The Global Race for Talent:

Brain Drain, Knowledge Transfer and Growth

Marta Prato,Yale University

June 5-6 2023
World Bank Annual Conference on Development Economics 2023: Growth and Resilience

Migrants Create Collaboration Bridges across Countries

Migrants Create Collaboration Bridges across Countries

Jean Calvignac

Patent Number: 5,251,206

Calvignac et al.

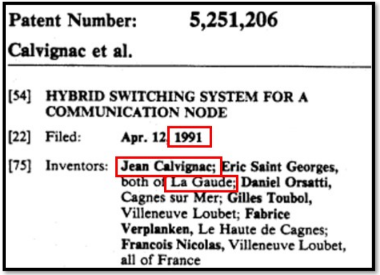
[54] **HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE**

[22] Filed: **Apr. 12, 1991**

[75] Inventors: **Jean Calvignac; Eric Saint Georges,** both of La Gaude; **Daniel Orsatti,** Cagnes sur Mer; **Gilles Toubol,** Villeneuve Loubet; **Fabrice Verplanken,** Le Haute de Cagnes; **Francois Nicolas,** Villeneuve Loubet, all of France

Migrants Create Collaboration Bridges across Countries

Jean Calvignac



Patent Number: 5,251,206

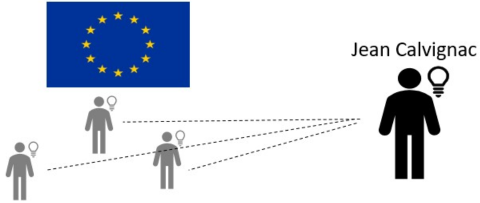
Calvignac et al.

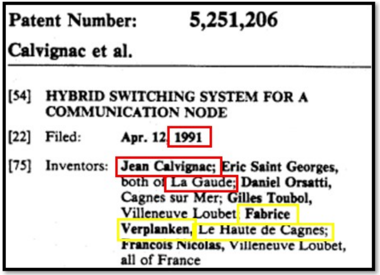
[54] **HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE**

[22] Filed: **Apr. 12, 1991**

[75] Inventors: **Jean Calvignac; Eric Saint Georges,** both of La Gaude; **Daniel Orsatti,** Cagnes sur Mer; **Gilles Toubol,** Villeneuve Loubet; **Fabrice Verplanken,** Le Haute de Cagnes; **Francois Nicolas,** Villeneuve Loubet, all of France

Migrants Create Collaboration Bridges across Countries





Patent Number: 5,251,206

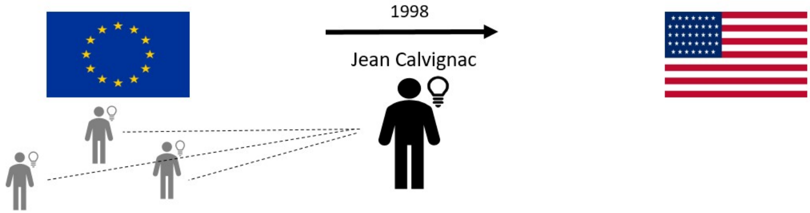
Calvignac et al.

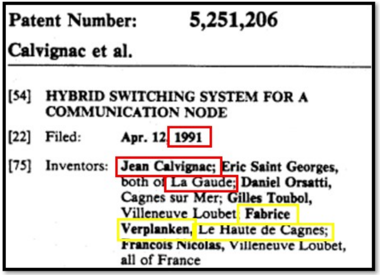
[54] HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE

[22] Filed: Apr. 12, 1991

[75] Inventors: Jean Calvignac; Eric Saint Georges, both of La Gaude; Daniel Orsatti, Cagnes sur Mer; Gilles Toubol, Villeneuve Loubet; Fabrice Verplanken, Le Haute de Cagnes; Francois Nicolas, Villeneuve Loubet, all of France

Migrants Create Collaboration Bridges across Countries





Patent Number: 5,251,206

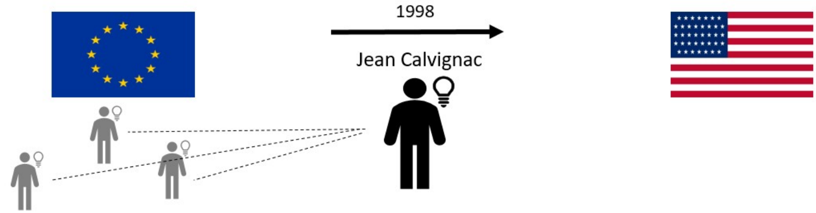
Calvignac et al.

[54] HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE

[22] Filed: Apr. 12, 1991

[75] Inventors: Jean Calvignac; Eric Saint Georges, both of La Gaude; Daniel Orsatti, Cagnes sur Mer; Gilles Toubol, Villeneuve Loubet; Fabrice Verplanken, Le Haute de Cagnes; Francois Nicolas, Villeneuve Loubet, all of France

Migrants Create Collaboration Bridges across Countries



Patent Number: 5,251,206

Calvignac et al.

[54] **HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE**

[22] Filed: **Apr. 12, 1991**

[75] Inventors: **Jean Calvignac; Eric Saint Georges,** both of La Gaude; **Daniel Orsatti,** Cagnes sur Mer; **Gilles Toubol,** Villeneuve Loubet; **Fabrice Verplanken,** Le Haute de Cagnes; **Francois Nicolas,** Villeneuve Loubet, all of France

(10) **Patent No.: 7,406,080 B2**

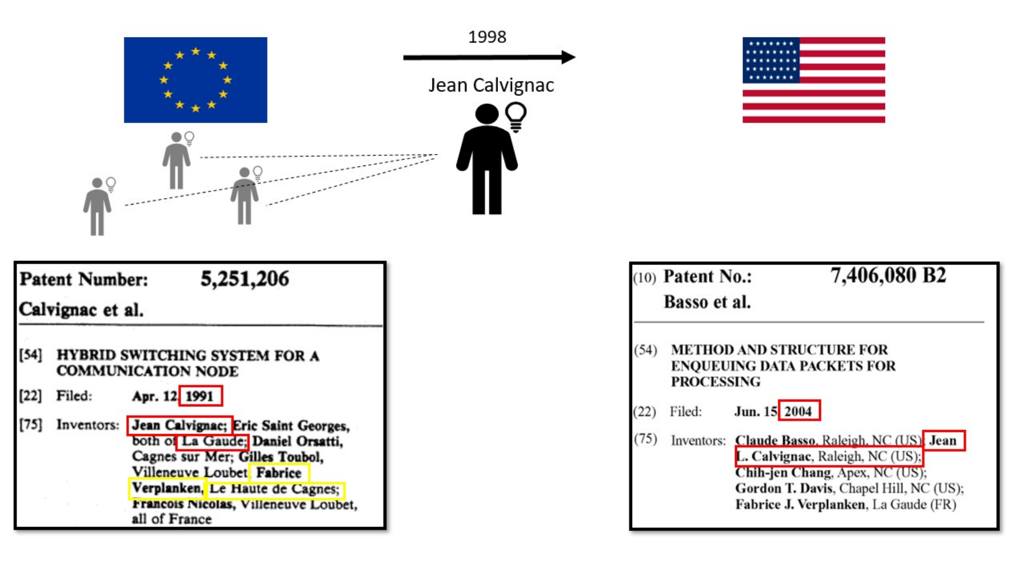
Basso et al.

(54) **METHOD AND STRUCTURE FOR ENQUEUING DATA PACKETS FOR PROCESSING**

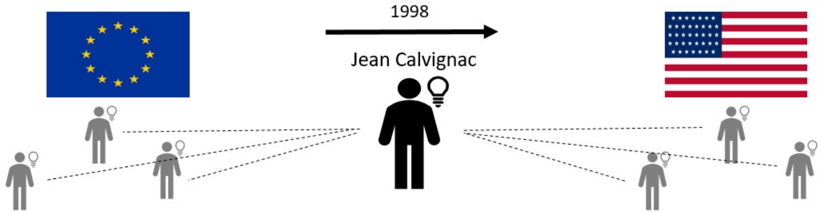
(22) Filed: **Jun. 15, 2004**

(75) Inventors: **Claude Basso**, Raleigh, NC (US); **Jean L. Calvignac**, Raleigh, NC (US); **Chih-jen Chang**, Apex, NC (US); **Gordon T. Davis**, Chapel Hill, NC (US); **Fabrice J. Verplanken**, La Gaude (FR)

Migrants Create Collaboration Bridges across Countries



Migrants Create Collaboration Bridges across Countries



Patent Number: 5,251,206

Calvignac et al.

[54] HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE

[22] Filed: Apr. 12, 1991

[75] Inventors: Jean Calvignac; Eric Saint Georges, both of La Gaude; Daniel Orsatti, Cagnes sur Mer; Gilles Toubol, Villeneuve Loubet; Fabrice Verplanken, Le Haute de Cagnes; Francois Nicolas, Villeneuve Loubet, all of France

(10) **Patent No.:** 7,406,080 B2

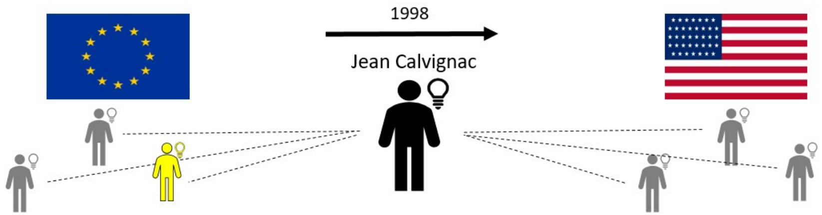
Basso et al.

(54) METHOD AND STRUCTURE FOR ENQUEUING DATA PACKETS FOR PROCESSING

(22) Filed: Jun. 15, 2004

(75) Inventors: **Claude Basso**, Raleigh, NC (US); **Jean L. Calvignac**, Raleigh, NC (US); **Chih-jen Chang**, Apex, NC (US); **Gordon T. Davis**, Chapel Hill, NC (US); **Fabrice J. Verplanken**, La Gaude (FR)

Migrants Create Collaboration Bridges across Countries



Patent Number: **5,251,206**

Calvignac et al.

[54] **HYBRID SWITCHING SYSTEM FOR A COMMUNICATION NODE**

[22] Filed: **Apr. 12, 1991**

[75] Inventors: **Jean Calvignac; Eric Saint Georges,** both of **La Gaude; Daniel Orsatti,** Cagnes sur Mer; **Gilles Toubol,** Villeneuve Loubet; **Fabrice Verplanken,** Le Haute de Cagnes; **Francois Nicolas,** Villeneuve Loubet, all of France

(10) **Patent No.:** **7,406,080 B2**

Basso et al.

(54) **METHOD AND STRUCTURE FOR ENQUEUING DATA PACKETS FOR PROCESSING**

(22) Filed: **Jun. 15, 2004**

(75) Inventors: **Claude Basso**, Raleigh, NC (US); **Jean L. Calvignac**, Raleigh, NC (US); **Chih-jen Chang**, Apex, NC (US); **Gordon T. Davis**, Chapel Hill, NC (US); **Fabrice J. Verplanken**, La Gaude (FR)

Motivation and Research Question

- Brain Drain: 6% of EU inventors live in US; 0.4% of US inventors live in EU (PCT data 2001-2010)

Research Questions

1. How does inventors migration affect migrants' productivity, collaboration networks, and knowledge spillovers on locals?

2. What is the role of tax and migration policy in shaping migration flows (brain drain), the innovative capacity of the economy, productivity, and output?

Approach and Results

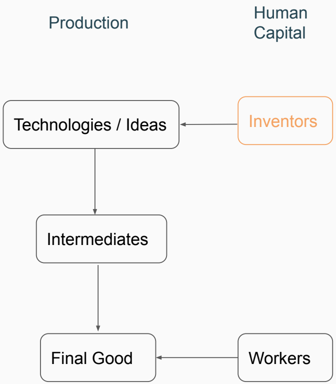
▸ Literature Review

- **Theory:** A two-country innovation-based growth model with new features:
  - i) Migration and return decisions ii) Learning in endogenous interaction networks
  - Key insight: migration has ambiguous effect on output in SR and LR
- **Empirics:** Construct a micro-level dataset of EU-US migrant inventors from EPO
  - After migration, migrants increase patent applications by 42% per year on average.
  - After migration, share of migrants' local co-inventors at origin declines (-20 pp).
  - Local inventors at origin increase patenting by 15% per year after a collaborator emigrates.
- **Quantitative** counterfactuals: 1) EU tax and 2) US migration policies

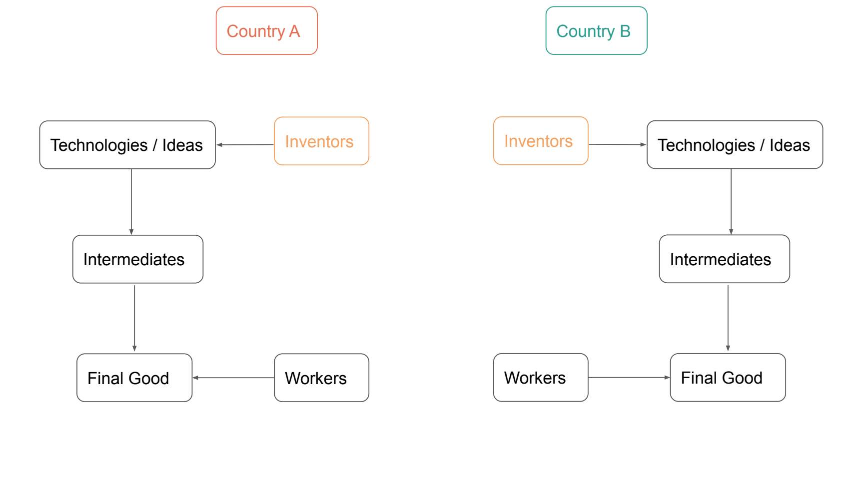
  A 10 pp EU tax cut to eliminate brain drain increases innovation in EU and reduces it in US:
  - EU GDP: + 1.5% S.R., -7.5% L.R.
  - Large effect of knowledge spillovers: w/o spillovers EU GDP +2.1% S.R., +2.3% L.R.

