Competitive equilibrium

AE318 - Labour Economics

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- Perfect competition
- The effect of a shock on female labour supply

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The competitive equilibrium
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The competitive equilibrium (1)

- Labour demand
  - Production function: $F(L)$ where L denotes labour input
  - Firm's profit: $F(L) - wL$, where w is the wage
  - Labour demand: $F'(L^d) = w$
- Labour supply
  - Utility function: $u(R, e, \theta) = R - e\theta$
    - R income
    - e employment dummy variable
    - θ the disutility of labour for the individual
  - $G(\theta)$ is the cumulative distribution function of θ

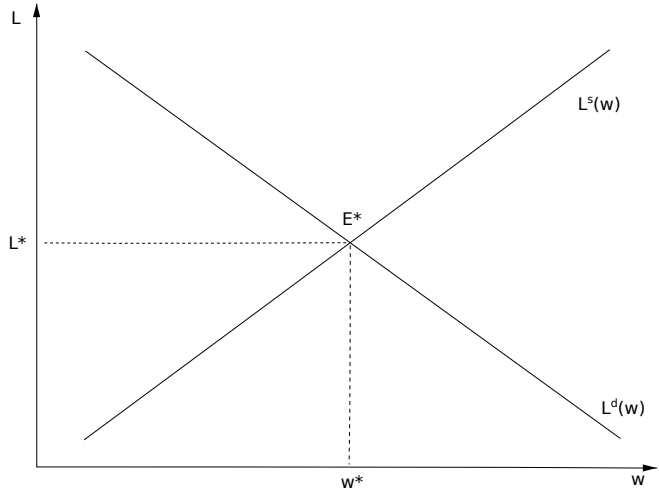
The competitive equilibrium (2)

- A worker with characteristic θ has utility $w - \theta$ if she works, 0 if not
- Only individuals with $\theta < w$ decide to work
- If we normalize the measure of the labour force to 1, then labour supply is equal to $G(w)$
- At equilibrium, labour supply equals labour demand:

$$F'[G(w^*)] = w^*$$

- Competitive equilibrium is a collective optimum: Allocation of individuals between employment and inactivity is efficient

The competitive equilibrium (3)



Tax incidence

- Fiscal incidence is the situation in which the agent to whom tax is charged is not necessarily the real payer
- The essential point about tax incidence is knowing who the *end* payer of the tax or the *end* recipient of the subsidy is
- Payroll tax: rate t on wage w, charged to the firm (if $t < 0$: subsidy)
- Labour demand: $F'(L^d) = w(1 + t)$
- Equilibrium: $L^d[w(1 + t)] = L^s(w)$
- What happens if we switch from, say $t_0 = 0$ to $t_1 < 0$?

When labour supply is inelastic

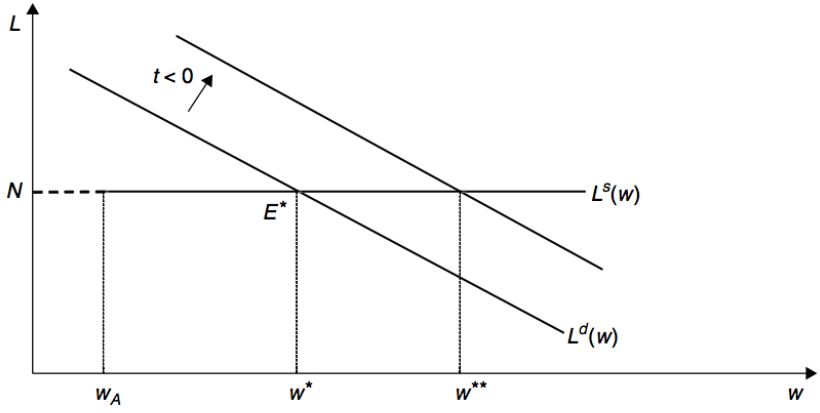


FIGURE 3.2
The effects of a reduction in payroll taxes with inelastic labor supply.

