Opening the Floodgates: Industry and Occupation Adjustments to Labor Immigration

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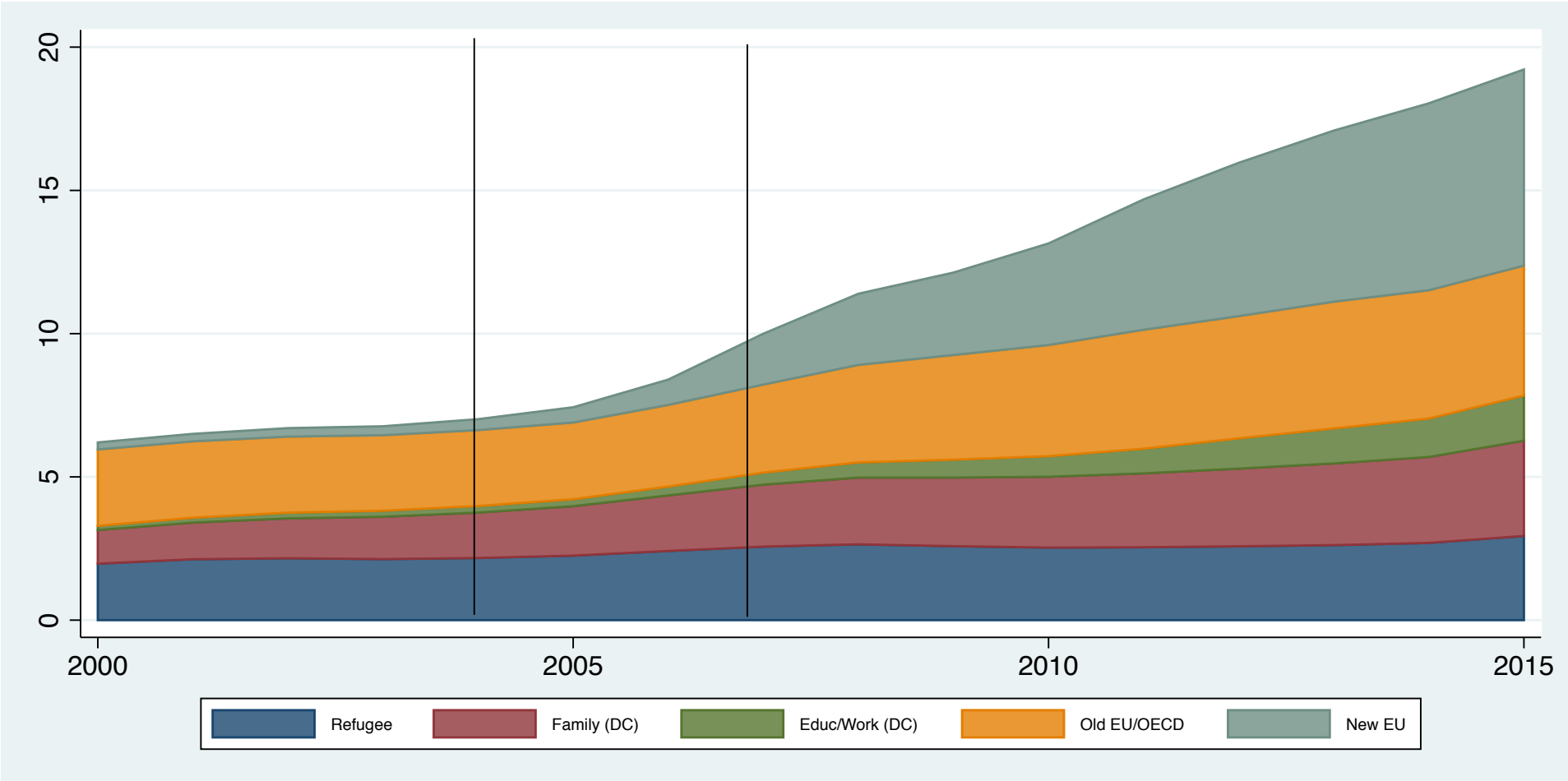
A Pretty Big Labor Supply Shock



2004&2007 EU enlargement: Migration restrictions lifted for 100 mill people.
Norway received the largest inflow of immigrants relative to population.

