Time to Accumulate: The Great Migration and the Rise of the American South

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Motivation

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$\Rightarrow$ Propose **migration-induced labor scarcity** as a contributor to **structural change in the American South**, by analyzing **the American Great Migration**.

Motivation

- During the era of the Second Great Migration (1940-1970), millions of Black and White Southerners left the South.
- This period and after is also characterized by structural change and economic development in the South.
- The South's economic transformation contributed to the migration (Day, 1967; Boustan, 2016), but ...

Figure: Florida migrants on their way to New Jersey (1940).

This Paper

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Focusing on the Second Great Migration (1940-1970), I argue that

- large out-migration induced local capital deepening and capital-augmenting technical change,
- ... resulting in the subsequent structural change and non-agricultural development in the South.

This Paper: Overview

1. **Stylized model** with two factors of production: labor and capital.
   - Interpret the Great Migration using established theoretical results (macroeconomics and trade).
   - **Prediction:** Factor substitution and trade $\Rightarrow$ *Structural change.*

2. **Empirical analysis** tests the predictions.
   - Shift-share instrumental variable strategy (e.g., Derenoncourt 2022).
   - **Finding:** Greater exposure to Northern migration pull factors $\Rightarrow$ *Structural change, capital accumulation.*

3. Fully calibrated **quantitative model** in realistic geography.
   - Builds on dynamic spatial equilibrium frameworks.
   - **Contribution analysis:** Factor substitution $>$ trade

This Paper: Contribution

- **Development and Macroeconomics**:
  - Propose a new channel and related evidence on how out-migration can incentivize structural change (re-optimization of factor usages).
  - e.g., Bustos, Garber and Ponticelli (2020); Andersson, Karadja and Prawitz (2022); Dinkelman, Kumchulesi and Mariotti (Forthcoming)
    Migration and development | Structural change

- **Economic History**:
  - Offer an alternative perspective on how the Great Migration changed the American South.
  - e.g. Bateman and Weiss 1981; Wright 1986; Caselli and Coleman II 2001; Hornbeck and Naidu 2014 Great Migration | Development of the South

- **Spatial Economics**:
  - Builds a quantitative model featuring factor abundance and factor substitution with separate dynamics (migration and investment).
  - e.g., Eaton and Kortum (2002); Burstein and Vogel (2017); Kleinman, Liu and Redding (2023) Dynamic spatial equilibrium frameworks

Perspective - History

History: The South

- Even after the Civil War and slavery's abolition, the Southern labor market tended to be separated from the rest of the country ("The North"), especially until World War I and the 1920s border closure.

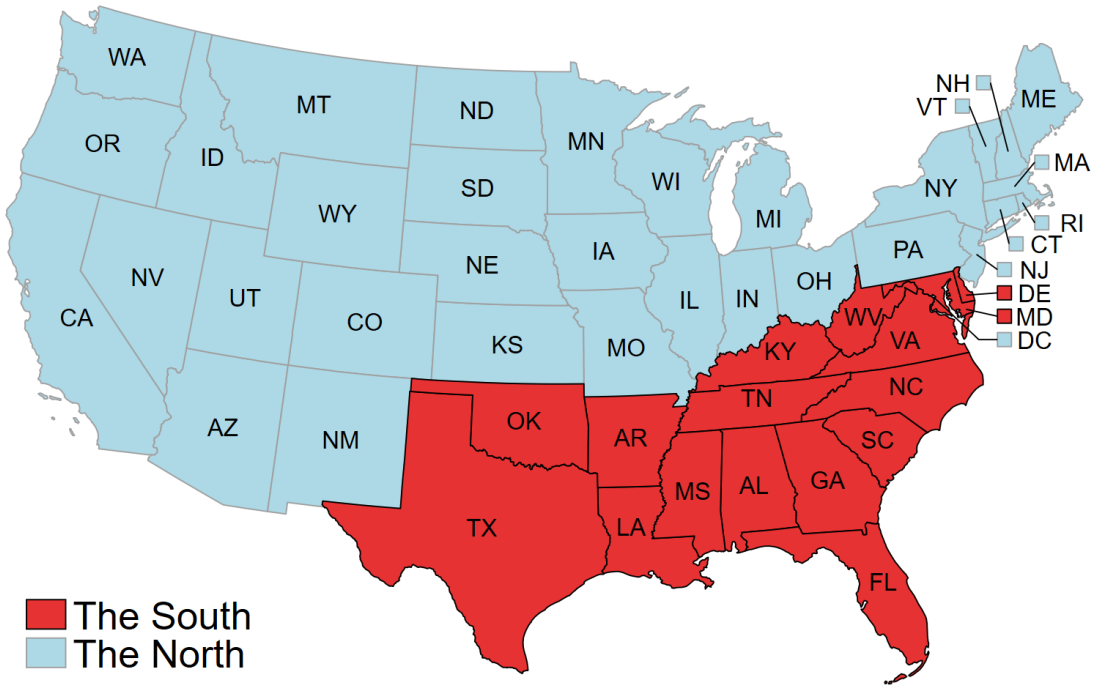


Figure: The American South (Analysis Sample).

History: The Migration

- Then, economic booms in the North attracted Southerners of all races, especially after World War II and until the 1960s.

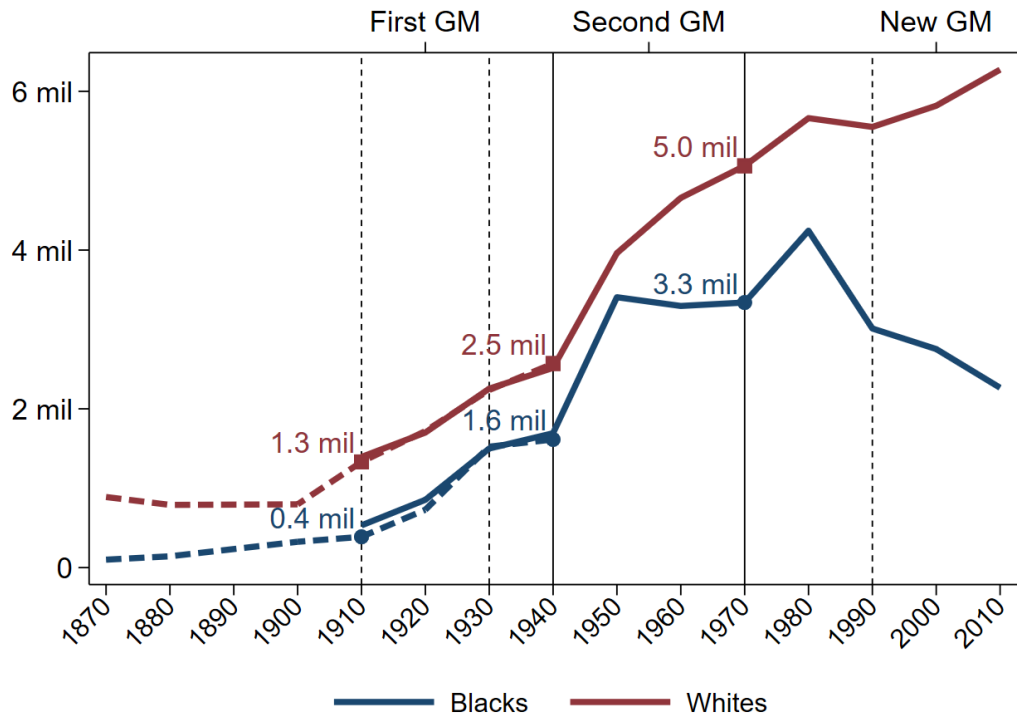


Figure: Southern-Born Population Living in the North, 1870-2010.

* Dashed lines from the Full-count Census. Straight lines from the IPUMS sample. Reproduced from Bazzi, Ferrara, Fiszbein, Pearson and Testa (2023).

Cf. International immigration

History: Structural Change

- Still in 1940, the South's economy lagged behind the North's.
- The South experienced a rapid structural change during the mid-20th century, as well as a catch-up in non-agricultural wages.

