Tradability and the Labor-Market Impact of Immigration: Theory and Evidence from the United States

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Immigration and domestic labor market outcomes

- Large literature: variation in exposure across geographic regions, skill groups
- Within regions, jobs are differentially exposed to immigration
- Occupations (or industries) differ in immigrant-intensity and tradability
  - textile machine operation, housekeeping, firefighting

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1. Empirically: $\uparrow$ immigrants into a region in U.S.
   1. within less tradable occupations: $\downarrow$ native employment in more relative to less immigrant-intensive occupations (crowding out)
   2. within more tradable occupations: neither crowding out nor in
2. Mechanism: price $\downarrow$ in immigrant-intensive occupations, less so in more tradable occupations
3. $\Rightarrow$ variation in native wage outcomes across occupations

   workers in immigrant-intensive, non-tradable occup. gain less (or lose)

Theory

Occupation production

- Production of occupation o in region r task production function

$$Q_{ro} = A_{ro} \left(\left(A^I_{ro} L^I_{ro} \right)^{\frac{\rho-1}{\rho}} + \left(A^D_{ro} L^D_{ro} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}$$

  - Immigrant cost share, $S^I_{ro} \geq S^I_{ro'}$ iff $\left(A^I_{ro} / A^D_{ro} \right)^{\rho-1} \geq \left(A^I_{ro'} / A^D_{ro'} \right)^{\rho-1}$

Occupation production

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- Supply of workers in region r, N^D_r and N^I_r

- Each worker $k = D, I$ chooses o to max. wage income $\underbrace{W^k_{ro}}_{\text{"occ. wage"}} \times \underbrace{\varepsilon_{\omega o}}_{\text{eff. units}}$

$$L^k_{ro} = \int_{\omega \in \Omega^k_{ro}} \varepsilon_{\omega o} d\omega$$

where $\varepsilon_{\omega o} \sim$ Fréchet with parameter $\theta > 0$, where $\uparrow \theta \Rightarrow \downarrow$ dispersion $\Rightarrow$ higher labor supply elasticity

skilled and unskilled

Occupation demand

And occupation's price sensitivity of demand

- Final good produced using range of occupations, CES: η

$$Y_r = \left(\sum_{o \in \mathcal{O}} \mu_{ro}^{\frac{1}{\eta}} \left(Y_{ro} \right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

- Absorption of each occupation uses output from different regions, CES: α

$$Y_{ro} = \left(\sum_{j \in \mathcal{R}} Y_{jro}^{\frac{\alpha-1}{\alpha}} \right)^{\frac{\alpha}{\alpha-1}}$$

  - subject to bilateral trade costs: $Q_{ro} = \sum_{j \in \mathcal{R}} \tau_{rjo} Y_{rjo}$

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- $\Rightarrow$ Occupation demand elasticity

$$\epsilon_{ro} \equiv S_{ro}^{\text{trade}} \times \alpha + (1 - S_{ro}^{\text{trade}}) \times \eta$$

- Occupations grouped into two disjoint sets, $g = T, N$, analytics: $\epsilon_{rT} > \epsilon_{rN}$

Comparative static: $\uparrow$ in the number of immigrants

- Consider o in set $g = \{T, N\}$, assume $-r$ prices & quantities fixed

$$n^k_{ro} = \alpha^k_{rg} + \frac{(\theta+1)\,(\epsilon_{rg} - \rho)}{\theta + \epsilon_{rg}} S^I_{ro} n^I_r \Phi^I_r$$

$$w^k_{ro} = \alpha^{wk}_{rg} + \frac{(\epsilon_{rg} - \rho)}{\theta + \epsilon_{rg}} S^I_{ro} n^I_r \Phi^I_r$$

$\Phi^I_r \geq 0$ where $w^D_{ro} - w^I_{ro} = \Phi^I_r n^I_r$

- Margins of adjustment (two ways to absorb immigrants):
  1. output expansion of I-intensive occupations — crowding-in
     - ★ stronger the more sensitive is occupation demand to price
  2. substitution from natives to immigrants w/in each occupation — crowding-out
     - ★ stronger the more substitutable are natives and immigrants

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- Adjustment within T v.s. within N: $\epsilon_{rN} < \epsilon_{rT} \Rightarrow$
  - more crowding-out (or less crowding-in) w/in N
  - wages $\downarrow$ in I-intensive occupations more (or $\uparrow$ less) w/in N

Comparative statics: generalizations

- Add education heterogeneity
  - $L_{ro}^k = \sum_e L_{reo}^k$, where $L_{reo}^k = Z_{reo}^k \int_{z \in \mathcal{Z}_{reo}^k} \varepsilon(z, o)\, dz$
  - Assume $Z_{reo}^k = Z_{re}^k$, then sufficient statistic $n_r^k \equiv \sum_e \frac{S_{reo}^k}{S_{ro}^k} n_{re}^k$
- Allow for changes in native supply and in occupation productivity

$$n_{reo}^k = \alpha_{reg}^k + \frac{(\epsilon_{rg} - \rho)(\theta + 1)}{\epsilon_{rg} + \theta} \tilde{w}_r S_{ro}^I + \frac{(\epsilon_{rg} - 1)(\theta + 1)}{\epsilon_{rg} + \theta} a_{ro}$$

$$\tilde{w}_r \equiv w_{ro}^D - w_{ro}^I = \Phi_r^I n_r^I + \Phi_r^D n_r^D + \sum_o \Phi_{ro}^A a_{ro}$$

Comparative statics: generalizations

- Add education heterogeneity
  - $L^k_{ro} = \sum_e L^k_{reo}$, where $L^k_{reo} = Z^k_{reo} \int_{z \in \mathcal{Z}^k_{reo}} \varepsilon(z, o)\, dz$
  - Assume $Z^k_{reo} = Z^k_{re}$, then sufficient statistic $n^k_r \equiv \sum_e \frac{S^k_{reo}}{S^k_{ro}} n^k_{re}$
- Allow for changes in native supply and in occupation productivity

$$n^k_{reo} = \alpha^k_{reg} + \frac{(\epsilon_{rg} - \rho)(\theta + 1)}{\epsilon_{rg} + \theta} \tilde{w}_r S^I_{ro} + \frac{(\epsilon_{rg} - 1)(\theta + 1)}{\epsilon_{rg} + \theta} a_{ro}$$

$$\tilde{w}_r \equiv w^D_{ro} - w^I_{ro} = \Phi^I_r n^I_r + \Phi^D_r n^D_r + \sum_o \Phi^A_{ro} a_{ro}$$

