Asymmetric Shocks and Heterogeneous Worker Mobility in the Euro Zone

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Risk sharing in the eurozone

- Labor mobility a corner stone in optimal currency area theory (Mundell, 1961), when
  - neither currencies can adjust
  - nor fiscal policy is integrated

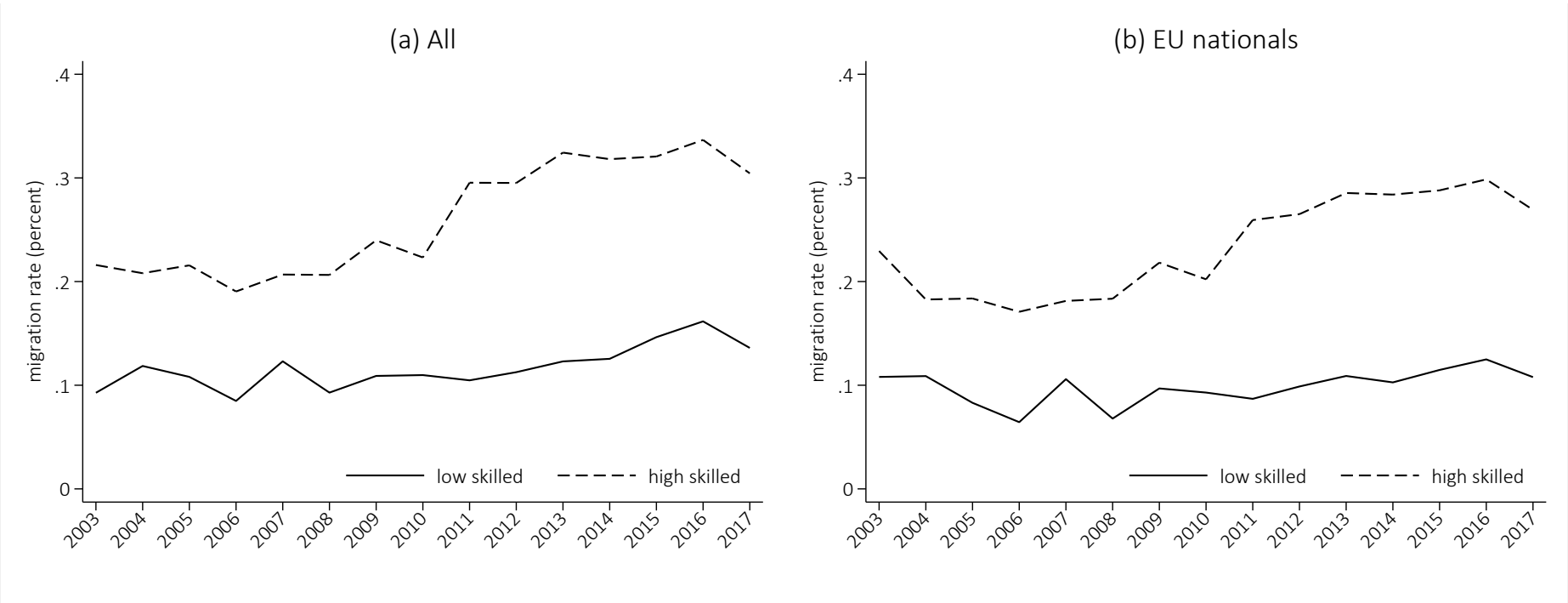
- Labor mobility meant to dissipate asymmetric shocks in absence of flexible exchange rates and compensating fiscal policy

- Renewed attention since the euro crisis
  - euro zone with (almost) no integrated fiscal policy
  - integrated labor markets as a core pillar of Single Market

- Common assumption in models used to analyze this: homogeneity of workers.

Migration in Europe

- Empirical fact for many contexts of international migration: **higher geographic mobility of high skilled workers** (Grogger and Hanson, 2011; Docquier and Rapoport, 2012; Clemens and Mendola, 2020; Bütikofer and Peri, 2021)
- Inner-European migration no exception:



Source: European Union Labour Force Survey. more

This paper

- Formulates a dynamic spatial equilibrium model with frictions and geographic mobility of heterogeneous workers
  - different skill groups, imperfect substitutes in production
  - migration preference correlated with skill
- Documents higher mobility of more educated workers within Europe
  - May mitigate potential of labor mobility to absorb asymmetric shocks
  - Brain drain may in fact aggravate shocks for individual countries
- Calibrates model to European data to evaluate role of labor mobility.

Preview of Results

Labor mobility reduces costs of permanent asymmetric shocks

- labor mobility increases welfare of stayers in a country hit by a negative productivity shock
- limits the effects on unemployment and nominal wages in that country
- raises prices, leading to a real wage loss for low skilled workers
- same for negative shock to demand for a country's output

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- to mitigate short-lived shocks even for the high skilled.

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Comparison to integrated fiscal policy

- fiscal transfers would offer faster relief than migration
- but longer-term not superior to integrated labor markets.

Overview of the model

- **Heterogeneous workers** who differ in productivity and in their preference for locations
- National labor markets with **search frictions** that are linked through **worker mobility**
- Employment in **skill-specific intermediate goods** market, whose outputs are **imperfect substitutes** in production of **final national goods, traded** and consumed internationally
- Nash bargaining, but **sluggish wage adjustment**
- **Taylor rules** for economies inside and outside the euro area.

Production

Every worker in country j produces 1 unit of an intermediate good, which can be $\{L_j, H_j\}$, with value $\{p_{j,L}, p_{j,H}\}$

- Intermediate goods combined by competitive firms to produce a country's final output (omitting time subscripts throughout)

$$Y_j = A_j \left((1 - \alpha_j) H_j^{\rho} + \alpha_j L_j^{\rho} \right)^{\frac{1}{\rho}}$$

- National goods have potentially different prices P_j.

more

Utility

Individual i chooses consumption vector $(c_{i,1}, ..., c_{i,N})$ and location j_i generating per period utility flow

$$\mathcal{U}(c_{i,1}, ..., c_{i,N}; j_i) = \left(\sum_j \psi_{j,j_i} c_{i,j}^{\xi} \right)^{\frac{1}{\xi}} + \epsilon_{i,j_i}$$

- tastes ψ_{j,j_i} for different countries' goods such that $\sum_j \psi_{j,j_i} = 1$
- location preference shock $\epsilon_{i,j}$ with mean μ_{j,s_i,n_i}
- location chosen every period, migration at cost $k_{j,d}$ (function of distance between current location j and destination d).

optimal consumption

Values of working and unemployment

Working and unemployed individuals respectively maximize

$$
\begin{aligned}
W_{j,s,n} &= \frac{w_{j,s,n} + d_j - T_j}{P_j^u} + \epsilon_j + \frac{\mathbb{W}_{j,s,n}}{1+r} \\
U_{j,s,n} &= \frac{b_j + d_j - T_j}{P_j^u} + \epsilon_j + \frac{\mathbb{U}_{j,s,n}}{1+r},
\end{aligned}
$$

with

- expected continuation values $\mathbb{W}_{j,s,n}$ and $\mathbb{U}_{j,s,n}$ details
- price per utility under optimal consumption

$$
P_j^u = \left(\sum_k P_k^{(1-\xi)} \psi_{k,j}^{\xi} \right)^{\frac{1}{1-\xi}}.
$$

Labor market

Otherwise (almost) standard DMP

- free firm entry until $Vac_{j,s} = 0$
- Nash bargaining for natives determines $w_{j,s,j}$
- immigrants ($n \neq j$) suffer a wage penalty $w_{j,s,n} = \nu_j w_{j,s,j}$
- Cobb-Douglas matching probability $\varsigma \left(\sum_n u_{j,s,n}\right)^{\eta} v_{j,s}^{1-\eta}$ with random matches across nationalities n.

details

Equilibrium employment level $\sum_n e_{j,s,n}$ in each sector and country then determines supply of intermediate goods

$$H_j = \sum_n e_{j,H,n} \quad \text{and} \quad L_j = \sum_n e_{j,L,n}.$$

equilibrium conditions

Nominal wage rigidity and exchange rates

Role for monetary policy: we assume national central banks sets nominal interest rates according to Taylor-rule

$$int_{j,t} = \bar{int} + \rho\ int_{j,t-1} + (1-\rho)\left(\phi_y \Delta output_{j,t} + \phi_p \Delta inflation_{j,t}\right),$$

No-arbitrage then requires

$$(1 + int_{j,t}) = (1 + int_{j',t})\mathbb{E}\left(\frac{E_{j',t+1}}{E_{j',t}} \cdot \frac{E_{j,t}}{E_{j,t+1}}\right),$$

with exchange rates $E_{j,t}$ relative to the euro.

Data

Calibration of 277 parameters to 286 moments from **EU-LFS**, **EU-SILC** and **Eurostat** data for

- 17 countries, grouped as AT, (BE and LU), DE, DK, ES, FR, IT, NL, PT, high income non-euro countries (CH, SE, UK), low income non-euro countries (CZ, HU, PL, RO)
- 2012-2017.

Migration flows constructed from EU-LFS

- info on where respondents were last year
- info on nationality only in broad groups
  $\Rightarrow$ assume migration only between country of own nationality and any other location (in both directions)

Bilateral **migrant stocks** from Eurostat

- allows separate identification of taste parameters $\mu_{j,s,n}$ and costs $k_{j,d}$.

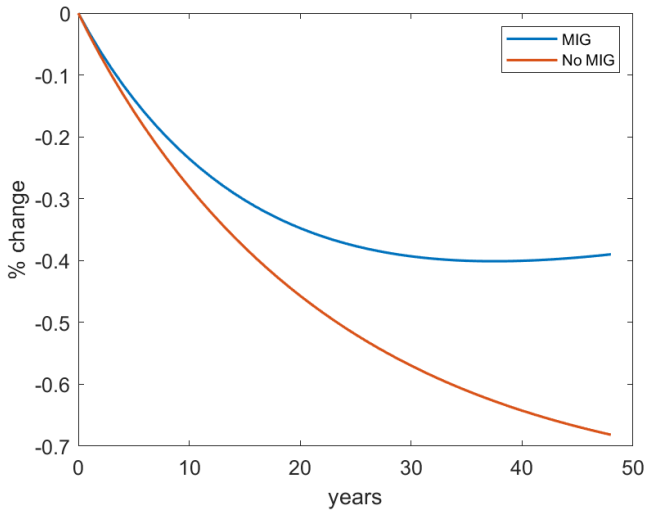
Asymmetric shocks

We examine different types of shocks

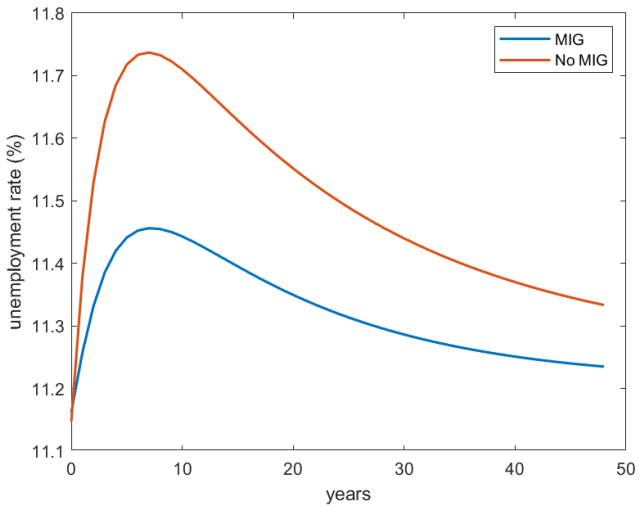
- Unexpected permanent shock to Italian TFP
- Non-permanent shock
- Shock to southern European countries
- Shock to demand for Italian output.