Trends in non-agricultural wages

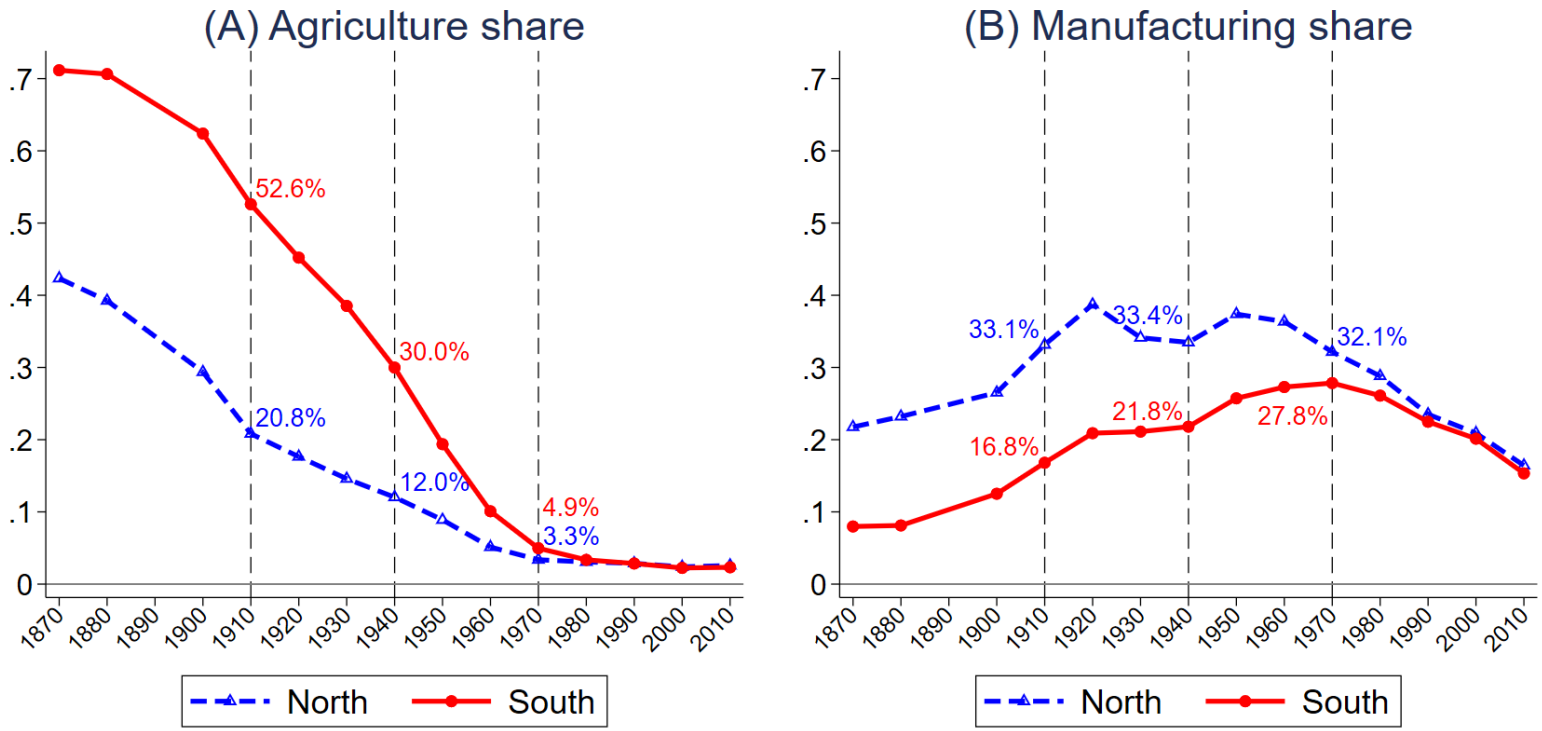


Figure: Employment share by region, 1870-2010.

History: Capital Accumulation

- ... accompanied by catch-ups in agricultural mechanization and manufacturing capital investment.

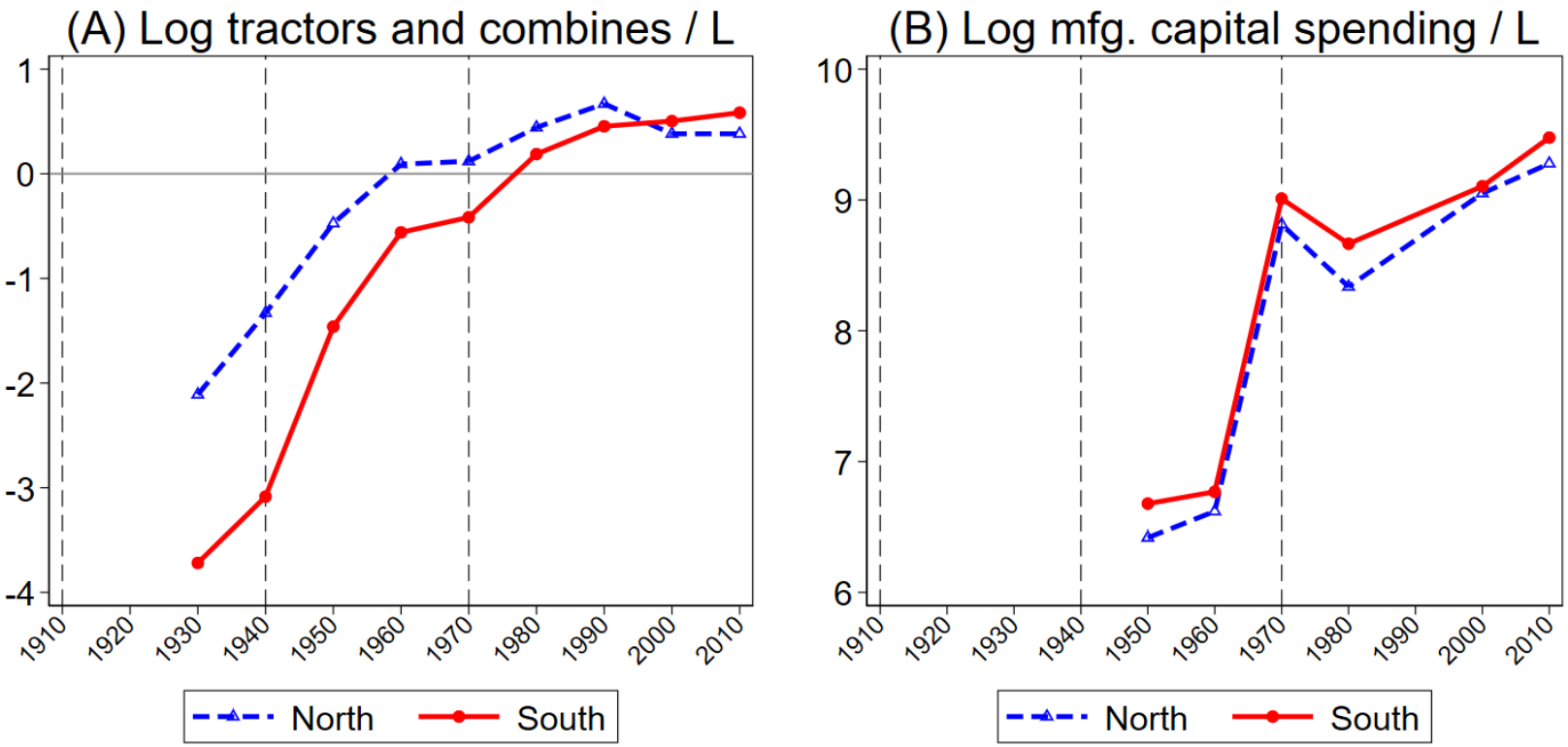


Figure: Capital investment by region, 1930-2010.

Perspective - Economics

Theory: Assumptions

The production function takes the constant elasticity of substitution (CES) structure using labor L and capital K:

$$Y = \left(\rho(Z_L L)^{\frac{\sigma-1}{\sigma}} + (1-\rho)(Z_K K)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

with factor-augmenting technologies Z_L and Z_K. The CES parameters govern the elasticity of substitution (σ) and production weight (ρ).

- **Assumption 1**: $\sigma^a > 1$ for agriculture but $\sigma^m < 1$ for non-agriculture.
  - Estimates from Herrendorf, Herrington and Valentinyi, 2015; Oberfield and Raval, 2021, among others.