- Re-write:

$$n^D_{reo} = \alpha^D_{reg} + \beta^D_r x_{ro} + \beta^D_{rN} \mathbb{I}_o(N)\, x_{ro} + \nu^D_{reo} \quad \text{where} \quad x_{ro} \equiv S^I_{ro} n^I_r$$

$$\beta^D_r \equiv \frac{(\epsilon_{rT} - \rho)(\theta + 1)}{\epsilon_{rT} + \theta} \Phi^I_r \qquad \beta^D_{Nr} \equiv \frac{(\theta + \rho)(\theta + 1)(\epsilon_{rN} - \epsilon_{rT})}{(\epsilon_{rN} + \theta)(\epsilon_{rT} + \theta)} \Phi^I_r$$

Connecting theory and data

Empirical implementation

$$n^D_{reo} = \alpha^D_{reg} + \beta^D_r x_{ro} + \beta^D_{rN} \mathbb{I}_o(N) x_{ro} + \nu^D_{reo} \quad \text{where} \quad x_{ro} \equiv \sum_e S^I_{reo} n^k_{re}$$

- Estimate average treatment effect: β^D and β^D_N
- Letting $a_{ro} = a_o + \tilde{a}_{ro}$, incorporate national occupation fixed effects

$$n^D_{reo} = \alpha^D_{reg} + \alpha_o + \beta^D x_{ro} + \beta^D_N \mathbb{I}_o(N) x_{ro} + \nu^D_{reo}$$

Empirical implementation

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$$n^D_{reo} = \alpha^D_{reg} + \alpha_o + \beta^D x_{ro} + \beta^D_N \mathbb{I}_o(N) x_{ro} + \nu^D_{reo}$$

- Residual contains n^D_r and a_{ro}
  - May be correlated with x_{ro} through n^I_{re}
  - Use variant of Card instrument

$$x^*_{ro} \equiv \sum_e S^I_{reo} \frac{\Delta N^{I*}_{re}}{N^I_{re}} \quad \text{with} \quad \Delta N^{I*}_{re} \equiv \sum_c f_{rec} \Delta N^{-r}_{ec}$$

  where c is a source (country or country group) of immigrants

- a_{ro} may be correlated with x_{ro} through S^I_{reo}; also measurement error in S^I_{reo}
  - Robustness: use S^I_{-reo}, lags of S^I_{reo}

Data

- Census Integrated Public Use Micro Samples (IPUMS):
  - 1980: 5 percent census; 2012 three-year ACS: 3 percent sample
  - Individuals between age 16 and 64
    - Foreign-born share of U.S. working age hours $\uparrow$ from 6.6 to 16.4 percent
- Local labor markets: 722 commuting zones
- Education: two native groups (SMC-, CLG+)
- Instrument:
  - twelve sources (e.g. Mexico, China, India, Western Europe)
  - three education groups (HSD, HSG – SMC, CLG+)

Occupations and tradability

- 50 occupations
  - Slight aggregation in baseline (50 occupations)
- Tradability: Use Blinder and Krueger (JOLE 2013) measure of occupation "offshorability"
  - Based on professional coders' assessment of ease with which each occupation could potentially be offshored
  - Goos et al. (2014) provide evidence supporting this measure:
  - Grouped into 25 tradable and 25 non-tradable, using median
- Results robust using industries instead of occupations
  - tradables: agriculture, manufacturing, and mining

Occupation tradability

Most tradable occupations	Least tradable occupations
Fabricators	Firefighting
Printing Machine Operator	Therapists
Woodworking Machine Operator	Construction Trade
Metal and Plastic Processing Operator	Personal Service
Textile Machine Operator	Private Household Occupations
Math and Computer Science	Guards
Records Processing	Vehicle Mechanic
Machine Operator, Other	Electronic Repairer
Precision Production, Food and Textile	Health Assessment
Computer, Communication Equipment Operator	Extractive

- 19 of 50 occupations achieve the minimum tradability measure

Empirics: Allocation regressions

Domestic allocation results

Ignoring occupation tradability

$$n^D_{ro} = \alpha^D_r + \alpha^D_o + \beta^D x_{ro} + \iota^D_{ro}$$

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	-.088	-.1484**	-.0988**	-.1298***	-.2287***	-.2099***
	(.0646)	(.0685)	(.0407)	(.0399)	(.0472)	(.0366)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.822	.822	.822	.68	.68	.679
F-stat (first stage)		129.41			99.59	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%.

- Ignoring differences between more and less tradable occupations: evidence that immigrants crowd out native workers

Domestic allocation results

$$n_{ro}^D = \alpha_{rg}^D + \alpha_o^D + \beta^D x_{ro} + \beta_N^D \mathbb{I}_o(N)\, x_{ro} + \nu_{ro}^D$$

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.089*	.0086	.0053	.0223	-.0335	-.0209
	(.0492)	(.0884)	(.0609)	(.036)	(.066)	(.0599)
β_N^D	-.303***	-.303***	-.238***	-.309***	-.373***	-.33***
	(.062)	(.101)	(.091)	(.097)	(.126)	(.113)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.836	.836	.836	.699	.699	.699
Wald Test: P-values	0.00	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		105.08			72.28	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

1. $\beta^D = 0$: Neither crowding in nor out within T
2. $\beta_N^D < 0$: More crowding out within N than within T

- LA 1980-12: private household services & firefighting (N): $x_{ro} - x_{ro'} = 0.65$ $\Rightarrow \mathbf{n_{ro} - n_{ro'} = 0.22}$, labor supply elasticity $= 2 \Rightarrow \mathbf{w_{ro} - w_{ro'} = 0.11}$

Robustness: domestic allocation

- Robustness to confounding secular trends
  - Restrict CZs, excluding 5 largest immigrant-receiving CZs Details
  - Sample years:
    - 1980-2007 Details
    - 1990-2012 Details
    - 1980-1990 Details
  - Dropping workers employed in routine or communication-intensive occupations Details: routine Details: communication
  - Use national S^{I}_{-reo} rather than regional S^{I}_{reo} Details
  - Averaging of 1970, 1980 to calculate S^{I}_{reo} Details
- Robustness to definitions of tradability
  - Different cutoffs for occupation tradability Details
  - Analysis by industry Details

Occupation wages

$$Wage^D_{reo} \equiv W^D_{ro} L^D_{reo} / N^D_{reo} = \gamma W^D_{ro} Z^k_{reo} \left(\pi^D_{reo}\right)^{\frac{-1}{\theta+1}}$$

$$\implies w^D_{ro} = wage^D_{reo} + \frac{1}{\theta+1} d \ln \pi^D_{reo} \qquad \theta = 1$$

$$w^D_{ro} = \alpha^D_{rg} + \alpha^D_o + \beta^D x_{ro} + \beta^D_N \mathbb{I}_o(N) x_{ro} + \nu^D_{ro}$$