Theory

Model Overview

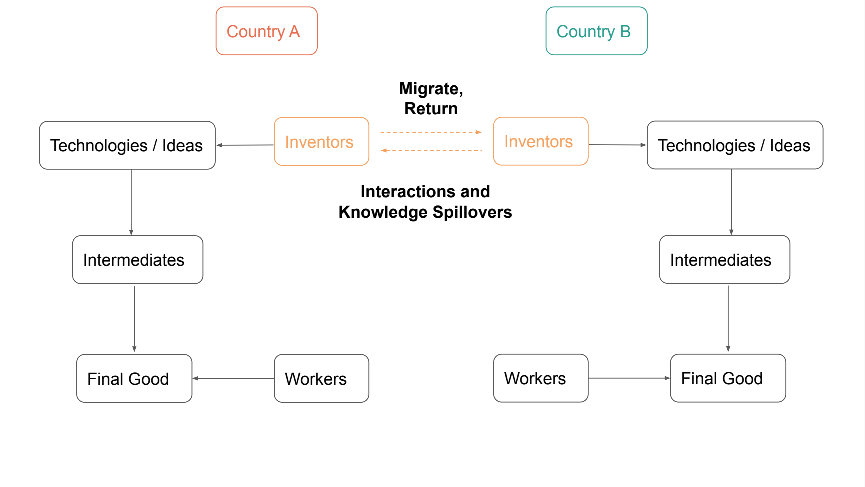


Model Overview



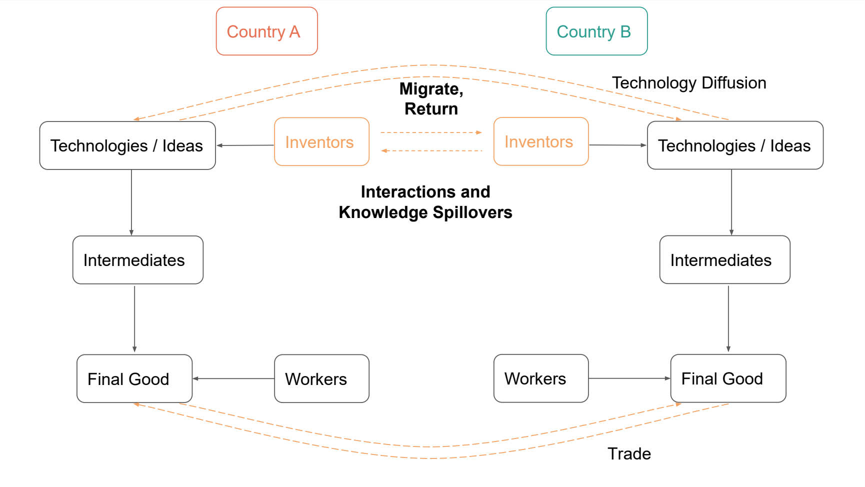
- 2 countries $c \in A, B$; TFP of country c is $\bar{A}_c$

Model Overview



- Inventors born in A or B, decide where to move, and (i) innovate (ii) meet and learn

Model Overview



Innovation

- Inventors born in c with initial (z, ϵ) that determine number of ideas q
    - Heterogeneous initial talent $z \sim \tilde{F}_c(z) = z^{-\theta_c}$ exogenous CDF , $z \geq 1$
    - Heterogeneous initial foreign productivity differential $\epsilon \sim \Upsilon_c(\epsilon)$, $\epsilon \in \mathbb{R}$

Innovation

- Inventors born in c with initial (z, ϵ) that determine number of ideas q
  - Heterogeneous initial talent $z \sim \tilde{F}_c(z) = z^{-\theta_c}$ exogenous CDF , $z \geq 1$
  - Heterogeneous initial foreign productivity differential $\epsilon \sim \Upsilon_c(\epsilon)$, $\epsilon \in \mathbb{R}$
- An inventor produces a bundle of technologies/ideas q every period:

$$q(z, \epsilon) = \begin{cases} z & \text{if in home country } c \quad \rightarrow \quad \text{earn } \pi_c(z, \epsilon) \propto \bar{A}_c q \\ \max\{z + \epsilon, 1\} & \text{if move abroad to } -c \quad \rightarrow \quad \text{earn } \pi_{-c}(z, \epsilon) \propto \bar{A}_{-c} q \end{cases}$$

  - Evolution of ϵ exogenous: $\epsilon' = \rho_c \epsilon + v, \qquad v \sim N(0, \omega_c^2)$

Innovation

- Inventors born in c with initial (z, ϵ) that determine number of ideas q
  - Heterogeneous initial talent $z \sim \tilde{F}_c(z) = z^{-\theta_c}$ exogenous CDF , $z \geq 1$
  - Heterogeneous initial foreign productivity differential $\epsilon \sim \Upsilon_c(\epsilon)$, $\epsilon \in \mathbb{R}$
- An inventor produces a bundle of technologies/ideas q every period:

$$q(z, \epsilon) = \begin{cases} z & \text{if in home country } c \quad \rightarrow \quad \text{earn } \pi_c(z, \epsilon) \propto \bar{A}_c q \\ \max\{z + \epsilon, 1\} & \text{if move abroad to } -c \quad \rightarrow \quad \text{earn } \pi_{-c}(z, \epsilon) \propto \bar{A}_{-c} q \end{cases}$$

  - Evolution of ϵ exogenous: $\epsilon' = \rho_c \epsilon + v, \qquad v \sim N(0, \omega_c^2)$
- Reasons for inventors to move:
  - If they have a high draw of idiosyncratic productivity abroad (ϵ)
  - To the technology frontier where they earn higher returns

Learning

- Evolution of z depends on learning from others: ▸ Selection and Sorting

$$\begin{cases} \text{w.p. } 1\text{-}\lambda \text{ do not meet anyone:} & z' = z \\ \text{w.p. } \lambda \text{ meet inventors with bundle } \hat{q}(\hat{z}, \hat{\epsilon})\text{:} & z' = z\hat{q}^{\eta}, \quad \text{where } z \geq 1, \hat{q} \geq 1, \eta \geq 0 \end{cases}$$

Learning

- Evolution of z depends on learning from others: ▸ Selection and Sorting

$$\begin{cases} \text{w.p. } 1\text{-}\lambda \text{ do not meet anyone:} & z' = z \\ \text{w.p. } \lambda \text{ meet inventors with bundle } \hat{q}(\hat{z}, \hat{\epsilon})\text{:} & z' = z\hat{q}^{\eta}, \quad \text{where } z \geq 1, \hat{q} \geq 1, \eta \geq 0 \end{cases}$$

- Probability of meeting $\hat{q}$ varies for locals and immigrants (network frictions)

▸ Selection and Sorting

Network Frictions and Network Formation

- $\psi_{c,d}^{k,m}$: Endogenous interaction network: probability that inventor born in c, living in d meets inventor born in k, living in m

$$\psi_{c,d}^{k,m} = \begin{cases} \overbrace{\frac{\mu_{k,m}}{\sum_{k',m' \in \mathcal{J}} \mu_{k',m'}}}^{\text{Frequency of type } k,m} \overbrace{\xi_{c,d}^{k,m}}^{\text{Friction}} & \text{for } c \neq k \text{ or } d \neq m \\ 1 - \sum_{c \neq k, d \neq m} \psi_{c,d}^{k,m} & \text{for } c = k \text{ and } d = m \end{cases}$$

  - $\xi_{c,d}^{k,m}$ for $c \neq k$ or $d \neq m$: exogenous network frictions
  - $\mu_{k,m}$: mass of inventors who are born in country k and reside in m in the current period

▸ Value Functions and Growth

Network Frictions and Network Formation

- $\psi_{c,d}^{k,m}$: Endogenous interaction network: probability that inventor born in c, living in d meets inventor born in k, living in m

$$\psi_{c,d}^{k,m} = \begin{cases} \overbrace{\frac{\mu_{k,m}}{\sum_{k',m' \in \mathcal{J}} \mu_{k',m'}}}^{\text{Frequency of type } k,m} \overbrace{\xi_{c,d}^{k,m}}^{\text{Friction}} & \text{for } c \neq k \text{ or } d \neq m \\ 1 - \sum_{c \neq k, d \neq m} \psi_{c,d}^{k,m} & \text{for } c = k \text{ and } d = m \end{cases}$$

  - $\xi_{c,d}^{k,m}$ for $c \neq k$ or $d \neq m$: exogenous network frictions
  - $\mu_{k,m}$: mass of inventors who are born in country k and reside in m in the current period

- Reasons for inventors to move:
  - To change their interaction network and improve learning opportunities
- Migrants transfer knowledge to inventors at origin making them more productive

▸ Value Functions and Growth

Summary of effects in the model

- Suppose B is the frontier and net migration from A to B
- Effect of migration on B is ambiguous:
  - More inventors in B: innovation in $B \uparrow$
  - Migrants more productive in B (ϵ,$\{\psi_{c,d}^{k,m}\}$): innovation in $B \uparrow$
  - (Full model: immigrants crowd out locals): (innovation in $B \downarrow$)
- Effect of migration on A is ambiguous:
  - Fewer inventors in A : innovation in $A \downarrow$
  - Migrants transfer knowledge to locals in A (λ, $\{\psi_{c,d}^{k,m}\}$,η): innovation in $A \uparrow$
  - A benefits from frontier innovation with a lag (σ): productivity in $A \uparrow$
- Aggregate talent allocation trade-off
  - More inventors at frontier increase growth but deteriorate TFP gap

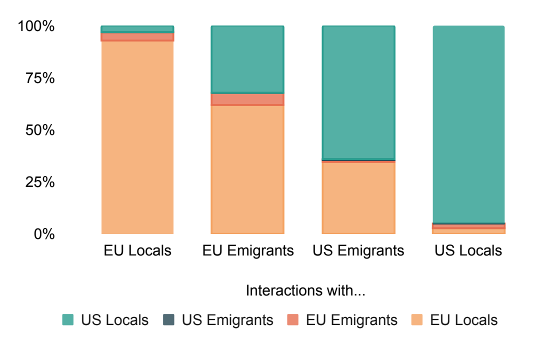
Empirical Analysis and Calibration

Strategy

1. Set A= EU, B = US. Set $\theta_A = \theta_B$, $I_A = I_B$, $\rho_A = \rho_B$, $\omega_A = \omega_B$.
2. Calibration in 3 steps: External + Direct Data Match + SMM
3. Key new parameters: learning (λ, η), network $(\{\psi_{i,j}^{k,m}\})$, and productivity process (ρ, ω)
4. New moments using EPO and PCT ▸ Data
   - Different interaction networks for locals and migrants.
   - Evolution of productivity of migrants after migration.
   - Evolution of productivity of locals when a co-inventor emigrates.
   - Gross and net migration flows, return intensity.

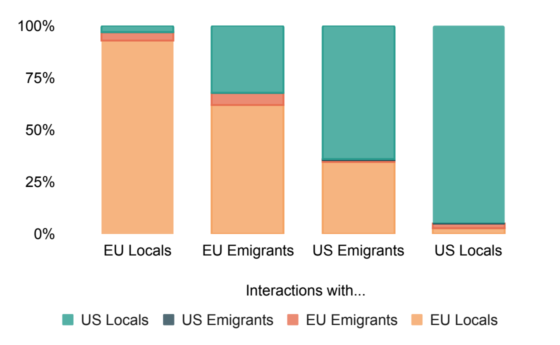
Migration allows to access different interaction networks.

- Collaboration networks from micro data on inventor - coinventor pairs ▸ Event Study



Migration allows to access different interaction networks.

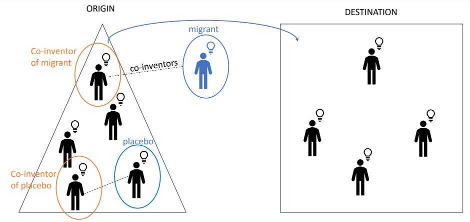
- Collaboration networks from micro data on inventor - coinventor pairs ▸ Event Study



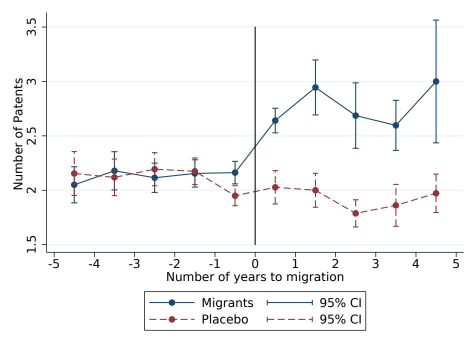
- Meeting probability and frictions: $\overbrace{\psi_{c,d}^{k,m}}^{\text{data}} = \overbrace{\frac{\mu_{k,m}}{\sum_{k',m' \in \mathcal{J}} \mu_{k',m'}}}^{\text{data}} \overbrace{\xi_{c,d}^{k,m}}^{\text{calibrated}}$

Empirical Strategy

1. Goal: Evolution of patenting of migrants and local co-inventors (not causal!)
2. Match migrants with "placebo" inventors ▸ Details
    - who did not migrate and are not co-inventors of migrant
    - same country of origin, first year in sample, cumulative patent stock at migration
    - file for a patent in the first year after migration
3. Build co-inventor network for real and placebo migrants
    - Exclude co-inventors who are themselves migrants
    - Observe change in productivity when co-inventor emigrates



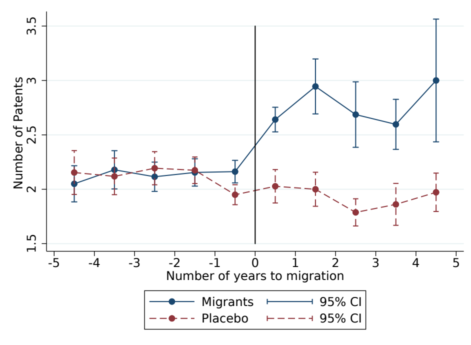
Increase in Patenting for EU and US Migrants and Local Co-Inventors



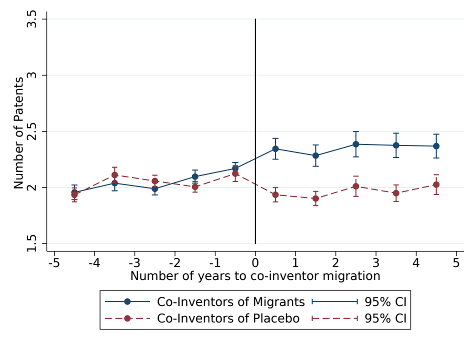
Migrants vs. Placebo

Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. EU co-inventors of migrants: 28,661 observations; US co-inventors of migrants: 11,879 observations; EU co-inventors of placebo: 23,967 observations; US co-inventors of placebo: 13,147 observations.

Increase in Patenting for EU and US Migrants and Local Co-Inventors



Migrants vs. Placebo

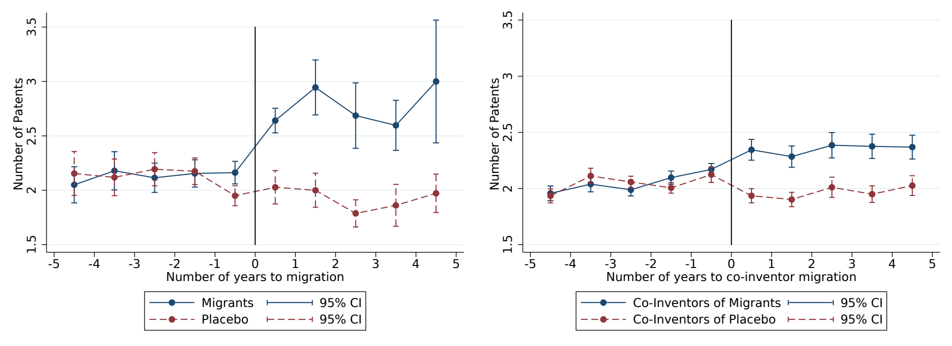


Co-Inventors of Migrants vs. Placebo

Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. EU co-inventors of migrants: 28,661 observations; US co-inventors of migrants: 11,879 observations; EU co-inventors of placebo: 23,967 observations; US co-inventors of placebo: 13,147 observations.

Increase in Patenting for EU and US Migrants and Local Co-Inventors

- Migrants: increase patents 42% per year after migration. ▸ Heterog. ▸ Event Study
- Locals at origin: increase patents 15% per year after co-inventor migrates. ▸ Heterog. ▸ Event Study



Migrants vs. Placebo

Co-Inventors of Migrants vs. Placebo

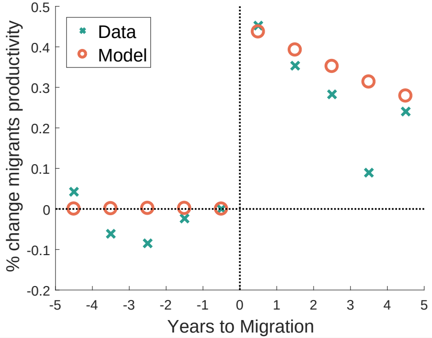
Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. EU co-inventors of migrants: 28,661 observations; US co-inventors of migrants: 11,879 observations; EU co-inventors of placebo: 23,967 observations; US co-inventors of placebo: 13,147 observations.