  $\Rightarrow$ Factors are reallocated across sectors from a common shock.
- **Assumption 2**: The South is labor abundant, and agriculture is labor-intensive.
  - "Old South," as described in Bateman and Weiss, 1981; Whatley, 1985; Wright, 1986.

  $\Rightarrow$ Changes in factor endowment affect the regional specialization.

Theory: Factor Substitution

Mechanism 1 (Alvarez-Cuadrado, Van Long and Poschke, 2017).

- **Question**: How an economy adjust when the economy-wide capital-to-labor ratio, $k = K/L$, changes?

- Out-migration makes labor more scarce and more expensive ...
  - A flexible sector ($\sigma > 1$, agriculture) substitutes labor for capital more flexibly,
  - ... while inflexible sector ($\sigma < 1$, non-agriculture) absorbs labor.

  $\Rightarrow$ Structural change out of agriculture

- Formally, each sector's labor and capital share always takes an opposite direction to the changes in k.
  - The capital share in agriculture increases.

Mechanism 1 (formal statement)

Theory: Factor Substitution

		Factor substitution	Trade	Directed technical change	Summary
Labor:	agriculture	↓			
	non-agri.	↑			
Capital:	agriculture	↑			
	non-agri.	↓			
Output:	agriculture	-			
	non-agri.	-			

Table: Theoretical predictions on economic allocation.

Theory: The Role of Trade

- **Assumptions**:
  - U.S. as two "countries": the South and the North.
  - Agriculture is labor intensive.

$\Rightarrow$ The South has a comparative advantage in agriculture.

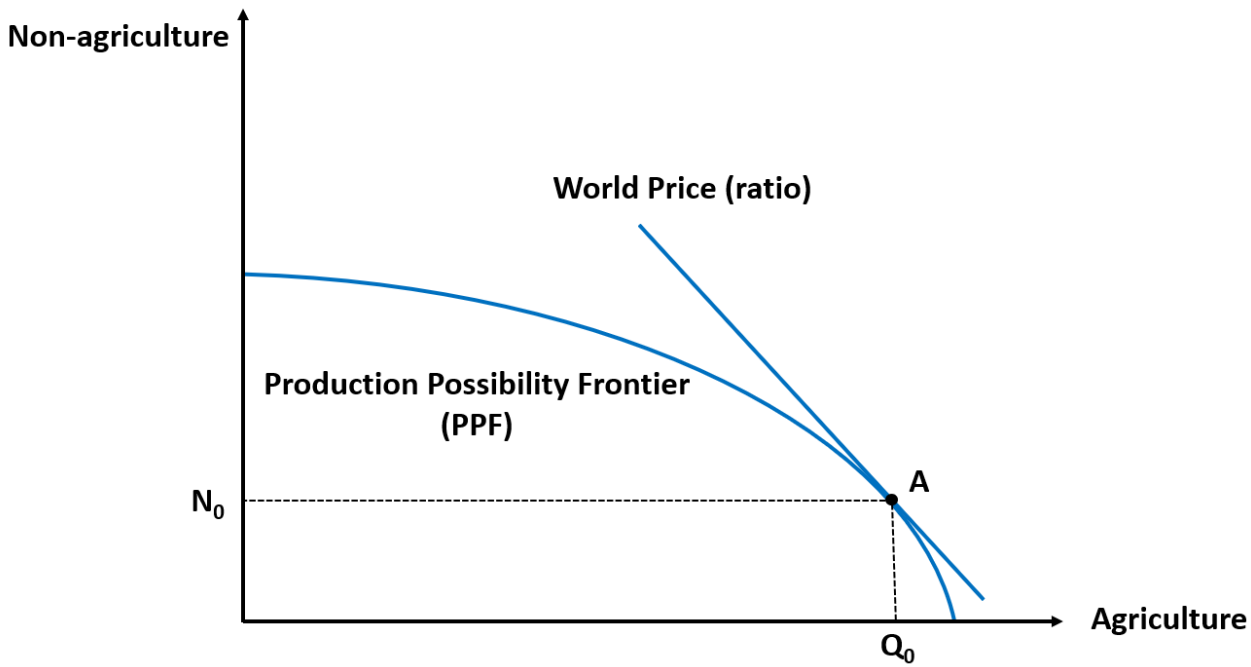


Figure: Basic Heckscher-Ohlin model.

Theory: The Role of Trade

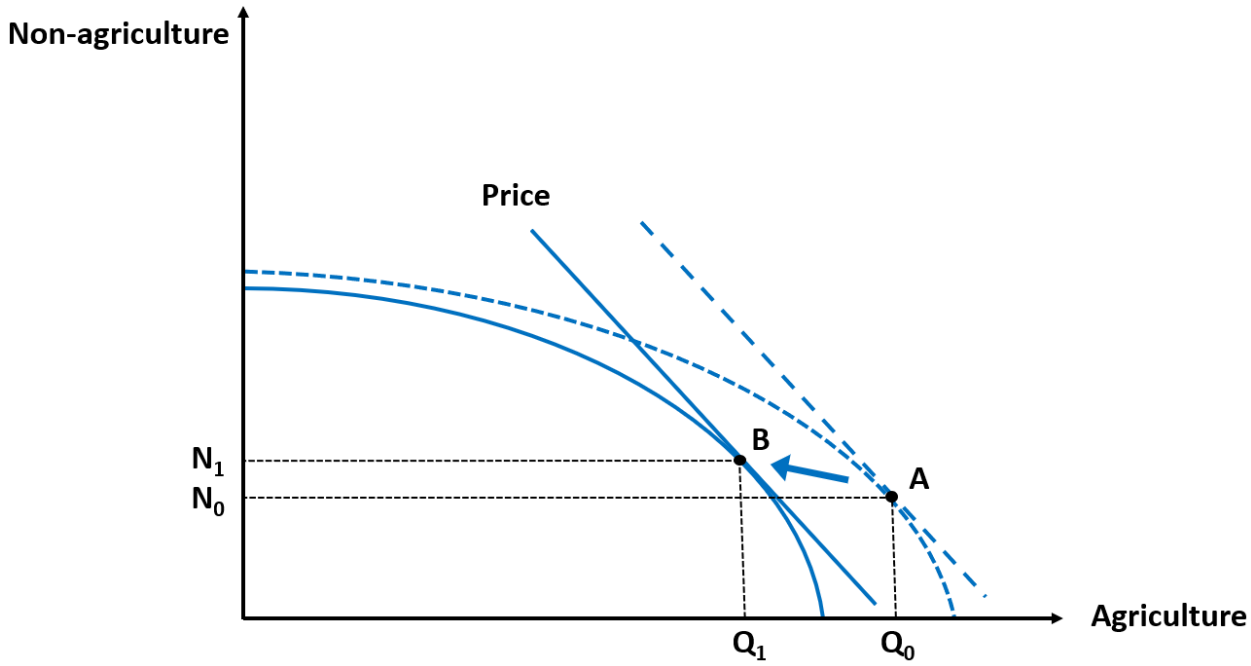


Figure: Rybczynski theorem (Rybczynski, 1955; Romalis, 2004).

- The decrease in the labor endowment in the South leads to
  - ... a relative contraction in agricultural production
  - ... but a relative increase in non-agricultural production.

Theory: The Role of Trade

		Factor substitution	Trade	Directed technical change	Summary
Labor:	agriculture	↓	↓		
	non-agri.	↑	↑		
Capital:	agriculture	↑	↓		
	non-agri.	↓	↑		
Output:	agriculture	-	↓		
	non-agri.	-	↑		

Table: Theoretical predictions on economic allocation.