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.075***	.0394	.0331	.0192	-.021	-.0065
	(.0229)	(.0449)	(.0313)	(.0321)	(.0565)	(.0518)
β^D_N	-.1885***	-.2043***	-.1708***	-.1674***	-.2341***	-.2026***
	(.0378)	(.0702)	(.0496)	(.0609)	(.0866)	(.0766)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.798	.797	.797	.712	.711	.712
Wald Test: P-values	0.01	0.01	0.00	0.00	0.00	0.00
F-stat (first stage)		102.77			65.90	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

Occupation wages

$$Wage_{reo}^{D} \equiv W_{ro}^{D} L_{reo}^{D} / N_{reo}^{D} = \gamma W_{ro}^{D} Z_{reo}^{k} \left(\pi_{reo}^{D}\right)^{\frac{-1}{\theta+1}}$$

$$\pi_{reo}^{k} = \frac{\left(Z_{reo}^{k} W_{ro}^{k}\right)^{\theta+1}}{\sum_{j\in\mathcal{O}} \left(Z_{rej}^{k} W_{rj}^{k}\right)^{\theta+1}} \implies wage_{reo}^{D} = wage_{re}^{D}$$

$$wage_{reo}^{D} = \alpha_{rg}^{D} + \alpha_{o}^{D} + \beta^{D} x_{ro} + \beta_{N}^{D} \mathbb{I}_{o}(N)\, x_{ro} + \nu_{ro}^{D}$$

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.0382***	.0461**	.0376**	.003	-.0075	.0012
	(.0136)	(.0231)	(.0172)	(.021)	(.031)	(.0295)
β_N^D	-.0565**	-.0828	-.0762**	.0073	-.0223	-.0189
	(.0276)	(.0521)	(.0374)	(.0279)	(.0365)	(.0311)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.639	.639	.639	.613	.613	.613
Wald Test: P-values	0.34	0.38	0.18	0.64	0.36	0.52
F-stat (first stage)		105.08			72.28	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

Empirics: Occupation labor payments

Occupation labor payments

- Assume $lp_{ro} = p_{ro} q_{ro} + \nu_{ro}$ where ν_{ro} uncorrelated with x_{ro}

$$lp_{ro} = \alpha_{rg} + \alpha_o + \gamma x_{ro} + \gamma_N \mathbb{I}_o(N) x_{ro} + \nu_{ro}$$

	(1) OLS	(2) 2SLS	(3) RF
γ	.392***	.387**	.327**
	(.115)	(.163)	(.123)
γ_N	-.351***	-.401***	-.323***
	(.116)	(.136)	(.092)
Obs	34892	34892	34892
R-sq	.897	.897	.897
Wald Test: P-values	0.38	0.89	0.98
F-stat (first stage)		127.82	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

- $\gamma_N < 0 \iff \epsilon_T > \epsilon_N$ LP $\uparrow$ more w/ exposure in $\mathcal{O}(T)$ than $\mathcal{O}(N)$

Robustness: occupation labor payments

- Robustness to confounding secular trends
  - Restrict CZs, excluding 5 largest immigrant-receiving CZs Details
  - Sample years:
    - 1980-2007 Details
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Quantitative model

Quantitative model: extensions and calibration

- Extensions:
  1. workers differentiated by their education level
  2. regional agglomeration/congestion
  3. cross-region worker mobility
  4. full general equilibrium

- Assigning parameter values:

lit based $\alpha = 7$ (trade elasticity); $\theta = 1$ (skill dispersion); $\nu = 1.5$ (natives' mobility); $\lambda = 0.05$ (agglomeration)

trade costs NT: infinite; T: match regional trade shares

empirics targeting native allocation regressions: $\eta = 1.57$ (occupation substitutability) and $\rho = 5.6$ (native, immigrant substitutability)

wage data

Extended model

1. Workers differentiated by their education level, e (2 domestic, 3 immigrant)

$$L^k_{reo} = Z^k_{reo} \int_{\omega \in \Omega^k_{reo}} \varepsilon(\omega, o)\, dz$$

where $Z^k_{reo} = \bar{Z}^k_{reo} N^{\lambda}_r$, N_r is population in r, and λ governs the extent of regional agglomeration/congestion

- Efficiency units of type k workers perfect substitutes across e

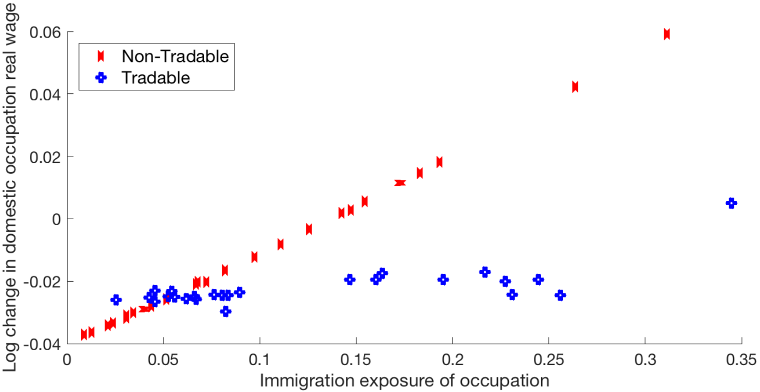
$$L^k_{ro} = \sum_e L^k_{reo}$$

2. Workers k, e, source country c, choose where to live, e.g. Redding (2016)

$$N^{kc}_{re} = \frac{\left(U^{kc}_{re} \frac{Wage^k_{re}}{P_r}\right)^{\nu}}{\sum_{j \in \mathcal{R}} \left(U^{kc}_{je} \frac{Wage^k_{je}}{P_j}\right)^{\nu}} N^{kc}_e \quad \text{where} \quad N^I_{re} = \sum_c N^{kc}_{re}$$

