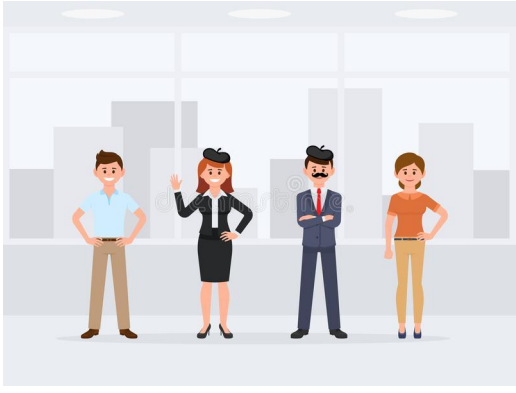
The Global Race for Talent: Brain Drain, Knowledge Transfer and Growth by Marta Prato

Irisa Lee Yi Liu Drew Van Kuiken

July 6, 2022

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Human Capital Flight (Brain Drain) Isn't All Bad



It's also not entirely good. Equilibrium effects are complicated.

Research Question

What happens when high-skill workers move?

Theory and Empirics Can Connect Migration and Aggregate Growth

- Theoretical model, empirical estimation, and policy simulations to explore aggregate dynamics.
- Track effects at home- and host- country level:
  - Allocation: Where do talented workers flow?
  - Innovation: How do migrant and non-migrant inventors' ideas develop?
  - Knowledge Transfer: Do migrants facilitate cross-border knowledge diffusion?

Paper Measures EU-US Migration Via Patent Data

- EU-US Corridor
- Track number of patents for migrant and non-migrant inventors and co-inventors
- Modify standard endogenous growth model to include migration decisions
- On balanced growth path, consider two policies:
  - Tax regimes, e.g., more profitable to invent in US
  - Migration caps, e.g., H1B program

Plan

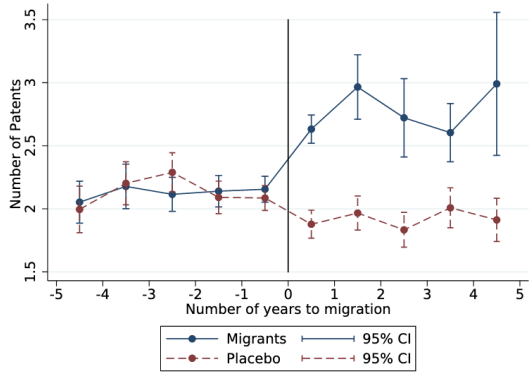
Patent Data Is Both Rich and Imperfect

Panel A: Number of Unique Observations			
	Full Sample	EU Origin	US Origin
Unique Inventors	4,029,289	1,639,331	1,034,769
w/ more than 1 patent	1,293,431	593,328	344,938
Migrants	12,743	7,299	2,433
Return Migrants	2,371	1,350	475

- Patent dataset gives location, co-inventors, and citations
- Use last names to categorize inventor country of origin

Yet Patent Counts Show Clear Trend Following Migration

Mean Number of Patents Before and After Migration Versus Placebo

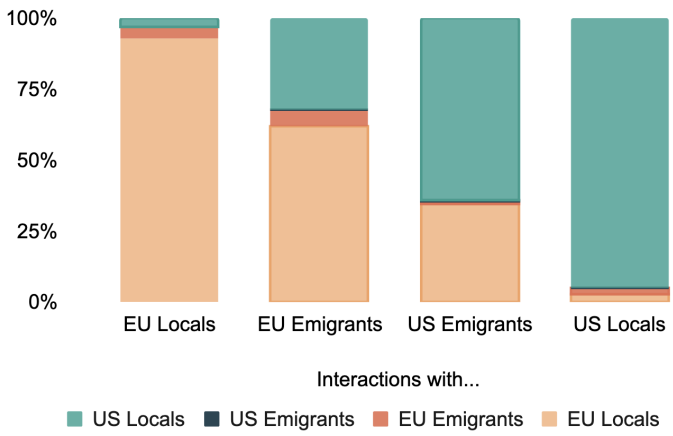


- Local co-inventors who never migrate patent more too!