Unexpected permanent shock to Italian TFP (-1%)

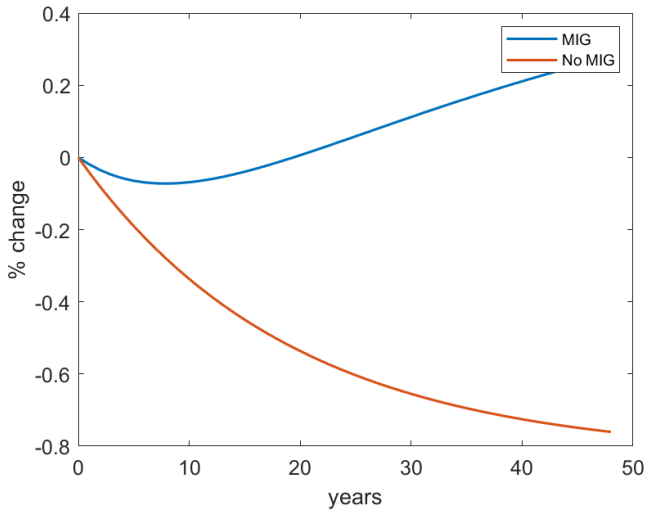
(a) Low sk. nom. wage



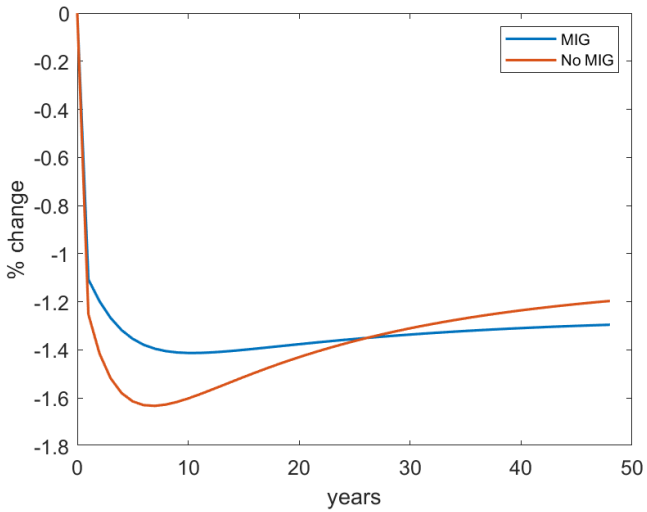
(b) Total unempl.



(c) High sk. nom. wage

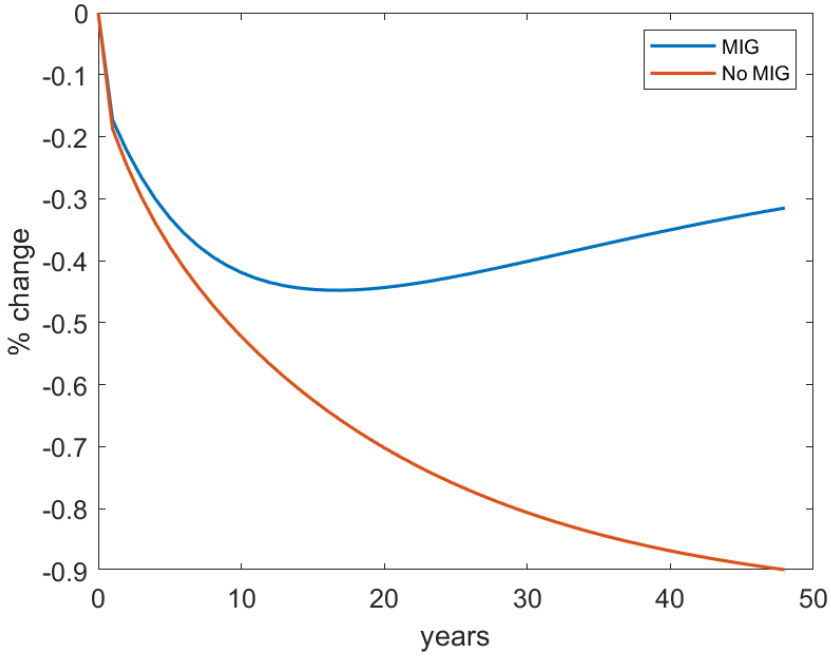


(d) Output/capita

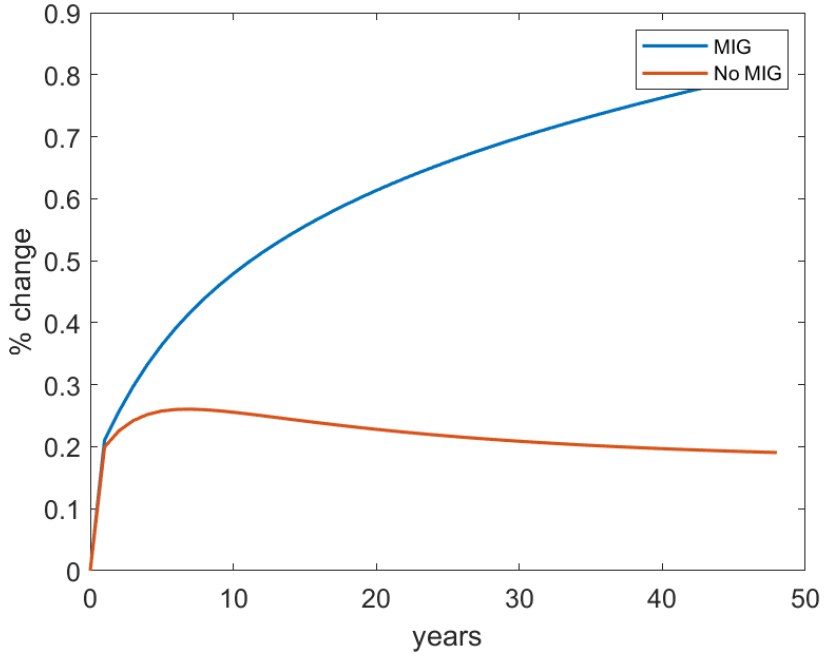


Unexpected permanent shock to Italian TFP (-1%)

(a) High sk. real wage



(b) Price of Italian output



Unexp. perm. shock to either productivity or demand

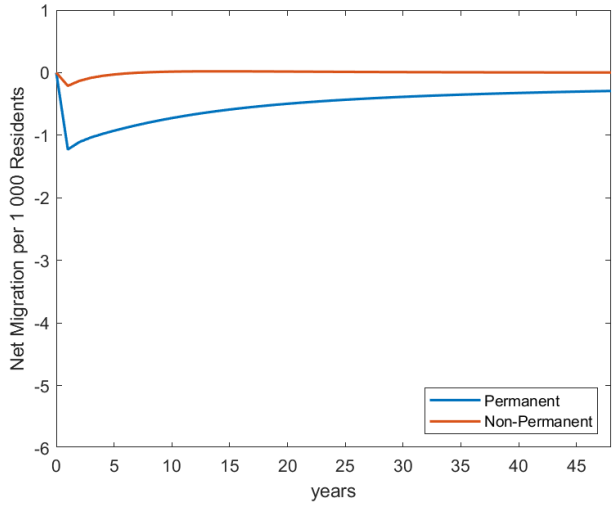
- Migration response concentrated among the high skilled
- Effects on wages and unemployment of the high skilled largely muted through migration
- Smaller mitigating effect also for the low skilled
- Short-run effect on output smaller with migration
- Long-run effect on output larger with migration
- Price of national good rises more strongly with migration following productivity shock
- Price of national good falls less strongly with migration following demand shock.

Weaker effects when

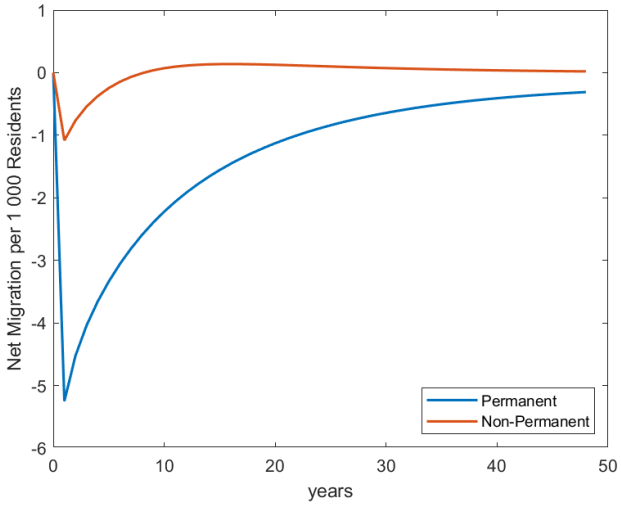
- shock affects other countries too show
- shock is non-permanent. show

Permanent vs Non-Permanent

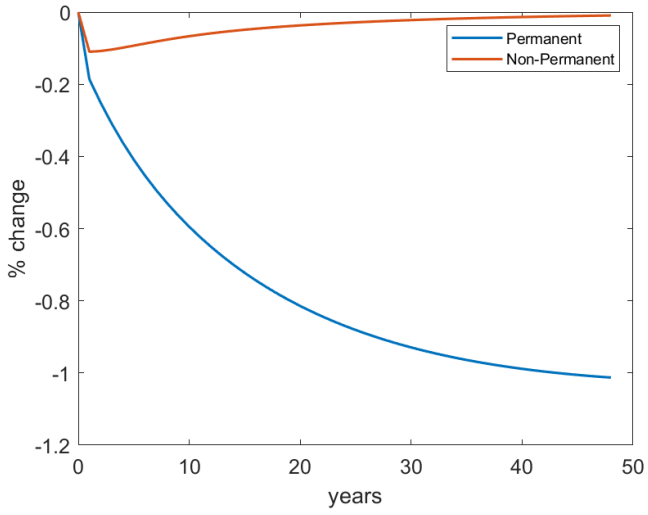
(a) Low skilled migration



(b) High skilled migration



(c) Low skilled Real Wage



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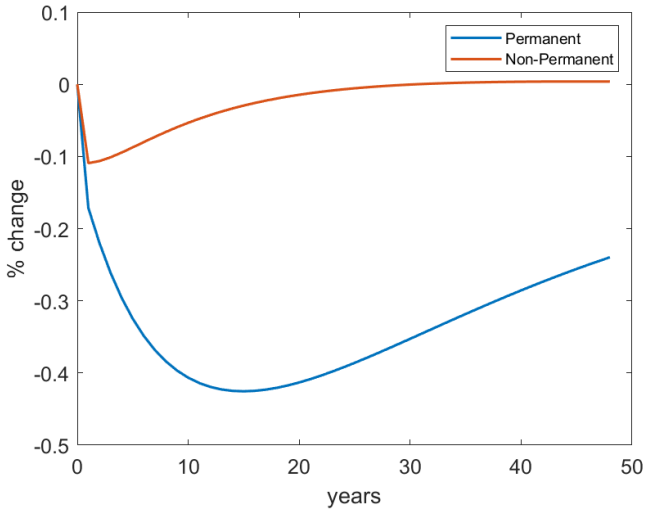
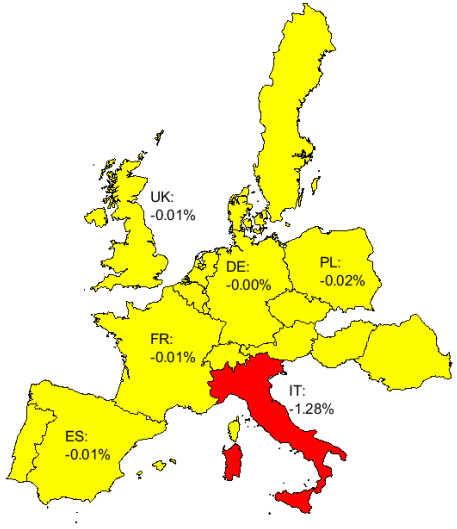
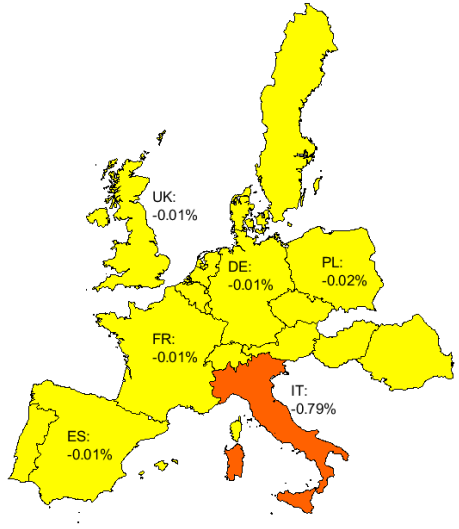