When labour supply is elastic

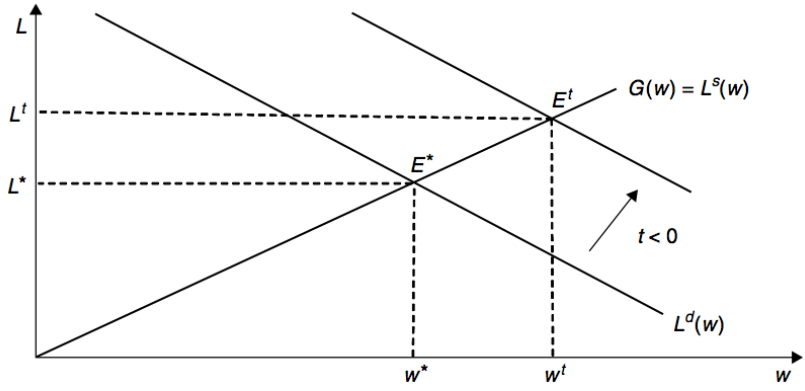


FIGURE 3.1
Market equilibrium with perfect competition.

Elasticity of wage to tax rate

- The elasticity of wage with respect to the tax rate η_t^w is :

$$\eta_t^w = \frac{\eta_w^d}{\eta_w^s - \eta_w^d}$$

  - $\eta_w^d < 0$ represents labour demand elasticity
  - η_w^s designates labour supply elasticity
- With inelastic supply: wages absorb all the tax change
- When supply is elastic: wages and employment increase
- Both workers and firms share the tax burden (depending on their elasticities)

Empirical evidence

- Gruber (1997) studied the incidence of a dramatic change in payroll taxation in Chile in 1981
  - Chile privatized social security and disability insurance programs
  - Average payroll tax for manufacturing firms dropped from 30% to 8.5% in 1982
  - Gruber shows that net wage increased of the same amount and there was no impact on the employment level
- Anderson and Meyer (2000) have obtained similar results in their study of the consequences of a change in the financing of unemployment insurance in the state of Washington in the middle of the 1980s

The competitive equilibrium

- Perfect competition
- The effect of a shock on female labour supply

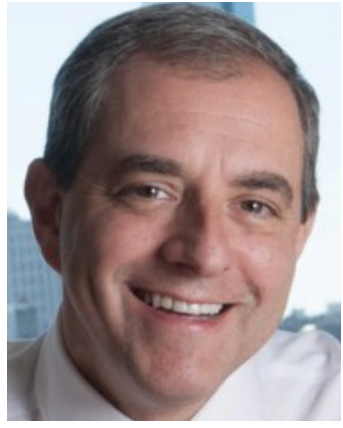
The impact of migrants on a labour market

- The effect of an immigration-induced shock

Acemoglu, Autor and Lyle (2004)

Women, War, and Wages: The Effect of Female Labor Supply on the Wage Structure at Midcentury, *Journal of Political Economy*, 2004

Daron Acemoglu
MIT



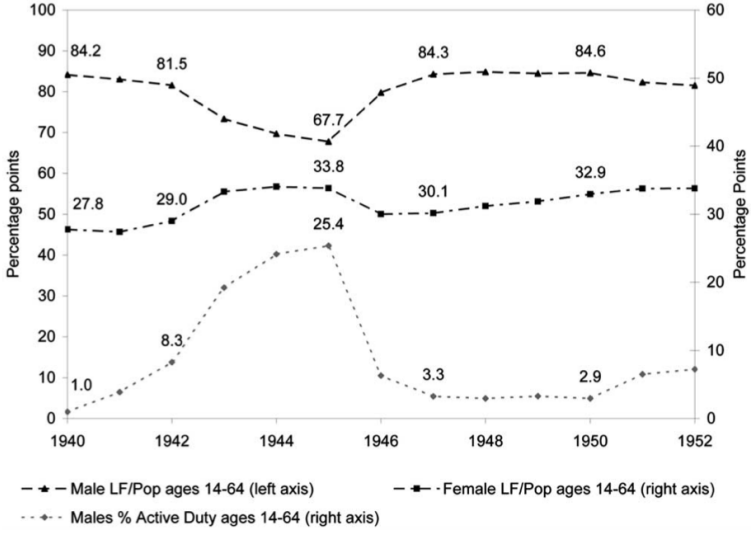
David Autor
MIT

David Lyle
U.S. Military Academy

The effect of a shock on labour supply - introduction

- Research questions: What is the effect of a shock on labour supply on employment and wages? What is the elasticity of labour demand?
- They use the stark changes during WWII as an exogenous shock on labour supply
  - Between 40 and 55% of all eligible males aged 18-44 were mobilized for WWII, and 73% were deployed overseas
  - This shock on the supply of labour was partly compensated by women entering the labour market: female employment rate increased from 24% in 1930 to 34% in 1950
  - Consequently, labour supply increased massively during the war and post-war periods in the U.S.