▸ OLS Specification ▸ Co-inventor RDD

Migrants and Locals Have Different Interaction Networks

Figure 5: Interaction Networks



- Paper shows inventors access different networks post-migration.

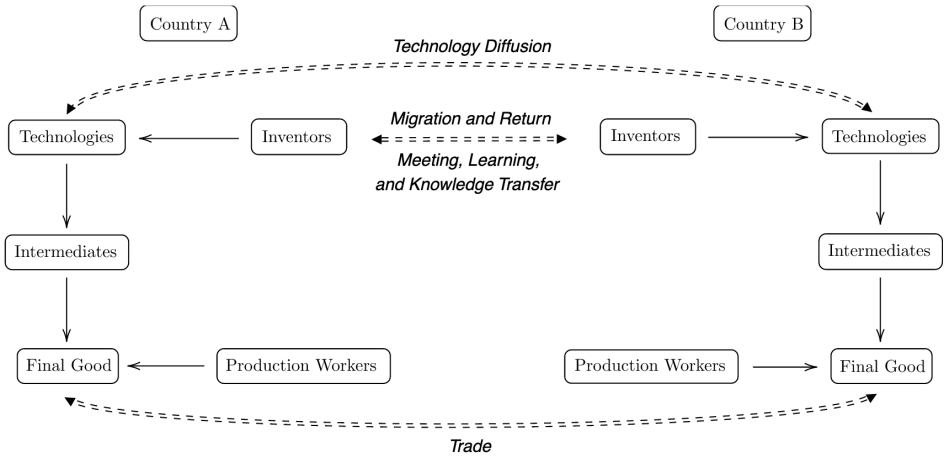
In Summary, Four Main Findings Motivate Model Design

1. EU has brain drain, US has brain gain
2. Migrants are more productive after migration
3. Migrant co-inventors are more productive after migration
4. Migrant interaction networks are more diverse after migration

Plan

Use Endogenous Growth Model with a Few Tweaks

Figure 1: Summary of the Model



Inventors: Inventors Are Heterogeneous on Two Dimensions

- Individual talent drawn from exogenous country-specific distribution: $z \in \tilde{\mathcal{F}}_c$, $c \in \{EU, US\}$.
  - By assumption, $\tilde{\mathcal{F}}_{EU} = \tilde{\mathcal{F}}_{US}$.
  - z is an endogenous process.

- Individuals also draw idiosyncratic, country-wide productivity differential ε from an exogenous, country-specific distribution.
  - E.g., talented auto engineers might be better suited for Mercedes-Benz than, ahem, Ford.
  - ε follows an exogenous, AR(1) process.

- Inventors produce ideas, q:

$$q(z, \varepsilon) = \begin{cases} z & \text{if local} \\ z + \varepsilon & \text{if migrant} \end{cases}$$

Inventors: Inventor Talent Evolves Via Learning

- Every period, with probability λ, an inventor has a meeting with another inventor.
  - By construction, meetings can only increase an inventor's talent
  - Talent increase is proportional to partner's production bundle $\tilde{q}$

- Inventors can meet with: locals, migrants from another country, or migrants from their country.
  - Introduce meeting frictions, i.e., locals more likely to meet locals

Inventors: Inventor Talent Evolves Via Learning

- Every period, with probability λ, an inventor has a meeting with another inventor.
  - By construction, meetings can only increase an inventor's talent
  - Talent increase is proportional to partner's production bundle $\tilde{q}$
- Inventors can meet with: locals, migrants from another country, or migrants from their country.
  - Introduce meeting frictions, i.e., locals more likely to meet locals
- Link back to 4 main findings:
  - Heterogeneity and learning $\Longrightarrow$ Brain Drain and increase in migrant production
  - Meeting frictions $\Longrightarrow$ networks more diverse following migration.