Welfare effects of perm. shock to Italian TFP (-1%)

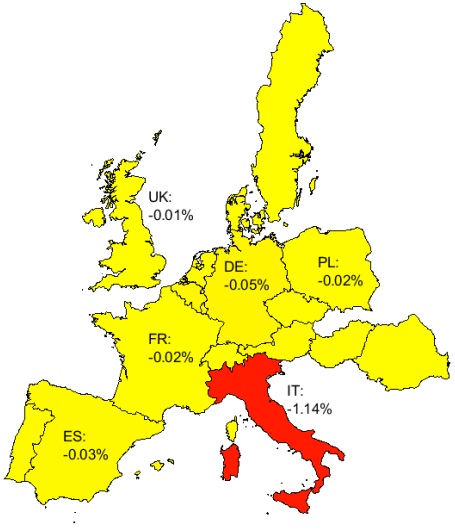
(a) Low skilled, no migration



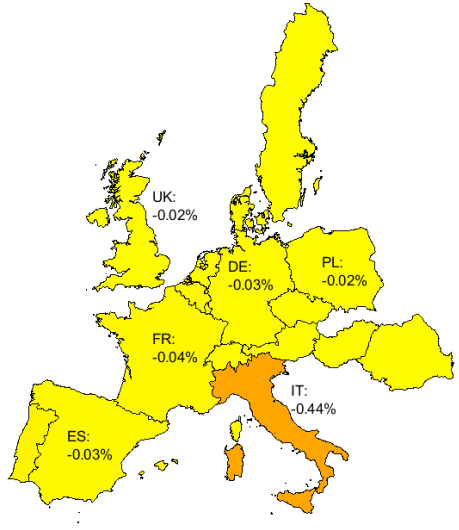
(b) High skilled, no migration



(c) Low skilled, with migration

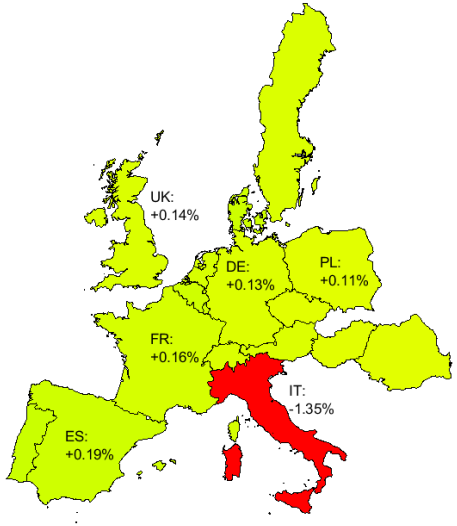


(d) High skilled, with migration

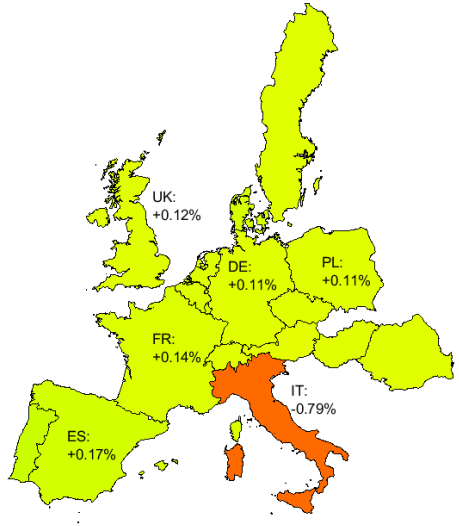


Welf. effects of perm. demand shock to Italian good (-1%)

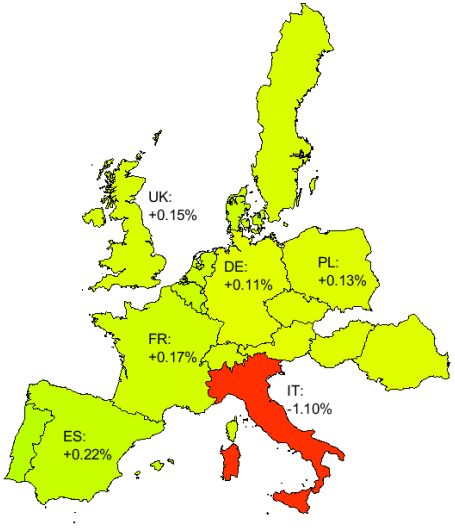
(a) Low skilled, no migration



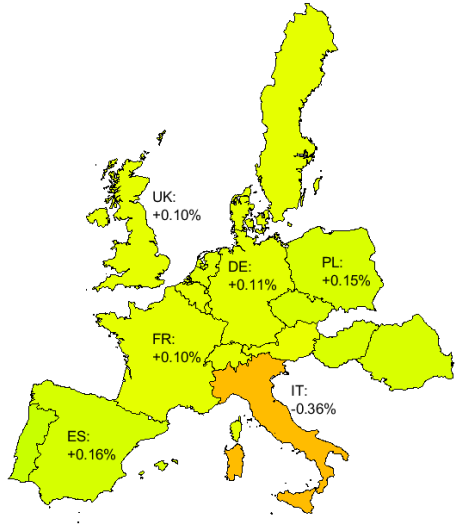
(b) High skilled, no migration



(c) Low skilled, with migration



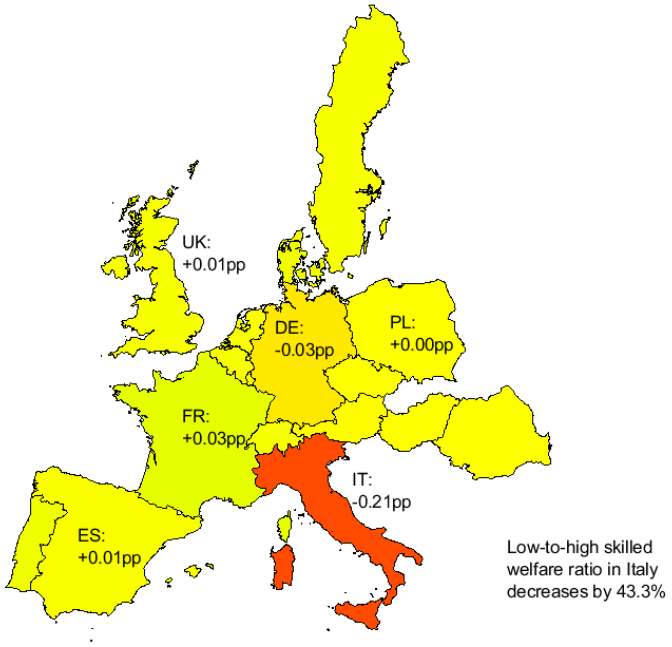
(d) High skilled, with migration



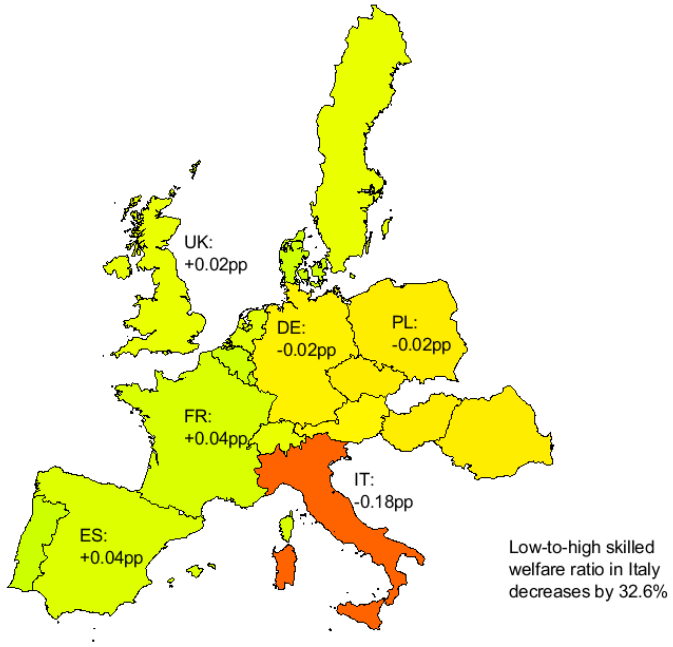
Effect of migration on welfare gap between skill groups

Following a -1% permanent shock to

(a) productivity



(b) demand



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Common fiscal policy

Integrated unemployment insurance as an alternative shock absorption channel

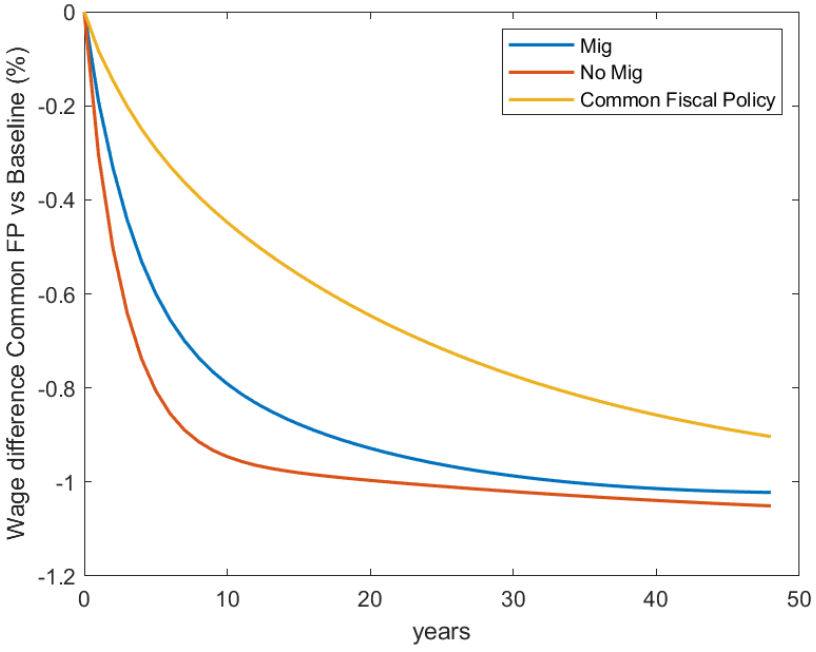
- Government budget constraint becomes
  $\sum_j b_j \sum_s \sum_n u_{j,s,n} = \sum_j T_j \sum_s \sum_n (e_{j,s,n} + u_{j,s,n})$
- Italian gross wages $\downarrow$, net wages $\uparrow$

More interesting: comparison to migration

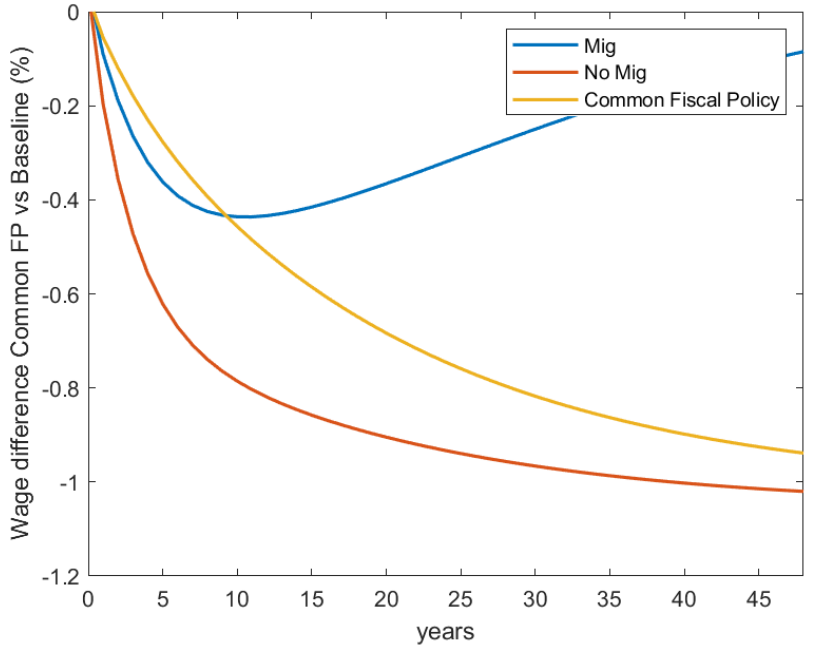
- Ambiguous effect on Italian net wages:
  - $\downarrow$ relative to migration if workers cannot leave following the shock
    $\rightarrow$ dominates in the long-run for high-skilled
  - $\uparrow$ relative to migration because part of unemployment benefits covered by foreign taxes
    $\rightarrow$ dominates in the short-run for both groups
- Italian unemployment rate for all skill types $\uparrow$ compared to migration.