Labour during WWII



The effects of a demographic shock

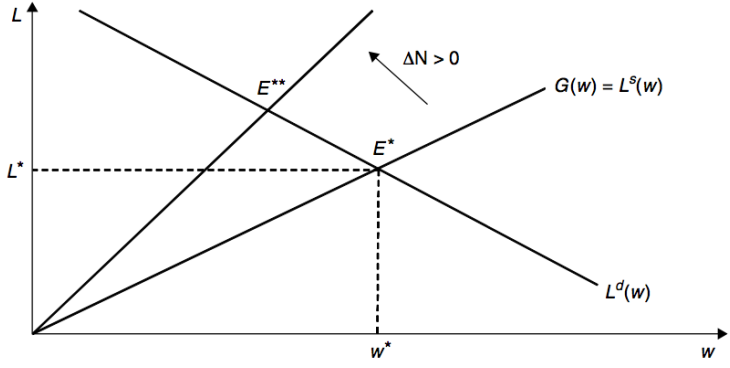


FIGURE 3.3
The effects of a demographic shock.

Simple model

- Question: What should be the impact of an increase in female employment on female and male wages?
- Cobb-Douglas production function: $Y = AK^{\alpha}L^{1-\alpha}$
- CES between male M and female labour F:

$$L = \left[(1-\lambda)(a_M M)^{\frac{\sigma-1}{\sigma}} + \lambda(a_F F)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

  - σ: elasticity of substitution between females and males
  - a_M and a_F are positive factor-augmenting productivity terms
  - λ is a share parameter
- Integrating this labour input into the production function gives *nested CES function*

$$Y = AK^{\alpha}\left[(1-\lambda)(a_M M)^{\frac{\sigma-1}{\sigma}} + \lambda(a_F F)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{(1-\alpha)\sigma}{\sigma-1}}, \sigma > 0,\ a_i > 0$$

Simple model (2)

- With W^i designating the unit wage cost of labour input i, equalizing wages with the marginal products of each labour input gives:

$$
\begin{aligned}
W^F &= (1-\alpha)\lambda a_F A K^{\alpha} \left(a_F F\right)^{-\alpha} \\
&\quad \times \left[(1-\lambda)\left(\frac{a_M M}{a_F F}\right)^{\frac{\sigma-1}{\sigma}} + \lambda\right]^{\frac{1-\alpha\sigma}{\sigma-1}} \\
W^M &= (1-\alpha)\,(1-\lambda)\, a_M A K^{\alpha} \left(a_M M\right)^{-\alpha} \\
&\quad \times \left[(1-\lambda) + \lambda\left(\frac{a_F F}{a_M M}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1-\alpha\sigma}{\sigma-1}}
\end{aligned}
$$

Simple model (3)

- Short run: capital and male supply exogenous
- Differentiating the FOC:

$$\frac{\partial \ln W^F}{\partial \ln F} = -(1 - s^m)\alpha - s^m \frac{1}{\sigma}$$
$$\frac{\partial \ln W^M}{\partial \ln F} = -(1 - s^m)\alpha + (1 - s^m)\frac{1}{\sigma}$$

  - s^m is the share of male labour in labour costs
- If $\sigma \to \infty$, men and women are perfect substitutes: male and female wages are equally affected
- What about the case $\alpha \to 0$?