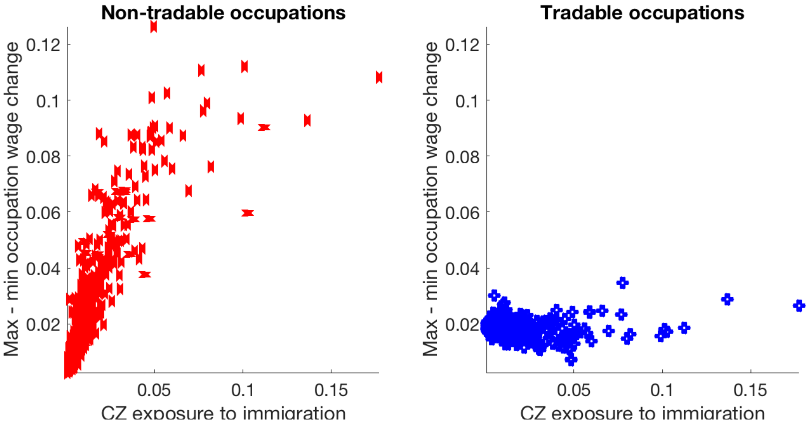
Halve Latin American immigrants

Occupation wage changes in Los Angeles



Halve Latin American immigrants

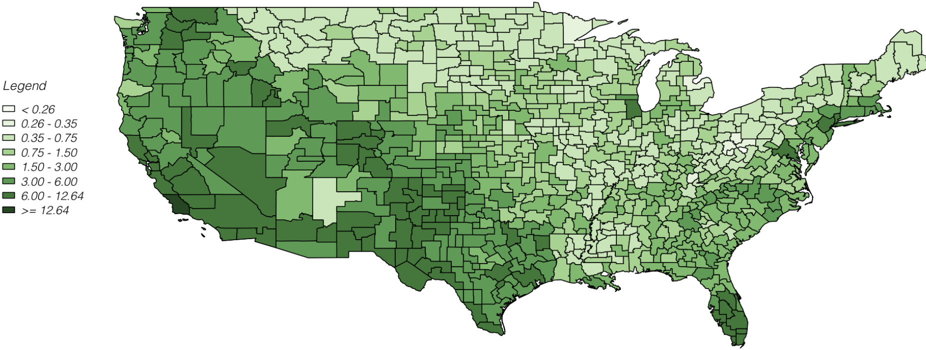
Highest - lowest occupation wage change



$$x_r^l \equiv \left| \sum_e S_{re}^l n_{re}^l \right|$$

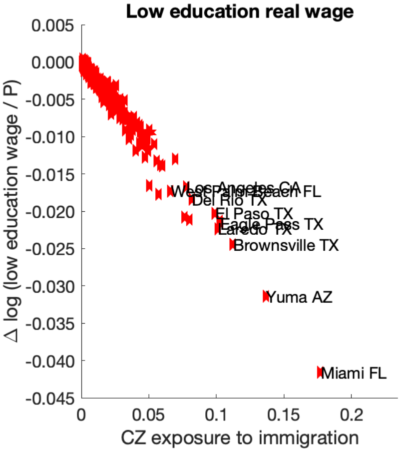
Halve Latin American immigrants

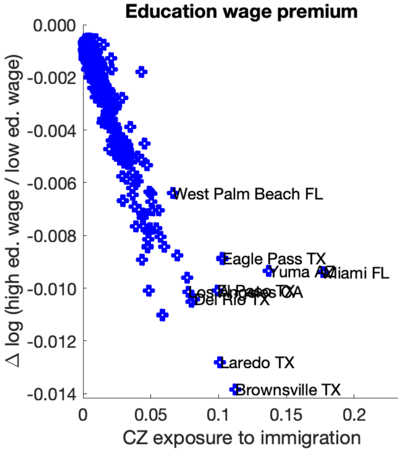
Highest - lowest occupation wage change



Halve Latin American immigrants

Changes in real wage (low education) and education wage premium





Halve Latin American immigrants

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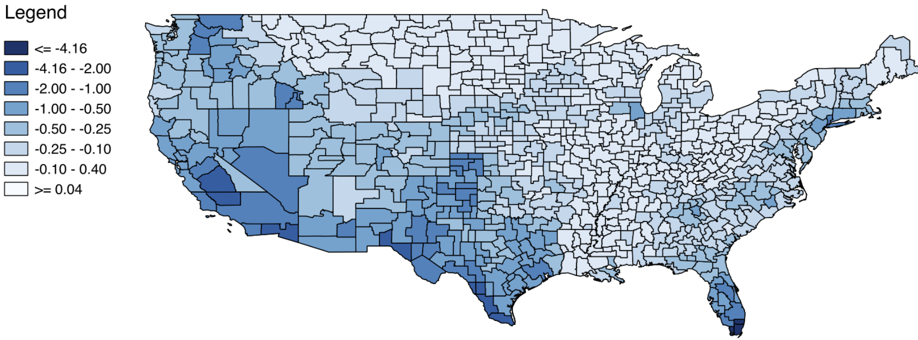
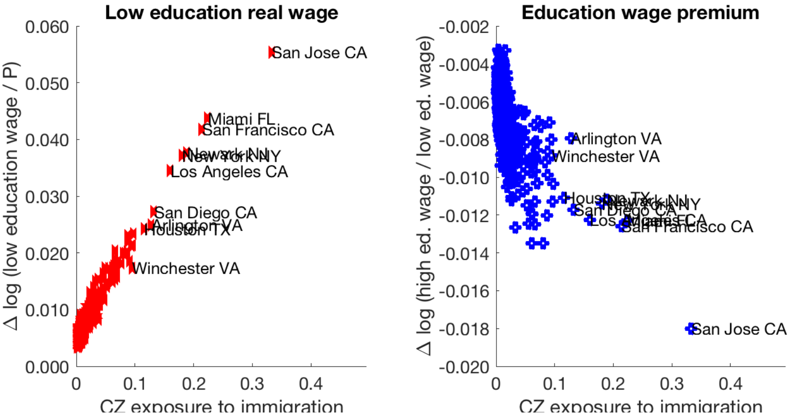


Doubling of college-educated immigrants

Changes in real wage (low education)



Doubling of college-educated immigrants

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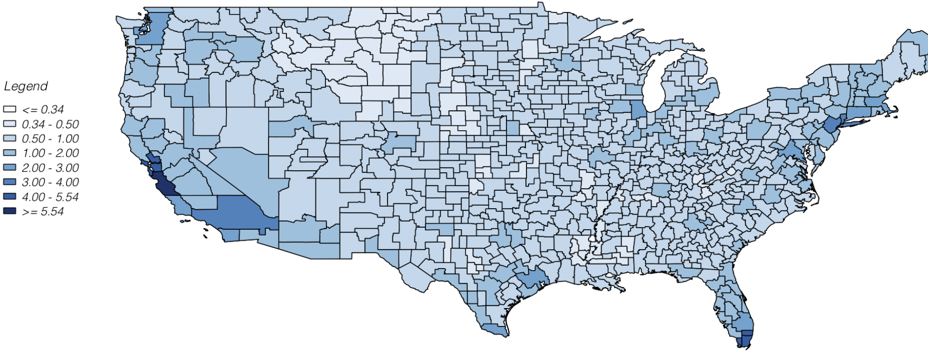
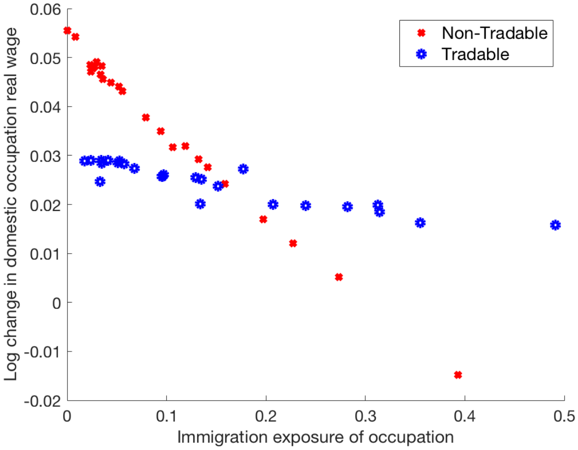