Common fiscal policy, following 1% decrease in demand for Italian output

(a) Low skilled real wage

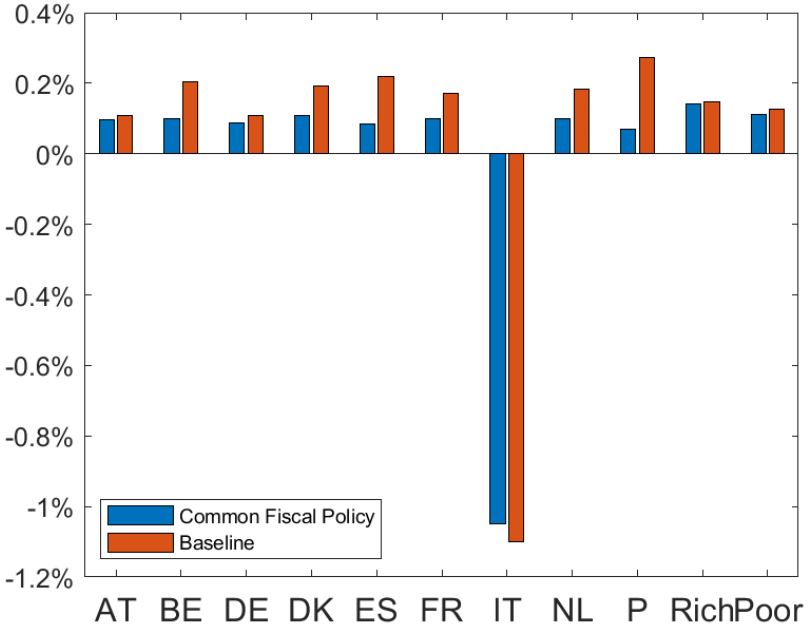


(b) High skilled real wage

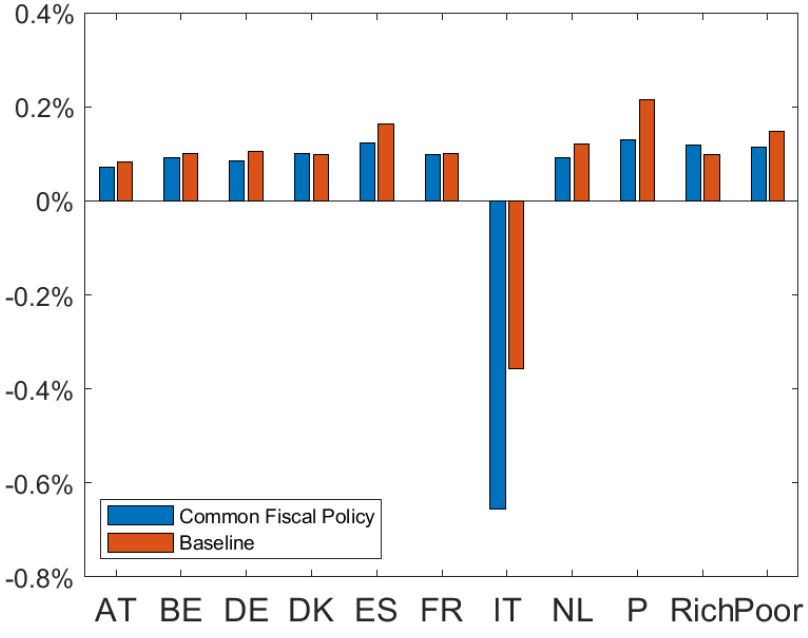


Common fiscal policy, following 1% decrease in demand for Italian output

(a) Low skilled welfare



(b) High skilled welfare



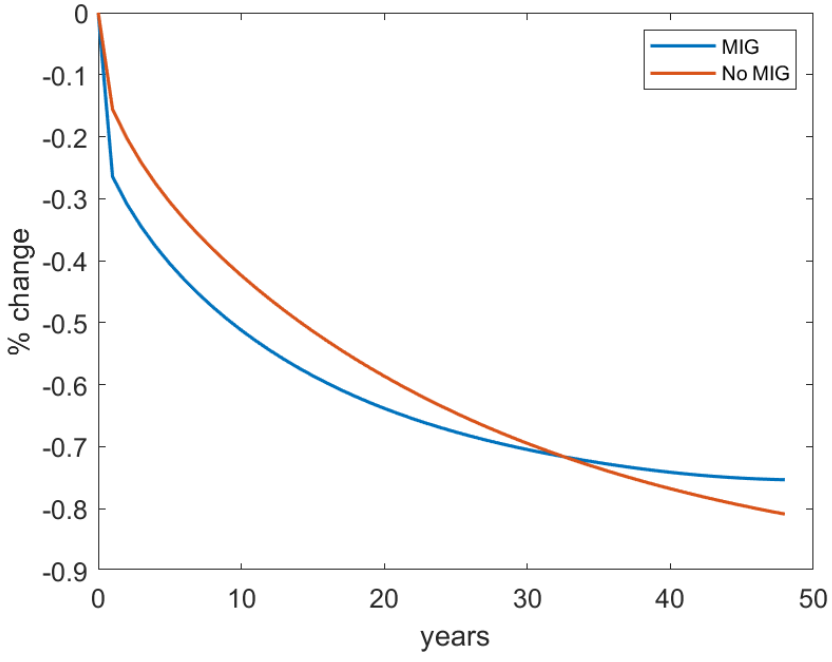
Tax on skilled emigrants

Any positive tax welfare decreasing (even for stayers)

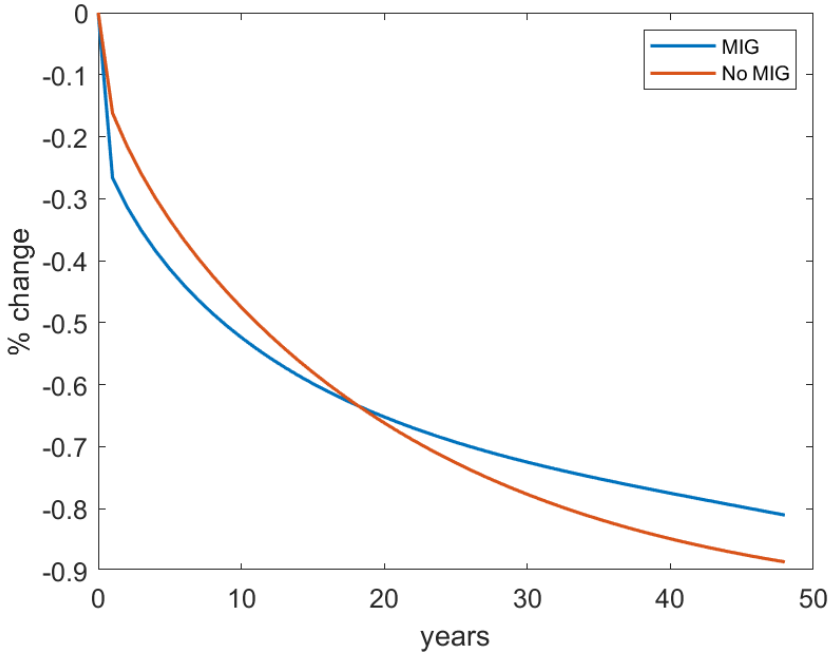
- We choose a tax rate that following a -1% TFP shock equates loss for low skilled and loss for high skilled workers in Italy
  $\rightarrow$ ca 1% of high skilled foreign earnings more
- Italian high skilled net emigration $\downarrow$, little effect on low skilled emigration
- High skilled unemployment $\uparrow$
- High skilled wage $\downarrow$

Tax on skilled emigrants, following 1% decrease in TFP in Italy

(a) Low skilled wage



(b) High skilled wage



Conclusions

- Heterogeneity in workers' skill levels and migration preferences can attenuate the stabilizing function of labor mobility
- Heterogeneous effects with skilled workers gaining disproportionately
- Effect of migration similar for productivity and demand shocks (though effects on other countries very different)
- Overall beneficial effect of migration for all worker groups in country affected by shock
- Migration in Europe too low for brain drain to reverse beneficial effect also on low skilled workers
- Migration also too low to absorb temporary shocks.

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Appendix

Migration

Preference shock ϵ drawn from type I EV distribution with mean $\mu_{j,s,n}$

- probabilities of staying in country j for workers and unemployed:

$$\pi^{j}_{j,s,n,W} = \frac{\exp(\mu_{j,s,n}+(1-x_{j,s})W_{j,s,n}+x_{j,s}U_{j,s,n})}{\exp(\mu_{j,s,n}+(1-x_{j,s})W_{j,s,n}+x_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}$$

$$\pi^{j}_{j,s,n,U} = \frac{\exp(\mu_{j,s,n}+f_{j,s}W_{j,s,n}+(1-f_{j,s})U_{j,s,n})}{\exp(\mu_{j,s,n}+(1-f_{j,s})W_{j,s,n}+f_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}.$$

- probabilities of moving from country j destination d for workers and unemployed:

$$\pi^{d}_{j,s,n,W} = \frac{\exp(\mu_{d,s,n}+f_{d,s}W_{d,s,n}+(1-f_{d,s})U_{d,s,n}-k_{j,d})}{\exp(\mu_{j,s,n}+(1-x_{j,s})W_{j,s,n}+x_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}$$

$$\pi^{d}_{j,s,n,U} = \frac{\exp(\mu_{d,s,n}+f_{d,s}W_{d,s,n}+(1-f_{d,s})U_{d,s,n}-k_{j,d})}{\exp(\mu_{j,s,n}+(1-f_{j,s})W_{j,s,n}+f_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}.$$

Value of a filled vacancy

Firms match with searching workers in their country, but cannot discriminate on nationality.

Profit for an intermediate goods producer in sector $s \in \{H, L\}$ of country j generates per job filled with an n national is

$$J_{j,s,n} = \frac{p_{j,s} - w_{j,s,n}}{P_j^u} + \frac{\mathbb{E}_n \left[\left(x_{j,s} + (1 - x_{j,s})(1 - \pi^j_{j,s,n,W}) \right) Vac_{j,s} + (1 - x_{j,s}) \pi^j_{j,s,n,W} J_{j,s,n} \right]}{1 + r_j},$$

with

$x_{j,s}$ the probability of exogenous separations in sector s of country j

$\pi^j_{j,s,n,W}$ the probability of a worker in country j staying.