Theory: Directed Technical Change

- With two factors of production, technical change can be biased toward a factor that becomes more abundant (when $\sigma \neq 1$, Acemoglu, 2002, 2007).
  - Market size effects ($\sigma > 1$) vs. price effect ($\sigma < 1$)

- Agriculture ($\sigma > 1$, substitutes):
  - Relatively less labor $\Rightarrow$ capital-augmenting/labor-augmenting $\uparrow$
- Non-agriculture ($\sigma < 1$, complements):
  - More labor $\Rightarrow$ capital-augmenting/labor-augmenting $\uparrow$

Formal remark

Theory: Directed Technical Change

		Factor substitution	Trade	Directed technical change	Summary
Labor:	agriculture	↓	↓	↓	
	non-agri.	↑	↑	↑	
Capital:	agriculture	↑	↓	-	
	non-agri.	↓	↑	-	
Output:	agriculture	-	↓	-	
	non-agri.	-	↑	-	

Table: Theoretical predictions on economic allocation.

Preview of Results

		Factor substitution	Trade	Directed technical change	Summary (share)	SSIV results (level)
Labor:	agriculture	↓	↓	↓	⇓	⇓
	non-agri.	↑	↑	↑	⇑	⇑
Capital:	agriculture	↑	↓	-	?	⇑
	non-agri.	↓	↑	-	?	⇑
Output:	agriculture	-	↓	-	⇓	-
	non-agri.	-	↑	-	⇑	⇑

- Empirical analysis tests the common and non-competing predictions and evaluates the competing predictions.
- Quantitative analysis assesses the contribution of each model element (factor substitution $>$ directed technical change $\approx$ trade adjustment).

Note on the second period, endogenous migration

Empirical Evidence

Data

- **Full-count Population Census** (Ruggles et al., 2024a,b).
  - Migration status and county-level characteristics.
  - Matched using the Census Tree approach (Buckles et al., 2023)
- **Census of Agriculture** (Haines et al., 2018).
  - Agricultural revenue; farm acre harvested; and more
  - Measures on capital: tractors and combines
- **Historical, Demographic, Economic, and Social Data: The United States, 1790-2002** (Haines et al., 2010).
  - Manufacturing value-added, employment, wages; and more
  - Measure on capital: manufacturing capital spending
- **Additional Datasets.**
  - County business pattern (Eckert et al., 2022; Census Bureau, 2023)
  - Net migration rates (ICPSR 4171, 8493, 26761, and 34638)
- **Sample**: 1,096 counties in 16 Southern states[1] between 1940-2010

[1] Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Empirical Strategy: A Primer

The equation estimates year-specific differences between counties with different levels of net out-migration rates (= −net migration rates):

$$Y_{c,t} = \beta_t \left(out\_mig\_rate^{1940-1970} \right)_c + \alpha_{s,t} + \alpha_c + \gamma X_{c,t} + \gamma_t X_c + \varepsilon_{c,t} \qquad (2)$$

- Fixed effects ($\alpha_{s,t}$ and α_c) and controls ($X_{c,t}$ and X_c).

✓ **Identification challenges**: Reverse causality and omitted variable

Empirical Strategy: A Primer

The equation estimates year-specific differences between counties with different levels of **Northern migration exposure (instrument)**:

$$Y_{c,t} = \beta_t \left(\widehat{Northern\_Exposure}^{1940-1970} \right)_c + \alpha_{s,t} + \alpha_c + \gamma X_{c,t} + \gamma_t X_c + \varepsilon_{c,t} \quad (2')$$

- Fixed effects ($\alpha_{s,t}$ and α_c) and controls ($X_{c,t}$ and X_c).

✓ **The excluded instrument measures the differential exposure to migration pull factors from the North.**

  - Shift-Share Instrumental Variable (SSIV) strategy: Combines predetermined share and predicted shift.
  - Follow the GM literature in the opposite direction in a reduced form. (e.g., Boustan 2010, Derenoncourt 2022, and Bazzi, Ferrara, Fiszbein, Pearson and Testa 2023)

Idea: Migration Push vs. Pull

The South	$\Rightarrow$	The North
Origin	$\Rightarrow$	Destination
(migration push)		(migration pull)

- **Goal**:
  - Use variations in out-migration explained by the 'Northern pull' ($\Rightarrow$ Excluded instrument)
  - ... and take into account the 'Southern push'. ($\Rightarrow$ Fixed effects and controls)

SSIV: Conceptual Framework

Pre-period migration share (1910-1940).

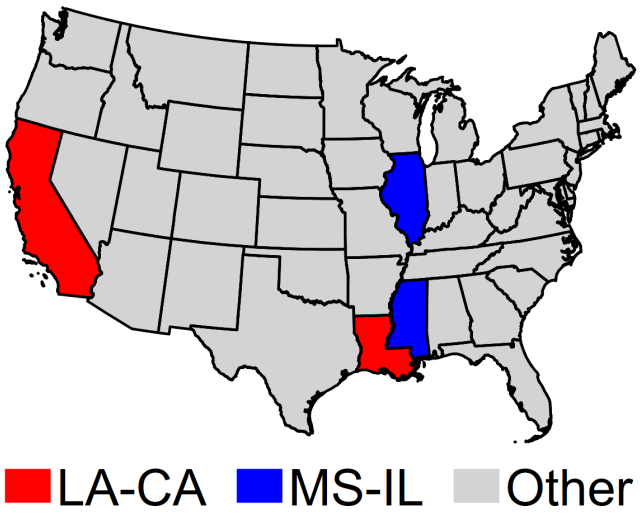


Figure: State-level migration pairs.

Sunset Limited Train | Illinois Central Railroad

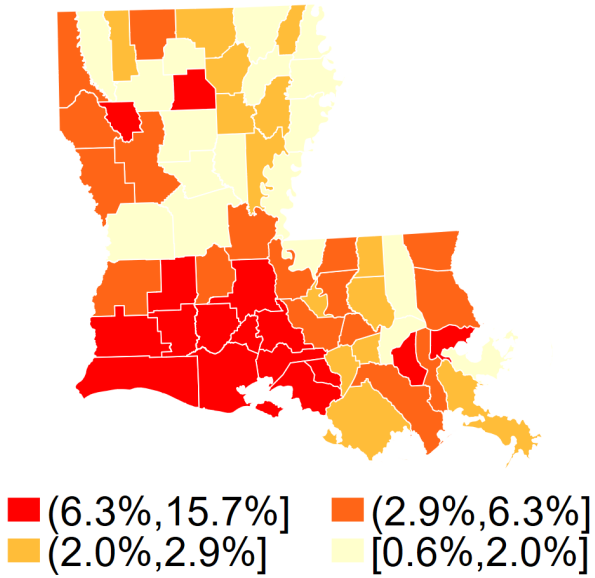


Figure: Louisiana to L.A. county (within-state variation in mig. share).

- Around 28% of out-of-South Louisianan migrants went to CA (17% to IL), while only 11% of Mississippian migrants went to CA (30% to IL).
- Capitalize on the empirical regularity known as "chain migration." (e.g., Stuart and Taylor 2021 for the GM)

SSIV: Conceptual Framework

- Assume that between 1910-1940, out-of-South migrants went to ...
  - County A: 66% to L.A. and 34% to Chicago
  - County B: 34% to L.A. and 66% to Chicago

  and L.A. is predicted to receive 3x more migration (1940-1970):
  - County A: $\underbrace{66\%}_{\textit{instrument}} \times \underbrace{3}_{\textit{weight}} + \underbrace{34\%}_{\textit{instrument}} \times \underbrace{1}_{\textit{weight}} = 2.32$
  - County B: $34\% \times 3 + 66\% \times 1 = 1.68$

  $\Rightarrow$ County A is 38% $(= 2.32/1.68 - 1)$ more exposed the Northern migration pull factors.

SSIV: Bolts and Nuts

- **Share**: Matched Census between 1910-1940 using the Census Tree approach (Buckles, Haws, Price and Wilbert, 2023).
  - Robustness: 1935-1940 migration matrix using 1940 Census
- **Shift**: OLS Prediction (1940-1970) with variables representing demographic,[2] economic,[3] and political environments.[4]
  - Robustness: Actual net migration rates (as in Card 2001) or machine learning prediction (random forest algorithm).
- Interpretation and statistical tests mainly follow the "share" view of SSIV (Goldsmith-Pinkham, Sorkin and Swift, 2020).