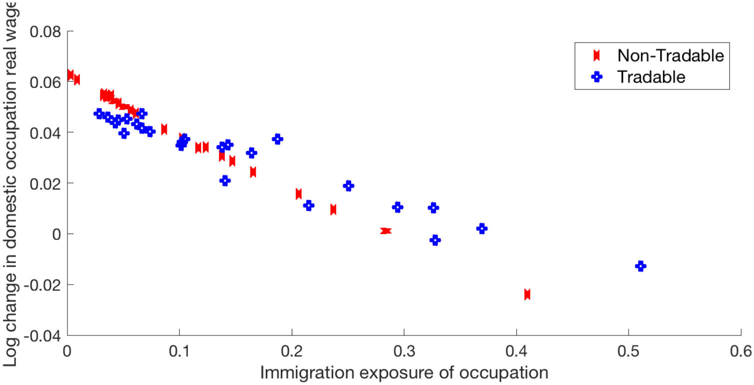
Doubling of college-educated immigrants

Occupation wage changes in Los Angeles (Fixing prices outside of LA, no regional mobility)



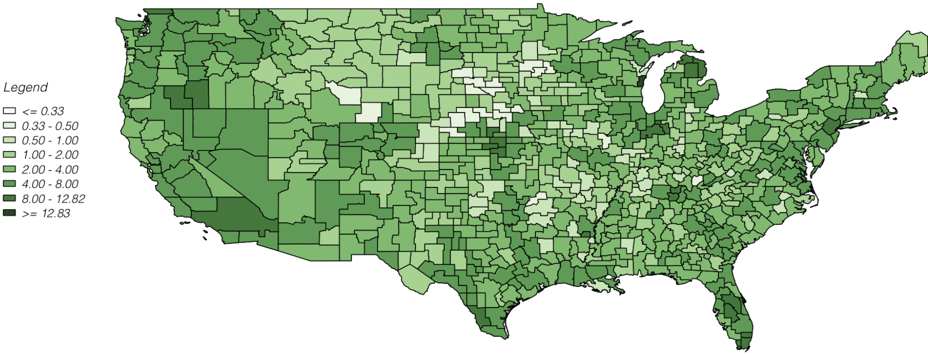
Doubling of college-educated immigrants

Occupation wage changes in Los Angeles (General equilibrium)



Doubling of college-educated immigrants

Highest - lowest occupation wage change



Conclusions

- Study impact of immigration across workers who are differentially exposed:
  - CZs receive different immigrant supply shocks
  - immigrants are differentially important across occupations
  - tradability $\Rightarrow$ differential price response
- Theoretically and empirically,
  1. relatively more crowding out across N occupations than across T occupations
  2. $\Rightarrow$ natives that are more exposed to immigration within N lose relatively more (or gain less) from immigration than those exposed within T
- Quantitatively,
  - on average, immigration raises real wage of natives workers
  - large within CZ effects of immigration (especially within N)
  - nature of the shock matters for differential impact of N vs T

APPENDIX

Alternative occupation production function

- o output is a Cobb-Douglas combination of a continuum of tasks, $z \in [0, 1]$
- Within k, worker productivity may vary across o, but not across z w/in o
- Efficiency units of D and I are perfect substitutes in z; for $\rho > 1$ output is

$$Y_o(z) = L_o^D(z) \left(\frac{A_o^D}{z} \right)^{\frac{1}{\rho-1}} + L_o^I(z) \left(\frac{A_o^I}{1-z} \right)^{\frac{1}{\rho-1}}$$

- Task cost function is $C_o(z) = \min\{C_o^D(z), C_o^I(z)\}$
- Alternative assumptions yield same equilibrium conditions:

$$P_o = \exp\left(\frac{1}{1-\rho} \right) \left(A_o^D (W_o^D)^{1-\rho} + A_o^I (W_o^I)^{1-\rho} \right)^{\frac{1}{1-\rho}}$$

$$\frac{L_o^D}{L_o^I} = \frac{A_o^D}{A_o^I} \left(\frac{W_o^D}{W_o^I} \right)^{-\rho}$$

- Equivalently, Eaton and Kortum (2002) Fréchet assumptions
  - See Dekle, Eaton, and Kortum (2007)

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Alternative: imperfect substitutability btw skilled, unskilled

Same qualitative results, different regression

- Production of occupation o in region r

$$Q_{ro} = A_{ro}\left(\left(A_{ro}^{U}L_{ro}^{U}\right)^{\frac{\rho-1}{\rho}} + \left(A_{ro}^{H}L_{ro}^{H}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}$$

  where immigrants and natives are perfect substitutes within H and L

$$N_r^k = A_r^{kI}N_r^{kI} + A_r^{kD}N_r^{kD} \quad \text{for } k = U, S$$

  and each individual ($k = D$ or I) draw an iid productivity across occupations from the same Fréchet distribution

- This is the same model, so theoretical results apply
- However, the "shock" induced by immigration differs
  - Impact of immigration depends on skill composition of immigrants
  - Empirical specification would differ

Back

Immigrant allocation results

- Conduct same exercises for changes in immigrant allocations
  - Consider three immigrant groups: HSD-, HSG & SMC, COL+

	(1a)	(2a) Low Ed	(3a)	(1b)	(2b) Med Ed	(3b)	(1c)	(2c) High Ed	(3c)
	OLS	2SLS	RF	OLS	2SLS	RF	OLS	2SLS	RF
β^I	.3345	.6316	.1753	-.2132	-.3846	-.26	-.8253***	-1.391***	-.9635***
	(.2889)	(.6106)	(.3309)	(.1937)	(.3099)	(.1934)	(.1717)	(.265)	(.1971)
β^I_N	-1.425***	-2.036**	-1.379***	-.8943***	-1.203***	-.8488***	-.4716***	-.6842**	-.3991**
	(.3988)	(.8431)	(.379)	(.2317)	(.3529)	(.134)	(.1736)	(.2895)	(.1814)
Obs	5042	5042	5042	13043	13043	13043	6551	6551	6551
R-sq	.798	.797	.799	.729	.728	.73	.658	.649	.662
Wald Test: P-values	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		863.39			185.66			128.32	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^I + \beta^I_N = 0$.