Calibrated Parameters and Moments

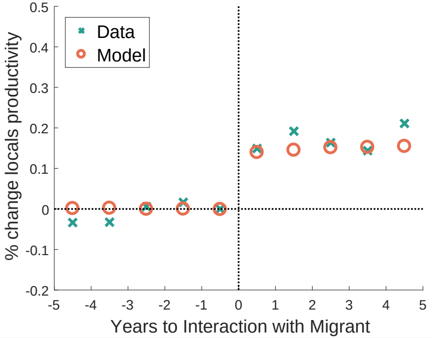
- Key Parameters: ▸ Full Calibration (26 parameters) ▸ Table of Moments ▸ Untargeted Moments

Parameter	Description	Value	Target	Data	Model
		— Direct Match to Micro Data —			
$\{\xi_{i,j}\}$	Meeting Frictions	See Figure	Interaction Network		
		— SMM (Joint Calibration) —			
ω_A	Foreign Productivity Shock SD A	0.201	Ev. Study EU-US migrants	0.43	0.35
ρ_A	Foreign Productivity Persistence A	0.893	Return migrant share	0.13	0.10
η	Learning Technology	0.335	Ev. Study Co-inventors US	0.12	0.13
λ	Meeting Intensity	0.101	Ev. Study Co-inventors EU	0.19	0.16
κ	Cost of Migration	0.102	Share mig. US-EU	0.40	0.41
σ	Technology Absorption	0.016	TFP gap	0.90	0.90

Goodness of Fit



Migrants



Local Co-Inventors

Quantitative Analysis

Policies

- The full model includes two policies

1) **Tax on inventors' profits**, rebated lump sum to production workers

$$\pi_c(z, \epsilon, t) = (1 - \tau_c) p(\bar{A}_{c,t}) q(z, \epsilon)$$

  - Calibration: $\tau_{EU} = 0.4$, $\tau_{US} = 0.3$

Policies

- The full model includes two policies

1) **Tax on inventors' profits**, rebated lump sum to production workers

$$\pi_c(z,\epsilon,t) = (1-\tau_c)p(\bar{A}_{c,t})q(z,\epsilon)$$

   - Calibration: $\tau_{EU} = 0.4$, $\tau_{US} = 0.3$

2) **Immigration Cap in US**
   - At most $\bar{\mu}$ immigrants admitted per period
   - Selected at random among those willing to move
   - Calibration: $\bar{\mu} = 0.006$ as share of US inventors

▸ Values

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics

▸ Back

- Tax cut in EU for US immigrants and EU return migrants (real world policy)

▸ Return Intensity and Flows

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics ‣ Back

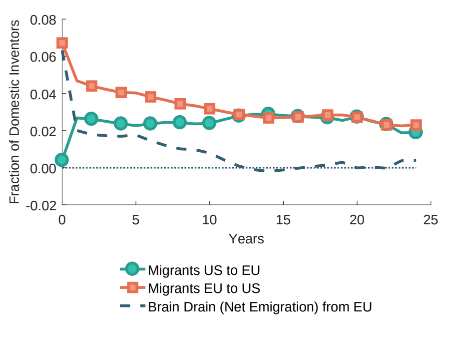
- Tax cut in EU for US immigrants and EU return migrants (real world policy)
- Solve Transitional Dynamics for tax cut from 0.4 to 0.3

‣ Return Intensity and Flows

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics

Back

- Tax cut in EU for US immigrants and EU return migrants (real world policy)
- Solve Transitional Dynamics for tax cut from 0.4 to 0.3



Stock of Migrants

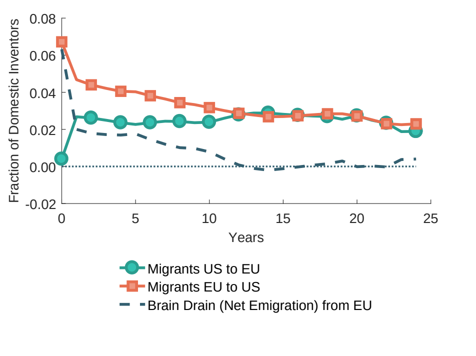
- Net Immigration ↑ in EU, ↓ in US

Return Intensity and Flows

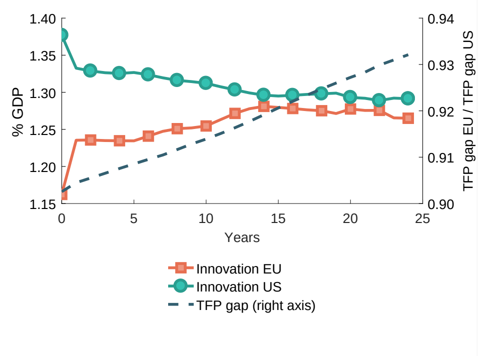
Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics

▸ Back

- Tax cut in EU for US immigrants and EU return migrants (real world policy)
- Solve Transitional Dynamics for tax cut from 0.4 to 0.3



Stock of Migrants



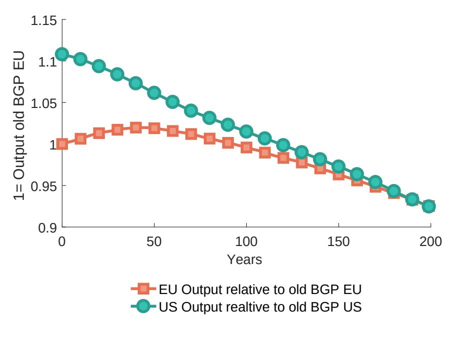
Innovation

- Net Immigration ↑ in EU, ↓ in US
- Net Innovation ↑ in EU, ↓ in US

▸ Return Intensity and Flows

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics ‣ Back

Output Dynamics EU and US



- EU GDP increases in the S.R., decreases in the L.R. relative to initial BGP

‣ Growth Rates

Decomposition of Effects on EU Output

Channel	EU Output	
	25 yrs	200 yrs
Direct Reallocation Effect	+2.63	+32.50
Change in Diffusion from US	-0.87	-33.77
Change in Migrants' Product.	-0.36	-4.69
Migrants' Selection	+0.65	+ 8.26
Knowledge Spillovers	-0.57	-9.77
Net Effect	+ 1.48	-7.47%

- Sizeable effect of interaction network and knowledge spillovers

Conclusion

Conclusion

- A comprehensive framework for migration decisions, knowledge networks and innovation
- New micro level evidence on migrant inventors: mobility, output and collaborations
- Lessons from policy counterfactuals
  - Policies to change migration flows produce many opposing effects and can backfire
  - Knowledge spillovers have sizeable effects on productivity and output
  - Open questions for future research
    - Knowledge spillovers larger or smaller in developing countries ?
    - Relationship between migration, occupational sorting, inequality?

Appendix

Literature Review and Contribution

Back

1. **Endogenous Growth Theory**
   Romer (1990), Grossman, Helpman (1991), Aghion, Howitt (1992), Kortum (1997), Alvarez, Buera, Lucas (2007), Lucas (2009) Lucas, Moll (2014), Perla, Tonetti(2014), Akcigit, Kerr (2018), Akcigit, Caicedo, Miguelez, Stantcheva (2018), Buera, Lucas (2018), Buera, Oberfield (2020), Ehrlich, Kim (2015)
   → Introduce endogenous migration in innovation-driven growth model

2. **Talent Allocation and Growth**
   Lucas (1988), Barro (1991), Mankiw, Romer, Weil (1992), Jones (2009), Jovanovich (2014), Hsieh, Hurst, Jones, Klenow (2019), Lagakos, Moll, Porzio, Qian, Schoellman (2018), Porzio (2017), Wuchty, Jones, Uzzi (2007), Jaravel, Petkova, Bell (2020), Akcigit, Pearce, Prato (2020)
   → Effect of migration on talent allocation

3. **Empirical Literature on Innovation and Immigration**
   Kerr (2008), Kerr, Lincoln (2010), Foley, Kerr (2013), Hunt, Gauthier-Loiselle (2010), Borjas and Doran (2012), Ottaviano, Peri (2006), Moser, Voena, Waldinger (2014), Akcigit, Baslandze, Stantcheva (2016), Akcigit, Grigsby, Nicholas (2017), Arkolakis, Peters, Lee (2019), Bernstein, Diamond, McQuade, Pousada (2018), Burchardi, Chaney, Hassan, Tarquinio, Terry (2020), Breschi, Lissoni (2009), Breschi, Lissoni, Miguelez (2017), Agrawal, Cockburn, McHale (2006), Agrawal, Kapur, McHale, Oetll (2011)
   → Mobility + Output + Interactions

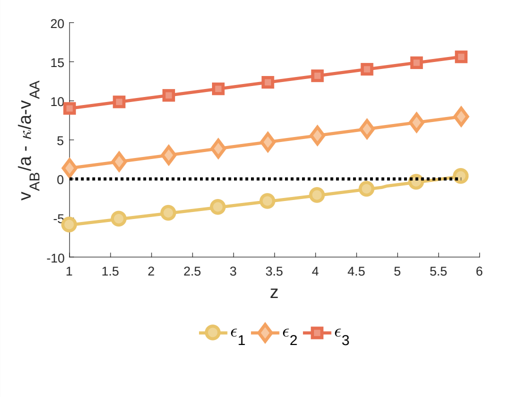
- EPO Patent Data : Panel of inventors from 1978 to 2016
  - Country of Residence $\rightarrow$ mobility
  - Patent Applications + Year $\rightarrow$ proxy for output
  - Co-inventors Network $\rightarrow$ interactions
  - Experience = Years since entering sample
- PCT Patent Data from 1978 to 2014 (aggregate flows)
- Namsor commercial database for name ethnicity

◂ Back

Value Functions: A Nationals

Back 1 Back 2

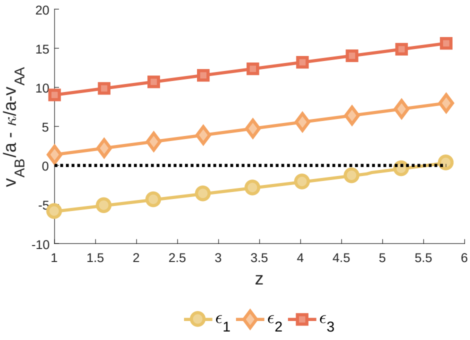
Value Functions: A Nationals



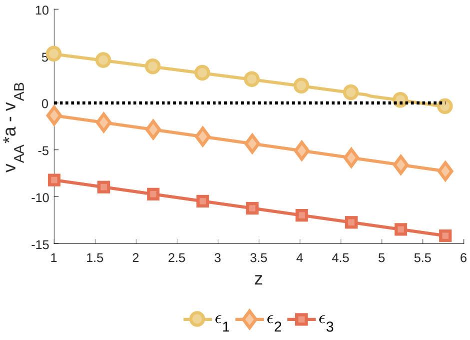
Migration Decision

▸ Back 1 ▸ Back 2

Value Functions: A Nationals



Migration Decision



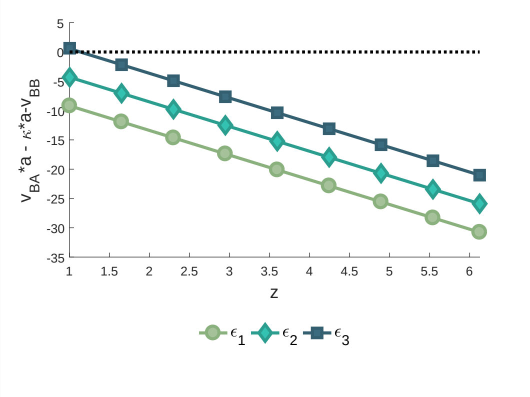
Return Decision

▸ Back 1 ▸ Back 2

Value Functions: B Nationals

Back

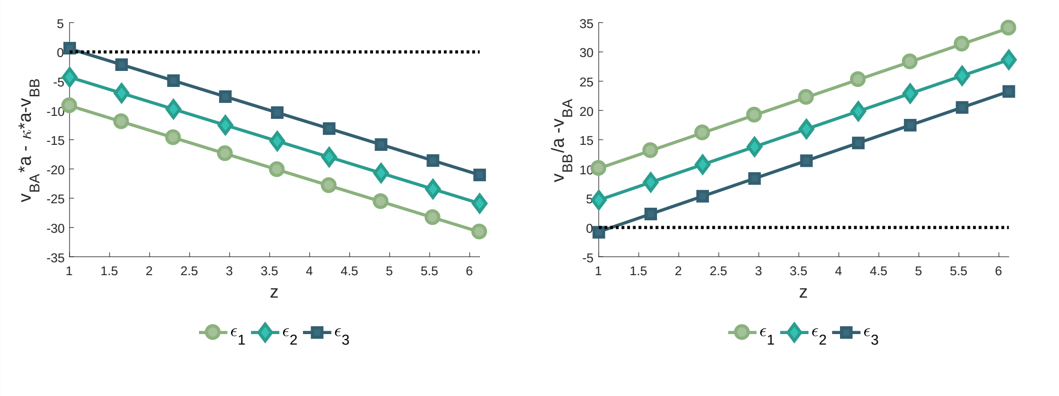
Value Functions: B Nationals



Migration Decision

Back

Value Functions: B Nationals



Migration Decision

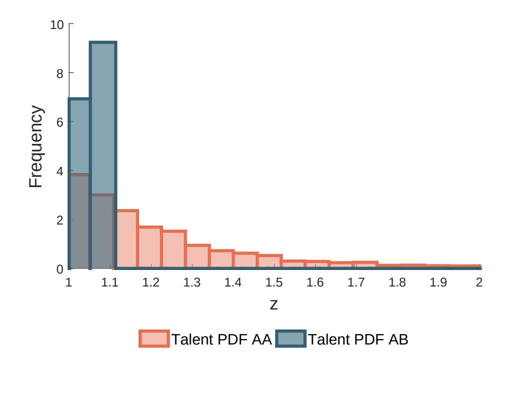
Return Decision

Back

Talent Distributions

Back

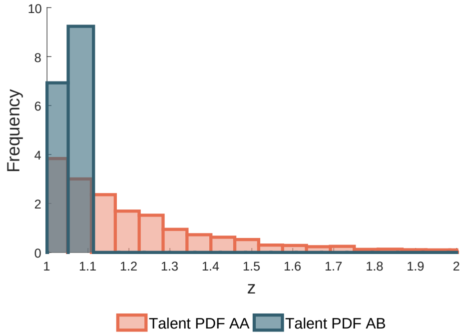
Talent Distributions

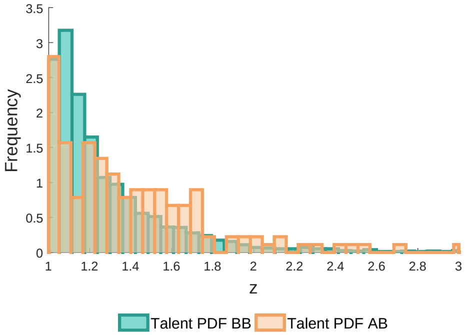


Talent in country A (EU)

Back

Talent Distributions





Talent in country A (EU)

Talent in Country B (US)

Back

Quantify international knowledge transfer

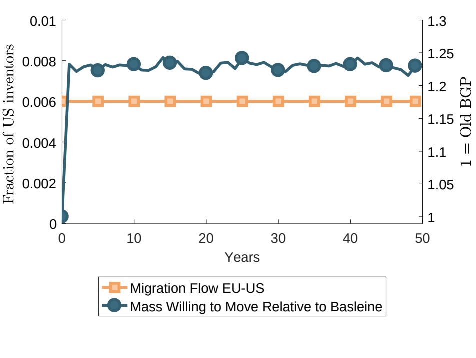
Back

- Shut down interactions across different groups:
  $\psi_{AA,AA} = \psi_{AB,AB} = \psi_{BB,BB} = \psi_{BA,BA} = 1$

	Baseline	New	% Change
—Innovation and Growth —			
Innovation EU	1.19%	1.08%	-9.2%
Innovation US	1.39%	1.48%	6.5%
Growth Rate	1.39%	1.48%	6.5%
TFP Gap	0.90	0.83	-8.2%
—Talent Allocation —			
Avg. Talent EU Locals	1.21	1.20	-1.1%
Avg. Talent EU Migrants	1.35	1.98	47.2%
Avg. Talent US Locals	1.28	1.28	0.4%
Avg. Talent US Migrants	1.02		-100.0%
—Migration Flows —			
EU-US Migrants	0.07	0.10	54.5%
US-EU Migrants	0.00	0.00	-100.0%
Return Share	0.10	0.03	-65.4%