11% population growth - almost **70%** was net immigration.

Research Question

- What is the impact of a large labor supply shock?
  - Industry adjustments: Employment, wage costs.
  - Occupation adjustments: Occ. choice & wages.
- As we will see, supply shock *uneven* across occupations.
- Test simplest possible factor proportions theory:
  - When opening the floodgates, immigrants sort into occupations o.
  - Industry i intensive in use of an occupation o.
  - Labor supply shock to o lowers relative wages.
  - Costs/prices decline $\longrightarrow$ i grows more than other industries.

Identification

- Policy change externally imposed - ideal natural experiment.
- Even so, identification challenge: High growth occupations/industries attract immigrants.
- Our solution: Occupations are more or less *language intensive*.
  - Norwegian typically workplace language.
  - Low language intensive occupations more attractive for immigrants.
  - Opening the floodgates $\longrightarrow$ immigrants sort disproportionally to those occupations.
  - A supply shifter for change in immigrant share in o.

Literature

- *Immigration and industry adjustment*: Dustmann and Glitz (2015), Gandal, Hanson and Slaughter (2004), González and Ortega (2011), Hanson and Slaughter (2002), Lewis (2003), Wagner (2010).

- *EU enlargement*: Baldwin (1995), Baldwin et al. (1997), Caliendo, Opromolla, Parro, Sforza (2018), Dustmann and Frattini (2011), Kennan (2017).

- *Occupation adjustments*: Burstein et al (2018), Card (2001), Ortega & Verdugo (2018), Peri & Sparber (2009), Shape & Bollinger (2016).

Today

- Data.
- (Sketch of) a factor-proportions model.
- Econometric model.
- Quantitative analysis.
- Results and conclude.

Data

Three main datasets:

1. Balance sheet data for all private sector firms (joint-stock companies).
    - Total employment & wage costs for industry-commuting zone (CZ) pairs *ir*.
2. All job spells + immigration status (country of birth):
    - Immigrant share $\mu_{ot} \equiv M_{ot}/(N_{ot}+M_{ot})$ for occupation o at time t.
    - Pre-period factor-intensity matrix $\lambda_{io} \equiv L_{io}/\sum_o L_{io}$.
    - Restrict to full-time employees.

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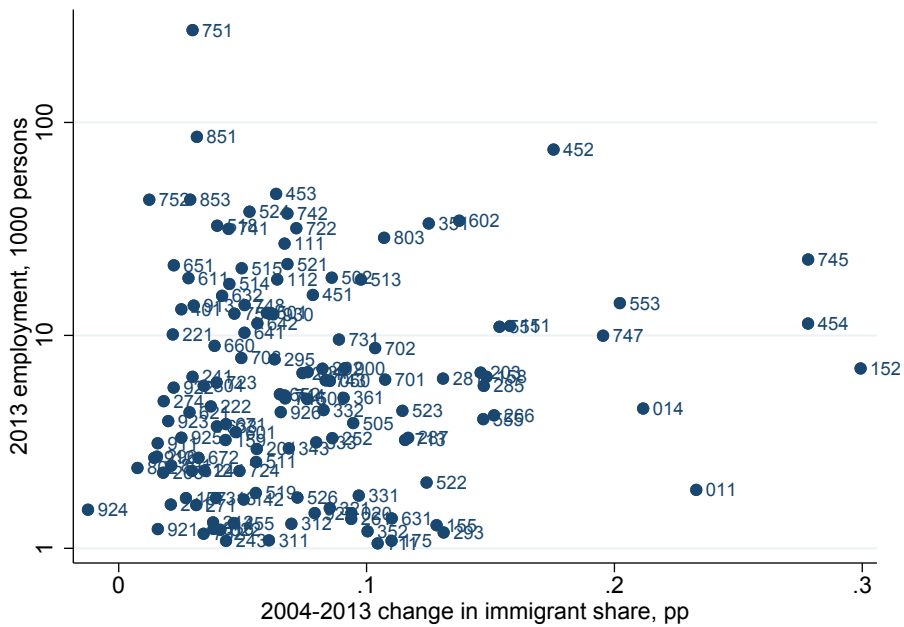
Data