Transition between steady states

We want to evaluate outcomes following asymmetric changes in productivity and product demand

- steady state outcomes with and without integrated labor markets
- transitions between steady states
- realistic responses in unemployment/wages

Transition between steady states

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- steady state outcomes with and without integrated labor markets
- transitions between steady states
- realistic responses in unemployment/wages

Wages (of natives) in each country follow a path

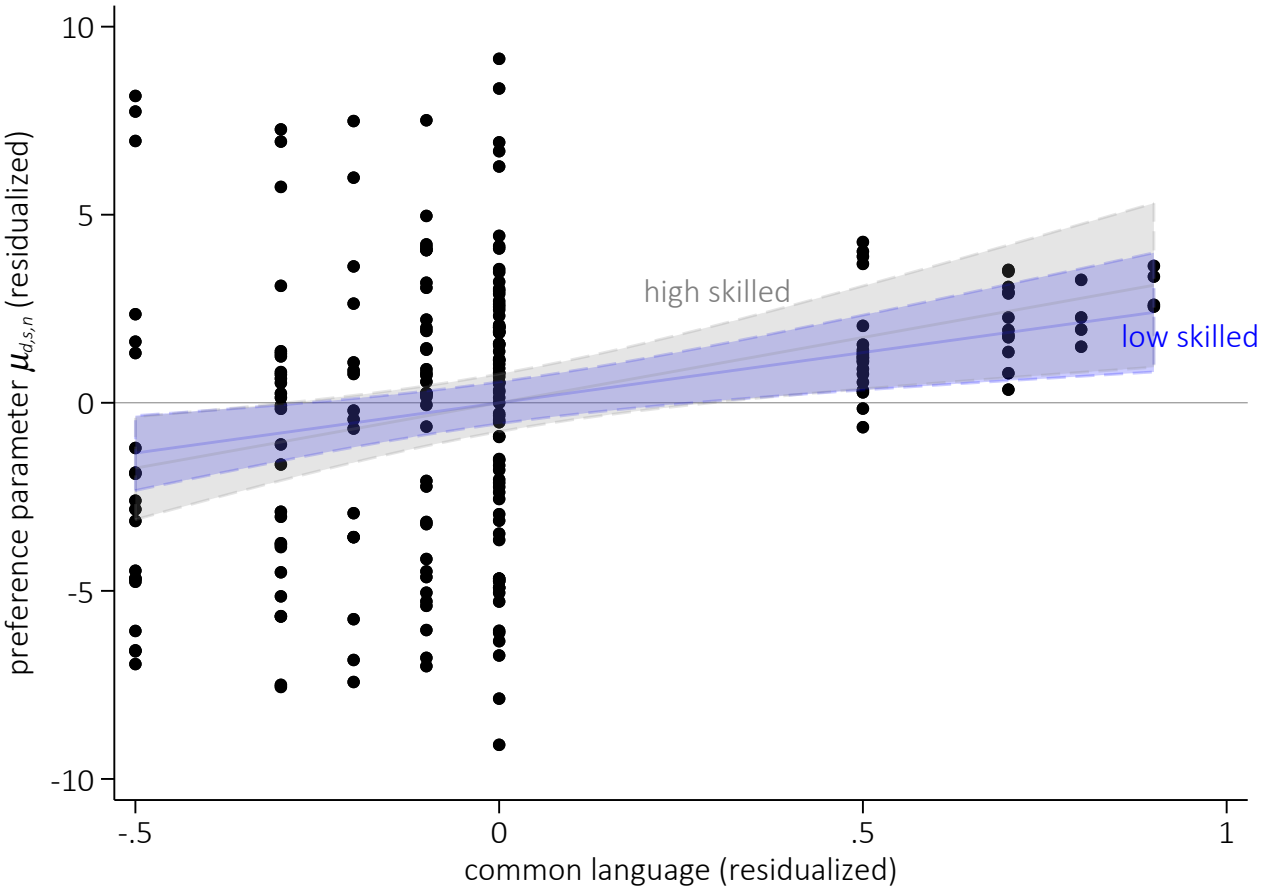
$$w_{j,s,j,t} = \frac{E_{j,t-1}}{E_{j,t}} \omega w_{j,s,j,t-1} + (1-\omega) w^*_{j,s,j,t},$$

where

- $w^*_{j,s,j,t}$ would have split surplus according to Nash-bargaining
- $E_{j,t}$ is country j's exchange rate relative to the euro
- ω is a persistence parameter

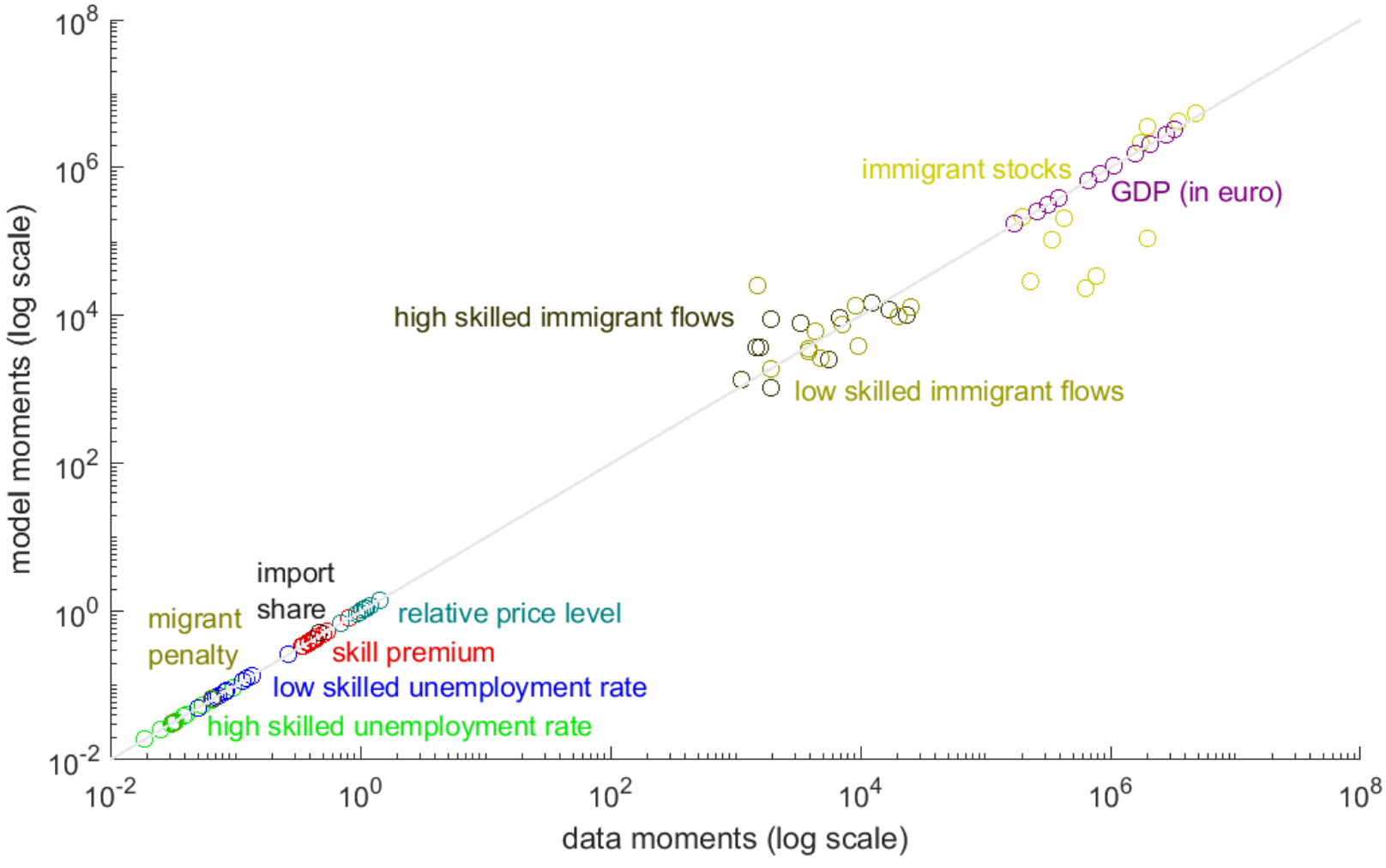
$\Rightarrow$ Role for monetary policy.

Location preferences



Note: Correlation of estimated bilateral preference parameters $\mu_{d,s,n}$ with countries n and d sharing an official language, each residualized after controlling for origin-skill effects; shaded areas indicate 95% confidence intervals on the linear fit; when countries are grouped for the model, a group has a language if at least one country in the group has it as an official language; source: CEPII GeoDist database.

Model fit



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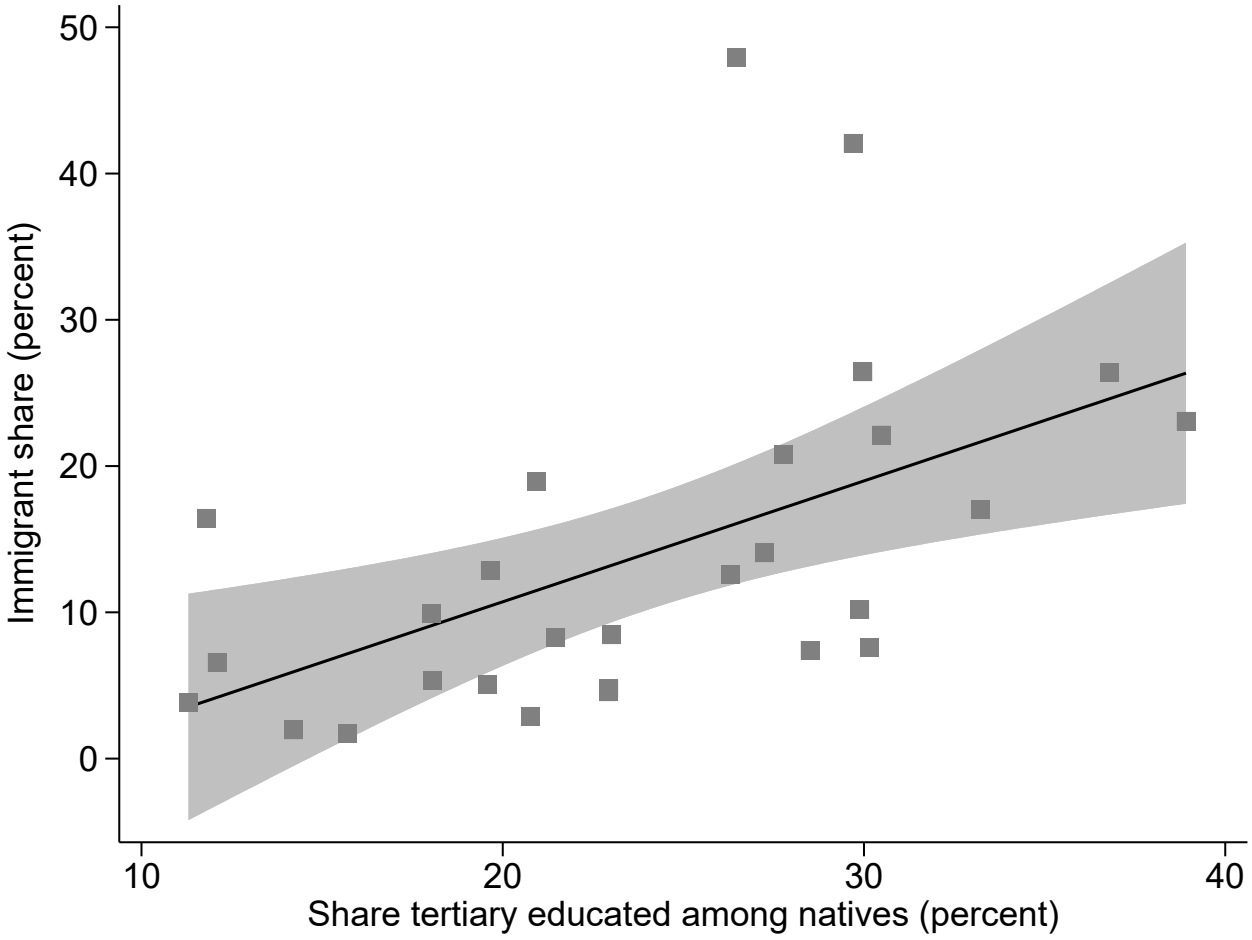
Calibration