Formal terms | Zero stage table | Share v. Shift

[2] Log values of the total, Black, and White population, 1940 values of the share of foreigners, Black and White

[3] Urbanization, median income, median rents, total housing units, 1940 values of employment share and median occupational score

[4] Republican vote share of presidential elections

Empirical Strategy: Estimating Equation

$$Y_{c,t} = \beta_t \left(\widehat{Northern\_Exposure}^{1940-1970} \right)_c + \alpha_{s,t} + \alpha_c + \gamma X_{c,t} + \gamma_t X_c + \varepsilon_{c,t} \quad (3)$$

- State-by-year fixed effects, $\alpha_{s,t}$, and county fixed effects, α_c. The role of FE
- Time-varying control $\gamma X_{c,t}$: Contemporaneous log population and net migration rate.
- Control $\gamma_t X_c$: Time-interacted values of ...
  - (1) time-invariant county characteristics,
  - (2) pre-period out-migration rates (between 1910 and 1940),
  - (3) predicted out-migration rates (between 1940 and 1970, by racial),
  - (4) 1940 agriculture variables, and
  - (5) the changes in trade exposure (Japan shock).
  - (+) For agricultural outcomes, pre-period value in 1930.

  Detailed lists | Identification assumption
- Standard errors are clustered at the county level or at the 250 km-level (Conley, 1999).

Result: Migration (First stage)

Panel A. First-stage regression

	Net out-of-county out-migration rate (1940-1970)				
	(1)	(2)	**(3)**	(4)	(5)
Migration exposure (SSIV, 1std)	4.579***	7.098***	**3.726*** **	3.642***	4.841***
Clustered s.e. (county)	(1.270)	(1.538)	**(0.777)**	(0.842)	(1.036)
State fixed effect		Yes	**Yes**	Yes	Yes
Baseline controls			**Yes**	Yes	Yes
Adjacent counties' exposure control				Yes	
Squared and cubic terms control					Yes
First-stage F (Kleibergen-Paap robust F)	13.00	25.15	26.59	18.51	25.26

Panel B. Alternative first stage (migration linkage-corrected)

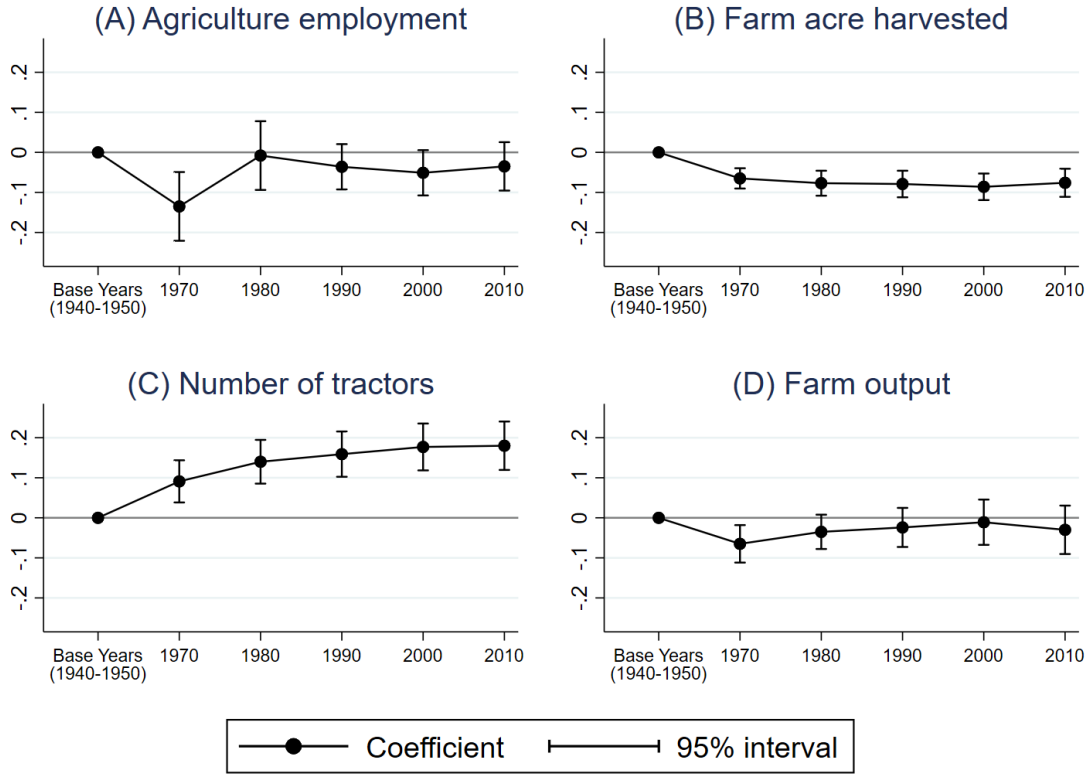
	Net out-of-county out-migration rate (1940-1970)				
	(1)	(2)	(3)	(4)	(5)
Linkage-corrected migration exposure (SSIV, 1std)	5.053	7.625**	3.777***	3.663***	4.582***
Clustered s.e. (county)	(3.704)	(3.289)	(0.663)	(0.636)	(0.874)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Unit of observation: county. Sample: 1,096 counties.

- One S.D. greater exposure to Northern pull factors induce 3.6%∼4.8% more out-of-county out-migration (Baseline = Panel A, Column 3).
- Robustness (Panel B): Correction for within-South migration linkages (Borusyak, Dix-Carneiro and Kovak, 2023).

First-stage scatter plot | Geographical distribution of the exposure measure | Identifying assumption

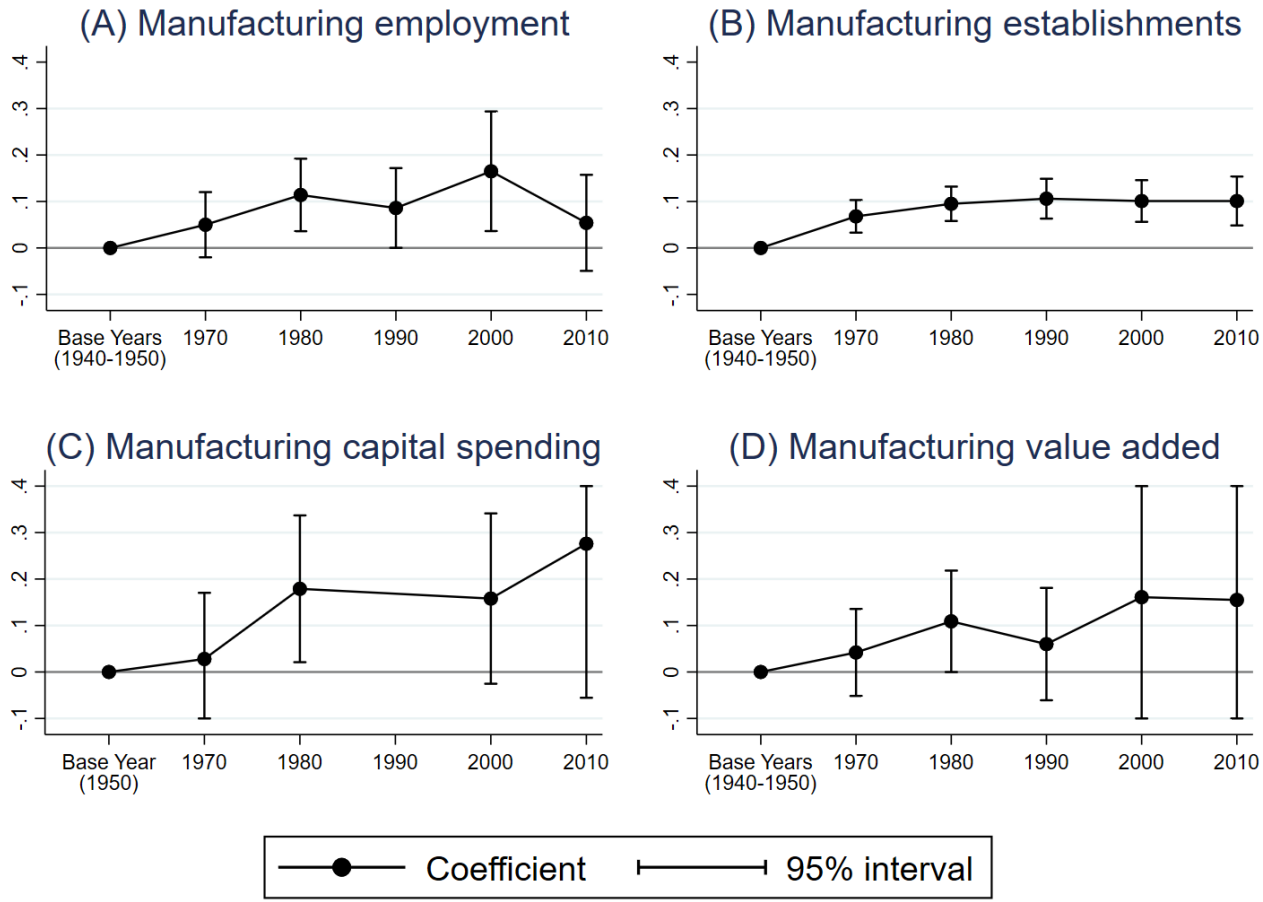
Result: Agriculture, SSIV reduced form.