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics ▸ Back

- Willingness to move and return intensity ↑ in EU

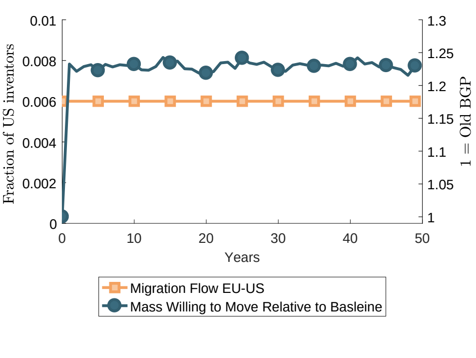


Migration Flows EU to US

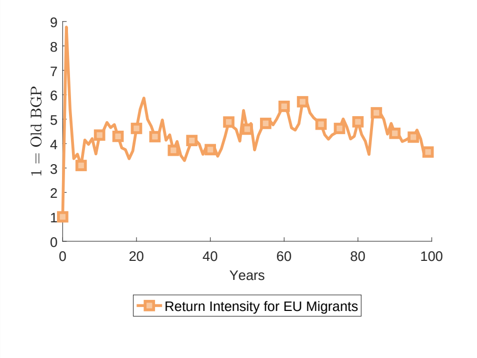
◂ Back

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics ‣ Back

- Willingness to move and return intensity ↑ in EU



Migration Flows EU to US



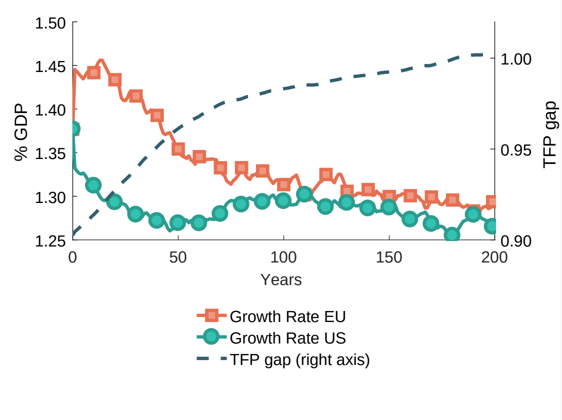
Innovation

◂ Back

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics

▸ Back

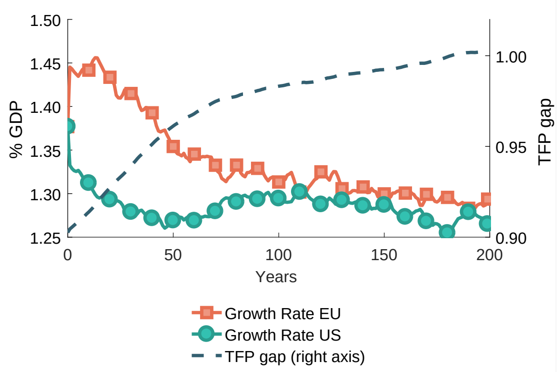
Growth Rates



◂ Back

Policy Counterfactual 1: Tax Cut in EU, Transitional Dynamics

Back

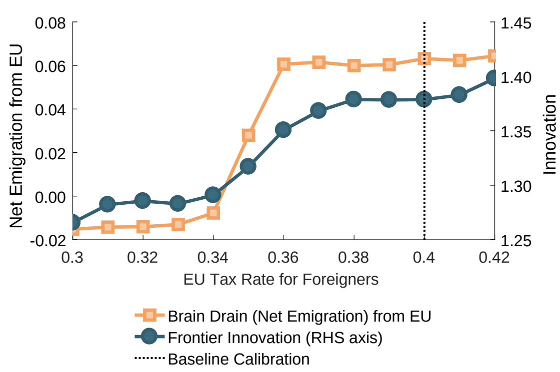


Growth Rates and TFP gap

Policy Counterfactual 1:Tax Cut in EU, BGP comparison ‣ Back

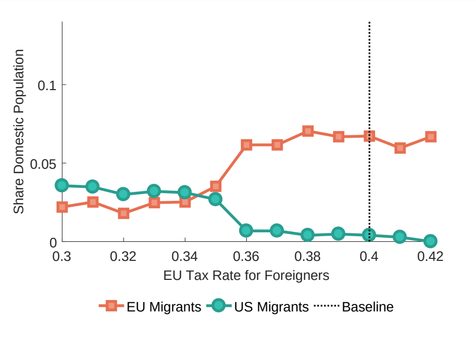
- Tax cut in EU for US immigrants and EU return migrants (real world policy)
- **Takeawy: reducing EU brain drain lowers aggregate growths**

Brain Drain and Frontier Innovation



Policy Counterfactual 1: Tax Cut in EU, BGP Comparison ‣ Back

- Net Immigration and Innovation ↑ in EU, ↓ in US

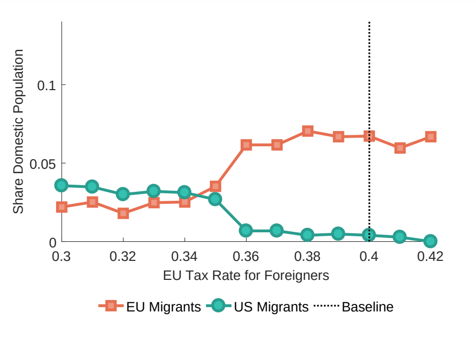


Stock of Migrants

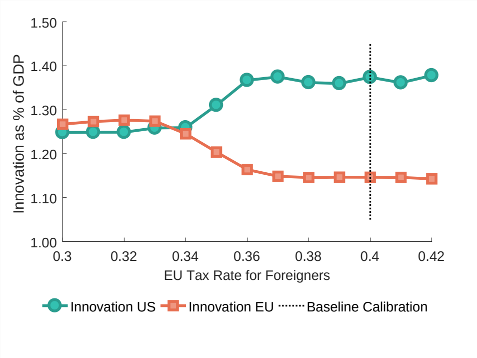
Policy Counterfactual 1: Tax Cut in EU, BGP Comparison

‣ Back

- Net Immigration and Innovation ↑ in EU, ↓ in US



Stock of Migrants

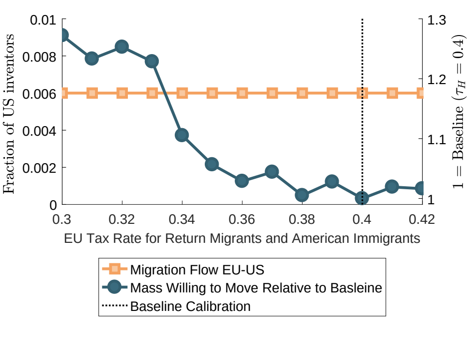


Innovation

Policy Counterfactual 1:Tax Cut in EU, BGP comparison

Back

- Cutting tax rate induces more migration, for both EU and US

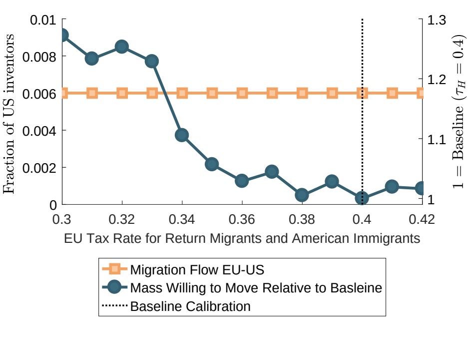


Migration Flow EU to US

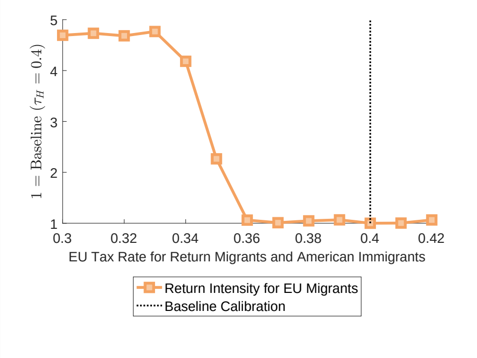
Policy Counterfactual 1:Tax Cut in EU, BGP comparison

Back

- Cutting tax rate induces more migration, for both EU and US



Migration Flow EU to US



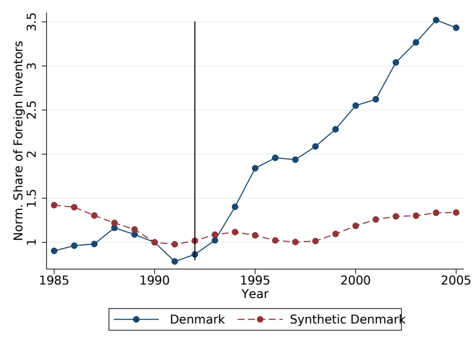
EU Return Intensity

Policy Counterfactual 1: Tax Cut in EU, Real World comparison

‣ Back

- Model prediction confirmed by real-world tax reform in Denamrk

Replication of Akcigit, Baslandze and Stantcheva (2016)

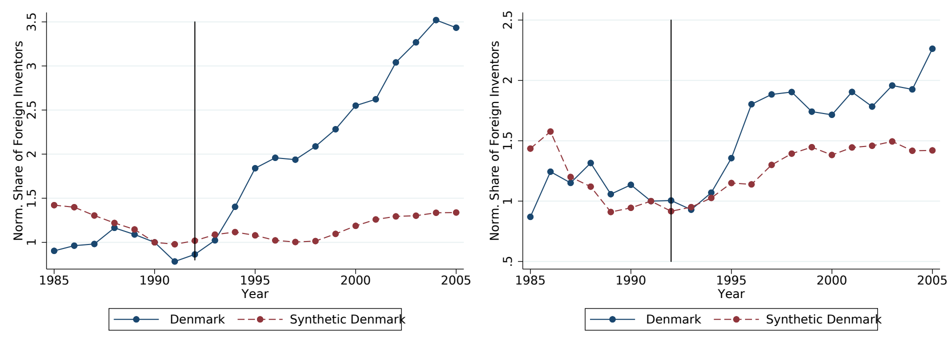


DK Immigration

Policy Counterfactual 1: Tax Cut in EU, Real World comparison ‣ Back

- Model prediction confirmed by real-world tax reform in Denamrk

Replication of Akcigit, Baslandze and Stantcheva (2016)



DK Immigration DK Emigration

Policy Counterfactual 1: Tax Cut in EU, Welfare

‣ Back

Table 1: Counterfactual Tax Cut for Foreign Inventors in the EU: Welfare Change

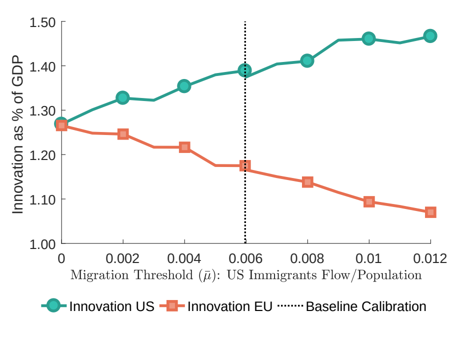
Welfare Change						
Average EU Inventor			EU Workers	Average US Inventor		US Workers
Local	Emigrant	Return Migrant		Local	Emigrant	
6.1 %	7.3 %	4.3 %	-0.3 %	-0.6 %	3.1 %	-1.3 %
EU Nationals Weighted Average				US Nationals Weighted Average		
1.6 %				-1.1 %		
Global Weighted Average						
0.2 %						

Policy Counterfactual 2: Migration Caps ‣ Back

- Exercise: Change immigration limit in US

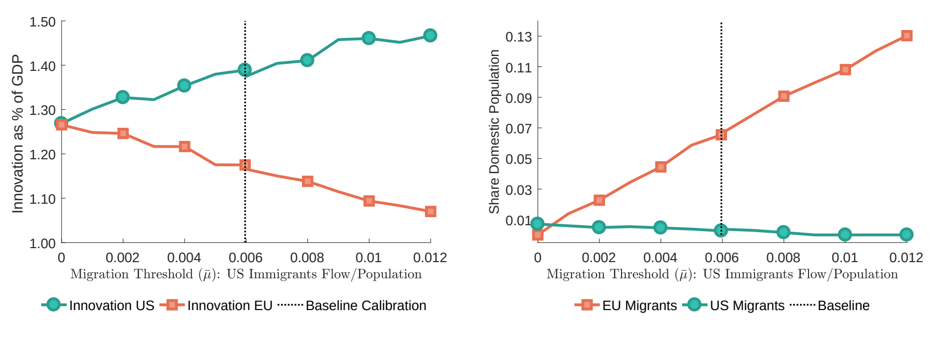
Policy Counterfactual 2: Migration Caps ‣ Back

- Innovation in US increases with more immigration



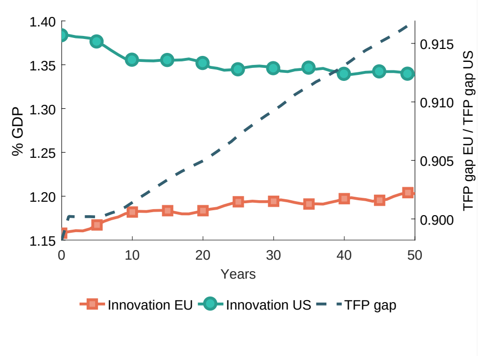
Policy Counterfactual 2: Migration Caps ▸ Back

- Innovation in US increases with more immigration



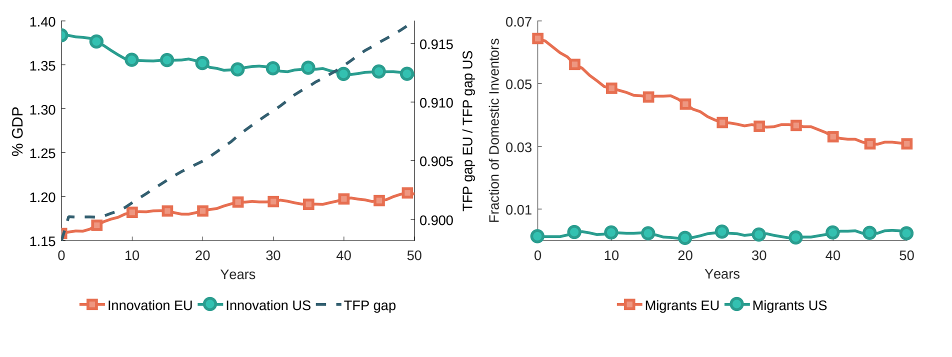
Policy Counterfactual 2: Migration Caps ‣ Back

- Increase in immigration : quantity dominates quality effect



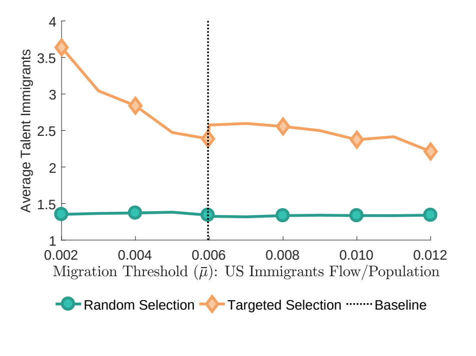
Policy Counterfactual 2: Migration Caps ‣ Back

- Increase in immigration : quantity dominates quality effect



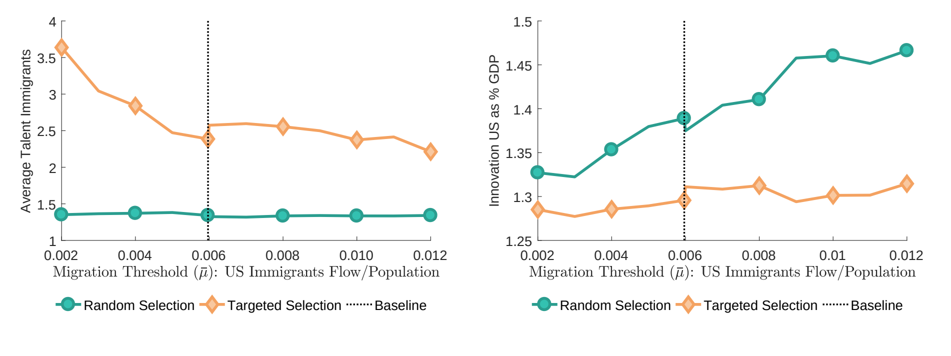
Policy Counterfactual 2: Targeted Migrants Selection ‣ Back

- Targeting migrants induces strong quality effects



Policy Counterfactual 2: Targeted Migrants Selection ‣ Back

- Targeting migrants induces strong quality effects



Meeting Frictions

Back

- Number of meetings between type c, d and k, m

$$\mu_{c,d}\psi_{c,d}^{k,m} = \mu_{c,d}\frac{\mu_{k,m}}{\sum_{k',m'}\mu_{k'.m'}}\xi_{c,d}^{k,m} = \mu_{k,m}\psi_{k,m}^{c,d} = \mu_{k,m}\frac{\mu_{c,d}}{\sum_{c',d'}\mu_{c',d'}}\xi_{k,m}^{c,d}$$

$$\Rightarrow \xi_{c,d}^{k,m} = \xi_{k,m}^{c,d}$$

- There are 6 free parameters to calibrate:

	AA	AB	BB	BA
AA	*	ξ_1	ξ_2	ξ_3
AB	ξ_1	*	ξ_4	ξ_5
BB	ξ_2	ξ_4	***	ξ_6
BA	ξ_3	ξ_5	ξ_6	****

where

$$* = (1 - \psi_{AA,AB} - \psi_{AA,BB} - \psi_{AA,BA})\frac{\sum_{k',m'}\mu_{k',m'}}{\mu_{BA}}$$