Mobilization and female weeks worked

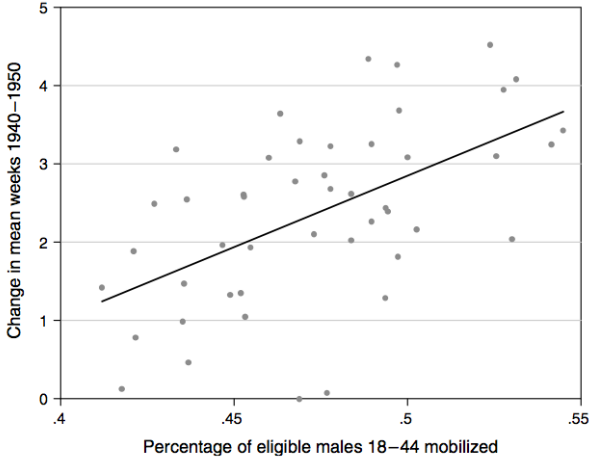


FIGURE 3.4
State World War II mobilization rates and change in female mean weeks worked per year in 1940–1950 and 1950–1960.

Source: Acemoglu et al. data set (2004).

Mobilization and female wages

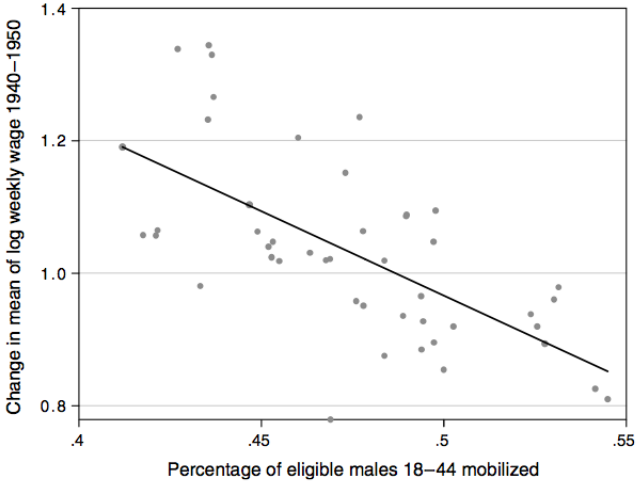


FIGURE 3.5
State World War II mobilization rates and change in mean female weekly wages, 1940–1950.

Source: Acemoglu et al. data set (2004).

Mobilization and female weeks worked

- The way mobilization rates are correlated with variations in female weeks worked could be estimated with:

$$y_{ist} = \delta_s + \gamma d_{1950} + \boldsymbol{x}_{ist}\boldsymbol{\beta_t} + \varphi m_s d_{1950} + \varepsilon_{ist}$$

  - y_{ist} weeks worked by women i living in state s in year $t \in \{1940, 1950\}$
  - m_s the mobilization rate in state s
  - δ_s state dummies
  - d_{1950} a dummy variable equal to 1 in 1950 and to 0 in 1940
  - $\boldsymbol{x}_{ist}$ other covariates
  - ε_{ist} the error term
- The result shows that a growth of mobilization rate increased worked weeks in 1950 compared to 1940
- So the mobilization rates are significantly correlated with the rise in female employment

Question about identification

- How can we be sure that the growth in female employment changes the labour supply curve and not the labour demand?
  - If high mobilization states entail a higher demand for labour for some reasons not accounted in the model, we should observe a positive correlation between mobilization and male employment
  - If it is due to difficulties of men in reentering the labour market, we should observe an increase in demand for female labour, and so a negative correlation between mobilization and male employment
- The coefficient rate on male weeks worked is insignificant

Determinants of mobilization

- The mobilization rate may be partly driven by economic factors that also influence female and male employment. In this case, the coefficient of the mobilization rate would not reflect a causal relationship
- It would be interesting to find non-economic determinants of mobilization to serve as instruments

Determinants of mobilization

	Mean	Mobilization rate
Share farmers	.15	−.15 (.05)
Share nonwhite	.10	−.01 (.05)
Average education	8.89	.02 (.01)
Share aged 13-24	.42	.25 (.34)
Share aged 25-34	.31	.15 (.48)
Share German origin	.007	−3.19 (.89)
Share Japanese or Italian origin	.010	1.70 (.52)
Share married	.50	−.10 (.17)
Share fathers	.47	.08 (.13)
R^2		.78

Table: 1940 State Level Determinants of WWII Mobilization rates (N=47 States)
The first column displays the mean value of each variable. The second column displays the results of the regression of the mobilization rate. Standard errors in parentheses.
Source: Acemoglu, Autor and Lyle (2004, Table 4)