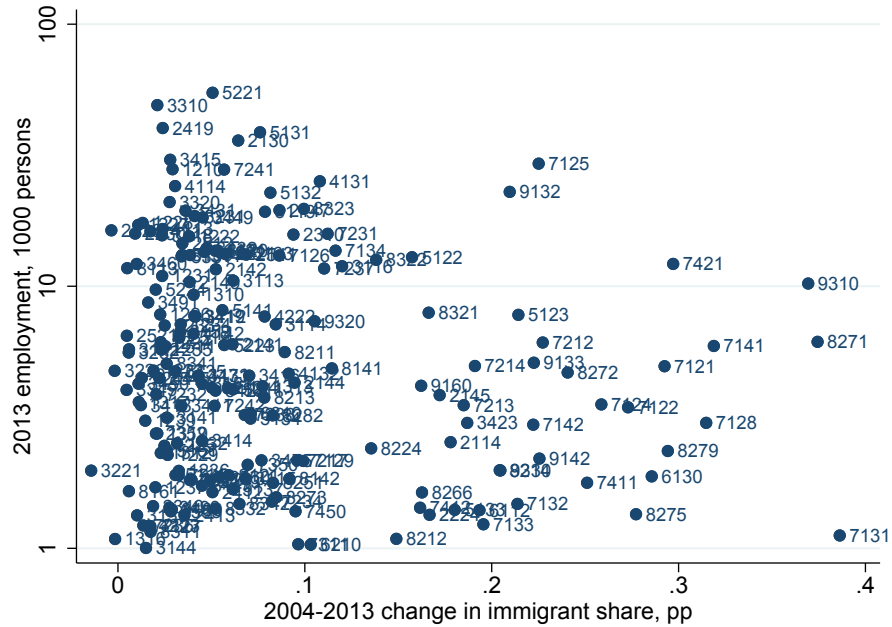
3. O*Net occupation characteristics:
   - Range from 1=not important to 5=extremely important.
   - Take average of oral+written comprehension/expression.
   - Get language intensity $\mathbb{L}_o$ for 341 STYRK occupations, using concordance from Hoen (2016).
     - ★ Carpenters: -1.50, pre-school teachers: 0.36 (standardized).

Data

Industries



Occupations



Note: The figure shows the percentage point change in the share of immigrant relative to total employees on the x-axis, and total 2013 employment on a log scale on the y-axis (in 1000s persons). The unit of observation is 3-digit NACE sector (left figure) and 4-digit STYRK occupation code (right figure). Industries/occupations with 2013 employment $<$ 1000 persons are omitted from the figures.

The Factor Intensity Matrix (2004)

	Professor or similar STYRK 2310			Sum
NACE803 "Higher education"	.52	.	.	1
NACE 751 "Administration of the state (..)	.06	.	.	1
NACE 732 "Research (..) on natural sciences and engineering"	.05	.	.	1

	Carpenter or similar STYRK 7421			Sum
NACE203 "Manufacture of builders' carpentry and joinery"	.21	.	.	1
NACE205 "Manufacture of other products of wood (..)	.19	.	.	1
NACE454 "Building completion"	.15	.	.	1

The Model

- Purpose:
  1. Framework to guide reduced form regressions.
  2. GE counterfactual analyses.

- Main ingredients:
  - Industry i produce output with different occupation intensities.
  - Roy model of sorting of immigrants/natives to occupations.
    - ★ Aggregate labor supply shock $\longrightarrow$ occupational wage adjustment.
  - Immigrants/natives perfect substitutes within o.

Production and Labor Demand

- Production function

$$y_i = \varphi_i \prod_o L_{io}^{\omega_{io}},$$

  $L_{io} = o$ employment in i, $\sum_o \omega_{io} = 1$.
- Cobb-Douglas preferences across sectors. Expenditure shares β_i.
- Perfectly competitive markets.
- Demand for labor in sector i of occupation o:

$$L_{io} = \omega_{io} \frac{\beta_i Y}{w_o},$$

  $Y =$ aggregate income, $w_o =$ wage.