Goods Production (Simplified) ◂ Back

- Full model follows Akcigit, Kerr (2018), Akcigit, Pearce, Prato (2020). Includes intermediates, market for ideas, congestion. ▸ Full Model

Goods Production (Simplified) ◂ Back

- Full model follows Akcigit, Kerr (2018), Akcigit, Pearce, Prato (2020). Includes intermediates, market for ideas, congestion. ▸ Full Model

- Simplified Final good output: $Y_{c,t} = \bar{A}_{c,t} L_{c,t}$

Goods Production (Simplified) ◂ Back

- Full model follows Akcigit, Kerr (2018), Akcigit, Pearce, Prato (2020). Includes intermediates, market for ideas, congestion. ▸ Full Model
- Simplified Final good output: $Y_{c,t} = \bar{A}_{c,t} L_{c,t}$
- Price of idea bundle is a function of TFP: $p_{c,t} = p(\bar{A}_{c,t})$

Goods Production (Simplified) Back

- Full model follows Akcigit, Kerr (2018), Akcigit, Pearce, Prato (2020). Includes intermediates, market for ideas, congestion. Full Model
- Simplified Final good output: $Y_{c,t} = \bar{A}_{c,t} L_{c,t}$
- Price of idea bundle is a function of TFP: $p_{c,t} = p(\bar{A}_{c,t})$
- Profits for inventors: $\pi_c(z, \epsilon, t) = p(\bar{A}_{c,t}) q(z, \epsilon)$

Goods Production (Simplified) Back

- Full model follows Akcigit, Kerr (2018), Akcigit, Pearce, Prato (2020). Includes intermediates, market for ideas, congestion. Full Model
- Simplified Final good output: $Y_{c,t} = \bar{A}_{c,t} L_{c,t}$
- Price of idea bundle is a function of TFP: $p_{c,t} = p(\bar{A}_{c,t})$
- Profits for inventors: $\pi_c(z, \epsilon, t) = p(\bar{A}_{c,t}) q(z, \epsilon)$
- Each idea bundle q increases TFP by $q \times \bar{A}_{c,t}$

Goods Production

◂ Back

Goods Production ◂ Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha}\int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha}dj$$

Goods Production

◂ Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ

Goods Production

◂ Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$

Goods Production ◂ Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$
- Market for Ideas ▸ Details on Market for Ideas

Goods Production

Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$
- Market for Ideas Details on Market for Ideas
    - Inventors randomly matched to intermediate firms at endogenous rate $(\mu_{Ac} + \mu_{Bc})^{\nu-1}$

Goods Production

Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$
- Market for Ideas Details on Market for Ideas
    - Inventors randomly matched to intermediate firms at endogenous rate $(\mu_{Ac} + \mu_{Bc})^{\nu-1}$
    - Bundle q improves intermediate $A_{j,c}$ quality to $A_{j,c} + q\bar{A}_c$

Goods Production

Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$
- Market for Ideas Details on Market for Ideas
  - Inventors randomly matched to intermediate firms at endogenous rate $(\mu_{Ac} + \mu_{Bc})^{\nu-1}$
  - Bundle q improves intermediate $A_{j,c}$ quality to $A_{j,c} + q\bar{A}_c$
  - Value of ideas determines their price $p_{c,t} = \frac{r+1}{r} \alpha L_c \bar{A}_{c,t}$

Goods Production

Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$
- Market for Ideas Details on Market for Ideas
  - Inventors randomly matched to intermediate firms at endogenous rate $(\mu_{Ac} + \mu_{Bc})^{\nu-1}$
  - Bundle q improves intermediate $A_{j,c}$ quality to $A_{j,c} + q\bar{A}_c$
  - Value of ideas determines their price $p_{c,t} = \frac{r+1}{r} \alpha L_c \bar{A}_{c,t}$
  - Exogenous ideas arrival $\tilde{\sigma}_{c,t} = \sigma \max\{\bar{A}_{-c,t} - \bar{A}_{c,t}, 0\}$

Goods Production

Back

- Final good $Y_{c,t}$ produced with labor $L_{c,t}$ and intermediate goods $k_{j,c,t}$ of quality $A_{j,c,t}$

$$Y_{c,t} = \frac{1}{1-\alpha}(L_{c,t})^{\alpha} \int_0^1 (A_{j,c,t})^{\alpha}(k_{j,c,t})^{1-\alpha} dj$$

- Intermediate goods monopolists produce at MC ζ
- Let $\bar{A}_c = \int_0^1 A_{j,c} dj$ be aggregate TFP. Final good output $Y_c = \frac{1}{1-\alpha} L_c \bar{A}_c$
- Market for Ideas Details on Market for Ideas
    - Inventors randomly matched to intermediate firms at endogenous rate $(\mu_{Ac} + \mu_{Bc})^{\nu-1}$
    - Bundle q improves intermediate $A_{j,c}$ quality to $A_{j,c} + q\bar{A}_c$
    - Value of ideas determines their price $p_{c,t} = \frac{r+1}{r} \alpha L_c \bar{A}_{c,t}$
    - Exogenous ideas arrival $\tilde{\sigma}_{c,t} = \sigma \max\{\bar{A}_{-c,t} - \bar{A}_{c,t}, 0\}$
- Profits for inventors: $\pi_c(z, \epsilon, t) = (1-\tau_c)(\mu_{Ac} + \mu_{Bc})^{\nu-1} p_{c,t}(\bar{A}_{c,t}) q(z, \epsilon)$

Values for local and migrant inventors ◂ Back

- Value of local of nationality A, residence A, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AA}(z,\epsilon,t) = \pi_A(z,t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AA,j} \int_1^{\infty} \left(\overbrace{W_{AA}(zy^{\eta},\epsilon',t+1)}^{\text{continuation value}} \right) dF_j(y) \right.$$

$$\left. + (1-\lambda) W_{AA}(z,\epsilon',t+1) \right) d\upsilon_{\epsilon'|\epsilon},$$

Values for local and migrant inventors ◂ Back

- Value of local of nationality A, residence A, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AA}(z, \epsilon, t) = \pi_A(z, t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AA,j} \int_1^{\infty} \left(\overbrace{W_{AA}(zy^{\eta}, \epsilon', t+1)}^{\text{continuation value}} \right) dF_j(y) + (1-\lambda) W_{AA}(z, \epsilon', t+1) \right) d\upsilon_{\epsilon'|\epsilon},$$

- Immigration restriction: B admits at most $\bar{\mu}$ immigrants, selected at random
- Probability of being drafted $m_t = \bar{\mu}/\text{mass willing to move}$

Values for local and migrant inventors ◂ Back

- Value of local of nationality A, residence A, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AA}(z,\epsilon,t) = \pi_A(z,t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AA,j} \int_1^{\infty} \left(\overbrace{W_{AA}(zy^{\eta}, \epsilon', t+1)}^{\text{continuation value}} \right) dF_j(y) \right.$$
$$\left. + (1-\lambda) W_{AA}(z, \epsilon', t+1) \right) d\upsilon_{\epsilon'|\epsilon},$$

- Immigration restriction: B admits at most $\bar{\mu}$ immigrants, selected at random
- Probability of being drafted $m_t = \bar{\mu}/\text{mass willing to move}$
- Migration problem for an inventor of nationality A

$$W_{AA}(z,\epsilon,t) = \max \left\{ \underbrace{V_{AA}}_{\text{value of local}}(z,\epsilon,t), m_t \left(\underbrace{V_{AB}(z,\epsilon,t)}_{\text{value of migrant}} - \underbrace{\kappa \bar{A}_A(t)}_{\text{cost of migration}} \right) + (1-m_t) V_{AA}(z,\epsilon,t) \right\}$$

Values for local and migrant inventors

- Value of a migrant of nationality A, residence B, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AB}(z, \epsilon, t) = \pi_B(z + \epsilon, t) + \beta\delta \int_{-\infty}^{\infty} \Bigg(\lambda \sum_j \psi_{AB,j} \int_1^{\infty} (W_{AB}(zy^{\eta}, \epsilon', t+1))\, dF_j(y)$$

$$+ (1 - \lambda) W_{AB}(z, \epsilon', t+1)\Bigg) d\upsilon_{\epsilon'|\epsilon}$$

Values for local and migrant inventors

- Value of a migrant of nationality A, residence B, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AB}(z, \epsilon, t) = \pi_B(z + \epsilon, t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AB,j} \int_1^{\infty} \left(W_{AB}(zy^{\eta}, \epsilon', t+1) \right) dF_j(y) \right.$$
$$\left. + (1-\lambda) W_{AB}(z, \epsilon', t+1) \right) d\upsilon_{\epsilon'|\epsilon}$$

- Return problem for an inventor of nationality A

$$W_{AB}(z, \epsilon, t) = \max\{V_{AB}(z, \epsilon, t), V_{AA}(z, \epsilon, t)\}$$

Values for local and migrant inventors

- Value of a migrant of nationality A, residence B, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AB}(z, \epsilon, t) = \pi_B(z + \epsilon, t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AB,j} \int_1^{\infty} (W_{AB}(zy^{\eta}, \epsilon', t+1))\, dF_j(y) \right.$$
$$\left. + (1-\lambda) W_{AB}(z, \epsilon', t+1) \right) d\upsilon_{\epsilon'|\epsilon}$$

- Return problem for an inventor of nationality A

$$W_{AB}(z, \epsilon, t) = \max\{V_{AB}(z, \epsilon, t), V_{AA}(z, \epsilon, t)\}$$

- Inventors move for i) higher profits (TFP) ii) learning (ψ) iii) idiosyncratic shock (ϵ).

Values for local and migrant inventors

- Value of a migrant of nationality A, residence B, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AB}(z, \epsilon, t) = \pi_B(z + \epsilon, t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AB,j} \int_1^{\infty} (W_{AB}(zy^{\eta}, \epsilon', t+1))\, dF_j(y) \right.$$
$$\left. + (1-\lambda) W_{AB}(z, \epsilon', t+1) \right) d\upsilon_{\epsilon'|\epsilon}$$

- Return problem for an inventor of nationality A

$$W_{AB}(z, \epsilon, t) = \max\{V_{AB}(z, \epsilon, t), V_{AA}(z, \epsilon, t)\}$$

- Inventors move for i) higher profits (TFP) ii) learning (ψ) iii) idiosyncratic shock (ϵ).
- Similar problem for inventors of origin B; no immigration restriction

Balanced Growth Path (BGP) Equilibrium

- A BGP is an equilibrium s.t. aggregate TFP grows at constant rates g_A, g_B and talent CDFs F_A, F_B are stationary.

Balanced Growth Path (BGP) Equilibrium

- A BGP is an equilibrium s.t. aggregate TFP grows at constant rates g_A, g_B and talent CDFs F_A, F_B are stationary.

- TFP growth in country A : ▸ Derivation

$$g_A = \underbrace{\overbrace{(\mu_{AA} + \mu_{BA})^{\nu-1}}^{\text{inventor-firm match rate}} \overbrace{\left(\sum_{j \in \{AA,BA\}} \mu_j \int_{-\infty}^{\infty} \int_1^{\infty} q(z,\epsilon) dF_j(z) d\Upsilon_j(\epsilon) \right)}^{\text{average idea quality}}}_{\text{Endogenous innovation. } \iota_c} + \underbrace{\overbrace{\sigma \max\{(\bar{A}_B/\bar{A}_A) - 1, 0\}}^{\text{exogenous technology flow}}}_{\text{Exogenous component}}$$

Balanced Growth Path (BGP) Equilibrium

- A BGP is an equilibrium s.t. aggregate TFP grows at constant rates g_A, g_B and talent CDFs F_A, F_B are stationary.
- TFP growth in country A : ▸ Derivation

$$g_A = \underbrace{\overbrace{(\mu_{AA} + \mu_{BA})^{\nu-1}}^{\text{inventor-firm match rate}} \overbrace{\left(\sum_{j \in \{AA,BA\}} \mu_j \int_{-\infty}^{\infty} \int_{1}^{\infty} q(z,\epsilon) dF_j(z) d\Upsilon_j(\epsilon) \right)}^{\text{average idea quality}}}_{\text{Endogenous innovation. } \iota_c} + \underbrace{\overbrace{\sigma \max\{(\bar{A}_B/\bar{A}_A) - 1, 0\}}^{\text{exogenous technology flow}}}_{\text{Exogenous component}}$$

- Brain Drain/Gain (μ_j) vs. Knowledge Transfer (F_j, σ)

Balanced Growth Path (BGP) Equilibrium

- A BGP is an equilibrium s.t. aggregate TFP grows at constant rates g_A, g_B and talent CDFs F_A, F_B are stationary.

- TFP growth in country A : ‣ Derivation

$$g_A = \underbrace{\overbrace{(\mu_{AA}+\mu_{BA})^{\nu-1}}^{\text{inventor-firm match rate}} \overbrace{\left(\sum_{j\in\{AA,BA\}} \mu_j \int_{-\infty}^{\infty}\int_{1}^{\infty} q(z,\epsilon)\,dF_j(z)\,d\Upsilon_j(\epsilon)\right)}^{\text{average idea quality}}}_{\text{Endogenous innovation. } \iota_c} + \underbrace{\overbrace{\sigma \max\{(\bar{A}_B/\bar{A}_A)-1,0\}}^{\text{exogenous technology flow}}}_{\text{Exogenous component}}$$

- Brain Drain/Gain (μ_j) vs. Knowledge Transfer (F_j, σ)

- There is BGP s.t. $g_A = g_B = \max\{\iota_A, \iota_B\}$, the TFP gap $a \equiv \frac{\bar{A}_A}{\bar{A}_B}$ is constant, and migration decisions are time-invariant. ‣ Calibration ‣ Complete Migration Problem

Market for Technologies

- Intermediate monopolists buy technologies q at price $p(q)$

◂ Back

Market for Technologies

- Intermediate monopolists buy technologies q at price $p(q)$
- Matches between inventors and intermediate firms:

$$x_c = (\overbrace{\mu_{Ac} + \mu_{Bc}}^{S_c})^{\nu} (F_c)^{1-\nu}$$

where $\mu_{Ac} + \mu_{Bc}$ inventors active in c, $F_c = 1$ intermediate firms

- Technology purchasing and selling probabilities:

$$\frac{x_c}{F_c} = x_c = (\mu_{Ac} + \mu_{Bc})^{\nu} \qquad \frac{x_c}{\mu_{Ac} + \mu_{Bc}} = \left(\frac{1}{\mu_{Ac} + \mu_{Bc}}\right)^{1-\nu}$$

◂ Back

Market for Technologies ctd

- Inventors appropriate surplus from technology transaction
- Value of owning product line A_j:

$$J(A_{j,c,t},t)=\Pi_{j,c,t}+\frac{1}{1+r}\Bigg[x_{c,t}\Big(\int_0^\infty(J(A_{j,c,t}+\tilde{\sigma}_{c,t}+q(z)\bar{A}_{c,t+1},t+1)-p_{j,c,t+1}(q(z)))dF_c(z)\Big)+ (1-x_{c,t})J(A_{j,c,t+1}+\sigma_{c,t},t+1)\Bigg].$$

- Solve for value and price along a BGP:

$$J(A_{j,c,t},t)=\frac{r+1}{r}\alpha L_c A_{j,c,t}+v_{2,c}\bar{A}_{c,t} \qquad p_{j,c,t}=p_{c,t}=\frac{r+1}{r}\alpha L_c\bar{A}_{c,t}$$

where

$$v_{2,A}=\frac{1+g_A}{r-g_A}v_{1,A}\sigma\max\{1/a-1,0\}; \qquad v_{2,B}=\frac{1+g_B}{r-g_B}v_{1,B}\sigma\max\{a-1,0\}$$

Migration

- Every period, inventors can migrate or return. Migration Problem:

$$W_{c,d}(z,\epsilon,t) = \max\left\{ \underbrace{V_{c,d}(z,\epsilon,t)}_{\text{value of staying}}, \underbrace{V_{c,-d}(z,\epsilon,t)}_{\text{value of moving}} - \underbrace{K_{c,d}}_{\text{cost of migration}} \right\}$$

Migration

- Every period, inventors can migrate or return. Migration Problem:

$$W_{c,d}(z,\epsilon,t) = \max\left\{ \underbrace{V_{c,d}(z,\epsilon,t)}_{\text{value of staying}}, \underbrace{V_{c,-d}(z,\epsilon,t)}_{\text{value of moving}} - \underbrace{K_{c,d}}_{\text{cost of migration}} \right\}$$