- Results strongly consistent with theory

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Robustness: Drop top 5 immigrant-receiving CZs

- Drop 5 largest immigrant-receiving CZs:
  - LA/Riverside/Santa Ana
  - New York
  - Miami
  - Washington DC
  - Houston

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.0881	.0406	.0274	.0084	-.0544	-.0508
	(.0534)	(.0895)	(.0739)	(.0431)	(.0722)	(.0597)
β^D_N	-.2722***	-.3577***	-.3422***	-.1791**	-.2222*	-.1961
	(.0854)	(.0779)	(.0934)	(.0874)	(.1295)	(.1182)
Obs	33473	33473	33473	26405	26405	26405
R-sq	.827	.827	.827	.687	.687	.687
Wald Test: P-values	0.04	0.00	0.00	0.03	0.00	0.01
F-stat (first stage)		26.98			35.39	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

Robustness: Terminal year (1980-2007)

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.081	-.0404	-.0495	-.0341	-.0967	-.1033
	(.0797)	(.1525)	(.1059)	(.0436)	(.0665)	(.0764)
β_N^D	-.4851***	-.4517**	-.3543*	-.3301***	-.3677***	-.3093***
	(.0858)	(.1895)	(.1915)	(.0988)	(.1152)	(.086)
Obs	31596	31596	31596	23215	23215	23215
R-sq	.789	.789	.788	.649	.648	.649
Wald Test: P-values	0.00	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		134.76			73.53	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

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Robustness: Start year (1990-2012)

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.1875**	.1396	.1908**	-.0481	-.2219*	-.146
	(.0895)	(.1035)	(.0768)	(.0892)	(.1316)	(.1187)
β_N^D	-.2702**	.0145	-.0068	-.216**	-.3388***	-.3051***
	(.1148)	(.3739)	(.2308)	(.1053)	(.1311)	(.1118)
Obs	33957	33957	33957	28089	28089	28089
R-sq	.776	.776	.776	.601	.6	.602
Wald Test: P-values	0.25	0.60	0.36	0.00	0.00	0.00
F-stat (first stage)		55.35			47.28	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

Robustness: Start and end year (1980-1990)

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	-.4114	-.6615**	-.6405*	.1181	.2368	.1606
	(.2516)	(.2967)	(.3423)	(.1631)	(.2585)	(.2353)
β^D_N	-.6394***	-.4463*	-.7786***	-.714***	-.6448	-.5311
	(.1987)	(.2471)	(.2374)	(.2642)	(.4431)	(.4478)
Obs	33861	33861	33861	26605	26605	26605
R-sq	.674	.674	.674	.514	.514	.513
Wald Test: P-values	0.00	0.00	0.00	0.00	0.12	0.20

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

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Robustness: tradability cutoff (23 T and 23 NT)

Include the top 23 most tradable (and least tradable) occupations, dropping 4 middle occupations

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.1824***	.0745	.0599	.1063**	.043	.05
	(.0594)	(.0888)	(.0663)	(.0521)	(.0897)	(.0901)
β_N^D	-.3914***	-.401***	-.3439***	-.3921***	-.4523***	-.4008***
	(.0846)	(.0917)	(.0828)	(.1092)	(.1384)	(.1256)
Obs	30835	30835	30835	24038	24038	24038
R-sq	.831	.831	.831	.697	.696	.697
Wald Test: P-values	0.01	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		112.65			71.65	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

Back

Robustness: tradability cutoff (21 T and 21 NT)

Include the top 21 most tradable (and least tradable) occupations, dropping 8 middle occupations

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.2383***	.1571*	.1177*	.0866*	.0332	.0436
	(.0585)	(.0849)	(.0673)	(.0511)	(.0869)	(.0868)
β_N^D	-.4393***	-.4809***	-.3941***	-.3964***	-.4863***	-.4239***
	(.0958)	(.0948)	(.0874)	(.1096)	(.1317)	(.1171)
Obs	28035	28035	28035	21262	21262	21262
R-sq	.827	.827	.827	.692	.691	.692
Wald Test: P-values	0.02	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		105.66			63.63	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

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Robustness: tradability cutoff (30 T and 20 NT)

Separate 50 occupations into 30 tradable and 20 non-tradable occupations

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.0353	-.0846	-.0407	-.0114	-.0683	-.0617
	(.0508)	(.0846)	(.0571)	(.0308)	(.0551)	(.0488)
β^D_N	-.2262***	-.2515***	-.2448***	-.3026***	-.382***	-.3042***
	(.0727)	(.0813)	(.0752)	(.0928)	(.1155)	(.0934)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.832	.832	.832	.7	.7	.7
Wald Test: P-values	0.02	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		99.52			53.11	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

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Robustness: tradability cutoff (20 T and 30 NT)

Separate 50 occupations into 20 tradable and 30 non-tradable occupations

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.232***	.1484*	.1156*	.0867	.0267	.0454
	(.0585)	(.0844)	(.067)	(.0574)	(.0943)	(.0919)
β^D_N	-.3931***	-.2963***	-.2335***	-.3181***	-.3521***	-.3248***
	(.084)	(.083)	(.0735)	(.0936)	(.1186)	(.1151)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.84	.84	.839	.698	.698	.699
Wald Test: P-values	0.01	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		117.27			58.42	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

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Robustness: Drop routine-intensive occupations

Drop workers employed in the most routine-intensive occupations ($\geq$ 75th percentile)

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.0826*	.1375**	.11	-.0517	-.0746	-.0517
	(.0442)	(.0655)	(.0672)	(.036)	(.0614)	(.057)
β^D_N	-.3045***	-.4347***	-.3592***	-.2212**	-.3263**	-.2901**
	(.0972)	(.0831)	(.0643)	(.0921)	(.1284)	(.1146)
Obs	32997	32997	32997	24693	24693	24693
R-sq	.822	.822	.822	.706	.706	.707
Wald Test: P-values	0.01	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		80.33			73.75	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

Back

Robustness: Drop communication-intensive occupations

Drop workers employed in the most communication-intensive occupations ($\geq$ 75th percentile)