Labor Supply

- Roy-Frechet model (Lagakos and Waugh, 2013, Redding, 2016).
- Indirect utility for worker ν in occupation o is $U_o(\nu) = z_o(\nu) w_o / P$
  - $z_o(\nu)$ is utility draw.
  - P is Cobb-Douglas price index.
- $z \sim$ Frechet with shape $\kappa > 1$ and location parameter $A_{go} > 0$, where $g \in \{(F)oreign, (N)ative\}$.
  - A_{Fo}: Average immigrant preference for occupation o.
- Workers choose occupation to maximize utility.
  - Supply of labor to each occupation upward sloping.
  - Higher w_o attracts more workers, but the marginal worker has worse draws.

Labor Market Equilibrium

- Labor market equilibrium:

$$\sum_i L_{io} = L_{No} + L_{Fo},$$

  with $\sum_o L_{Fo} = L_F$ and $\sum_o L_{No} = L_N$.

- Consider a shock to aggregate immigrant labor supply L_F.

- Solve the model in relative changes, e.g. equilibrium $\hat{L}_o = L'_o/L_o$.
  - L'_o and L_o refer to the counterfactual and initial equilibrium.

- Define the immigrant share in initial equilibrium

$$\mu_{Fo} = \frac{L_{Fo}}{L_o}.$$

Dekle, Eaton and Kortum (2007) Exact Hat Algebra

Proposition

In general equilibrium, the change in occupation employment, $\hat{L}_o$, is

$$\hat{L}_o = \left(\frac{\hat{Y}}{\hat{\Phi}_F} \right)^{\kappa/(\kappa+1)} \left(\mu_{Fo} \hat{L}_F \right)^{1/(\kappa+1)}.$$

The change in industry employment, $\hat{L}_i$, is

$$\hat{L}_i = \sum_o \lambda_{io} \hat{L}_o,$$

where $\lambda_{io} = L_{io}/L_i$ is the factor intensity of occupation o in industry i in the initial equilibrium.

Dekle, Eaton and Kortum (2007) Exact Hat Algebra

Proposition

Consider a shock to the labor supply of immigrants, L_F. In general equilibrium, the change in occupational wages and average industry wage costs is $\hat{w}_o = \hat{Y}/\hat{L}_o$ and $\hat{W}_i = \hat{Y}/\hat{L}_i$, respectively.

Empirics

- Use Prop 1 and log approximation to get

$$\Delta \ln L_i = \ln K + \kappa^* \sum_o \lambda_{io} \ln \mu_{Fo} + \varepsilon_i$$

  where $\kappa^* \equiv 1/(\kappa + 1)$.
  - RHS variation: Weighted average immigrant intensity of occupations prior to opening the floodgates.

- Robustness: Replace $\ln \mu_{Fo}$ with $\Delta \mu_o^* \equiv \Delta \mu_o / (1 - \mu_o)$.
  - OK if no native flight ($\hat{L}_{No} = 1$).
  - Attenuation bias if native flight (Aydemir & Borjas, 2011).

Baseline Specification

$$\Delta \ln L_i = \ln K_j + \kappa^* \sum_o \lambda_{io} \ln \mu_{Fo} + \varepsilon_i$$

- Unit of observation:
  - i is 3-digit industry-commuting zone (CZ) pair.
- K_j : 2-digit industry-CZ fixed effects:
  - Control for trends in industry output.
  - Only *within 2-digit* differences in instrument that matters.
- Weights λ_{io} refer to 2004 and the change Δ is 2004 to 2013.