- Value of inventor of type c, d

$$V_{c,d}(z,\epsilon,t) = \pi_d(z,\epsilon,t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_{k\in\{A,B\}} \sum_{m\in\{A,B\}} \psi_{c,d}^{k,m} \int_1^{\infty} \left(\overbrace{W_{c,d}(zq^{\eta},\epsilon',t+1)}^{\text{continuation value}} \right) dF_{k,m}(q,t+1) \right.$$
$$\left. + (1-\lambda) W_{c,d}(z,\epsilon',t+1) \right) d\upsilon_{\epsilon'|\epsilon},$$

Back

Migration

- Every period, inventors can migrate or return. Migration Problem:

$$W_{c,d}(z,\epsilon,t) = \max\Big\{ \underbrace{V_{c,d}(z,\epsilon,t)}_{\text{value of staying}}, \underbrace{V_{c,-d}(z,\epsilon,t)}_{\text{value of moving}} - \underbrace{K_{c,d}}_{\text{cost of migration}} \Big\}$$

- Value of inventor of type c, d

$$V_{c,d}(z,\epsilon,t) = \pi_d(z,\epsilon,t) + \beta\delta \int_{-\infty}^{\infty} \Bigg(\lambda \sum_{k\in\{A,B\}} \sum_{m\in\{A,B\}} \psi_{c,d}^{k,m} \int_1^{\infty} \Big(\overbrace{W_{c,d}(zq^{\eta},\epsilon',t+1)}^{\text{continuation value}} \Big) dF_{k,m}(q,t+1)$$
$$+ (1-\lambda) W_{c,d}(z,\epsilon',t+1) \Bigg) d\upsilon_{\epsilon'|\epsilon},$$

- Inventors move for i) higher profits (TFP) ii) interactions ($\psi_{c,d}^{k,m}$) iii) idiosyncratic shock (ϵ)
- Gross and net migration flows

Back

TFP and Balanced Growth Path (BGP) Equilibrium

- Each country c has a continuum of intermediates with quality $A_{c,x}$, which sell to final good aggregator, so that aggregate TFP is $\bar{A}_c = \int_0^1 A_{c,x} dx$ ▸ Goods Production

TFP and Balanced Growth Path (BGP) Equilibrium

- Each country c has a continuum of intermediates with quality $A_{c,x}$, which sell to final good aggregator, so that aggregate TFP is $\bar{A}_c = \int_0^1 A_{c,x} dx$ ▸ Goods Production

- Intermediates improve quality in 2 ways:
  - w.p. b_c buy idea bundle q
  - exogenous technology diffusion from frontier at rate σ

$$A'_{c,x} = A_{c,x} + b_c q \bar{A}_c + \sigma \max\{\bar{A}_{-c} - \bar{A}_c, 0\}$$

TFP and Balanced Growth Path (BGP) Equilibrium

- Each country c has a continuum of intermediates with quality $A_{c,x}$, which sell to final good aggregator, so that aggregate TFP is $\bar{A}_c = \int_0^1 A_{c,x} dx$ ▸ Goods Production
- Intermediates improve quality in 2 ways:
  - w.p. b_c buy idea bundle q
  - exogenous technology diffusion from frontier at rate σ

$$A'_{c,x} = A_{c,x} + b_c q \bar{A}_c + \sigma \max\{\bar{A}_{-c} - \bar{A}_c, 0\}$$

- BGP : TFP grows at constant rate $g_A = g_B = \max\{\iota_A, \iota_B\}$, the TFP gap $a \equiv \frac{\bar{A}_A}{\bar{A}_B}$ talent CDFs $F_{c,d}$ are stationary, and migration decisions are time-invariant. ▸ Uniqueness

$$g_c = b_c \underbrace{\Big(\overbrace{\mu_c}^{\#\text{ locals}} \overbrace{\int_1^\infty q \; dF_{c,c}(q)}^{\text{avg. locals' size}} + \overbrace{\mu_{-c}}^{\#\text{ immigr.}} \overbrace{\int_1^\infty q \; dF_{-c,c}(q)}^{\text{avg. immigrants' size}} \Big)}_{\text{Endogenous Innovation, } \iota_c} + \overbrace{\sigma \max\{(\bar{A}_{-c}/\bar{A}_c) - 1, 0\}}^{\text{Exogenous Technology Flow}}$$

Values for local and migrant inventors

- Migration problem for an inventor of nationality A

$$W_{AA}(z,\epsilon,t) = \max\left\{ \underbrace{V_{AA}(z,\epsilon,t)}_{\text{value of local}}, \underbrace{V_{AB}(z,\epsilon,t)}_{\text{value of migrant}} - \underbrace{\kappa \bar{A}_A(t)}_{\text{cost of migration}} \right\}$$

- Value of local of nationality A, residence A, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AA}(z,\epsilon,t) = \pi_A(z,t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AA,j} \int_1^{\infty} \left(\overbrace{W_{AA}(zy^{\eta},\epsilon',t+1)}^{\text{continuation value}} \right) dF_j(y) \right.$$
$$\left. + (1-\lambda) W_{AA}(z,\epsilon',t+1) \right) d\upsilon_{\epsilon'|\epsilon},$$

Values for local and migrant inventors

- Return problem for an inventor of nationality A

$$W_{AB}(z,\epsilon,t) = \max\{V_{AB}(z,\epsilon,t), V_{AA}(z,\epsilon,t)\}$$

- Value of a migrant of nationality A, residence B, for $j \in \{AA, AB, AB, BB\}$:

$$V_{AB}(z,\epsilon,t) = \pi_B(z+\epsilon,t) + \beta\delta \int_{-\infty}^{\infty} \left(\lambda \sum_j \psi_{AB,j} \int_1^{\infty} \left(W_{AB}(zy^{\eta}, \epsilon', t+1)\right) dF_j(y) \right.$$
$$\left. + (1-\lambda) W_{AB}(z, \epsilon', t+1) \right) d\upsilon_{\epsilon'|\epsilon}$$

- Inventors move for i) higher profits (TFP) ii) learning (ψ) iii) idiosyncratic shock (ϵ).

Growth Rate of the Economy

- Growth rate of the economy on a BGP: Back

$$g_A = \frac{\bar{A}_A(t+1) - \bar{A}_A(t)}{\bar{A}_A(t)}$$

$$= \frac{\int_0^1 \left(A_j + x_A \mathbb{E}(q)\bar{A}_A(t) + \sigma \max\{(\bar{A}_B(t) - \bar{A}_A(t)), 0\}\right) dj - \bar{A}_A(t)}{\bar{A}_A(t)}$$

Growth Rate of the Economy

- Growth rate of the economy on a BGP: Back

$$g_A = \frac{\bar{A}_A(t+1) - \bar{A}_A(t)}{\bar{A}_A(t)}$$

$$= \frac{\int_0^1 \left(A_j + x_A \mathbb{E}(q) \bar{A}_A(t) + \sigma \max\{(\bar{A}_B(t) - \bar{A}_A(t)), 0\} \right) dj - \bar{A}_A(t)}{\bar{A}_A(t)}$$

$$= x_A \int_1^\infty q(z) dF_A(z) + \sigma \max\{(1/\rho - 1), 0\}$$

Growth Rate of the Economy

- Growth rate of the economy on a BGP: Back

$$
\begin{aligned}
g_A &= \frac{\bar{A}_A(t+1) - \bar{A}_A(t)}{\bar{A}_A(t)} \\
&= \frac{\int_0^1 \left(A_j + x_A \mathbb{E}(q)\bar{A}_A(t) + \sigma \max\{(\bar{A}_B(t) - \bar{A}_A(t)), 0\}\right) dj - \bar{A}_A(t)}{\bar{A}_A(t)} \\
&= x_A \int_1^\infty q(z) dF_A(z) + \sigma \max\{(1/\rho - 1), 0\} \\
&= \iota_A + \sigma \max\{(1/\rho - 1), 0\}
\end{aligned}
$$

Assumptions

1. The exogenous occupational allocation, talent distribution, and location preference process are identical across countries: $l_A = l_B$, $\theta_A = \theta_B$, $\rho_A = \rho_B$, and $\omega_A = \omega_B$.

2. Compared with locals in A, migrants of nationality A are
   (i) more likely to meet other migrants from A ($\xi_{AB,AB} > \xi_{AA,AB}$),
   (ii) more likely to meet locals in B ($\xi_{AB,BB} > \xi_{AA,BB}$), and
   (iii) less likely to meet migrants from B in A ($\xi_{AB,BA} < \xi_{AA,BA}$).

   Similarly, for country B, $\xi_{BA,BA} > \xi_{BB,BA}$, $\xi_{BA,AA} > \xi_{BA,AA}$, and $\xi_{BA,AB} < \xi_{BB,AB}$.

◂ Back to Theory ◂ Back to Quantitative Analysis

Equilibrium characterization

- **Tax on inventors' profits**, rebated lump sum to production workers
$$\pi_c(z, \epsilon, t) = (1 - \tau_c) p(\bar{A}_{c,t}) q(z, \epsilon)$$

- Assume $\tau_A > \tau_B$.

- **Equilibrium Characterization**
  1. Under Assumptions 1 and 2, along a BGP, there exist thresholds $\bar{z}_{AA}(\epsilon)$, $\bar{z}_{AB}(\epsilon)$, $\bar{z}_{BB}(\epsilon)$, and $\bar{z}_{BA}(\epsilon)$ such that individuals with state (z, ϵ) of type:
     - AA move to B if $z > \bar{z}_{AA}(\epsilon)$, given ϵ; AB return to A if $z < \bar{z}_{AB}(\epsilon)$, given ϵ;
     - BB move to A if $z < \bar{z}_{BB}(\epsilon)$, given ϵ; BA return to B if $z > \bar{z}_{BA}(\epsilon)$, given ϵ.
  2. Along a BGP, there exist thresholds $\bar{\epsilon}_{AA}(z)$, $\bar{\epsilon}_{AB}(z)$, $\bar{\epsilon}_{BB}(z)$, and $\bar{\epsilon}_{BA}(z)$ such that individuals with state (z, ϵ) of type:
     - AA move to B if $\epsilon > \bar{\epsilon}_{AA}(z)$, given z; AB return to A if $\epsilon < \bar{\epsilon}_{AB}(z)$, given z;
     - BB move to A if $\epsilon > \bar{\epsilon}_{BB}(z)$, given z; BA return to B if $\epsilon < \bar{\epsilon}_{BA}(z)$, given z.

Data and Summary Statistics

More Summary Stats · Back

1. PCT: patent data with inventor nationality
2. EPO patent data and disambiguated inventor files Breschi, Lissoni, Tarasconi, (2016)
   - Inventors report their address to patent office
   - Define migrant as inventor with international change in address

Summary Stats CRIOS-Patstat Database

Unique Inventors	3,593,675
Inventors with more than 1 patent	1,130,154
Average Patents per Inventor	2.2
Migrants	11,392
Avg. Experience at First Migration	3.2
Return Migrants	1,786
Avg. # Years Abroad for Ret. Mig.	1.6

Empirical Evidence ‣ Go To Empirics

(i) Migration flows between the EU and the US are asymmetric: the US have more immigrants than emigrants (brain gain), while the EU faces larger outflows than emigrants (brain drain).

(ii) Migrants tend to become more productive after migration.

(iii) Local inventors tend to become more productive after they co-invent with an emigrant.

(iv) Migration allows to access different interaction networks.

Migration : Event Studies

Back

- Event Study : Outcomes before and after migration

$$x_{it} = \sum_{\tau=-5}^{5} \beta_\tau^{Mig} \, \mathbf{1}[L_{it}^{Mig} = \tau] + \sum_{\tau=-5}^{\tau=5} \beta_\tau^{All} \mathbf{1}[L_{it}^{All} = \tau] + \alpha_i + \alpha_t + \alpha_e + \epsilon_{it}$$

i=inventor, t=year, e=experience (years since first patent)

L_{it} = calendar year - year of migration of i (event time)

Control Group

- Control Group: Construct "placebo migrants" (as in Jaravel et al. (2018)), who did not migrate, look similar to migrants and are not co-inventors of migrants.
- Exact Match on experience at migration, calendar year of migration, cumulative patents stock at migration, cumulative number of co-inventors at migration, country of origin.
- Match 10,611 out of 11,367 inventors.

Summary Stats Before and After Matching, Inventors of EU origin

◂ Back

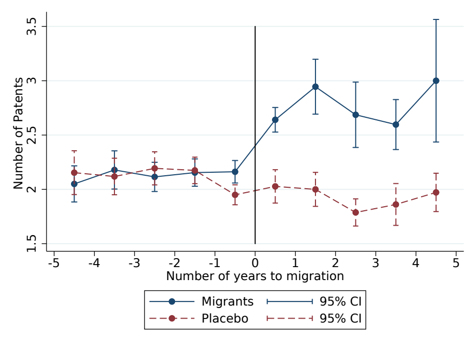
	-Panel A: Before Matching -							
	EU Migrants				All EU Inventors			
	N	Mean	Median	SD	N	Mean	Median	SD
First Year in Sample	1057	1999	2000	8.04	4087243	1999	2000	9.23
Experience	1057	2.49	1	3.47	4087243	3.37	1	4.64
Patent Stock	1057	8.67	4	17.71	4087243	3.88	2	9.22
Co-Inventors Stock	1057	13.38	7	17.49	4087243	5.59	3	10.46
Citations Stock	1057	2.25	0	7.29	4087243	0.92	0	3.30
	-Panel B: After Matching -							
	Matched EU Migrants				Control Group (Placebo)			
	N	Mean	Median	SD	N	Mean	Median	SD
First Year in Sample	955	1999	2000	7.95	955	1999	2000	7.95
Experience	955	2.05	1	2.94	955	2.05	1	2.94
Patent Stock	955	5.52	3	6.71	955	5.52	3	6.71
Co-Inventors Stock	955	10.45	6	12.18	955	6.45	4	7.93
Citations Stock	955	2.02	0	7.09	955	1.45	0	6.45

Summary Stats Before and After Matching, Inventors of US origin ◂ Back

	-Panel A: Before Matching -							
	US Migrants				All US Inventors			
	N	Mean	Median	SD	N	Mean	Median	SD
First Year in Sample	518	2000	2001	7.30	2150521	1999	2000	8.86
Experience	518	1.85	0	3.33	2150521	2.63	1	4.11
Patent Stock	518	5.16	2	7.72	2150521	3.32	1	6.40
Co-Inventors Stock	518	8.54	5	10.02	2150521	6.13	3	9.24
Citations Stock	518	0.98	0	3.71	2150521	0.64	0	2.56
	-Panel B: After Matching -							
	Matched US Migrants				Control Group (Placebo)			
	N	Mean	Median	SD	N	Mean	Median	SD
First Year in Sample	504	2001	2001	7.21	504	2001	2001	7.21
Experience	504	1.75	0	3.15	504	1.75	0	3.15
Patent Stock	504	4.45	2	5.72	504	4.45	2	5.72
Co-Inventors Stock	504	8.04	5	8.96	504	7.58	4	9.35
Citations Stock	504	1.00	0	3.75	504	0.66	0	2.20

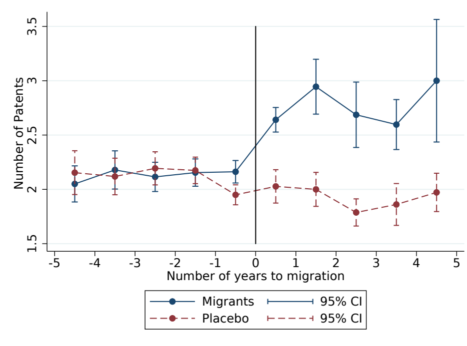
Migrants US-EU Corridor: Productivity ↑ after Migration

◂ Back

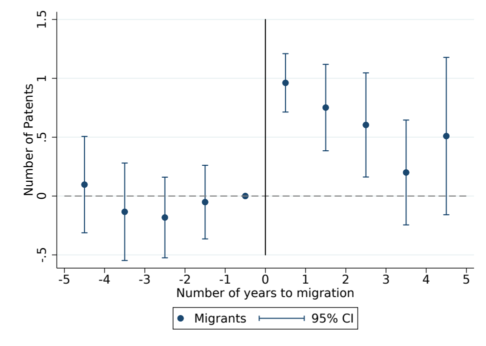


Raw Means

Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. SE clustered at inventor level.