Intermediates: Two Ways to Improve Product Quality

- Intermediate goods improve when:
  1. Monopolists purchase technology q from inventors
  2. Monopolists in laggard economy (i.e., ε_c is lower) receive exogenous technology spillover from frontier economy

- Purchases: Monopolists matched in market to inventors $\Longrightarrow$ crowding out possible

- Spillover: spillover size is proportional to average quality difference between economies

Intermediates: Two Ways to Improve Product Quality

- Intermediate goods improve when:
  1. Monopolists purchase technology q from inventors
  2. Monopolists in laggard economy (i.e., ε_c is lower) receive exogenous technology spillover from frontier economy

- Purchases: Monopolists matched in market to inventors $\Longrightarrow$ crowding out possible

- Spillover: spillover size is proportional to average quality difference between economies

- Link back to 4 main findings:
  - Knowledge spillovers $\Longrightarrow$ co-migrants become more productive.

Migrant Maximizes Over Value of Staying and Value of Migrating

Value of Staying:

$$
\begin{aligned}
V_{EU,EU}(z,\varepsilon,t) = \\
&\pi_{EU}(z,t) \\
&+ \beta\delta \int_{-\infty}^{\infty} (\lambda \sum_{j} \psi_{EU,EU,j,t} \int_{1}^{\infty} (W_{EU,EU}(z\tilde{q}^{\eta}, \varepsilon', t+1)) dF_{j,t}(\tilde{q}) \\
&+ (1-\lambda) W_{EU,EU}(z, \varepsilon', t+1)) dv_{\varepsilon'|\varepsilon}
\end{aligned}
$$

Migrant Maximizes Over Value of Staying and Value of Migrating

$$V_{EU,EU}(z,\varepsilon,t) =$$
$$\pi_{EU}(z,t)$$
$$+ \beta\delta \int_{-\infty}^{\infty} (\lambda \sum_{j} \psi_{EU,EU,j,t} \int_{1}^{\infty} (W_{EU,EU}(z\tilde{q}^{\eta}, \varepsilon', t+1)) dF_{j,t}(\tilde{q})$$
$$+ (1-\lambda) W_{EU,EU}(z, \varepsilon', t+1)) dv_{\varepsilon'|\varepsilon}$$

Current period profits

Migrant Maximizes Over Value of Staying and Value of Migrating

$$V_{EU,EU}(z,\varepsilon,t) =$$
$$\pi_{EU}(z,t)$$
$$+\beta\delta\int_{-\infty}^{\infty}(\lambda\sum_{j}\psi_{EU,EU,j,t}\int_{1}^{\infty}(W_{EU,EU}(z\tilde{q}^{\eta},\varepsilon',t+1))dF_{j,t}(\tilde{q})$$
$$+(1-\lambda)W_{EU,EU}(z,\varepsilon',t+1))dv_{\varepsilon'|\varepsilon}$$

Continuation Value

Migrant Maximizes Over Value of Staying and Value of Migrating

$$
\begin{aligned}
V_{EU,EU}(z,\varepsilon,t) = & \\
& \pi_{EU}(z,t) \\
& + \beta\delta \int_{-\infty}^{\infty} (\lambda \sum_{j} \psi_{EU,EU,j,t} \int_{1}^{\infty} (W_{EU,EU}(z\tilde{q}^{\eta},\varepsilon',t+1)) dF_{j,t}(\tilde{q}) \\
& + (1-\lambda) W_{EU,EU}(z,\varepsilon',t+1)) dv_{\varepsilon'|\varepsilon}
\end{aligned}
$$

Successful meeting

Migrant Maximizes Over Value of Staying and Value of Migrating

$$V_{EU,EU}(z,\varepsilon,t) = \pi_{EU}(z,t) + \beta\delta \int_{-\infty}^{\infty} (\lambda \sum_{j} \psi_{EU,EU,j,t} \int_{1}^{\infty} (W_{EU,EU}(z\tilde{q}^{\eta},\varepsilon',t+1))dF_{j,t}(\tilde{q}) + (1-\lambda)W_{EU,EU}(z,\varepsilon',t+1))dv_{\varepsilon'|\varepsilon}$$