- Agriculture substituted labor flexibly (released labor). Land harvested also decreased. Tractor usage continued to be increased (mechanization).
- Similar responses to shrinking labor supply from a natural disaster (Hornbeck and Naidu, 2014) or from changes in migration policy (Clemens, Lewis and Postel, 2018; Abramitzky, Ager, et al. 2023).

Table (agriculture)

Result: Manufacturing, SSIV reduced form.



- Inflexible sector (manufacturing) absorbed labor, and capital also increased, leading to increases in mfg VA & wages.
- Overall results are maintained and even grew at least until 2000 or 2010.

Result: Manufacturing, 1940-1950 vs. 1970-2010.

	(1) Manufacturing employment	(2) Manufacturing establishment	(3) Manufacturing capital spending	(4) Manufacturing value added	(5) Manufacturing annual payroll
(A) Out-migration rate (OLS, 1%)	-0.009***	-0.011***	-0.016***	-0.005***	-0.004**
Clustered s.e. (county)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
(B) Migration exposure (SSIV, 1std)	0.274***	0.192***	0.368***	0.402***	0.387***
Clustered s.e. (county)	(0.048)	(0.034)	(0.084)	(0.081)	(0.072)
(C) Migration exposure (SSIV, 1std)	0.086**	0.067***	0.214**	0.165**	0.189***
Clustered s.e. (county)	(0.039)	(0.022)	(0.087)	(0.073)	(0.060)
Fixed effects	Yes	Yes	Yes	Yes	Yes
(D) Migration exposure (SSIV, 1std)	0.082**	0.091***	0.136	0.086	0.154***
Clustered s.e. (county)	(0.038)	(0.018)	(0.088)	(0.072)	(0.057)
Conley s.e. (250km)	[0.026]	[0.013]	[0.069]	[0.048]	[0.049]
Fixed effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
R-squared	0.157	0.417	0.160	0.144	0.174
First-stage F	23.03	24.33	15.54	21.07	22.23
Counties	1,096	1,096	1,065	1,096	1,096

Unit of observation: county-year. All dependent variables are logged. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

- Opposite signs for OLS and SSIV (potential bias in OLS estimates)
- **Out-migration $\Rightarrow$ positive manufacturing development**.
  - Factor substitution and quasi-Rybczynski effect

Result: Wholesale and Retail, SSIV reduced form.

- The local non-tradable sector also grew in sales and employment.
- **Interpretation**: Labor-capital reallocation and local demand spillover

Result: 2SLS and Robustness

- **Summary**: Counties more exposed to migration experienced structural change out of agriculture and into manufacturing and consumer services. Employment share Education results
- **Second-stage estimates**: Scale the reduced-form estimates by the size of the migration response. First-stage migration response Second-stage results
- **Robustness checks**
  - Pretrend tests 1920-1930 outcomes
  - Overidentification tests 1910-1940 share vs. 1935-1940 share
  - Falsification tests using public sector outcomes Falsification
  - Placebo tests Shuffled treatment Random share Random shift
  - Alternative specifications: Overview of alternatives

Quantitative Evidence

Quantitative Framework

Road to the quantitative model: Complications.

The model elements are generalized to multiple industries, multiple regions (U.S. states), and multiple periods (1940-2010, decadal interval).

- Add structural change on the demand side (non-homothetic preferences).
  - Income level $\uparrow \Rightarrow$ Total outputs share on non-agriculture $\uparrow$
- Separate non-agriculture into ...
  - Tradable (manufacturing + producer services)
  - Non-tradable sectors (local services)
- Two types of agents supply each factor:
  - Workers for labor
  - Capitalists for capital

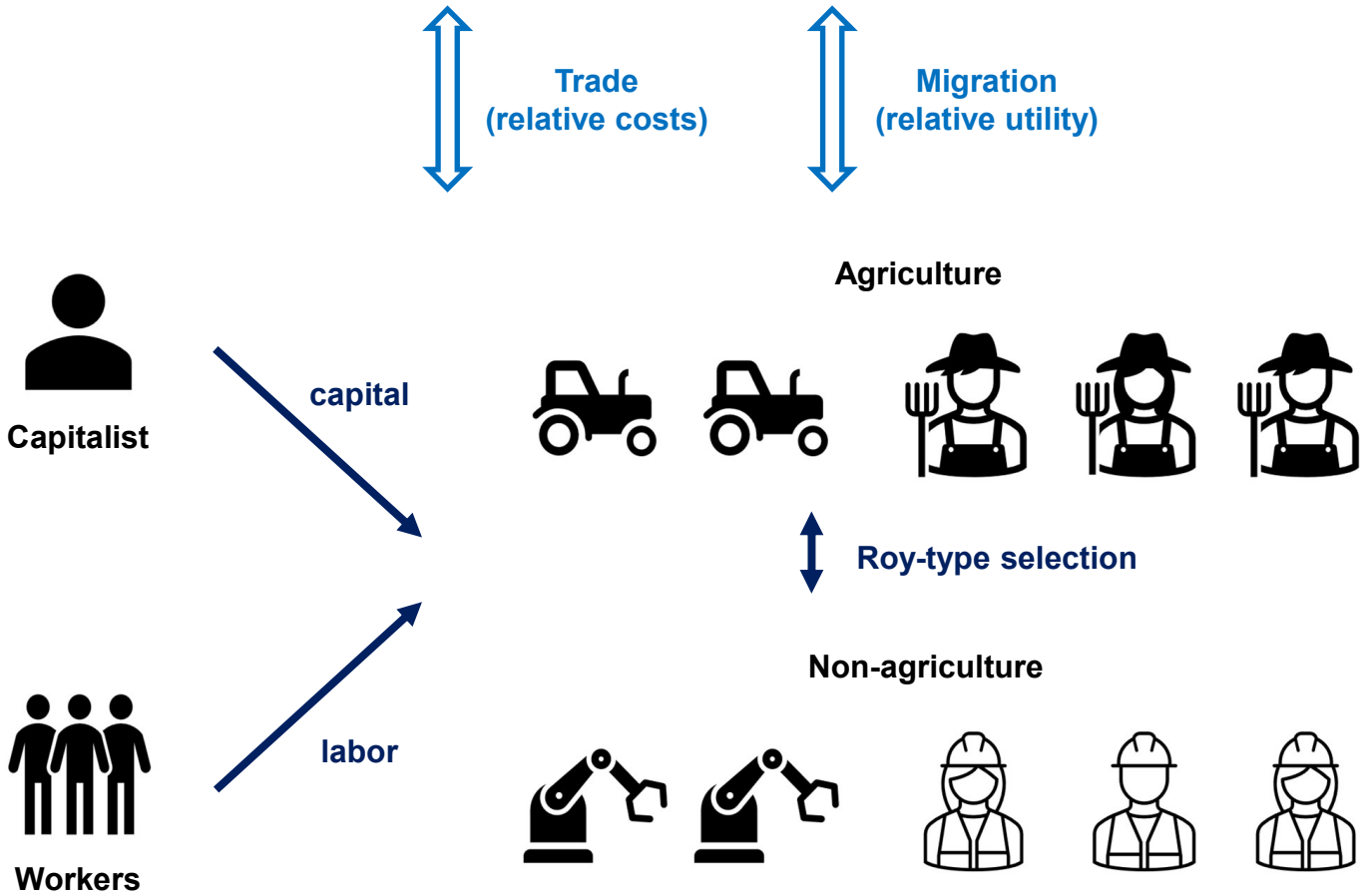
Quantitative Framework

Road to the quantitative model: Simplifications.

