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

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February 2018

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
  - housekeeping, firefighting, textile machine operation

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1. Document $\uparrow$ immigrants into a region in U.S. crowds out natives from immigrant-intensive occupations within less tradable occupations, neither crowding out nor crowding in within more tradable occupations
2. price $\downarrow$ in immigrant-intensive occupations, less 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 and occupation choice

- 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 $\left(A^{I}_{ro}/A^{D}_{ro}\right)^{\rho-1} \geq \left(A^{I}_{ro'}/A^{D}_{ro'}\right)^{\rho-1}$

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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 $\underbrace{W^k_{ro}}_{\text{"occ. wage"}} \times \underbrace{\varepsilon_{zo}}_{\text{eff. units}}$

  - more dispersed ε_{zo}, larger changes in wages to induce occupation switching $\rightarrow$ lower occupation labor supply elasticity

Occupation's price sensitivity of demand

- Final good produced using range of occupations, CES: η
- Absorption of each occupation uses output from different regions, CES: α
  - subject to trade costs
- 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, $g = T, N$
  - $\epsilon_{rT} > \epsilon_{rN}$

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

- Margins of adjustment:
  1. 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

  occupation wages adjust to induce workers to reallocate

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  occupation wages adjust to induce workers to reallocate

- Consider two occupations in set $g = T$ or $g = N$

$$n^k_{ro} - n^k_{ro'} = \beta^k_{rg}\left(S^I_{ro} - S^I_{ro'}\right)n^I_r$$

$$\beta^k_{rg} < 0 \text{ (crowding-out)} \iff \rho > \epsilon_{rg}$$

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- Adjustment within T v.s. within N. $\epsilon_{rN} < \epsilon_{rT} \Rightarrow$
  - $\beta^k_{rN} < \beta^k_{rT}$, more crowding-out w/in N
  - wages $\downarrow$ in I-intensive occupations more w/in N

Connecting theory and data

Empirical extensions

1. Incorporate national occupation fixed effects
2. Allow for native and immigrant workers to be differentiated by education level
3. Restrict $\beta_g^D = \beta_{rg}^D$ for all r
4. Possible correlation between immigration inflows into a region and occupation/region productivity shocks (deviations from rg and o means)
   - instrument for inflows: use variant of Card instrument

Data, occupations and tradability

- Ipums, 1980-2012
- 50 occupations and 722 commuting zones
- 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

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

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.089*	.0086	.0053	.0223	-.0335	-.0209
	(.0492)	(.0884)	(.0609)	(.036)	(.066)	(.0599)
β^D_N	-.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 $\beta^D + \beta^D_N = 0$.

1. $\beta^D = 0$: Neither crowding in nor out within T
2. $\beta^D_N < 0$: 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

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 ↑ more w/ exposure in $\mathcal{O}(T)$ than $\mathcal{O}(N)$

Binned scatterplots

Robustness: occupation labor payments

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Quantitative model

Quantitative model: extensions and calibration

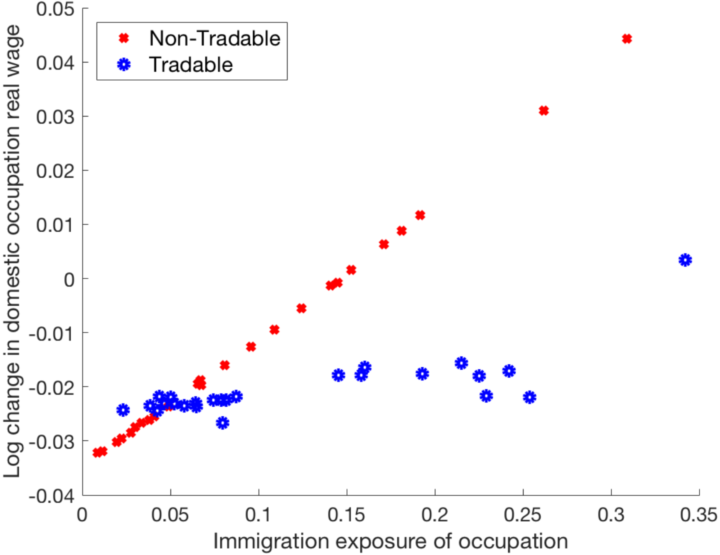
- Extensions:
  1. workers differentiated by their education level
  2. regional agglomeration/congestion
  3. cross-region worker mobility
  4. full general equilibrium