Choice of whether to migrate next period

Migrant Maximizes Over Value of Staying and Value of Migrating

Value of Migrating:

$$
\begin{aligned}
V_{EU,US}(z,\varepsilon,t) = \\
&\pi_{US}(z+\varepsilon,t) \\
&+\beta\delta\int_{-\infty}^{\infty}(\lambda\sum_{j}\psi_{EU,US,j,t}\int_{1}^{\infty}(W_{EU,US}(z\tilde{q}^{\eta},\varepsilon',t+1))dF_{j,t}(\tilde{q}) \\
&+(1-\lambda)W_{EU,US}(z,\varepsilon',t+1))dv_{\varepsilon'|\varepsilon}
\end{aligned}
$$

Profits include epsilon

Establish a Link Between Individual Migration Decisions and Aggregate Growth

Individuals

- Inventors maximize over value of staying, and value of going. Migration has a cost.
- When migrating, three things to consider:
  1. Higher TFP $\Longrightarrow$ higher inventor profits
  2. q (tech. bundle) is a function of ε
  3. Change in meeting frictions as immigrant, potential to make higher quality matches

Aggregates

- TFP is a function of quality of technology in a country.
- For laggard economy, knowledge spillover is proportional to TFP gap.
- Matches between intermediates and inventors can crowd out innovation by locals.

Plan

The Model Matches the Data Very Well

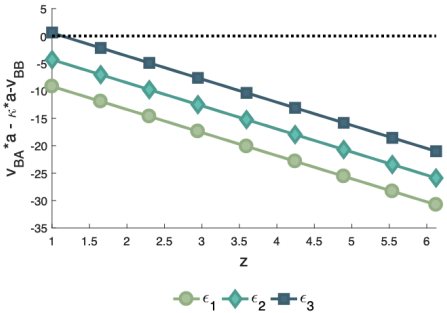
Table 6: Moments

Moment	**Data**	**Model**
Share Migrants EU-US	6.00	6.83
Share Migrants US-EU (% domestic inventors)	0.40	0.39
Share Return Migrants (% migrants)	0.13	0.10
Δ productivity migrants EU-US (%)	0.28	0.32
Δ productivity co-inventors of migrants EU (%)	0.17	0.16
Δ productivity co-inventors of migrants US (%)	0.19	0.18
Growth rate (%)	1.50	1.39
TFP gap	0.90	0.90

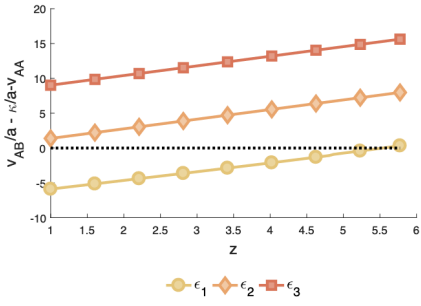
▸ Calibrated Moments

Value of Migration Much Higher for EU Locals

Value of Migration for US Locals



Value of Migration for EU Locals



▸ Data Compared to Event Study

Plan

Two Policy Scenarios to Replicate Real-World Policies

Tax Cuts

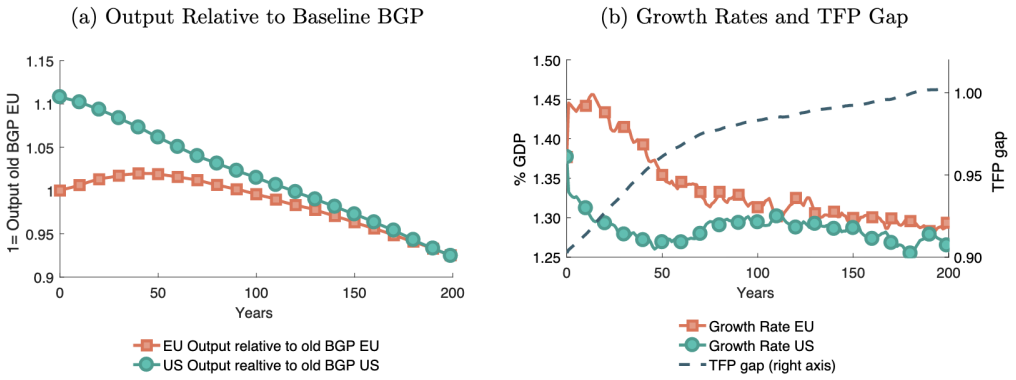
- Along BGP, EU has higher tax rates than US
- To stem brain drain, lower taxes for inventors to migrate and return home
- Eliminate tax gap between US and EU