Raw Means

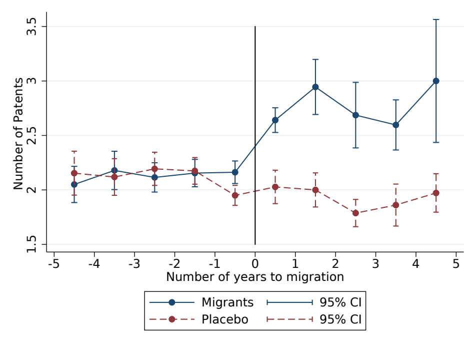


Regression Coefficients

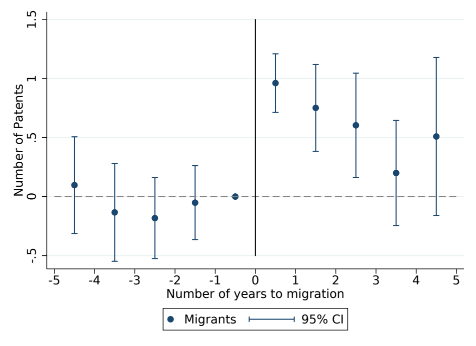
Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. SE clustered at inventor level.

Migrants US-EU Corridor: Productivity ↑ after Migration ◂ Back

- In 5 years after migration, migrants increase average patents per year by 42% . ▸ Heterog.



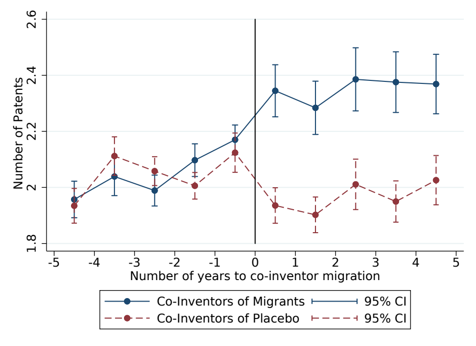
Raw Means



Regression Coefficients

Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. SE clustered at inventor level.

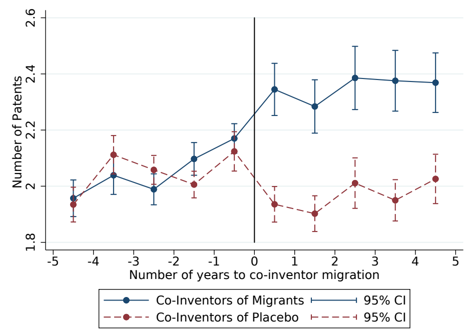
Co-Inventors of Migrants at origin: Productivity ↑ after Migration ◂ Back



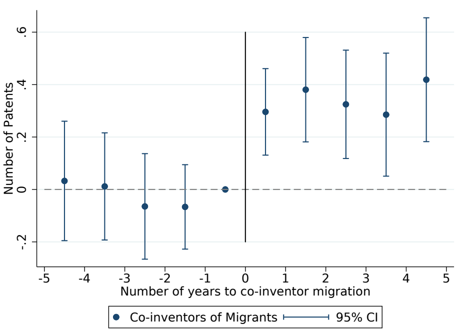
Raw Means

Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. SE clustered at inventor level.

Co-Inventors of Migrants at origin: Productivity ↑ after Migration ◂ Back



Raw Means



Regression Coefficients

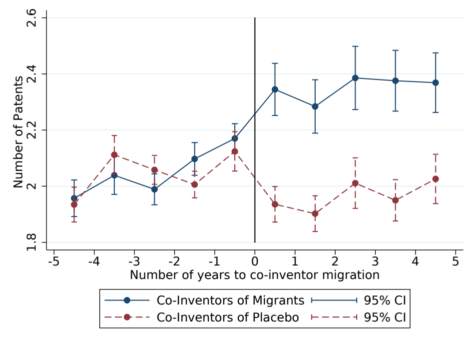
Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. SE clustered at inventor level.

Co-Inventors of Migrants at origin: Productivity ↑ after Migration

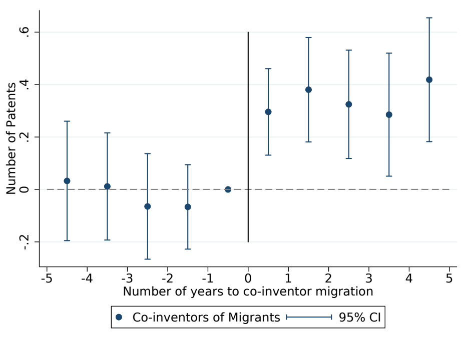
Back

- Locals at origin ↑ avg. patents per year by 15% after co-inventor migrates.

Heterogeneity



Raw Means



Regression Coefficients

Note: Unbalanced Panel. EU Migrants: 5,976 obs. US Migrants: 2,907 observations. EU Placebo: 5,189 observations. US Placebo: 2,474 observations. SE clustered at inventor level.

Patenting activity of migrants around migration: Heterogeneity

Back

	Number of Patent Applications per Year		
	(1)	(2)	(3)
	All	EU Origin	US Origin
Post Migration	0.8592***	0.8861***	0.8353***
	(0.0945)	(0.1067)	(0.2071)
Obs	16546	11165	5381
R2	0.390	0.438	0.344
Inventor FE	X	X	X
Year FE	X	X	X

Patenting activity of migrants around migration: Robustness

	(1)	(2)	(3)	(4)
Outcome	Pat.	Pat.	Cit.	Cit. 3 -yr
Sample	Same Firm	Diff. Firm	All	All
Post Mig.	0.8209***	1.0262***	0.2502	0.0970
	(0.1060)	(0.2200)	(0.7386)	(0.0975)
Obs	13353	3182	14548	14548
R2	0.380	0.455	0.459	0.355
Inventor FE	X	X	X	X
Year FE	X	X	X	X

Patenting of co-inventors of migrants around migration: Heterogeneity

Back

	Number of Patent Applications per Year		
	(1)	(2)	(3)
	All	EU Origin	US Origin
Post Migration	0.3597***	0.3382***	0.3895***
	(0.0610)	(0.0752)	(0.1049)
Obs	77654	52628	25026
R2	0.496	0.509	0.464
Inventor FE	X	X	X
Year FE	X	X	X

Patenting of co-inventors of migrants around migration: Robustness

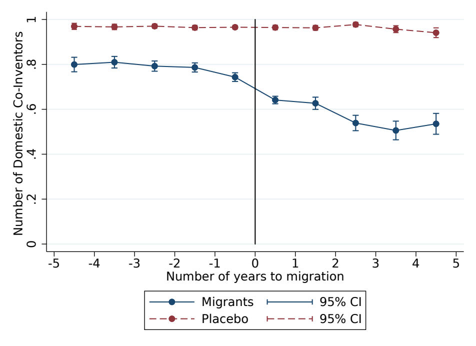
Panel A: All local co-inventors at origin

	(1)	(2)	(3)	(4)	(5)
Outcome	Pat.	Pat.	Pat.	Pat.	Cit. 3 -yr
Sample	Non-Switch	Switch	Ret.	Non-Ret.	All
Post Co-Inv. Mig.	0.3718***	0.2737	0.3246	0.3828***	0.0588
	(0.0879)	(0.1967)	(0.1980)	(0.0905)	(0.0865)
Obs	70149	7599	15877	61871	77748
R2	0.500	0.493	0.483	0.505	0.436
Inventor FE	X	X	X	X	X
Year FE	X	X	X	X	X

Panel B: Co-inventors at origin patenting with migrant after migration

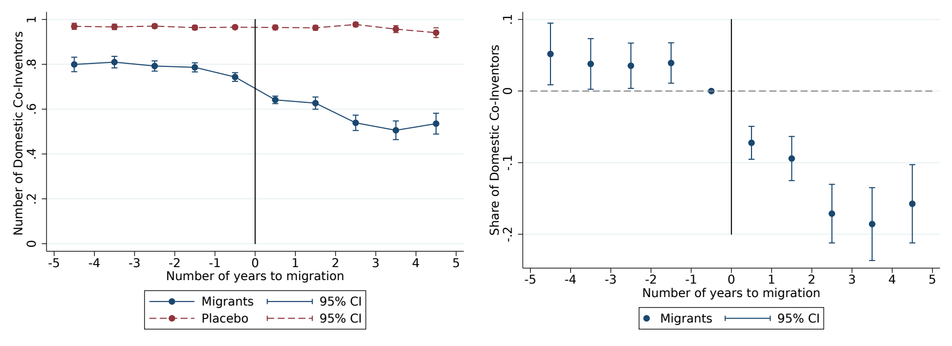
	(1)	(2)	(3)	(4)	(5)
	Pat.	Pat.	Pat.	Pat.	Cit. 3-yr
Post Co-Inv. Mig.	0.2895***	0.8706***	0.4614**	0.9906**	0.2769*
	(0.0912)	(0.1865)	(0.2259)	(0.4217)	(0.1613)
Obs	46922	13260	1245	2912	13260
R2	0.488	0.458	0.508	0.456	0.407
Inventor FE	X	X	X	X	X
Year FE	X	X	X	X	X
Only Migrant Switchers			X		
Only Return Migrants				X	
Only Co-Inventors after Migration		X	X	X	X

Migrants: Number of Domestic Co-Inventors ↓ after Migration ◂ Back



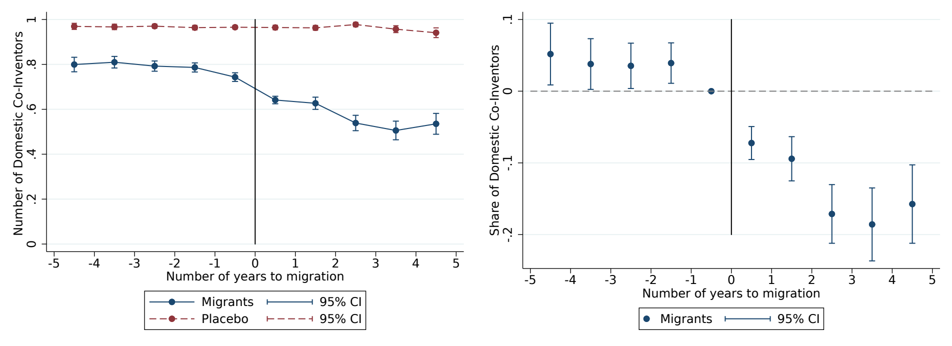
Note: Unbalanced Panel. EU Migrants: 5,761 obs. US Migrants: 2,801 observations. EU Placebo: 4,411 observations. US Placebo: 2,264 observations. SE clustered at inventor level.

Migrants: Number of Domestic Co-Inventors ↓ after Migration ◂ Back



Note: Unbalanced Panel. EU Migrants: 5,761 obs. US Migrants: 2,801 observations. EU Placebo: 4,411 observations. US Placebo: 2,264 observations. SE clustered at inventor level.

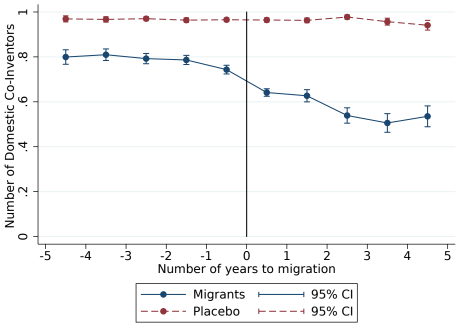
- After migration, on average, local co-inventors at origin decline by 30% .

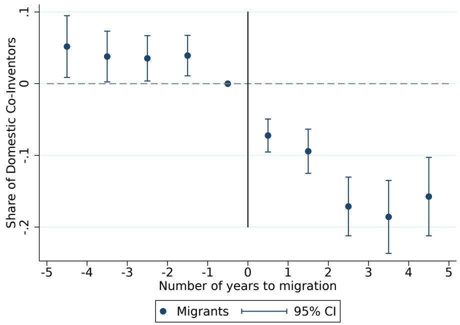


Note: Unbalanced Panel. EU Migrants: 5,761 obs. US Migrants: 2,801 observations. EU Placebo: 4,411 observations. US Placebo: 2,264 observations. SE clustered at inventor level.

Migrants: Number of Domestic Co-Inventors ↓ after Migration ◂ Back

- After migration, on average, local co-inventors at origin decline by 30% .

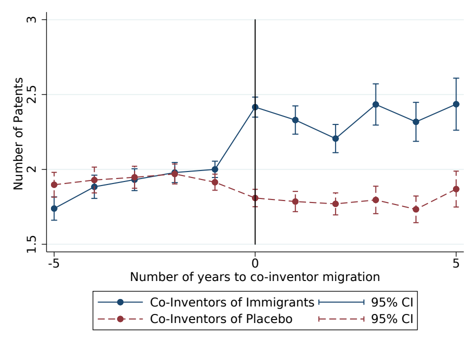




Note: Unbalanced Panel. EU Migrants: 5,761 obs. US Migrants: 2,801 observations. EU Placebo: 4,411 observations. US Placebo: 2,264 observations. SE clustered at inventor level.

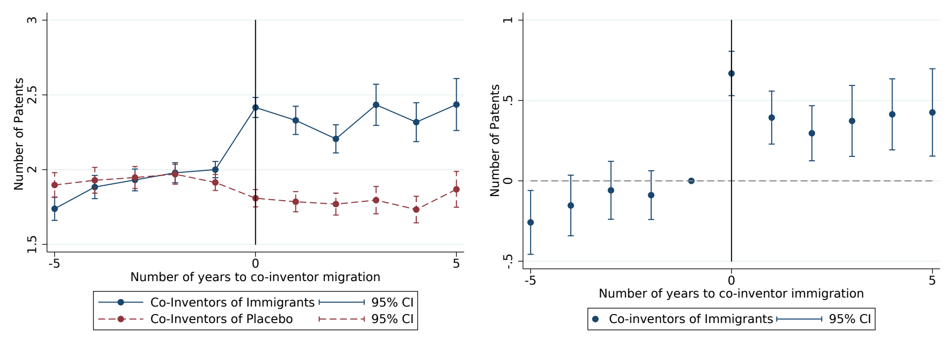
- Migrants access different interaction network after migration. ▸ Back

Co-Inventors of Migrants at Dest.: Productivity ↑ after Migration



Note: Unbalanced Panel. Co-inventors of migrants: 24,102 obs. Co-inventors of placebo: 20,616 obs. SE clustered at inventor level.

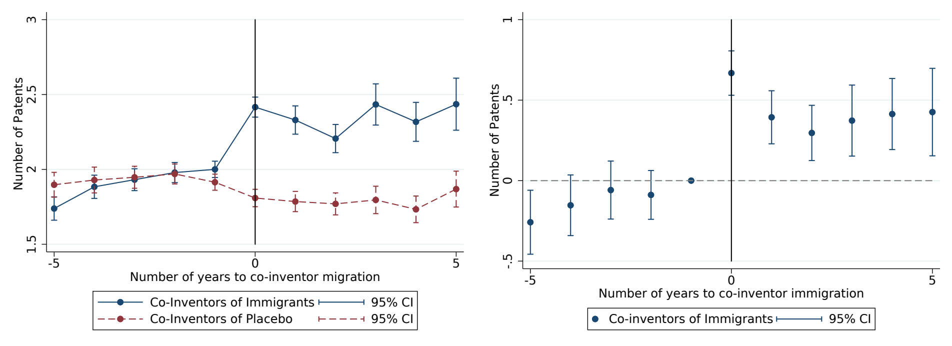
Co-Inventors of Migrants at Dest.: Productivity ↑ after Migration



Note: Unbalanced Panel. Co-inventors of migrants: 24,102 obs. Co-inventors of placebo: 20,616 obs. SE clustered at inventor level.

Co-Inventors of Migrants at Dest.: Productivity ↑ after Migration

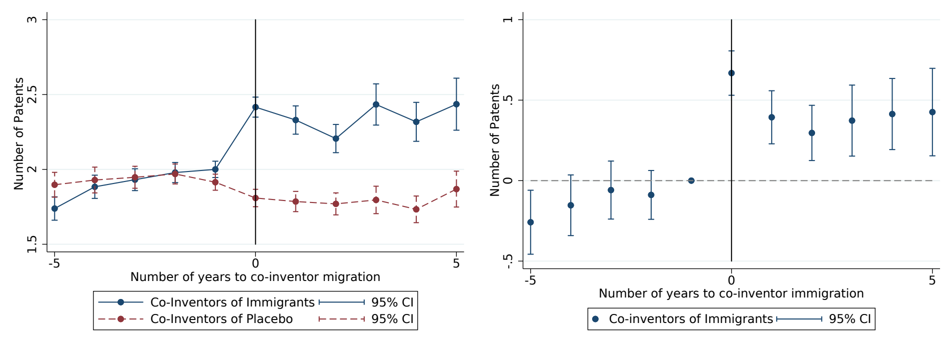
- After migration, avg. patents per year increase by 30% .