- Assigning parameter values:
  1. Nontradables: infinite trade costs, Tradables: match regional trade shares
  2. literature-based: α (trade elasticity), θ (skill dispersion), ν (natives' mobility), λ (aggloremation)
  3. target allocation regressions: $\eta = 1.9$ (occupation substitutability) and $\rho = 5.6$ (native, immigrant substitutability)

wage data

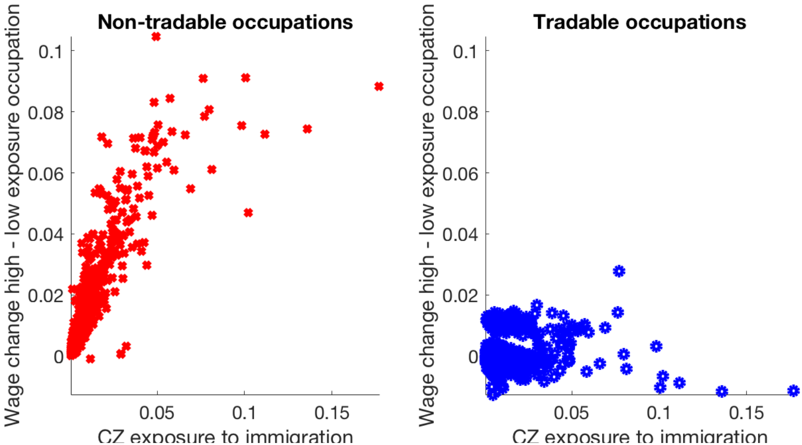
Halve Latin American immigrants

Occupation wage changes in Los Angeles



Halve Latin American immigrants

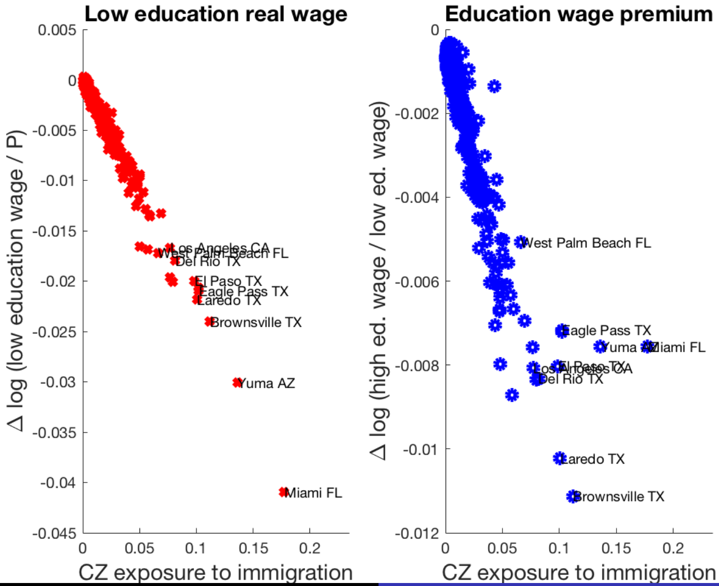
Wage change most - least exposed occupations to immigration