Migration Caps

- Along BGP, US has baseline migration cap of 1%
- If demand for migration exceeds cap, lottery to determine who gets a spot
- US selects most talented individuals and doubles migrant cap

Tax Cuts to Reverse Brain Drain Equalize TFP at Cost of Total Output

Figure 13: Tax Cut for Foreigners and Return Migrants in the EU: Transitional Dynamics.

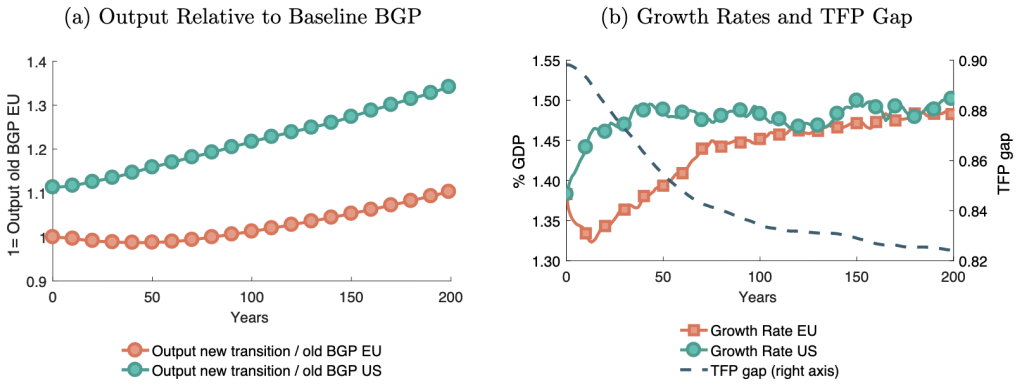


Fixing brain drain is hard

▸ Transition Dynamics

Reduced Migration Cap and Talent Selection Spurs Global Growth

Figure 17: Counterfactual Increase of US Migration Threshold: Transitional Dynamics.



Free markets rule!

▸ Transition Dynamics

Plan

Overview of Strengths of the Paper

- Relevant question
- Model with many layers and elements
- Empirics motivate model well

Strength: Relevance

The research question itself is interesting and important. Beyond that, this paper is also related to 6 strands of literature:

- Endogenous growth
- Human-capital-based growth
- Allocation of talent and relationship to growth
- Empirical study of knowledge diffusion
- Link between innovation, migration, and growth
- Effects of taxation on migration flows and innovation

Strength: Model

The model in this paper contains many layers:

- Innovation-based endogenous growth
- Heterogeneous agent
- Two countries setting
- Network of knowledge diffusion
- etc

which makes the analysis of effects of migration on various issues possible.

Strength: Model

Existing models

- either study only micro-level migration decisions, taking macro environments as given.
- or study only macro effects of immigration, taking migration flows as given.

This paper

- introduces endogenous migration in innovation-based growth model, allowing analysis of impact of policies.

Strength: Empirics

- The stylized facts motivate very well for a model
- Creative way of identifying country of origin
- Used micro-data to pinned down meeting frictions

Plan

Limitation: Mobility data

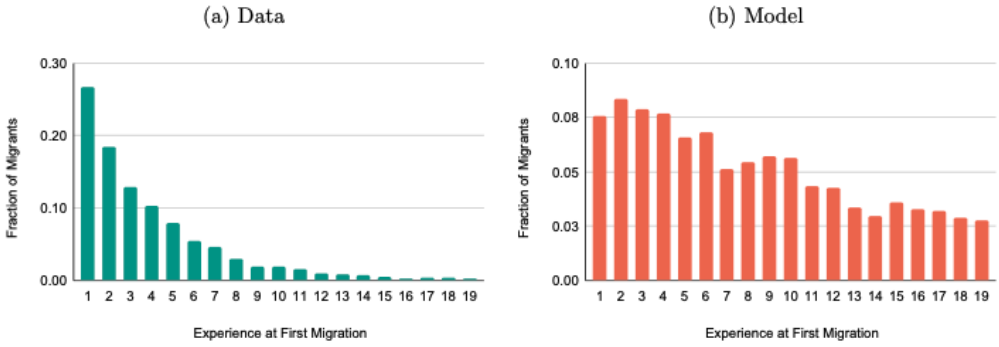
- No direct information on migration from patents
- Namsor (software that analyzes ethnic origin of names, via algorithmic search of administrative databases) used to return a likely country of origin
  - Approach might not distinguish foreign-born researchers and later generations of foreign researchers
- Empirical results that rely on individual flows depend on accuracy of software