IV

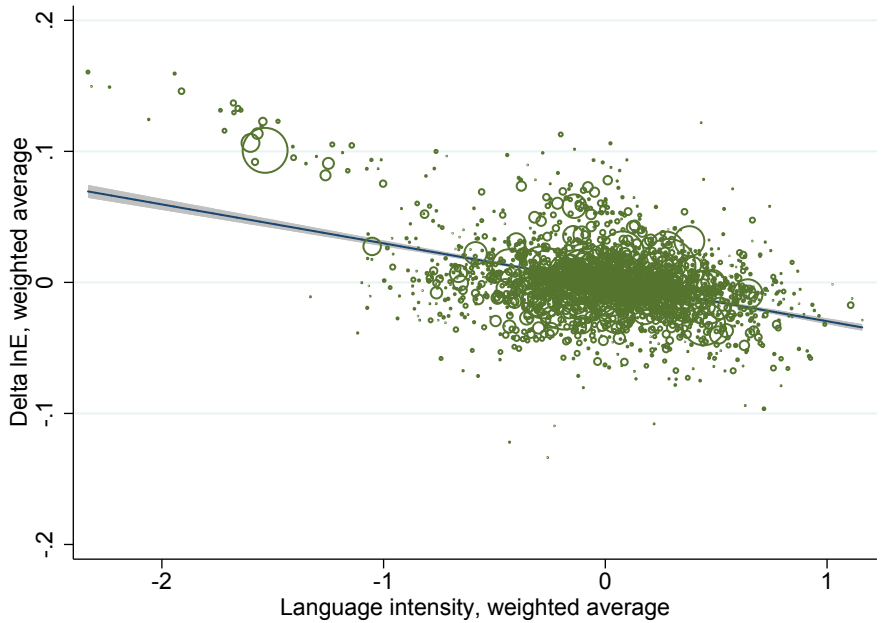
- Initial immigrant share μ_{Fo} partly determined by demand shocks that may persist in future years.
- Instrument μ_{Fo} with $\mathbb{L}_o$.
- Industry-level regressions:
  - Endogenous variable: $\sum_o \lambda_{io} \ln \mu_{Fo}$.
  - IV: $\sum_o \lambda_{io} \mathbb{L}_o$.

Identification

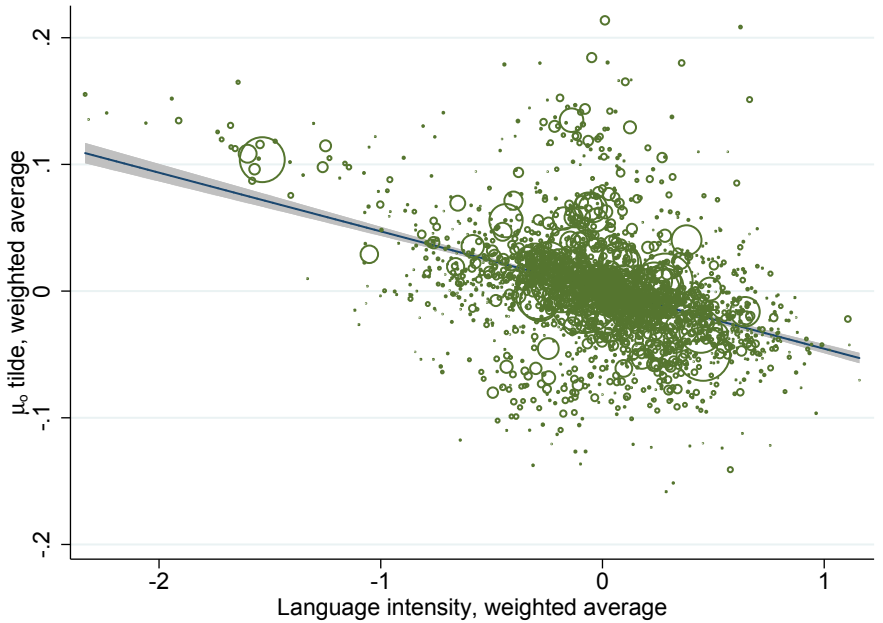
- Identifying variation:
  - Language intensity within 2-digit industry, across 3-digits.
- Exclusion restriction fails if language intensity & growth otherwise related.
- Our solutions:
  1. Control for pre-sample characteristics of the industry:
     - ★ Value added, employment, mean wages, wage share & export intensity.
  2. Control for the skill-intensity of the industry.
     - ★ Share of workers with high school or more.
  3. Falsification tests.