IV analysis

- This instrumental variables method is implemented with a *two-stage least squares* estimation of the following system of two equations:

$$\begin{aligned} y_{ist} &= \delta_s + \gamma d_{1950} + \mathbf{x}_{ist}^{'}\beta_t + \varphi m_s d_{1950} + \varepsilon_{ist} \\ m_s &= \alpha_0 + \mathbf{z}_s\boldsymbol{\alpha}_1 + v_s, \end{aligned}$$

  - $\mathbf{z}_s$ denotes the vector of the instruments and v_s is an error term
  - The second equation predicts m_s that we put in the first equation
- It seems that the war induced indeed an *exogenous* shift in female labour supply

The elasticities of female labour demand

What about the impact of the variation in the labour supply of women between 1940 and 1950 induced by the mobilization rate?

- The impact of women's labour supply on their wages may be analyzed on the basis of equation:

$$\ln W_{ist} = \delta_s + \gamma d_{1950} + \mathbf{x}'_{ist}\boldsymbol{\beta_t} + \chi \ln F_{st} + u_{ist}$$

- The female labour supply F_{st} can be instrumented by the mobilization rate using an equation in the first stage:

$$F_{st} = \delta_s + \lambda d_{1950} + \mathbf{x}'_{st}\boldsymbol{\rho_t} + \varphi m_s d_{1950} + \varepsilon_{ist}$$

Estimation results

	Log weekly earnings	
	(1) OLS	(2) Two-Stage Least Squares
F	$-.002$	$-.124$
	(.011)	(.029)
		First-Stage Coefficients
$m_s d_{1950}$		10.22
		(1.81)

Table: OLS and IV Estimates of the Impact of Female Labour Supply on Log Weekly Earnings, 1940-50

Sample: White Females (N =69,335)

Source: Acemoglu, Autor and Lyle (2004, Tables 3 and 9)

Estimation results

- OLS estimates are very different from IV estimates
- Selection bias: female employment increased more in states with greater demand for female labor?
- When endogeneity is controlled for, demand for female labour decreases with their wage, as predicted by the model of labour demand

Estimating the structural model

- The model estimated so far is not exactly the one derived from the theoretical model
- What if we want to directly estimate the parameters from the model?
- The structural model can be estimated by regressing the log of wages onto the log of employment with the equation, taking the full sample (males and females) with f_i female dummy:

$$\ln W_{ist} = \delta_s + \gamma d_{1950} + \varphi f_i + \mathbf{x}'_{ist}\boldsymbol{\beta_t} + \chi \ln\left(\frac{F_{st}}{M_{st}}\right) + \eta f_i \ln\left(\frac{F_{st}}{M_{st}}\right) + u_{ist}$$

- $\ln(F_{st}/M_{st})$ and $f_i \ln(F_{st}/M_{st})$ are instrumented by the state mobilization rate and its interaction with f_i

Structural parameter estimates

	Log Weekly Earnings	
	(1)	(2)
$\ln\left(\frac{F}{M}\right)$	$-.51$ (.11)	$-.25$ (.20)
$f.\ln\left(\frac{F}{M}\right)$	$-.31$ (.13)	$-.42$ (.19)
Estimated σ	3.18	2.37
Estimated σ_F	-1.21	-1.48
	First-Stage Coefficients	
$m_s d_{1950}$	1.56 (.19)	1.14 (.30)
Includes share of farmers, share of nonwhites and education	No	Yes

Table: IV Estimates of the Impact of Female / Male Labour Supply on Log Weekly Earning, 1940-50
Sample: White females and males
Source: Acemoglu, Autor and Lyle (2004, Tables 10)

Elasticities

- Increased labour supply from females reduces female earnings
  - a 10% increase in relative female labour supply reduces female wages by 7 to 8%, which corresponds to an own-labour demand elasticity of -1.2 to -1.5
- This result suggests that female labour demand is quite sensitive to wages
- Moreover, the elasticity of substitution is high:
  - A 10% increase in female labour supply lowers female wages relative to male wages by 3 to 4%