Parameter(s)	Notation	Percentiles of estimates 25th	50th	75th	Target (Source)
Panel A: Joint Calibration					
Means of location shock distributions	$\mu_{d,s,n}$	-3.8889	-0.0647	2.4268	Migrations flows (EU-LFS)
Migration cost	$k_0 + k_1 D_{j,d}$	3.978	4.397	5.132	Migration stocks (Eurostat)
Taste for different goods	$\psi_{j,j}$	0.0684	0.0767	0.1086	Price level (Eurostat)
Consumption home bias	ζ_j	0.303	0.499	0.551	Import share (OECD)
Vacancy cost	$\kappa_{j,s}$	0.0193	0.0345	0.0505	Unemployment (EU-LFS)
TFP	A_j	130.1	167.9	186.9	GDP (Eurostat)
Low skill efficiency	α_j	0.4232	0.4384	0.4771	Skill premium (EU-SILC)
Migrant wage penalty	ν_j	0.9429	0.9679	0.9735	Income difference (EU-SILC)
Panel B: Exogenously Set Parameters					
Parameter(s)	Notation	Percentiles of estimates 25th	50th	75th	Source
Replacement ratio	$b_j/w_{j,1,j}$	60.1%	70.3%	83.4%	OECD
Separation Rates	x_j	0.0225	0.0352	0.0512	EU-LFS
Skills elasticity	$1/(1-\rho)$		4	(tried 2-6)	Caliendo et al (forthcoming)
Goods elasticity	$1/(1-\xi)$		4	(tried 2-6)	Feenstra et al (2018)
Bargaining power	β		0.72		Shimer (2005)
Matching elasticity	η		0.72		Shimer (2005)
Discount Rate	r		5%	(tried 1-10%)	

Migration in Europe



Source: European Union Labour Force Survey.

back

Model with heterogeneous workers and no frictions

Two countries $j \in \{1, 2\}$ with

$$Y_j = A_j(\alpha L_j^\rho + (1-\alpha)H_j^\rho)^{1/\rho}$$

Payoffs to low and high skilled individuals i of nationality $n \in \{1, 2\}$ in country j

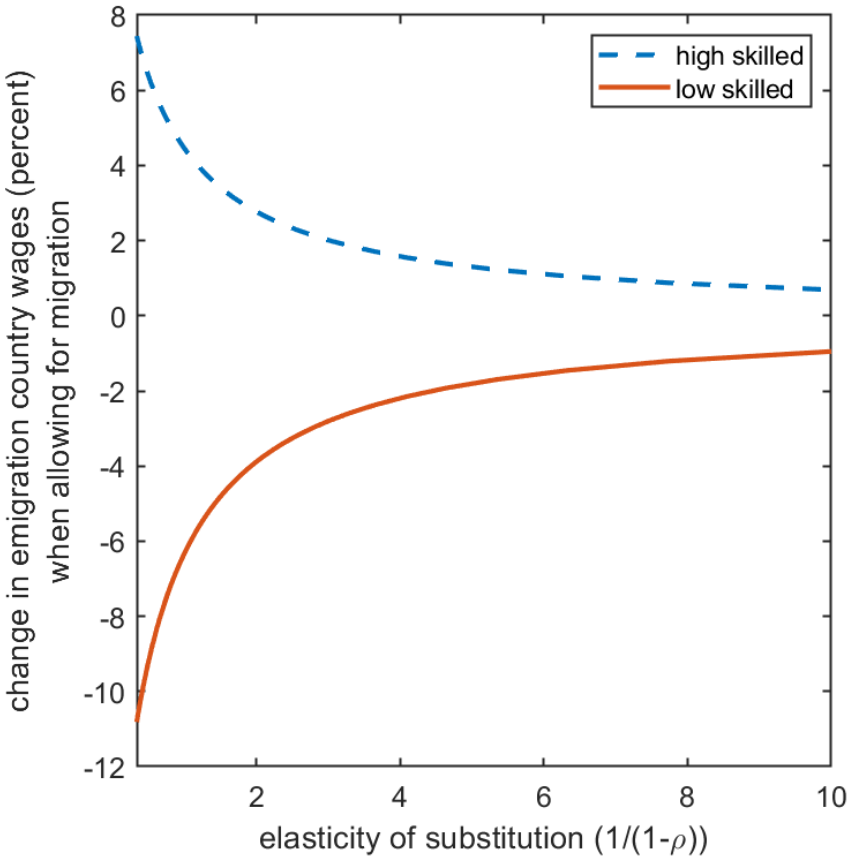
$$\begin{aligned} u_{n,j}^L &= w_j^L + \epsilon_{i,j}^L = \alpha A_j^\rho (Y_j/L_j)^{1-\rho} + \epsilon_{i,j}^L, \\ u_{n,j}^H &= w_j^H + \epsilon_{i,j}^H = (1-\alpha) A_j^\rho (Y_j/H_j)^{1-\rho} + \epsilon_{i,j}^H, \end{aligned}$$

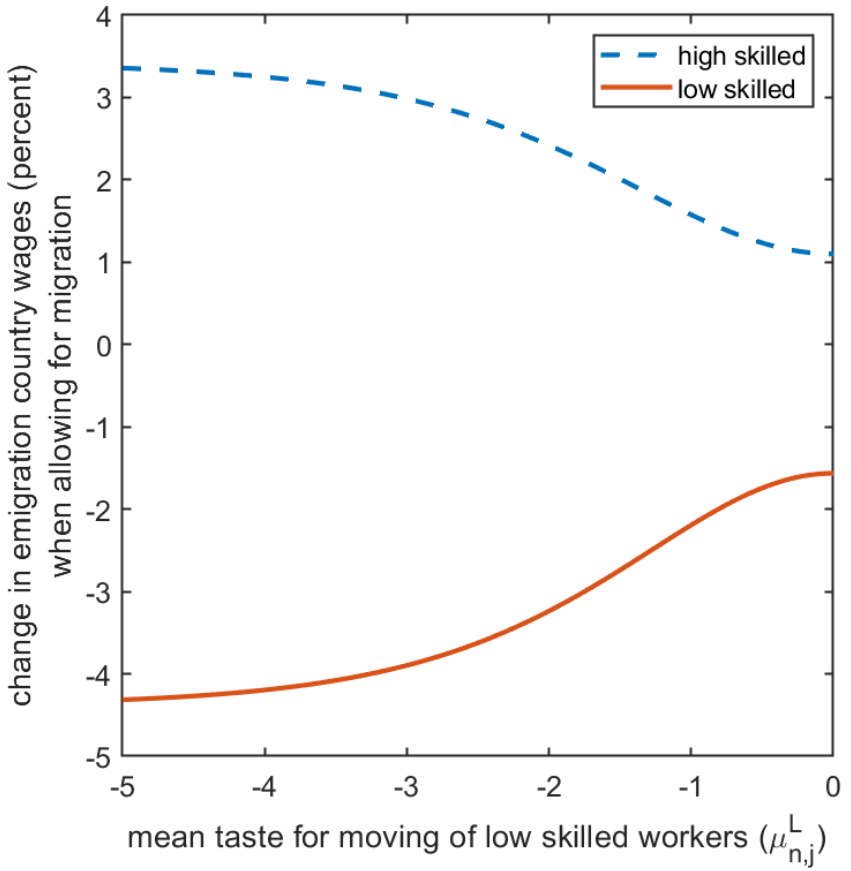
with $\epsilon_{i,j}^s \sim EV$ with mean $\mu_{n,j}^s$, $\quad s \in \{L, H\}$ and

- higher mobility of the high skilled, $\mu_{n,j}^L - \mu_{n,n}^L < \mu_{n,j}^H - \mu_{n,n}^H$ for $j \neq n$
- realistic values $\alpha < 0.5$, $\quad \rho < 1$, $\quad H_j \leq L_j$.

$\Rightarrow$ **unambiguously negative effect of migration on sending country.**

Model with heterogeneous workers and no frictions





Baseline parameterization: $\alpha = 0.4$, $H_j = L_j = 1$, $A_1 = 1$, $A_2 = 2$, $\rho = 0.75$, $\mu^L_{n,j} = -1$ and $\mu^L_{n,n} = \mu^H_{n,j} = \mu^H_{n,n} = 0$

back

Labor Market

Search and matching

- Workers differ in skill $s_i \in \{L, H\}$, origin nationality n_i, and correlated location preference
- Firms in intermediate goods sectors $\{L_j, H_j\}$ hire high or low skilled workers in segmented labor markets of each country j
- Every worker produces 1 unit of an intermediate good, with value $\{p_{j,L}, p_{j,H}\}$.

back

Production

Every worker produces 1 unit of an intermediate good, which can be $\{L_j, H_j\}$, with value $\{p_{j,L}, p_{j,H}\}$

- Intermediate goods combined by competitive firms to produce a country's final output (omitting time subscripts throughout)

$$Y_j = A_j \left(\alpha_j H_j^{\rho} + (1 - \alpha_j) L_j^{\rho} \right)^{\frac{1}{\rho}}$$

- National goods have potentially different prices P_j.

Utility

Individual i chooses consumption vector $(c_{i,1}, ..., c_{i,N})$ and location j_i generating per period utility flow

$$\mathcal{U}(c_{i,1}, ..., c_{i,N}; j_i) = \left(\sum_j \psi_j c_{i,j}^{\xi} \right)^{\frac{1}{\xi}} + \epsilon_{i,j_i}$$

- tastes ψ_j for different countries' goods such that $\sum_j \psi_j = 1$
- location preference shock $\epsilon_{i,j}$ with mean μ_{j,s_i,n_i}
- location chosen every period, migration at cost $k_{j,d}$ (function of distance between current location j and destination d).

Consumption

Budget constraint

$$\sum_j P_j c_{i,j} = \mathbb{1}_{e_i} w_{j_i,s_i} + (1 - \mathbb{1}_{e_i}) b_{j_i} + d_{j_i} - T_{j_i} \equiv I_i.$$

s_i indicates individual i's skill level/sector they can work
$\mathbb{1}_{e_i}$ indicates i's employment status
w_{j_i,s_i} is i's labor income if working in country j
b_{j_i} is the unemployment benefit level in country j
d_{j_i} are country j's firms' profits, distributed as lump-sum transfer
T_{j_i} are lump-sum taxes.