Note: Unbalanced Panel. Co-inventors of migrants: 24,102 obs. Co-inventors of placebo: 20,616 obs. SE clustered at inventor level.

Co-Inventors of Migrants at Dest.: Productivity ↑ after Migration

- After migration, avg. patents per year increase by 30% .



Note: Unbalanced Panel. Co-inventors of migrants: 24,102 obs. Co-inventors of placebo: 20,616 obs. SE clustered at inventor level.

Calibration Strategy

◂ Back

- I calibrate to the US-EU corridor (65% of data, 77% of migrants). Assume same:
  - Talent Distribution $\theta_A = \theta_B$, $I_A = I_B$
  - Foreign Productivity Process $\rho_A = \rho_B$ $\omega_A = \omega_B$;
- The full calibration proceeds in 3 steps
  - External Calibration (8 parameters): $\beta, r, \delta, \nu, \alpha, \tau_A, \tau_B, I_A$
  - Direct Match to Micro Data (6 parameters): $\{\xi_{i,j}\}(6)$
  - Simulated Method of Moments (8 parameters): $\kappa, \eta, \sigma, \theta_A, \rho_A, \omega_A, \bar{\mu}$

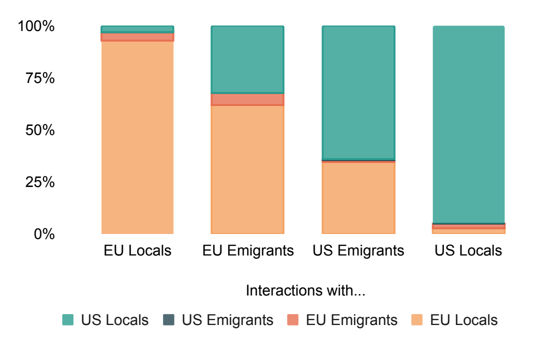
STEP 1: External Calibration

Back

Parameter	Description	Value
— *Panel A. External Calibration* —		
β	Discount Rate	0.97
r	Interest Rate	0.03
δ	Survival Rate	0.95
α	Final Good Production	0.11
ν	Inventor-Firm match rate	1.00
τ_A	Tax Rate EU	0.40
τ_B	Tax Rate US	0.30
l_A	Share R&D workers	0.01

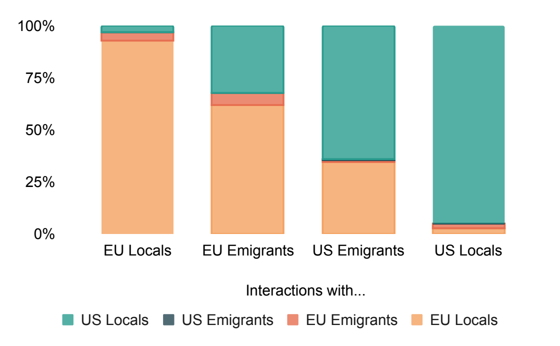
STEP 2: Direct match to micro-data ◂ Back

- Collaboration networks from micro data on inventor - coinventor pairs
- Migration allows to access different interaction networks. ▸ Event Study



STEP 2: Direct match to micro-data ◂ Back

- Collaboration networks from micro data on inventor - coinventor pairs
- Migration allows to access different interaction networks. ▸ Event Study



- Meeting probability and frictions: $\overbrace{\psi_{i,j}}^{\text{data}} = \overbrace{\frac{\mu_j}{\sum_{j' \in \mathcal{J}} \mu^{j'}}}^{\text{data}} \overbrace{\xi_{i,j}}^{\text{calibrated}}$

STEP 3: Internal Calibration

Back

Parameter	Description	Value	Target (Heuristic)
	— Panel C. SMM Calibration —		
$\bar{\mu}$	Migration cap to US	0.006	Share mig. EU-US
κ	Cost of Migration	0.102	Share mig. US-EU
ω_A	Location Shock SD A	0.201	Ev. Study EU-US migrants
ρ_A	Location Shock Persistence A	0.893	Return migrant share
η	Learning Technology	0.335	Ev. Study Co-inventors US
λ	Meeting Intensity	0.101	Ev. Study Co-inventors EU
σ	Technology Absorption	0.016	TFP gap
θ_A	Talent CDF A	15.000	Growth rate

Notes: All parameters are estimated jointly.

Table of Moments

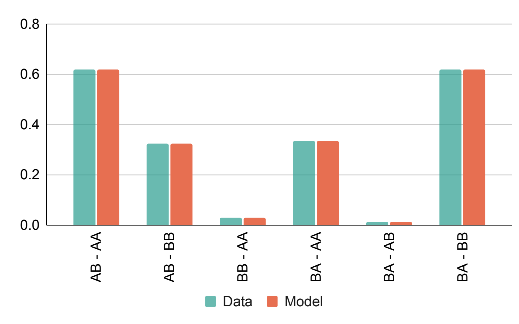
Moments ◂ Back

Moment	Data	Model
Share Migrants EU-US	6.00	6.59
Share Migrants US-EU (% domestic inventors)	0.40	0.41
Share Return Migrants (% migrants)	0.13	0.10
Δ productivity migrants EU-US (%)	0.43	0.35
Δ productivity co-inventors of migrants EU (%)	0.19	0.16
Δ productivity co-inventors of migrants US (%)	0.12	0.13
Growth rate (%)	1.50	1.35
TFP gap	0.90	0.90

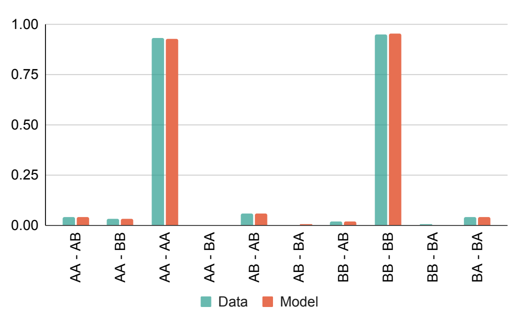
▸ Untargeted Moments ▸ Parameters

Interaction Networks: Data vs. Model

Back



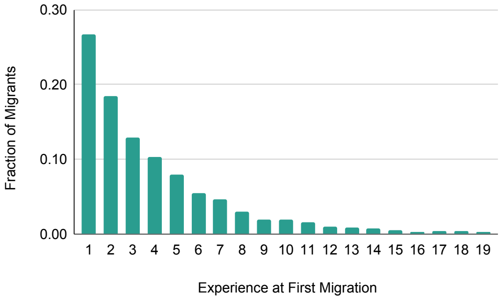
Interaction shares ($\psi_{i,j}$) - Targeted



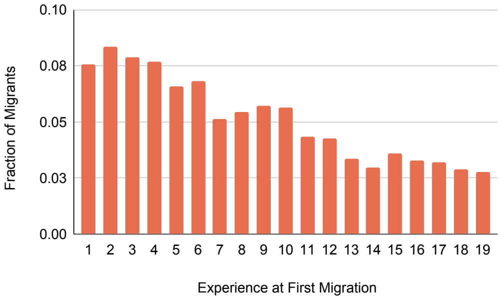
Interaction shares ($\psi_{i,j}$) - Non-Targeted

Experience at First Migration: Data vs. Model

Back



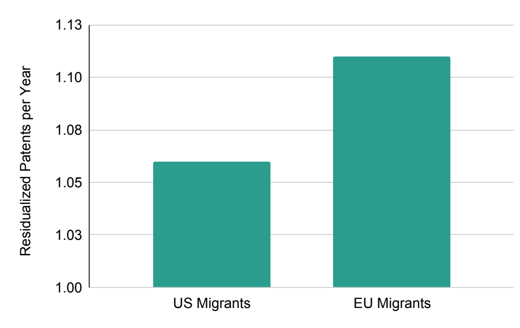
Data



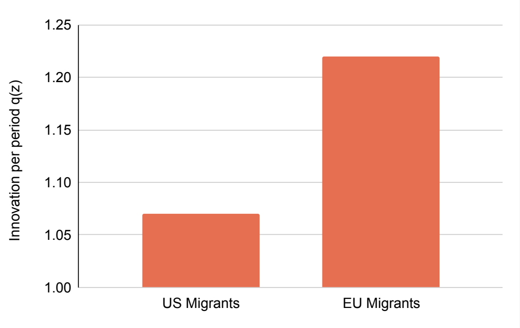
Model

Average Productivity of Migrants Before Migration: Data vs. Model

Back



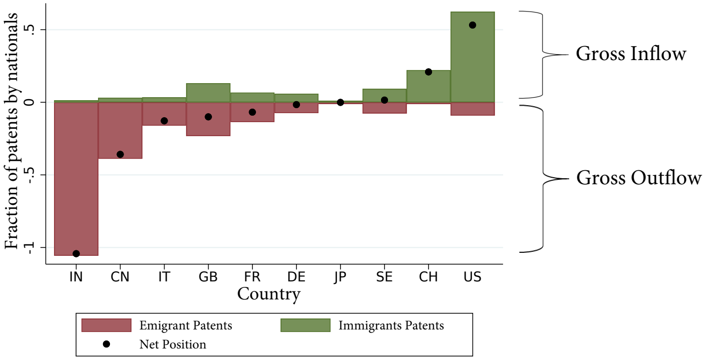
Average Patents per Year (Data)



Averge Innovation per Year, $q(z)$ (Model)

Mobility of Inventors

- Int'l Mobility of Inventors 2001-2010 (WIPO Data)

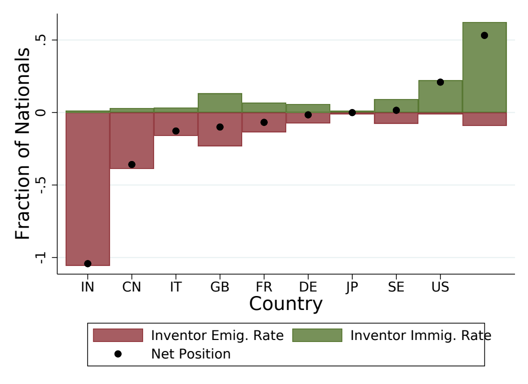


Source: Miguelez and Fink (2013)

Back

Brain Drain Rates

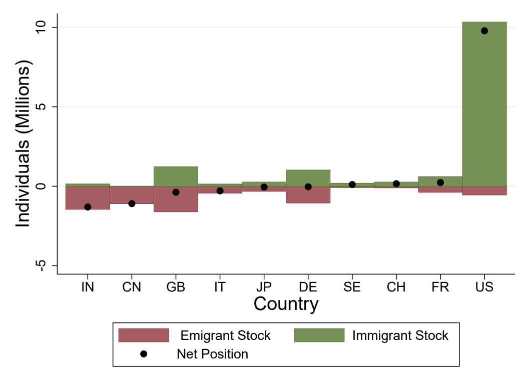
Mobility of Inventors 2001-2010 (WIPO Patent Data)



◂ Back

College Graduates International Mobility

Figure 1: Stock of College Educated Immigrants and Emigrants, 2000

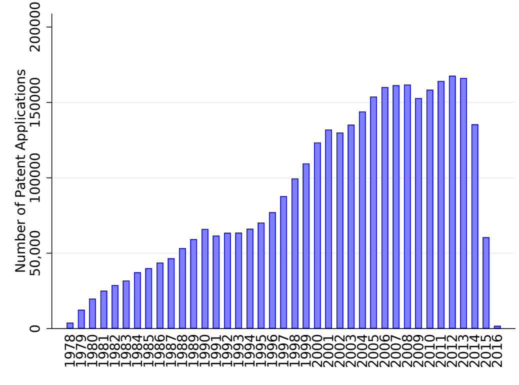


Source: Artuc, Docquier, Ozden, Parsons (2013)

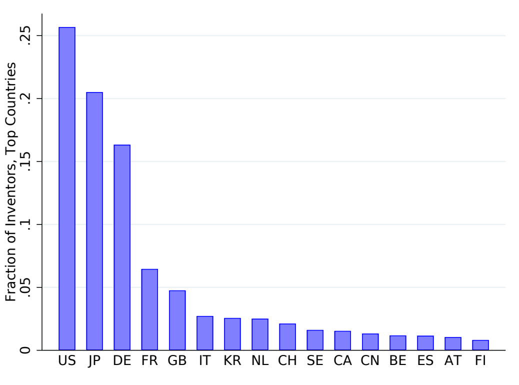
Back

Data

- EPO patent data and disambiguated inventor files (Breschi, Lissoni, Tarasconi, (2016))

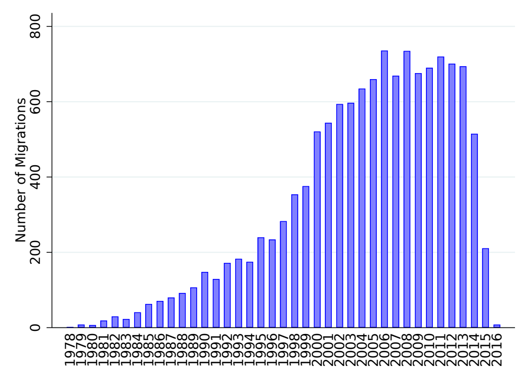


Patent Applications per Year

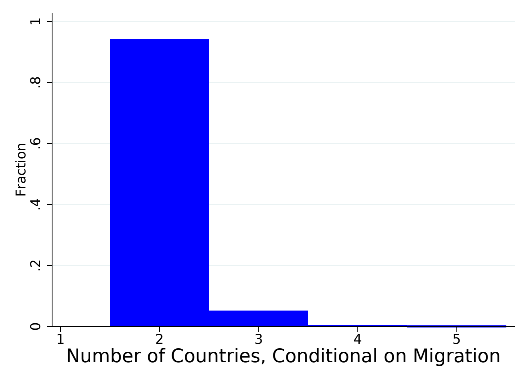


Share of Inventors by Country

Distribution of migrations by year

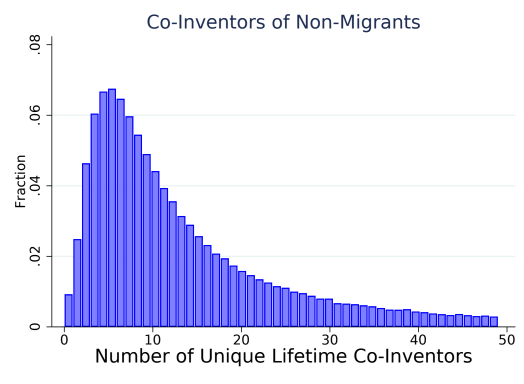


Distribution of number of countries of residence for migrants

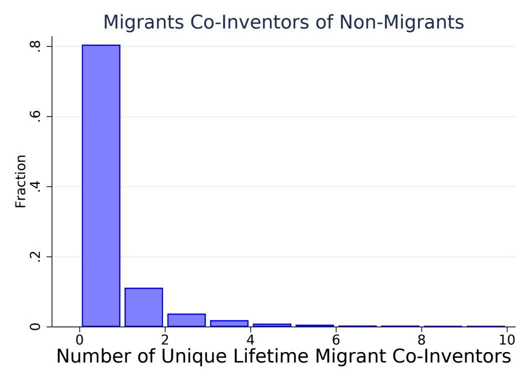


Co-Inventors

- Distribution of unique lifetime co-inventors for non-migrant inventors



Number of Co-Inventors



Number of Migrant Co-Inventors

Who teams up with migrants?

Inventors that work in teams with and w/o migrant co-inventors are different:

	Mean		Diff.	SE of Diff.
	w/ Mig.	w/o Mig.		
Avg years active	6.03	3.44	2.59	0.02
Avg pat per inventor	11.34	4.18	7.16	0.07
Avg cit-weighted pat	4.60	1.44	3.16	0.06
Avg Cit per pat	0.36	0.34	0.02	0.00
Avg Max # Cit	2.63	1.36	1.27	0.02