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.1124*	-.0476	-.0256	-.0146	-.1364	-.116
	(.0661)	(.1156)	(.0821)	(.0541)	(.0875)	(.0852)
β^D_N	-.2963***	-.2111*	-.1997*	-.2343***	-.3417***	-.2778***
	(.074)	(.1154)	(.1032)	(.079)	(.1205)	(.0996)
Obs	31172	31172	31172	22972	22972	22972
R-sq	.839	.838	.839	.672	.671	.672
Wald Test: P-values	0.01	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		84.84			183.2	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

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Robustness: Using S^I_{-reo} instead of S^I_{reo}

Use the national immigrant cost share of occupation o

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.089*	1.154*	.6561*	.0223	.2168	.0711
	(.0492)	(.6034)	(.3382)	(.036)	(.3651)	(.2351)
β^D_N	-.3034***	-1.817***	-1.163***	-.3088***	-2.565***	-2.064***
	(.0615)	(.5879)	(.4443)	(.0973)	(.4197)	(.5177)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.836	.822	.836	.699	.623	.701
Wald Test: P-values	0.00	0.01	0.04	0.00	0.00	0.00
F-stat (first stage)		8.88			16.27	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

Robustness: Averaging 1970 and 1980 for S^I_{reo}

Use the average values in 1970 and 1980 to calculate immigrant share of labor payment, S^I_{reo}

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.089*	-.0009	-.0049	.0223	-.0728	-.0375
	(.0492)	(.0931)	(.058)	(.036)	(.0718)	(.0473)
β^D_N	-.3034***	-.3007***	-.2272***	-.3088***	-.5027***	-.2387**
	(.0615)	(.1153)	(.0856)	(.0973)	(.1767)	(.1038)
Obs	33723	33723	33723	26644	26644	26644
R-sq	.836	.836	.836	.699	.697	.699
Wald Test: P-values	0.00	0.00	0.00	0.00	0.00	0.00
F-stat (first stage)		102.93			83.89	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta^D_N = 0$.

Robustness: Industry analysis

- Categorize
  - (T) goods-producing industries: agriculture, mining and manufacturing
  - (N) service industries

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.2441**	.5744	.6119	.4303***	.5429	.5789**
	(.1168)	(.4335)	(.4063)	(.1313)	(.3904)	(.2888)
β_N^D	-.3473**	-.4971	-.4842	-.7248***	-.9742**	-.8986***
	(.1372)	(.4113)	(.3481)	(.1803)	(.4814)	(.318)
Obs	22067	22067	22067	17202	17202	17202
R-sq	.827	.826	.828	.723	.723	.723
Wald Test: P-values	0.35	0.46	0.27	0.01	0.00	0.01
F-stat (first stage)		51.65			81.62	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\beta^D + \beta_N^D = 0$.

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Robustness: Drop top 5 immigrant-receiving CZs

- Drop 5 largest immigrant-receiving CZs:
  - LA/Riverside/Santa Ana
  - New York
  - Miami
  - Washington DC
  - Houston

	(1) OLS	(2) 2SLS	(3) RF
γ	.2844***	.1696	.1388
	(.0736)	(.1053)	(.1016)
γ_N	-.2067**	-.1979**	-.1829**
	(.0881)	(.0969)	(.0931)
Obs	34642	34642	34642
R-sq	.895	.895	.895
Wald Test: P-values	0.14	0.58	0.35
F-stat (first stage)		36.98	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

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Robustness: Terminal year (1980-2007)

	(1) OLS	(2) 2SLS	(3) RF
γ	.4057***	.4454***	.328***
	(.0993)	(.1246)	(.0926)
γ_N	-.5488***	-.6431***	-.4809***
	(.2034)	(.1286)	(.0933)
Obs	33200	33200	33200
R-sq	.853	.853	.852
Wald Test: P-values	0.27	0.04	0.10
F-stat (first stage)		160.91	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Robustness: Start year (1990-2012)

	(1) OLS	(2) 2SLS	(3) RF
γ	.5592***	.5133***	.7175***
	(.0818)	(.1302)	(.1192)
γ_N	-.4636***	-.2602*	-.5572***
	(.091)	(.1497)	(.0945)
Obs	35127	35127	35127
R-sq	.869	.869	.87
Wald Test: P-values	0.08	0.17	0.02
F-stat (first stage)		67.81	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: tradability cutoff (23 T and 23 NT)

Include the top 23 most tradable (and least tradable) occupations, dropping 4 middle occupations

	(1) OLS	(2) 2SLS	(3) RF
γ	.5961***	.6624***	.4943***
	(.1253)	(.1468)	(.1068)
γ_N	-.5629***	-.7093***	-.5223***
	(.1321)	(.1357)	(.0855)
Obs	32004	32004	32004
R-sq	.897	.896	.896
Wald Test: P-values	0.45	0.61	0.70
F-stat (first stage)		134.40	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: tradability cutoff (21 T and 21 NT)

Include the top 21 most tradable (and least tradable) occupations, dropping 8 middle occupations

	(1) OLS	(2) 2SLS	(3) RF
γ	.5898***	.6554***	.5115***
	(.1276)	(.1563)	(.1109)
γ_N	-.5533***	-.6957***	-.5321***
	(.1332)	(.1316)	(.0843)
Obs	29122	29122	29122
R-sq	.893	.893	.892
Wald Test: P-values	0.41	0.65	0.77
F-stat (first stage)		150.63	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: tradability cutoff (30 T and 20 NT)

Separate 50 occupations into 30 tradable and 20 non-tradable occupations

	(1) OLS	(2) 2SLS	(3) RF
γ	.349***	.2964*	.2742**
	(.1037)	(.1515)	(.1265)
γ_N	-.3232***	-.3465***	-.3023***
	(.0926)	(.0822)	(.0676)
Obs	34892	34892	34892
R-sq	.895	.895	.895
Wald Test: P-values	0.52	0.59	0.70
F-stat (first stage)		153.04	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

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Robustness: tradability cutoff (20 T and 30 NT)

Separate 50 occupations into 20 tradable and 30 non-tradable occupations

	(1) OLS	(2) 2SLS	(3) RF
γ	.6055***	.6847***	.5256***
	(.1317)	(.162)	(.1139)
γ_N	-.5629***	-.6817***	-.5043***
	(.1244)	(.122)	(.0863)
Obs	34892	34892	34892
R-sq	.902	.901	.901
Wald Test: P-values	0.31	0.97	0.75
F-stat (first stage)		98.59	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: Drop routine-intensive occupations

Drop workers in the most routine-intensive occupations ($\geq$ 75th percentile)