1st stage

$\sum_o \lambda_{io} \ln \mu_{Fo}$



$\sum_o \lambda_{io} \Delta \mu_o^*$



Note: The left figure shows a scatter plot between $\sum_o \lambda_{io} \mathbb{L}_o$ on the x-axis and $\sum_o \lambda_{io} \ln \mu_{Fo}$ on the y-axis. The right figure shows a scatter plot between $\sum_o \lambda_{io} \mathbb{L}_o$ on the x-axis and $\sum_o \lambda_{io} \Delta \mu_o^*$ on the y-axis. The unit of observation is a 3-digit NACE industry-CZ pair. Both variables are demeaned by 2-digit industry-CZ averages. The size of the circles represent industry-CZ employment. The line represents the linear regression line and the gray area the 95 percent confidence interval.

Employment Growth

Table: Immigration and Employment Growth. 2SLS Estimates.

Dep. variable: $\Delta \ln L_i$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\sum_o \lambda_{io} \ln \mu_{Fo}$	-.69	3.38[a]	3.75[a]	3.74[a]				
	(1.87)	(1.20)	(1.22)	(1.27)				
$\sum_o \lambda_{io} \Delta \mu_o^*$					-.18	2.44[a]	2.57[a]	2.59[a]
					(.48)	(.85)	(.83)	(.87)
Industry controls	No	No	Yes	Yes	No	No	Yes	Yes
Worker controls	No	No	No	Yes	No	No	No	Yes
NACE (2-dig)-CZ FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
				1st Stage Estimates				
$\sum_o \lambda_{io} \mathbb{L}_o$	-.01[a]	-.03[a]	-.03[a]	-.03[a]	-.05[a]	-.04[a]	-.04[a]	-.04[a]
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Number of obs.	3,554	2,835	2,835	2,835	3,554	2,835	2,835	2,835

Note: Robust standard errors clustered by 2-digit industry-CZ in parentheses. Changes refer to the time period 2004 to 2013. The unit of observation is a 3-digit industry (NACE)-CZ pair. Industry controls are: Log value added, log employment, log average wages, the share of exports in total sales and the share of wages in total costs (2000 values). The workers control is the share of workers with a completed high school education or higher (2000 values, averaged across firms in an industry). Models are weighted by industry-CZ log employment. [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.1$.

Industry Wage Costs

Table: Immigration and Industry Wage Costs. 2SLS Estimates.

Dep. variable: $\Delta \ln W_i$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\sum_o \lambda_{io} \ln \mu_{Fo}$	-2.49^a	-.95^b	-1.61^a	-1.52^a				
	(.68)	(.45)	(.49)	(.51)				
$\sum_o \lambda_{io} \Delta \mu_o^*$					-.64^a	-.67^b	-1.10^a	-1.12^a
					(.16)	(.32)	(.33)	(.35)
Industry controls	No	No	Yes	Yes	No	No	Yes	Yes
Worker controls	No	No	No	Yes	No	No	No	Yes
NACE (2-dig)-CZ FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
				1st Stage Estimates				
$\sum_o \lambda_{io} \mathbb{L}_o$	-.01^a	-.03^a	-.03^a	-.03^a	-.05^a	-.04^a	-.04^a	-.04^a
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Number of obs.	3,554	2,835	2,835	2,835	3,554	2,835	2,835	2,835

Note: Robust standard errors clustered by 2-digit industry and CZ in parentheses. Changes refer to the time period 2004 to 2013. The unit of observation is a 3-digit industry (NACE)-CZ pair. Industry controls are: Log value added, log employment, log average wages, the share of exports in total sales and the share of wages in total costs (2000 values). The workers control is the share of workers with a completed high school education or higher (2000 values, averaged across firms in an industry). Models are weighted by industry-CZ log employment. ^{a} p$<$ 0.01, ^{b} p$<$ 0.05, ^{c} p$<$ 0.1.