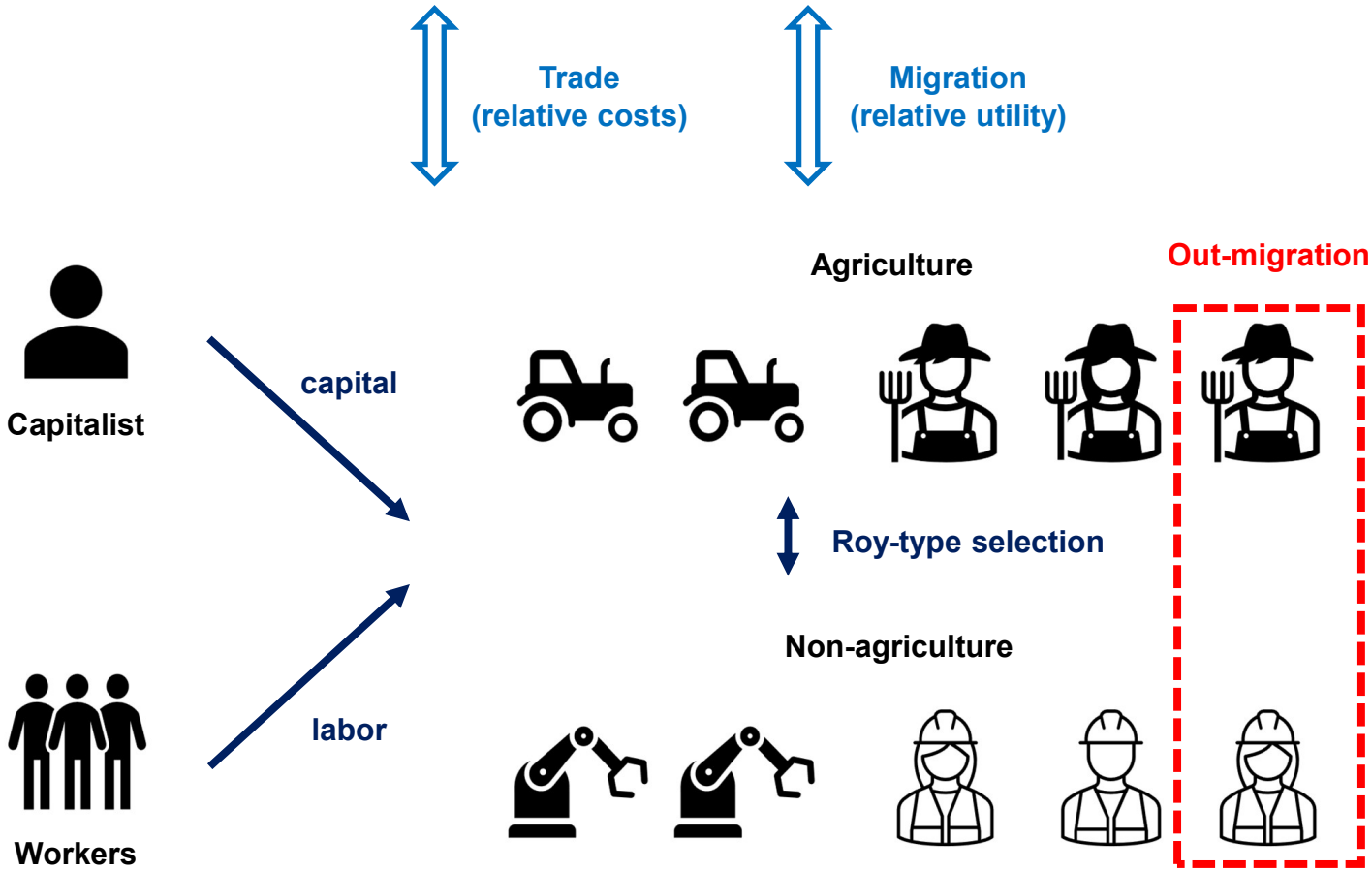
- Extreme value distributions for trade and migration.
  - $\Rightarrow$ Analytical gravity structure ($\sim$ McFadden 1974 logit model)
- Separate dynamics:
  - Migration decision by workers (but they live hand to mouth)
  - Investment by capitalists (but they are immobile as in Kleinman, Liu and Redding 2023)
- Dynamic exact hat-algebra (Caliendo, Dvorkin and Parro, 2019)
  - Focus on the portions that are (assumed to be) affected by the Great Migration.