	(1) OLS	(2) 2SLS	(3) RF
γ	.3282**	.3854*	.3458**
	(.1341)	(.2166)	(.1755)
γ_N	-.2904**	-.4286**	-.3768***
	(.1382)	(.1756)	(.1256)
Obs	33817	33817	33817
R-sq	.89	.89	.891
Wald Test: P-values	0.46	0.69	0.70
F-stat (first stage)		97.61	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: Drop communication-intensive occupations

Drop workers in the most communication-intensive occupations ($\geq$ 75th percentile)

	(1) OLS	(2) 2SLS	(3) RF
γ	.4441***	.4082**	.3781***
	(.119)	(.168)	(.1347)
γ_N	-.3639***	-.3259**	-.3107**
	(.126)	(.1601)	(.1275)
Obs	31974	31974	31974
R-sq	.883	.883	.882
Wald Test: P-values	0.12	0.33	0.25
F-stat (first stage)		108.96	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: Using S^I_{-reo} instead of S^I_{reo}

Use the national immigrant cost share of occupation o

	(1) OLS	(2) 2SLS	(3) RF
γ	.3918***	2.299***	1.081**
	(.1147)	(.4259)	(.4653)
γ_N	-.3512***	-2.296***	-1.275***
	(.1157)	(.441)	(.4854)
Obs	34892	34892	34892
R-sq	.897	.863	.896
Wald Test: P-values	0.38	0.99	0.34
F-stat (first stage)		9.34	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

Back

Robustness: Averaging 1970 and 1980 for S^I_{reo}

Use the average values in 1970 and 1980 to calculate immigrant share of labor payment, S^I_{reo}

	(1) OLS	(2) 2SLS	(3) RF
γ	.3918***	.592**	.3582**
	(.1147)	(.2319)	(.1541)
γ_N	-.3512***	-.6301***	-.3794***
	(.1157)	(.2223)	(.1392)
Obs	34892	34892	34892
R-sq	.897	.897	.897
Wald Test: P-values	0.38	0.62	0.70
F-stat (first stage)		141.15	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

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Robustness: Industry analysis

- Categorize
  - (T) goods-producing industries: agriculture, mining and manufacturing
  - (N) service industries

	(1) OLS	(2) 2SLS	(3) RF
γ	.4437***	.9535**	.7295**
	(.1661)	(.4569)	(.3101)
γ_N	-.4743***	-.8382*	-.5719*
	(.1803)	(.5033)	(.3148)
Obs	22014	22014	22014
R-sq	.838	.836	.839
Wald Test: P-values	0.80	0.35	0.16
F-stat (first stage)		61.31	

Standard errors clustered by state in parentheses. Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\gamma + \gamma_N = 0$.

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Extended model

Wage regression

- Model has predictions for changes in occupation wages. Empirical version:

$$w_{ro}^{D} = \alpha_{rg}^{D} + \alpha_{o}^{D} + \chi^{D} x_{ro} + \chi_{N}^{D} \mathbb{I}_{o}(N)\, x_{ro} + \iota_{ro}^{D}$$

  - Estimated using model-generated data, we obtain $\chi^{D} = 0$ and $\chi^{D} + \chi_{N}^{D} = -0.15$
  - roughly equal to $\beta^{D}/(\theta + 1)$ and $\beta_{N}^{D}/(\theta + 1)$

- Unfortunately do not observe w_{ro}^{D} because of selection

- However, we do observe $wage_{re}^{D}$, which to a first-order approximation is

$$wage_{re}^{D} = \sum w_{ro}^{D} \pi_{reo}^{D}$$

- Combining the two equations and estimating using model-generated data, we obtain $\chi^{D} = 0.01$ and $\chi^{D} + \chi_{N}^{D} = -0.18$

Domestic average group wage results

	(1) OLS	(2) 2SLS	(3) RF
χ^D	.602***	.8986***	.9678***
	(.1101)	(.139)	(.1617)
χ_N^D	-.8265***	-1.629***	-1.691***
	(.1535)	(.1779)	(.2439)
Obs	1444	1444	1444
R-sq	.979	.976	.979
Wald Test: P-values	0.00	0.00	0.00

Significance levels: * 10%, ** 5%, ***1%. For the Wald test, the null hypothesis is $\chi^D + \chi_N^D = 0$.

- Consistent with allocation results, exposure to immigration
  - in N decreases average wage ($\chi^D + \chi_N^D < 0$)
  - in N decreases average wage more than in T ($\chi_N^D < 0$)
- Distinct from allocation results, exposure to immigration
  - in T increases average wage ($\chi^D > 0$)

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Empirical literature review

- Differential adjustment btw tradable and non-tradable to immigration shocks
  - Dustmann & Glitz, 2015; Hong & McLaren, 2016; Peters, 2017
- While encompassing such between-sector impacts, we allow for differences in occupational adjustment *within* tradables when compared to *within* nontradables

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- Testing "strong" Rybczynski (FPI, fixed factor intensity, magnification)
  - Evidence against Rybczynski: Hanson & Slaughter, 2002; Gandal et al., 2004; Card & Lewis, 2007; Dustmann & Glitz, 2015
- Test new predictions for *differential* adjustment across more to less price-sensitive industries/occupations, resuscitating "relaxed" Rybczynski logic
- Our findings consistent with price response to immigration evidence in Cortes, 2008, and rationalizes industry differences in literature

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- Trade + native adjustment to immigration: Ottaviano, Peri, & Wright, 2013
- We characterize strength of crowding in/out, show how they differ w/in tradable versus w/in nontradable occupations/industries

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Theoretical literature review

Closest theoretical relation (but not focusing on immigration):

- Rybczynski (1955): $\uparrow$ in a factor's endowment $\Rightarrow$ crowding in
- Grossman and Rossi-Hansberg (2008) and Acemoglu, Gancia and Zilibotti (2015): $\downarrow$ in offshoring costs $\Rightarrow$ two effects closely related to the forces giving rise to crowding in and crowding out
- Acemoglu and Guerrieri (2008): provide a condition under which capital deepening $\Rightarrow$ crowding in or crowding out

Related theory focusing on immigration:

- Peri and Sparber (2009): crowding out; reallocation margin of adjustment benefits natives
- Ottaviano, Peri and Wright (2013): implications of immigration and offshoring for native employment in partial-equilibrium model of one industry (no comparisons across industries)

Relative to both literatures, we:

- generalize Rybczynski to many occupations, producer price $\neq$ import price, upward sloping labor supply curves, and heterogeneous tradability
- provide general conditions under which there is crowding in or out,
- show crowding out weaker in more tradable occupations
- and focus on changes in within-group wages

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