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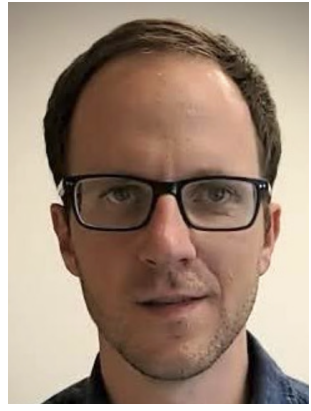
Dustmann, Schönberg and Stuhler (2017)

Labor Supply Shocks, Native Wages, and the Adjustment of Local Employment, *Quarterly Journal of Economics*, 2017

Christian Dustmann
UCL

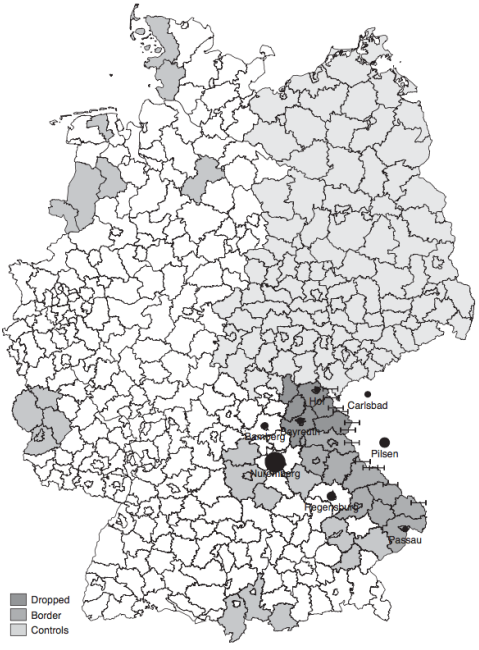
Uta Schönberg
UCL



Jan Stuhler
Carlos III

Grenzgängerregelung

- 14 months after fall of the Iron Curtain
- Czech workers allowed to seek employment (but not to reside) in eligible German border municipalities
- Big shock: around 10% of employment in border municipalities


Hof
Carlsbad
Bayreuth
Bamberg
Pilsen
Nuremberg
Regensburg
Passau
Dropped
Border
Controls

Share of Czech workers

Model

- Production: CES nested in a Cobb-Douglas

$$Q = AK^{\alpha}L^{1-\alpha} \text{ with } L = \left[\theta_U L_U^{\frac{\sigma-1}{\sigma}} + \theta_S L_S^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

with U and S the subscripts for unskilled and skilled labour

Model

- The change to demand for native workers in group g to a supply shock $\partial I = \partial L^I / L^N$ is:

$$\frac{\partial \log L_g^N}{\partial I} = \left(s_{g'}\phi^{-1} - s_g\sigma\right)\frac{\partial \log w_g}{\partial I} + \left(s_{g'}\phi^{-1} + s_{g'}\sigma\right)\frac{\partial \log w_{g'}}{\partial I} - \frac{\pi_g^I}{\pi_g^N}$$

  with ϕ the slope of aggregate demand, π_g^I the share of g workers among immigrants, s_g the contribution of g to the labour aggregate

- Direct negative effect depending on composition of I and N populations
- Positive effect through wage of own group
- Ambiguous effect through wage of other group

Model

- Elasticity of local labour supply to wage η_g, which implies:

$$\frac{\partial \log w_g}{\partial I} = \frac{1}{\eta_g} \frac{\partial \log L_g^N}{\partial I}$$

- Plugging this into the previous expression provides an expression for $\frac{\partial \log L_g^N}{\partial I}$ as a function of parameters only
- If $\eta_U = \eta_S$: w and L of the group most affected by the shock decline relative to those of the other group
- If $\eta_U > \eta_S$: effect on L_U is amplified and the effect on w_U reduced