Yields demand

$$c_{i,j} = I_i \left(\frac{\psi_j}{P_j} \right)^{\frac{1}{1-\xi}}.$$

back

Values of working and unemployment

Working and unemployed individuals respectively maximize

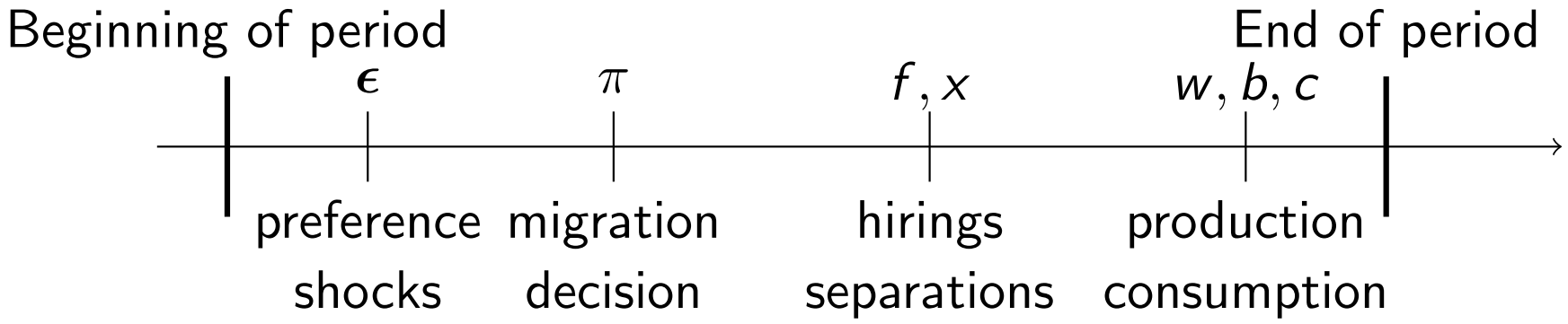
$$\begin{aligned} W_{j,s,n} &= \frac{w_{j,s} + d_j - T_j}{P^u} + \epsilon_j + \frac{\mathbb{W}_{j,s,n}}{1+r} \\ U_{j,s,n} &= \frac{b_j + d_j - T_j}{P^u} + \epsilon_j + \frac{\mathbb{U}_{j,s,n}}{1+r}, \end{aligned}$$

with

- expected continuation values $\mathbb{W}_{j,s,n}$ and $\mathbb{U}_{j,s,n}$ details
- price per utility under optimal consumption

$$P^u = \left(\sum_j P_j^{(1-\xi)} \psi_j^{\xi} \right)^{\frac{1}{1-\xi}}.$$

Timing


Beginning of period
End of period
ϵ
π
f, x
w, b, c
preference shocks
migration decision
hirings separations
production consumption

Value of a filled vacancy

Firms match with searching workers in their country, but cannot discriminate on nationality.

Then intermediate goods producers in sector $s \in \{H, L\}$ of country j generate expected profit per job

$$\mathbb{E}_n J_{j,s,n} = p_{j,s} - w_{j,s} + \frac{\mathbb{E}_n \left[\left(x_{j,s} + (1 - x_{j,s})(1 - \pi^j_{j,s,n,W}) \right) Vac_{j,s} + (1 - x_{j,s}) \pi^j_{j,s,n,W} J_{j,s,n} \right]}{1 + r},$$

with

$x_{j,s}$ the probability of exogenous separations in sector s of country j

$\pi^j_{j,s,n,W}$ the probability of a worker in country j staying

$\mathbb{E}_n$ the expectation over nationalities among the unemployed.

Migration

Preference shock ϵ drawn from type I EV distribution with mean $\mu_{j,s,n}$

- probabilities of staying in country j for workers and unemployed:

$$\pi^{j}_{j,s,n,W} = \frac{\exp(\mu_{j,s,n}+(1-x_{j,s})W_{j,s,n}+x_{j,s}U_{j,s,n})}{\exp(\mu_{j,s,n}+(1-x_{j,s})W_{j,s,n}+x_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}$$

$$\pi^{j}_{j,s,n,U} = \frac{\exp(\mu_{j,s,n}+f_{j,s}W_{j,s,n}+(1-f_{j,s})U_{j,s,n})}{\exp(\mu_{j,s,n}+(1-f_{j,s})W_{j,s,n}+f_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}.$$

- probabilities of moving from country j destination d for workers and unemployed:

$$\pi^{d}_{j,s,n,W} = \frac{\exp(\mu_{d,s,n}+f_{d,s}W_{d,s,n}+(1-f_{d,s})U_{d,s,n}-k_{j,d})}{\exp(\mu_{j,s,n}+(1-x_{j,s})W_{j,s,n}+x_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}$$

$$\pi^{d}_{j,s,n,U} = \frac{\exp(\mu_{d,s,n}+f_{d,s}W_{d,s,n}+(1-f_{d,s})U_{d,s,n}-k_{j,d})}{\exp(\mu_{j,s,n}+(1-f_{j,s})W_{j,s,n}+f_{j,s}U_{j,s,n})+\sum_{h\neq j}\exp(\mu_{h,s,n}+f_{h,s}W_{h,s,n}+(1-f_{h,s})U_{h,s,n}-k_{j,h})}.$$

Labor market

Otherwise (almost) standard DMP

- Nash bargaining
- free firm entry until $Vac_{j,s} = 0$
- expected profit $\mathbb{E}_n J_{j,s,n}$, with expectation over hired nationalities
- Cobb-Douglas matching probability $\varsigma \left(\sum_n u_{j,s,n}\right)^{\eta} v_{j,s}^{1-\eta}$ with random matches across nationalities n.

details

Equilibrium employment level $\sum_n e_{j,s,n}$ in each sector and country then determines supply of intermediate goods

$$H_j = \sum_n e_{j,H,n} \quad \text{and} \quad L_j = \sum_n e_{j,L,n}.$$

Flows into and out of unemployment

Flow into unemployment:

$$infl^{u}_{j,s,n} = x_{j,s}\pi^{j}_{j,s,n,W}e_{j,s,n} + (1 - f_{j,s})\left(\sum_{\iota \neq j}\pi^{j}_{\iota,s,n,W}e_{\iota,s,n} + \sum_{\iota \neq j}\pi^{j}_{\iota,s,n,U}u_{\iota,s,n}\right)$$

Flow into employment:

$$infl^{e}_{j,s,n} = f_{j,s}\pi^{j}_{j,s,n}u_{j,s,n,U} + f_{j,s}\left(\sum_{\iota \neq j}\pi^{j}_{\iota,s,n,W}e_{\iota,s,n} + \sum_{\iota \neq j}\pi^{j}_{\iota,s,n,U}u_{\iota,s,n}\right)$$

Flow from unemployment:

$$outfl^{u}_{j,s,n} = (1 - \pi^{j}_{j,s,n,U} + f_{j,s}\pi^{j}_{j,s,n,U})u_{j,s,n}$$

Flow from employment:

$$outfl^{e}_{j,s,n} = (1 - \pi^{j}_{j,s,n,W} + x_{j,s}\pi^{j}_{j,s,n,W})e_{j,s,n}.$$

Steady state equilibrium

Balanced worker flows:

$$\forall j,s,n: \quad outfl^u_{j,s,n} = infl^u_{j,s,n} \qquad \text{and} \qquad outfl^e_{j,s,n} = infl^e_{j,s,n}$$

Final goods demand equals supply:

$$\forall j: \quad \left(\sum_j D_j + \sum_j \sum_s \sum_n w_{j,s} e_{j,s,n}\right) \left(\frac{\psi_j}{P_j}\right)^{\frac{1}{1-\xi}} = A_j \left(\alpha_j L_j^\rho + (1-\alpha_j) H_j^\rho\right)^{\frac{1}{\rho}}$$

Intermediate goods demand equals supply:

$$\forall j: \quad Y_j \left(\frac{P_j (1-\alpha_j) A_j^\rho}{p_{j,H}}\right)^{\frac{1}{1-\rho}} = \sum_n e_{j,H,n} \quad \text{and} \quad Y_j \left(\frac{P_j \alpha_j A_j^\rho}{p_{j,L}}\right)^{\frac{1}{1-\rho}} = \sum_n e_{j,L,n}$$

Balanced government budget:

$$\forall j: \quad b_j \sum_s \sum_n u_{j,s,n} = T_j \sum_s \sum_n (e_{j,s,n} + u_{j,s,n})$$

+ Free entry condition
+ Nash bargaining determines wages
+ Matches are formed according to the matching function
+ Individuals choose the basket of goods and the country of residence to maximize their values $W_{j,s,n}$ or $U_{j,s,n}$.

back

Labor market

Value of an open vacancy

$$Vac_{j,s} = -\kappa_{j,s} + \frac{q_{j,s}\Pi_{j,s} + (1 - q_{j,s})Vac_{j,s}}{1 + r},$$

with

cost $\kappa_{j,s}$ of an open vacancy

$q_{j,s}$ the probability that vacancy is filled

$\Pi_{j,s} = \mathbb{E}_n J_{j,s,n}$ expected profit if vacancy is filled (expectation over nationalities composition within the unemployment pool)

back

Labor market

Free firm entry reduces the value of a vacancy to zero

$$(1+r)\kappa_{j,s} = q_{j,s}\Pi_{j,s}$$

Nash bargaining shares surplus $S_{j,s,n} = J_{j,s,n} - Vac_{j,s} + W_{j,s,n} - U_{j,s,n}$, such that wage $w_{j,s}$ satisfies

$$\beta \sum_n J_{j,s,n} e_{j,s,n} = (1-\beta) \sum_n (W_{j,s,n} - U_{j,s,n}) e_{j,s,n}$$

with bargaining power of workers β, and share $e_{j,s,n}$ of nationality n among workers of skill s in country j.

back

Labor market

Firms cannot discriminate based on workers' nationality, searching workers matched with vacancies at random within country and skill sectors.

Matching function

$$m\left(\sum_n u_{j,s,n}, v_{j,s}\right) = \varsigma\left(\sum_n u_{j,s,n}\right)^{\eta} v_{j,s}^{1-\eta}$$

with matching efficiency ς, and elasticity η with respect to the unemployment pool.

back

Labor market

Labor market tightness

$$\theta_{j,s} = \frac{v_{j,s}}{u_{j,s}},$$

hence job finding probability

$$f_{j,s} = \varsigma \theta_{j,s}^{1-\eta},$$

vacancy filling probability

$$q_{j,s} = \varsigma \theta_{j,s}^{-\eta} = f_{j,s}\theta_{j,s}.$$

back

Continuation values

Under the assumption that tastes ϵ_j are extreme value distributed, expected continuation values in the two employment states are

$$\mathbb{W}_{j,s,n} = \log\left[\exp((1-x_{j,s})W_{j,s,n} + x_{j,s}U_{j,s,n}) + \sum_{d\neq j}\exp\left(f_{d,s}W_{d,s,n} + (1-f_{d,s})U_{d,s,n} - k_{j,d}\right)\right] + \gamma$$

and

$$\mathbb{U}_{j,s,n} = \log\left[\exp(f_{j,s}W_{j,s,n} + (1-f_{j,s})U_{j,s,n}) + \sum_{d\neq j}\exp\left(f_{d,s}W_{d,s,n} + (1-f_{d,s})U_{d,s,n} - k_{j,d}\right)\right] + \gamma,$$

with Euler constant $\gamma \approx 0.577$.

