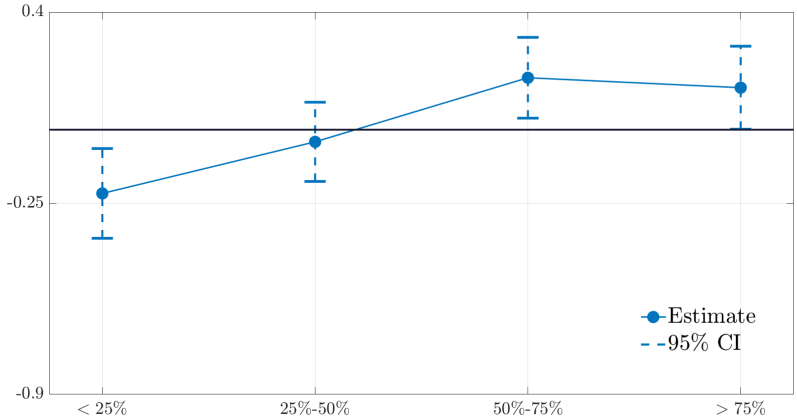
Notes: *"Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more;* $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A $1,000 increase in imports
  - + Decreases average labor income by 73bps
  - + Larger decline for less educated workers
  - + Smallest effect for workers with bachelor degree or more

return

Effect on education by income level

College enrollment by income quartiles β^q

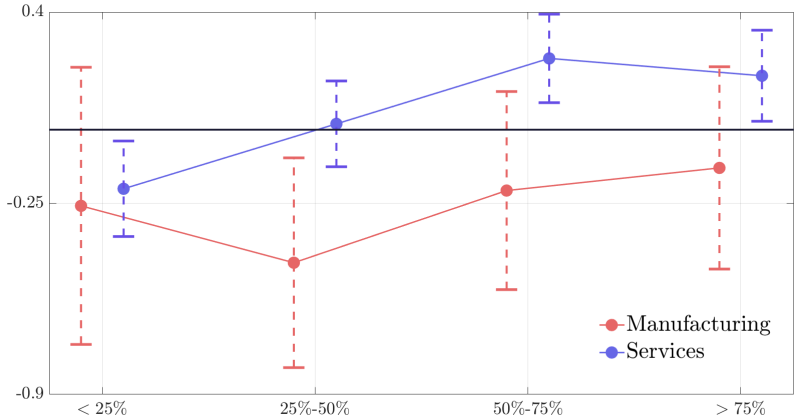


- Enrollment increases for top-income households
- Results by income quartile similar to wealth quartile

▸ PSID (wealth) ▸ Model

Effect on education by income level

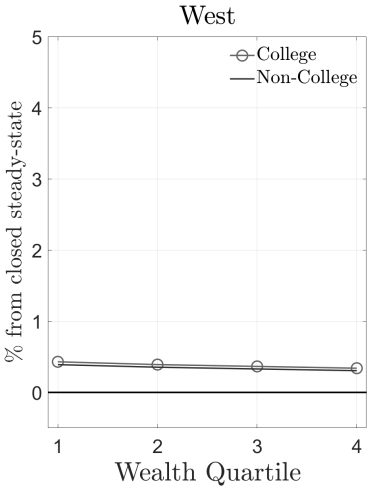
College enrollment by income quartiles β^q: effect by sector

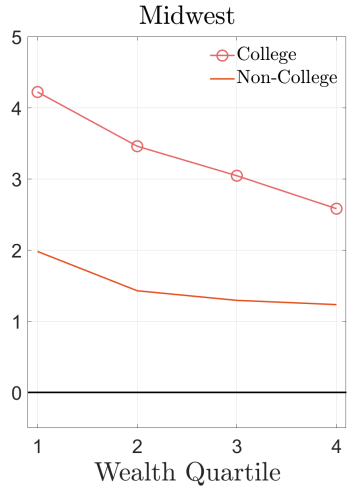


- Enrollment increases for top-income households
- Results by income quartile similar to wealth quartile
- Effect is larger for households working in services

▸ PSID (wealth) ▸ Model

Uneven Welfare gains of trade

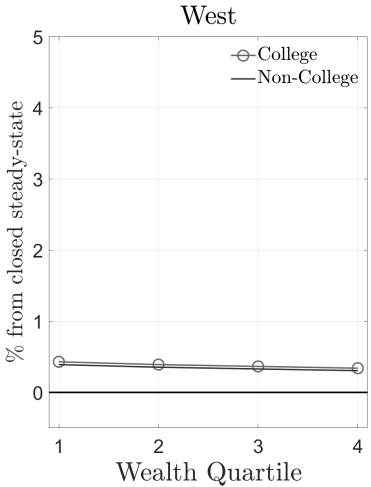


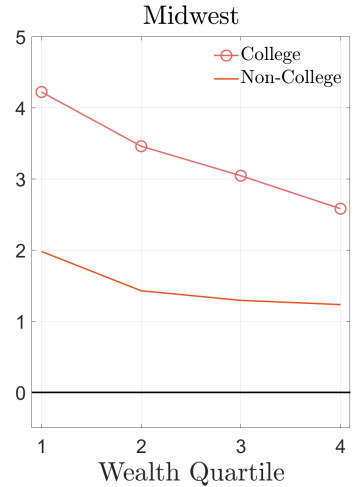


- Workers with and without a college education gain on impact

return

Uneven Welfare gains of trade





- Workers with and without a college education gain on impact
- Poor households with a college education gain the most.

return

Effect on Migration - ACS data

Δy_{rt}: change in migration number

	ages 18-25 college	ages 18-25 no college	ages 30-55
ΔIPW_{rt}	0.026^{**}	0.008	0.012
	(0.01)	(0.02)	(0.01)

Notes: $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$

- A \$1,000 increase in imports per worker
  - + Increases migration for ages 18-25 if enrolled in college by 2.6%
  - + Migration doesn't respond for other groups

return