Empirical strategy

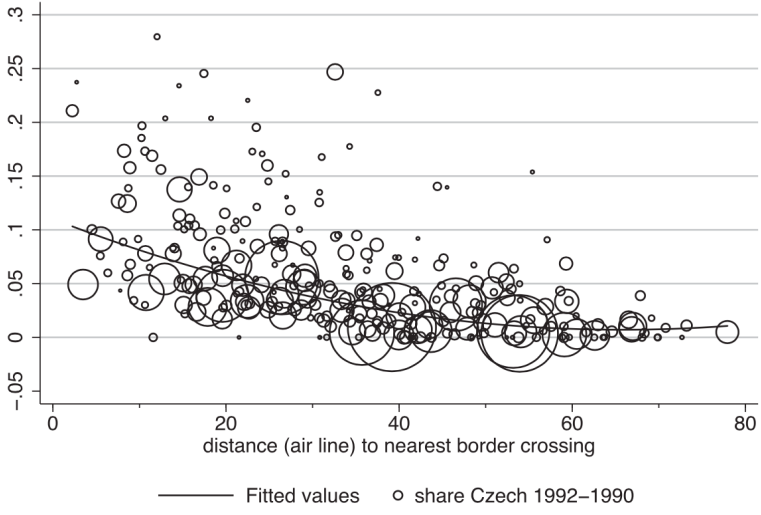
- For skill group g, age group s, area j and two time periods k and t, they estimate:

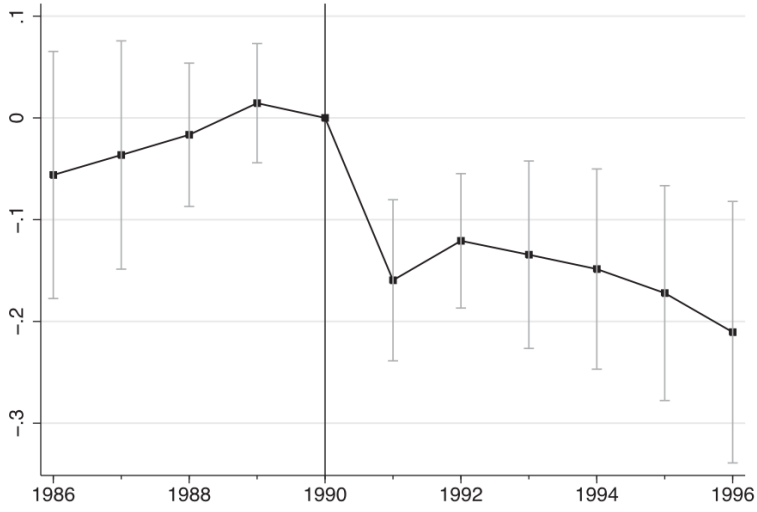
$$\Delta \log w_{gs,j} = \alpha_{gs} + \beta_{gs} \Delta C_j^{92-90} + u_{gs_j}$$
$$\Delta L^N_{gs,jtk} = \gamma_{gs} + \delta_{gs} \Delta C_j^{92-90} + v_{gs_j}$$

with $\Delta C_j^{92-90} = \frac{L^I_{j,92} - L^I_{j,90}}{L^N_{j,90} + L^I_{j,90}}$ and $\Delta L^N_{gs,j} = \frac{L^N_{gs,jt} - L^N_{gs,jk}}{L^N_{gs,jk}}$

- Idea: instrument the share of Czech workers by the distance to the border
- They select inland control districts using a synthetic control method

First stage


-.05
0
.05
.1
.15
.2
.25
.3
0
20
40
60
80
distance (air line) to nearest border crossing
Fitted values
share Czech 1992−1990


Panel a: Wage effects
.1
0
−.1
−.2
−.3
1986
1988
1990
1992
1994
1996

Panel b: Employment effects

Main results

- A 1 pp. increase in the share of Czech leads to
  - a 0.13% decrease of wages
  - a 0.93% decrease in native employment
  - a 0.07% (=1-.93) increase in local employment
- Larger effects from the unskilled than the skilled workers (twice bigger)
- OLS estimates biased upwards

Results by age groups

- Younger natives (less than 30 years old) seem to be affected differently than older workers
  - The effect on wage is larger and the effect on employment lower
- This could be due to:
  - Older workers being more elastic than younger ones
  - Wages of older workers could be more (downward) rigid than those of younger workers

Inflows vs. outflows

- The overall employment effect could be decomposed into:
  - workers leaving employment in a given area
  - workers not entering employment in a given area
- Results show that the outflow margin is not affected
  - most of the effect comes from inflows
  - mostly from inflows from unemployment, but a little from inflows from other areas as well

External validity

- Migrants did not live and consume locally (no demand effects)
- Unexpected and unusually large labour supply shock...
- ... in a region with little experience of immigration
- Shock may have been perceived as temporary by firms (do not react by investing in complementary factors)