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

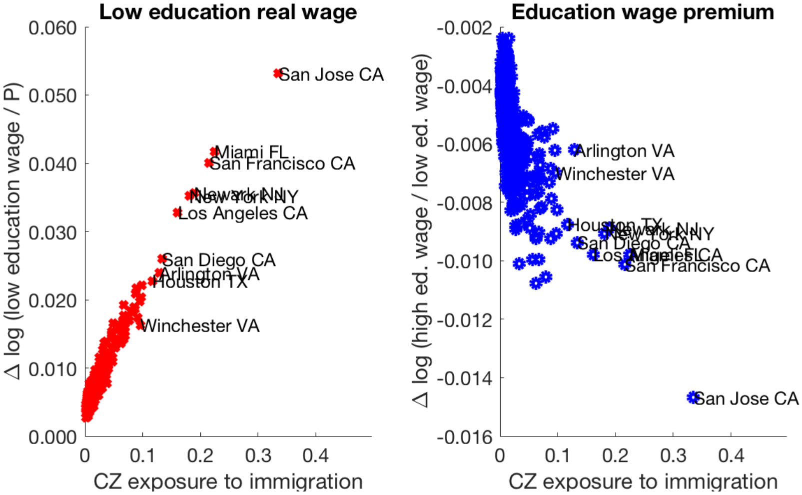
Halve Latin American immigrants

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



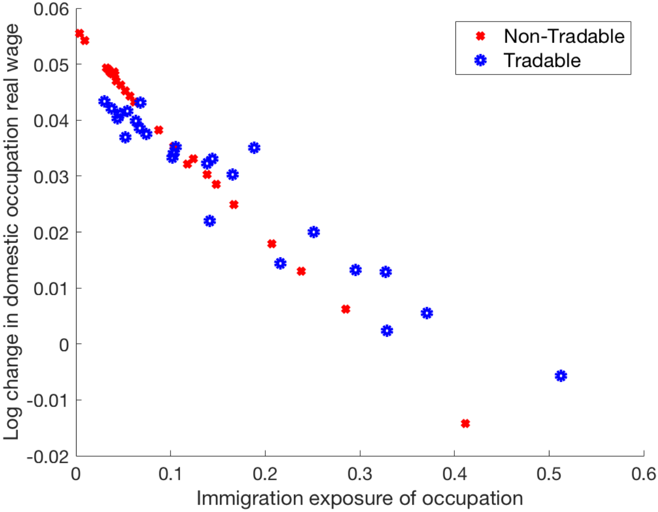
Doubling of college-educated immigrants

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



Doubling of college-educated immigrants

Occupation wage changes in Los Angeles (General equilibrium)



Doubling of college-educated immigrants

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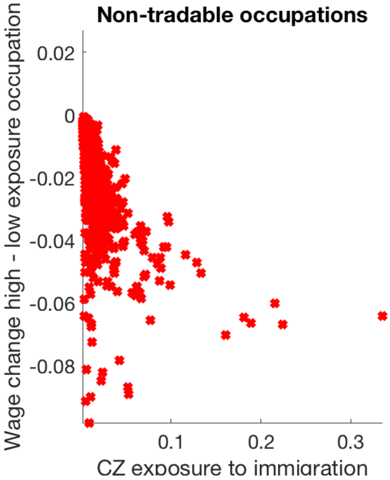

Conclusions

- 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 impact differential impact 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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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

Immigrant allocation results

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

	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)	(1c)	(2c)	(3c)
		Low Ed			Med Ed			High Ed	
	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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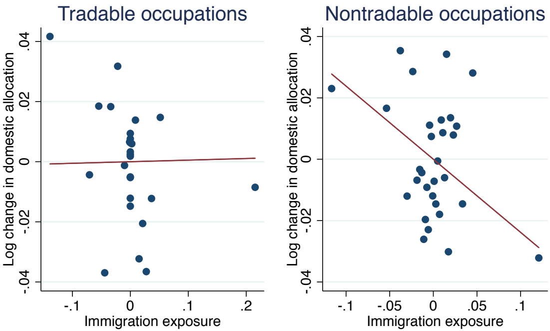
Domestic allocation results: Low Education

Binned scatterplots



Binscatter for β^D (left panel) and β_N^D (right panel) for low education

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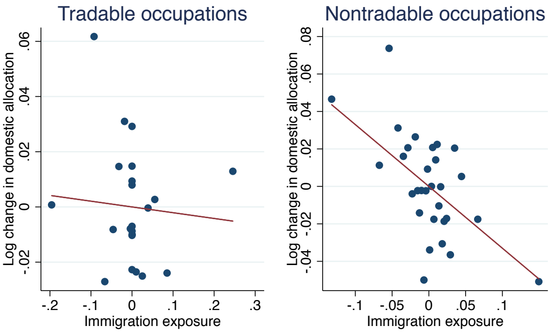
Domestic allocation results: High Education