Magnitudes

Employment:

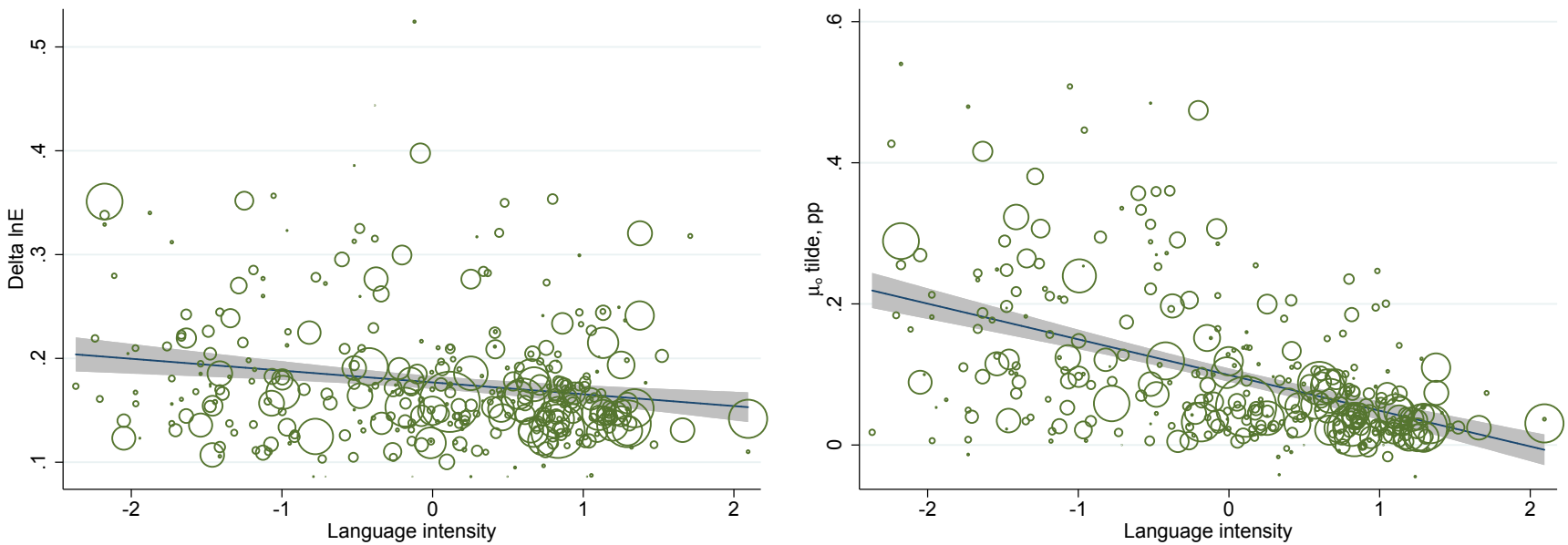
- $10th$ and $90th$ percentile of $\sum_o \lambda_{io} \ln \mu_{Fo}$: .14 and .22.
  - 30% higher employment growth for $90th$ vs $10th$ percentile industry $((.22 - .14) \times 3.74)$.

Average wage costs:

- 12% lower industry wage cost growth in $90th$ vs $10th$ percentile industry $((.22 - .14) \times (-1.52))$.
- Mean $\Delta \ln$ Avg. Wage $= 0.40$.

Mechanisms : Occupation Wages

- Calculate mean wages by occupation-CZ, w_o.
- Regress $\Delta \ln w_o$ on $\ln \mu_{Fo}$ or $\Delta \mu_o^*$, using same instrument.
- First stage:



Note: The left figure shows a scatter plot between $\mathbb{L}_o$ on the x-axis and $\ln \mu_{Fo}$ on the y-axis. The right figure shows a scatter plot between $\mathbb{L}_o$ on the x-axis and observed $\Delta \mu_o^*$ on the y-axis. The unit of observation is 4-digit occupation codes. The size of the circles represent occupation employment. The line represents the linear regression line and the gray area the 95 percent confidence interval.

Occupation Wages

Table: Immigration and Occupation Wage Growth.