back

Model fit: Low skilled migration flows

	AT	BE	DE	DK	ES	FR	IT	NL	PT	Rich	Poor
AT	0	0.002	3.054	0.168	0.000	0.034	0.015	0.121	0.000	0.229	0.020
	0	*0.014*	*3.014*	*0.154*	*0*	*0.047*	*0.029*	*0.133*	*0*	*0.215*	*0.033*
BE	0.010	0	0.589	0.076	0.188	1.705	0.100	3.296	0.136	0.035	0.008
	0.024	*0*	*0.581*	*0.072*	*0.181*	*1.686*	*0.111*	*3.242*	*0.147*	*0.047*	*0.023*
DE	0.822	0.300	0	0.358	0.891	2.065	0.290	3.211	0.385	3.853	1.275
	0.822	*0.287*	*0*	*0.345*	*0.910*	*2.087*	*0.287*	*3.227*	*0.384*	*3.838*	*1.279*
DK	0.001	0.000	0.614	0	0.211	0.209	0.000	0.013	0.000	0.868	0.025
	0.012	*0.011*	*0.604*	*0*	*0.211*	*0.219*	*0*	*0.028*	*0.007*	*0.842*	*0.039*
ES	0.054	0.597	3.266	0.422	0	0.805	0.115	0.006	0.482	1.982	0.076
	0.048	*0.590*	*3.222*	*0.440*	*0*	*0.800*	*0.010*	*0*	*0.471*	*1.969*	*0.086*
FR	0.068	1.585	2.929	0.273	0.807	0	0.198	0.138	2.792	4.896	0.003
	0.056	*1.574*	*2.882*	*0.259*	*0.811*	*0*	*0.194*	*0.144*	*2.740*	*4.806*	*0*
IT	0.077	0.351	1.419	0.083	0.313	0.717	0	0.022	0.004	0.235	0.001
	0.079	*0.340*	*1.391*	*0.069*	*0.327*	*0.714*	*0*	*0.035*	*0.018*	*0.220*	*0.013*
NL	0.006	0.525	2.322	0.066	0.131	0.260	0.005	0	0.557	0.001	0.002
	0.014	*0.510*	*2.286*	*0.065*	*0.145*	*0.260*	*0.019*	*0*	*0.557*	*0*	*0*
PT	0.001	0.211	0.490	0.045	0.258	0.488	0.000	0.001	0	1.219	0.001
	0	*0.201*	*0.472*	*0.036*	*0.243*	*0.484*	*0*	*0.005*	*0*	*1.197*	*0.006*
Rich	0.153	0.108	2.638	0.169	3.379	1.819	0.882	0.302	0.428	0	0.001
	0.152	*0.116*	*2.630*	*0.155*	*3.40*	*1.837*	*0.894*	*0.306*	*0.444*	*0*	*0.010*
Poor	2.664	0.727	8.625	0.328	0.990	0.975	2.268	2.418	0.069	7.397	0
	2.640	*0.712*	*8.480*	*0.313*	*0.992*	*0.959*	*2.245*	*2.398*	*0.061*	*7.286*	*0*

The table lists low skilled migration flows in 1,000s; rows show countries of origin; columns show countries of destination; italics show migration flows observed in the EU-LFS.

back

Model fit: High skilled migration flows

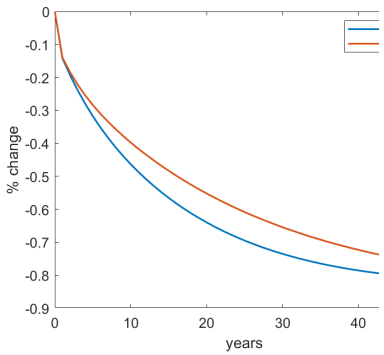
	AT	BE	DE	DK	ES	FR	IT	NL	PT	Rich	Poor
AT	0	0.055	2.259	0.044	0.424	0.258	0.089	0.248	0.000	0.283	0.000
	0	*0.064*	*2.244*	*0.044*	*0.428*	*0.274*	*0.096*	*0.255*	*0*	*0.286*	*0.014*
BE	0.035	0	0.432	0.123	0.361	5.311	0.001	1.632	0.000	0.222	0.003
	0.046	*0*	*0.428*	*0.108*	*0.356*	*5.238*	*0*	*1.603*	*0.015*	*0.218*	*0.018*
DE	0.749	0.539	0	0.171	1.712	3.528	0.288	1.993	0.201	5.200	0.686
	0.753	*0.527*	*0*	*0.157*	*1.686*	*3.593*	*0.286*	*1.996*	*0.214*	*5.296*	*0.700*
DK	0.005	0.036	0.388	0	0.006	0.370	0.000	0.021	0.003	0.515	0.062
	0.019	*0.051*	*0.389*	*0*	*0.020*	*0.355*	*0.015*	*0.035*	*0.018*	*0.510*	*0.077*
ES	0.088	0.254	1.106	0.136	0	2.051	0.062	0.225	0.278	4.454	0.526
	0.076	*0.248*	*1.115*	*0.133*	*0*	*2.143*	*0.047*	*0.215*	*0.292*	*4.652*	*0.540*
FR	0.011	1.092	1.462	0.156	1.173	0	0.038	0.214	0.296	7.416	0.287
	0.024	*1.081*	*1.423*	*0.142*	*1.122*	*0*	*0.042*	*0.210*	*0.296*	*7.413*	*0.295*
IT	0.059	0.061	0.617	0.111	0.444	2.132	0	0.000	0.082	0.162	0.001
	0.057	*0.050*	*0.642*	*0.105*	*0.472*	*2.324*	*0*	*0.011*	*0.101*	*0.158*	*0*
NL	0.046	0.315	1.398	0.155	0.021	0.367	0.032	0	0.223	0.000	0.001
	0.050	*0.302*	*1.377*	*0.141*	*0.035*	*0.375*	*0.029*	*0*	*0.224*	*0*	*0*
PT	0.001	0.004	0.186	0.004	0.273	0.001	0.036	0.002	0	0.555	0.028
	0	*0*	*0.171*	*0*	*0.270*	*0*	*0.020*	*0.007*	*0*	*0.561*	*0.033*
Rich	0.090	0.379	2.873	0.285	2.157	2.198	0.754	0.608	0.634	0	0.239
	0.097	*0.371*	*2.825*	*0.271*	*2.091*	*2.210*	*0.715*	*0.618*	*0.628*	*0*	*0.250*
Poor	0.355	0.605	1.793	0.009	0.253	0.567	0.358	0.664	0.112	4.449	0
	0.339	*0.591*	*1.753*	*0.007*	*0.256*	*0.568*	*0.334*	*0.653*	*0.121*	*4.448*	*0*

The table lists high skilled migration flows in 1,000s; rows show countries of origin; columns show countries of destination; italics show migration flows observed in the EU-LFS.

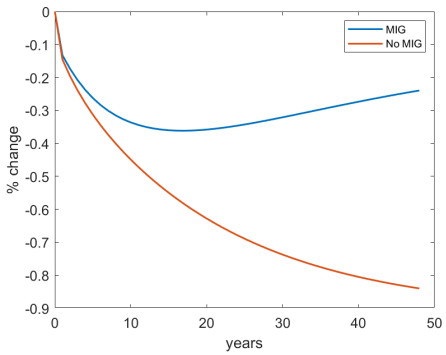
back

Joint shock to southern European TFP (-1%) on Italy

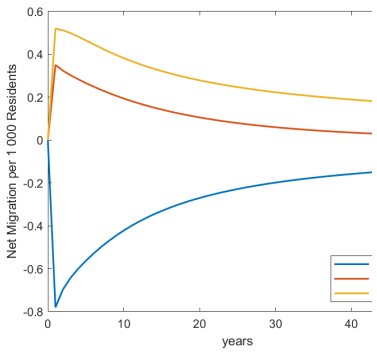
(a) Unskilled wage



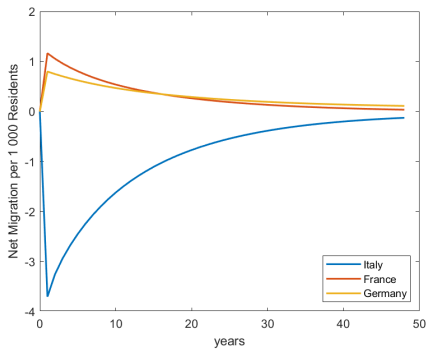
(b) Skilled wage



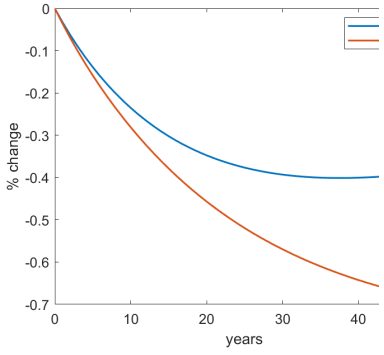
(c) Unskilled migration

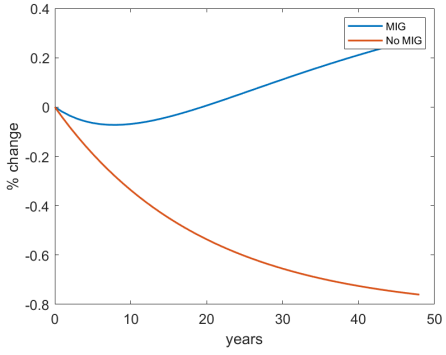


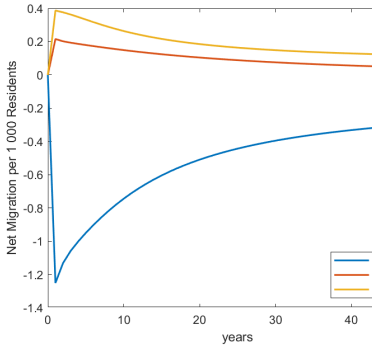
(d) Skilled migration

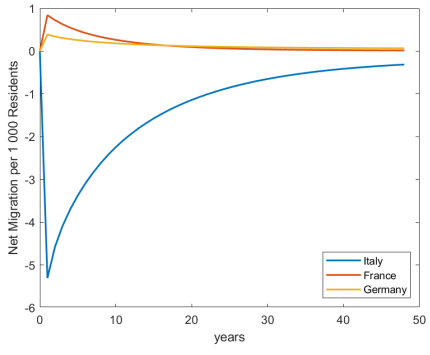


Comparison to shock to Italy only:









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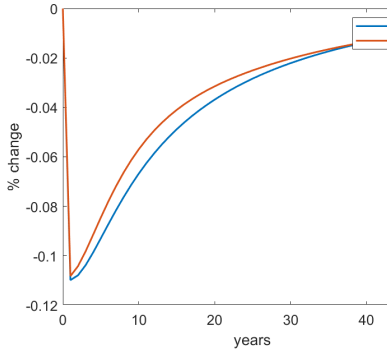
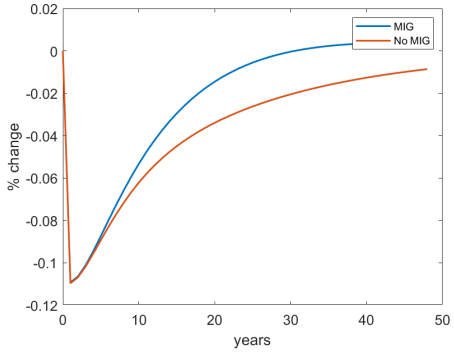
Unexpected non-permanent shock (persistence 0.8) to Italian TFP (-1%)

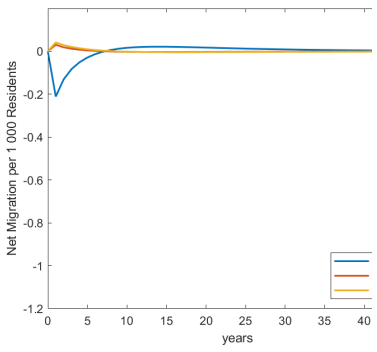
(a) Unskilled wage



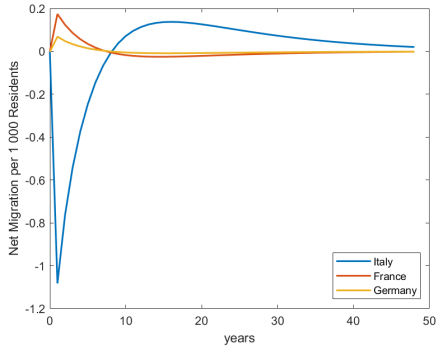
(b) Skilled wage



(c) Unskilled migration



(d) Skilled migration



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