Binned scatterplots



Binscatter for β^D (left panel) and β^D_N (right panel) for high education

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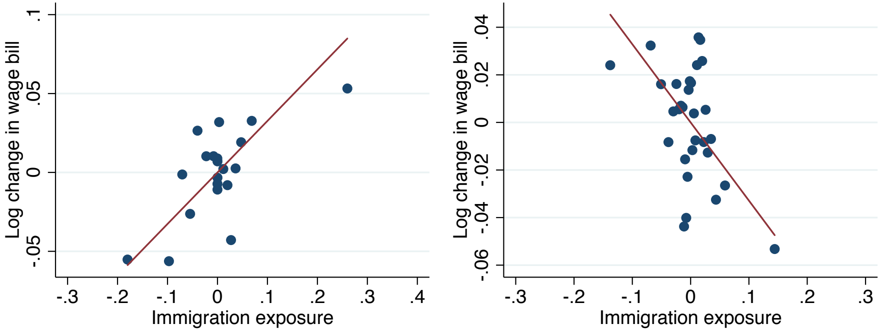
Occupation wage bill

Binned scatterplots



Binscatter for γ (left panel) and γ_N (right panel)

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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) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.0881	.0406	.0274	.0084	-.0544	-.0508
	(.0534)	(.0895)	(.0739)	(.0431)	(.0722)	(.0597)
β_N^D	-.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 $\beta^D + \beta_N^D = 0$.

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Robustness: Terminal year (1980-2007)

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.081	-.0404	-.0495	-.0341	-.0967	-.1033
	(.0797)	(.1525)	(.1059)	(.0436)	(.0665)	(.0764)
β^D_N	-.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 $\beta^D + \beta^D_N = 0$.

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Robustness: Start year (1990-2012)

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	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)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	-.4114	-.6615**	-.6405*	.1181	.2368	.1606
	(.2516)	(.2967)	(.3423)	(.1631)	(.2585)	(.2353)
β_N^D	-.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 $\beta^D + \beta_N^D = 0$.

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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) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.1824***	.0745	.0599	.1063**	.043	.05
	(.0594)	(.0888)	(.0663)	(.0521)	(.0897)	(.0901)
β^D_N	-.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 $\beta^D + \beta^D_N = 0$.

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Robustness: tradability cutoff (21 T and 21 NT)

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

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	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_N^D	-.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 $\beta^D + \beta_N^D = 0$.

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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) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.232***	.1484*	.1156*	.0867	.0267	.0454
	(.0585)	(.0844)	(.067)	(.0574)	(.0943)	(.0919)
β_N^D	-.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 $\beta^D + \beta_N^D = 0$.

Back

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_N^D	-.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 $\beta^D + \beta_N^D = 0$.

Back

Robustness: Drop communication-intensive occupations

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

	(1)	(2) Low Ed	(3)	(1)	(2) High Ed	(3)
	OLS	2SLS	RF	OLS	2SLS	RF
β^D	.1124*	-.0476	-.0256	-.0146	-.1364	-.116
	(.0661)	(.1156)	(.0821)	(.0541)	(.0875)	(.0852)
β_N^D	-.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 $\beta^D + \beta_N^D = 0$.

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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) Low Ed	(3)	(1)	(2) High Ed	(3)
	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 $\beta^D + \beta^D_N = 0$.

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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 $\beta^D + \beta^D_N = 0$.

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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 $\gamma + \gamma_N = 0$.

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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 $\gamma + \gamma_N = 0$.

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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) 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 $\gamma + \gamma_N = 0$.

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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 $\gamma + \gamma_N = 0$.

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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 $\gamma + \gamma_N = 0$.

Back

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 $\gamma + \gamma_N = 0$.

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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 $\gamma + \gamma_N = 0$.

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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 $\gamma + \gamma_N = 0$.

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 $\gamma + \gamma_N = 0$.

Back

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 $\chi^{D} + \chi_{N}^{D} = -0.18$

Changes in averages wages by occupation and region

	(1)	(2)	(3)	(1)	(2)	(3)
		Low Ed			High Ed	
	OLS	2SLS	RF	OLS	2SLS	RF
x_{ro}	.0382***	.0461**	.0376**	.003	-.0075	.0012
	(.0136)	(.0231)	(.0172)	(.021)	(.031)	(.0295)
$\mathbb{I}_o(N)\,x_{ro}$	-.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 $\beta^D + \beta^D_N = 0$.

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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Theoretical literature review

Closest theoretical relation (but not focusing on immigration):

- Rybczynski (1955): ↑ in a factor's endowment ⇒ crowding in
- Grossman and Rossi-Hansberg (2008): ↓ in offshoring costs ⇒ 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 ⇒ 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 ≠ 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

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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