Limitation: Patents

- Productivity or innovative output measured by number of patent applications
- Migrants can only be identified after at least one patent, but this excludes those who move before ever filing
- Also cannot track returns unless there are at least three patent applications
- Difficult to show any causal effects
  - Inventors move when they have a good draw of productivity
  - Not necessarily a causal effect of migration on innovative activity

Limitation: Experience at migration

Figure 9: Experience at First Migration: Data vs. Model

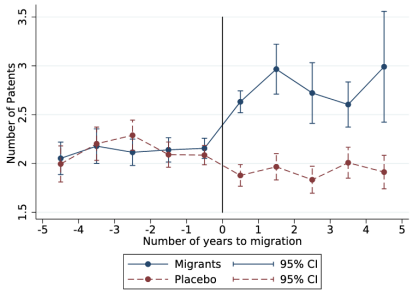


Limitations: Geographical differences

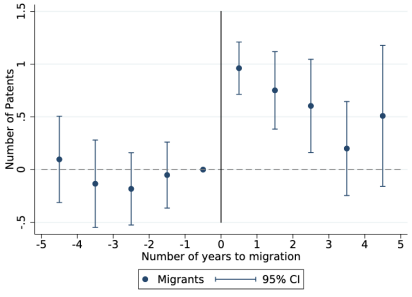
- Quantitative analysis starts from two countries with identical parameters and different policies
- There is room to include more country-specific heterogeneity; migration dynamics and knowledge spillovers could be very different
  - Country A is an emerging economy, country B is a developed economy
  - The countries have comparative advantages in different industries
- Would the results still be the same if we limited data to migrants moving between densely populated/urban areas?

OLS Supports Change In Behavior

(a) Raw Means

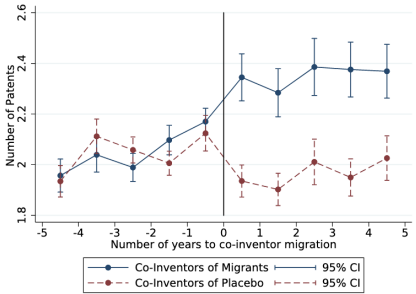


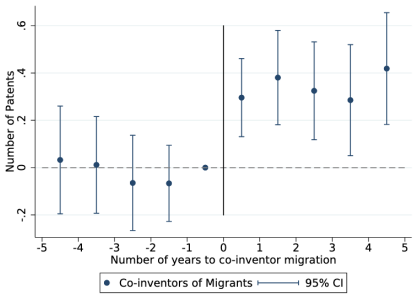
(b) Coefficients β_{τ}^{Mig} for migrants