Dep. var.: $\Delta \ln w_o$	(1) All	(2) Natives	(3) Imm.	(4) All	(5) Natives	(6) Imm.
$\ln \mu_{Fo}$	-1.62^a	-1.20^a	-1.48^b			
	(.41)	(.43)	(.65)			
$\Delta \mu_o^*$				-.44^a	-.33^a	-.41^b
				(.11)	(.12)	(.18)
Worker controls	Yes	Yes	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes	Yes	Yes
			1st Stage Estimates			
$\mathbb{L}_o$	-0.01^a	-0.01^a	-0.01^a	-0.05^a	-0.05^a	-0.05^a
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Number of obs.	10,238	10,070	4,934	10,238	10,070	4,934

Note: Standard errors clustered by CZ in parentheses. Changes refer to the time period 2004 to 2013. The unit of observation is occupation (4-digit)-CZ. The workers control is the share of workers with a completed high school education or higher (2003 values, across individuals in an occupation). Models are weighted by occupation-CZ log employment. ^{a} p$<$ 0.01, ^{b} p$<$ 0.05, ^{c} p$<$ 0.1.

- 21% lower wage growth in $90th$ vs $10th$ percentile occupation $(.25 - .12) \times (-1.62))$.

Sensitivity

1. Placebo : Regress 1999-2003 growth on 2004-2013 immigration.
2. Substitutability between immigrants and natives.

1. Placebo : Industry Employment

Table: Immigration and Industry Employment. Falsification Test.

Dependent variable: $\Delta \ln L_i$ (1999-2003)	(1)	(2)
$\sum_o \lambda_{io} \ln \mu_{Fo}$ (2004-2013)	-1.52	1.12
	(1.47)	(1.13)
Pre-sample industry controls	No	No
Pre-sample worker controls	No	No
Industry (2-digit)-CZ FE	No	Yes
	1st Stage Estimates	
$\sum_o \lambda_{io} \mathbb{L}_o$	-.01[a]	-.03[a]
	(.00)	(.00)
Number of observations	3,469	2,769

Note: Robust standard errors clustered by 2-digit industry-CZ in parentheses. Changes refer to the time period 2004 to 2013 for the instrument and 1999 to 2003 for the dependent variable. The unit of observation is a 3-digit industry-CZ pair. Models are weighted by industry-CZ log employment.[a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.1$.

1. Placebo : Industry Wage Costs

Table: Immigration and Industry Wage Costs. Falsification Test.

Dependent variable: $\Delta \ln W_i$ (1999-2003)	(1)	(2)
$\sum_o \lambda_{io} \ln \mu_{Fo}$ (2004-2013)	-1.00	-1.18
	(.92)	(.72)
Pre-sample industry controls	No	No
Pre-sample worker controls	No	No
Industry (2-digit)-CZ FE	No	Yes
	1st Stage Estimates	
$\sum_o \lambda_{io} \mathbb{L}_o$	-0.01[a]	-0.03[a]
	(.00)	(.00)
Number of observations	3,469	2,769

Note: Robust standard errors clustered by 2-digit industry-CZ in parentheses. Changes refer to the time period 2004 to 2013 for the instrument and 1999 to 2003 for the dependent variable. The unit of observation is a 3-digit industry-CZ pair. Models are weighted by industry-CZ log employment.[a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.1$.

2. Substitutability between immigrants and natives

Table: Immigrant-Native Wage Gap

Dep. var.: Log wage	Men			Women		
	(1)	(2)	(3)	(4)	5)	(6)
Immigrant dummy	-0.29[a]	-0.19[a]	0.02	-0.22[a]	-0.13[a]	0.01
	(0.03)	(0.03)	(0.01)	(0.03)	(0.03)	(0.01)
Age/experience/tenure	No	Yes	Yes	No	Yes	Yes
4-digit occupation FE	No	No	Yes	No	No	Yes
No obs	791,163	791,163	791,163	356,715	356,715	356,715

Note: Robust standard errors clustered by 4-digit occupation. Data set restricted to full time employees in year 2014.
[a] p< 0.01, [b] p< 0.05, [c] p< 0.1.

Conclusions

- Uneven supply of labor $\longrightarrow$ uneven growth of industries.
  - Immigration has quantitatively large impact on industry growth.
- Empirical support for the simplest possible factor proportions story.
  - Sorting of workers across occupations first order.
  - Relative occupation wages adjust