Return

Co-Inventors Increase Patents After Migration Too





Return

Calibrated Moments

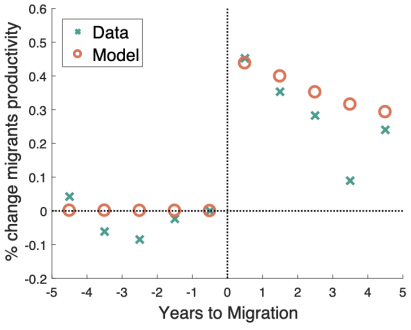
Table 5: Parameter Values

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
I_A	Share R&D workers	0.01
	— Panel B. Direct Match to Data —	
$\xi_{AB,AA}$	Meeting Frictions	1.31
$\xi_{AB,BB}$	Meeting Frictions	0.65
$\xi_{BB,AA}$	Meeting Frictions	0.06
$\xi_{BA,AA}$	Meeting Frictions	0.71
$\xi_{BA,AB}$	Meeting Frictions	0.32
$\xi_{BA,BB}$	Meeting Frictions	1.24
	— Panel C. SMM Calibration —	
$\bar{\mu}$	Migration cap to US (Share of Inventors)	0.01
κ	Cost of Migration	0.10
λ	Meeting Intensity HH	0.10
η	Learning Technology	0.34
σ	Technology Absorption	0.02
θ_A	Talent CDF H	15.00
ρ_A	Location Shock Persistence H	0.89
ω_A	Location Shock SD H	0.20

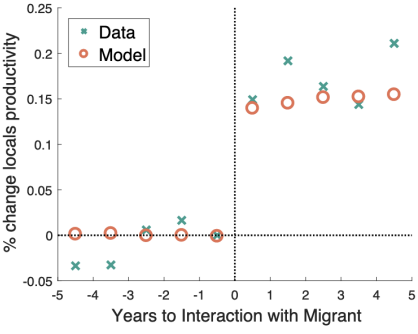
Return

Simulated Data Compared to Event Study

(a) Migrants around Time of Migration



(b) Locals around Interaction with Migrant

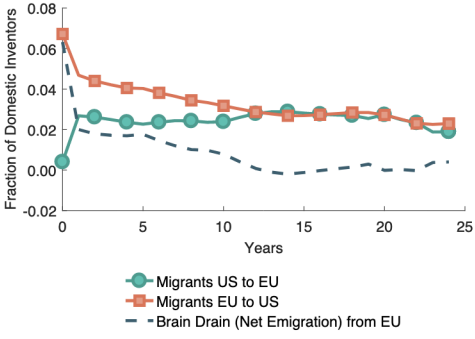


Return

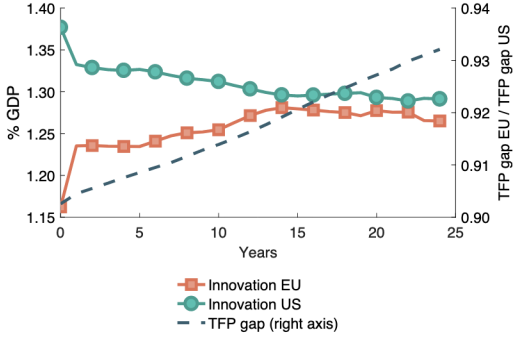
Tax Cut Transition Dynamics Look Better for EU

Figure 12: Tax Cut for Foreigners and Return Migrants in the EU: Transitional Dynamics.

(a) Migrant Inventors by Nationality



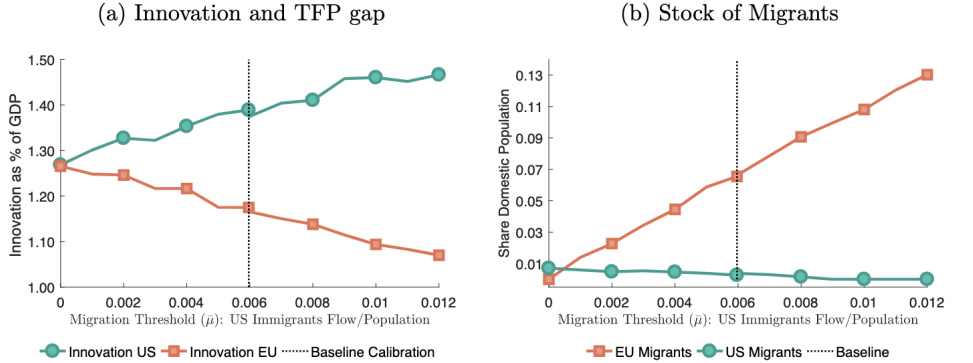
(b) Innovation and TFP gap



Return

Migration Limit Hurts US GDP Growth

Figure 14: Counterfactual Change to US Immigration Threshold ($\bar{\mu}$): BGP Comparison



Return