Model features Model parameters

Quantitative Framework: Overview

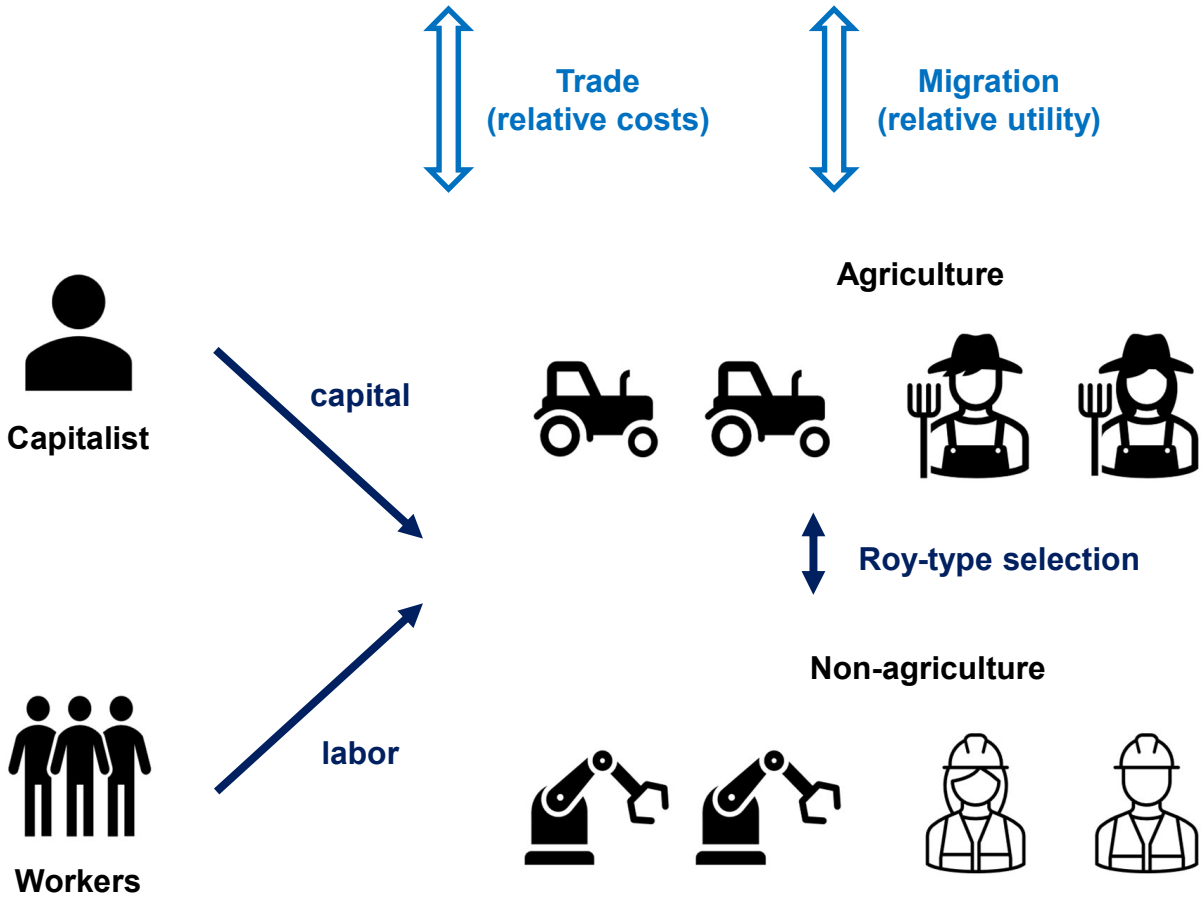


Quantitative Framework: Mechanism

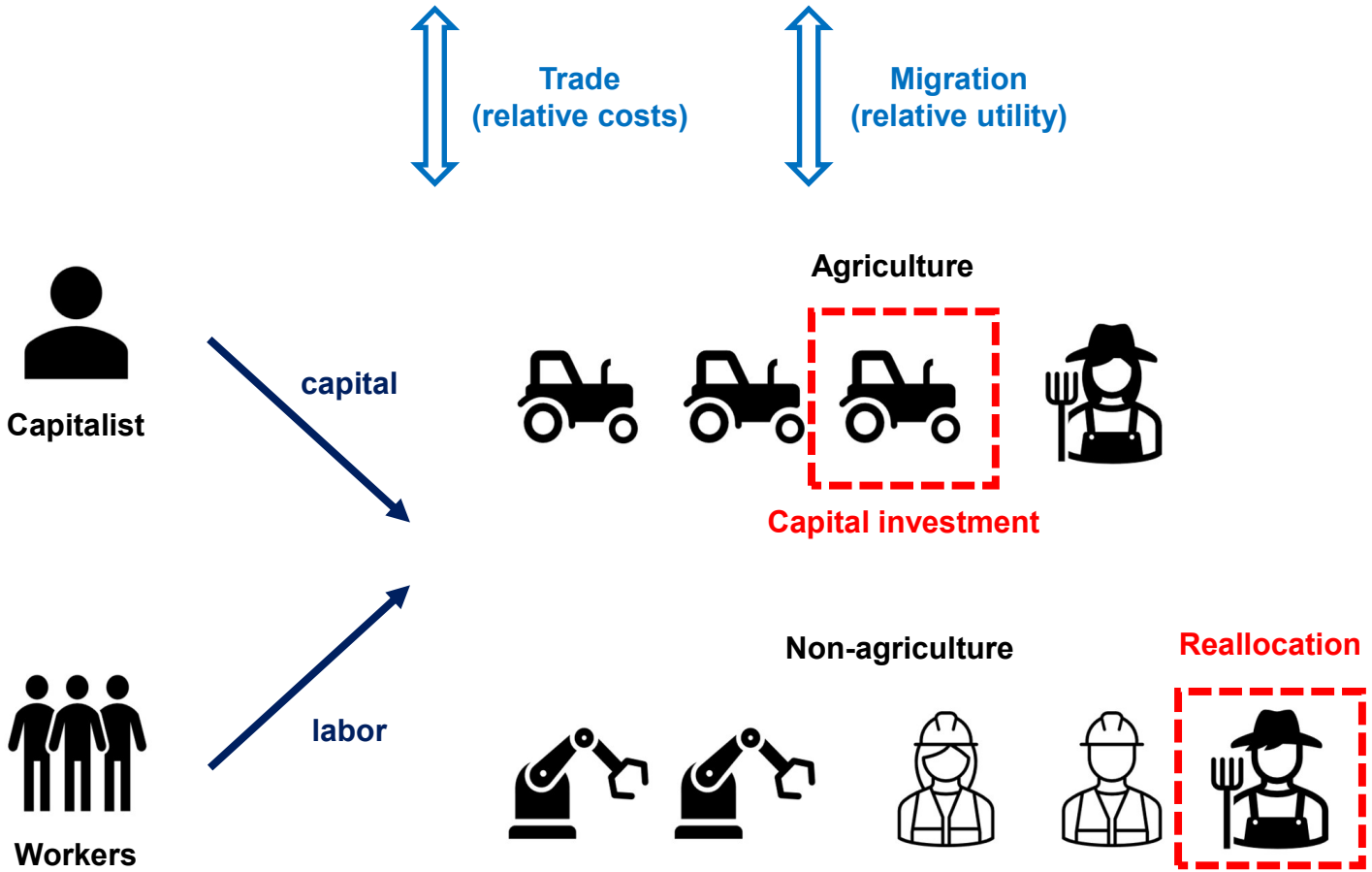


Migrants selection (1910-1930) Migrants selection (1940-1950)

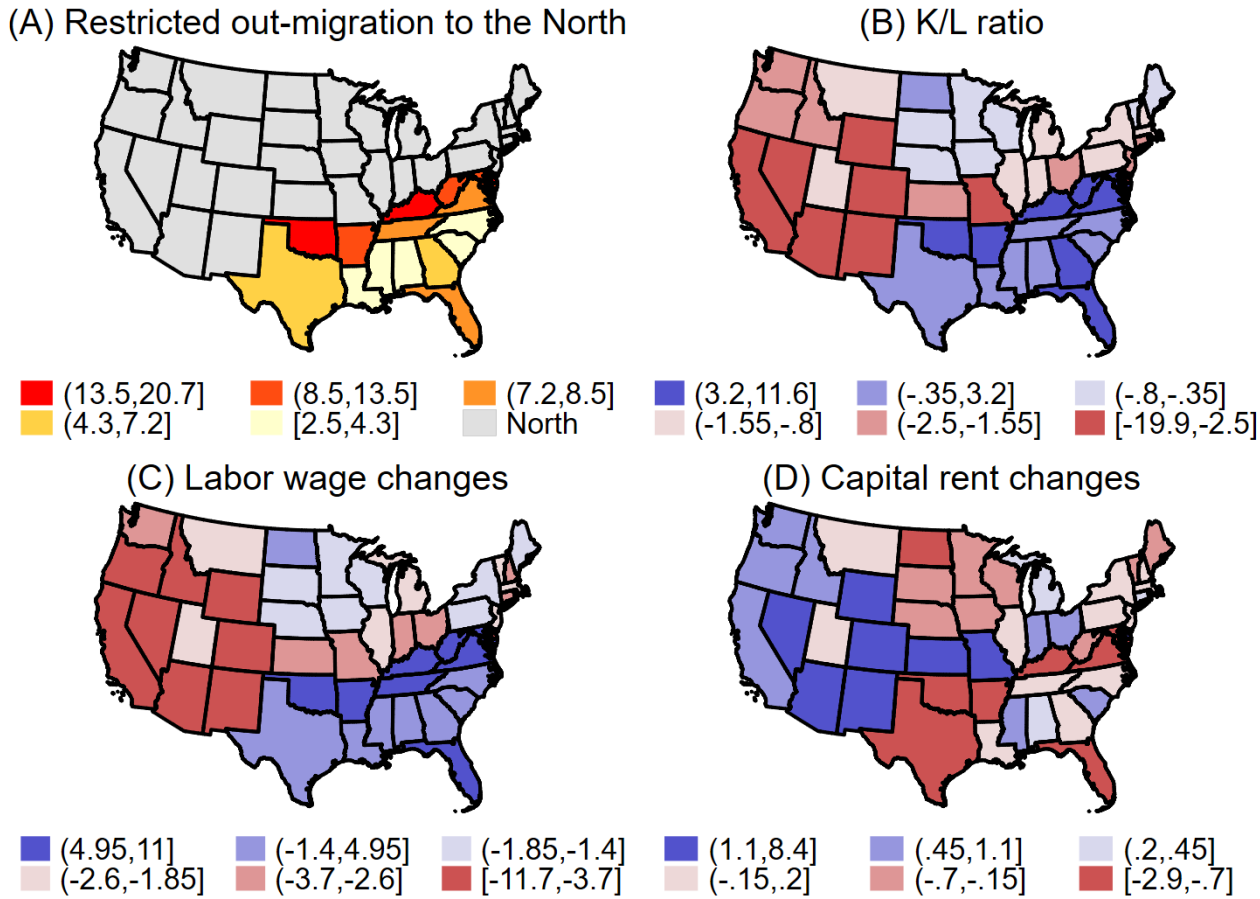
Quantitative Framework: Mechanism



Quantitative Framework: Mechanism



Result: Shock and Outcomes



- **Shock**: No migration from the South to the North (1940-1970)
- Model outcomes in 1970: Panels B to D.
  - The Southern states increased capital relative to labor.

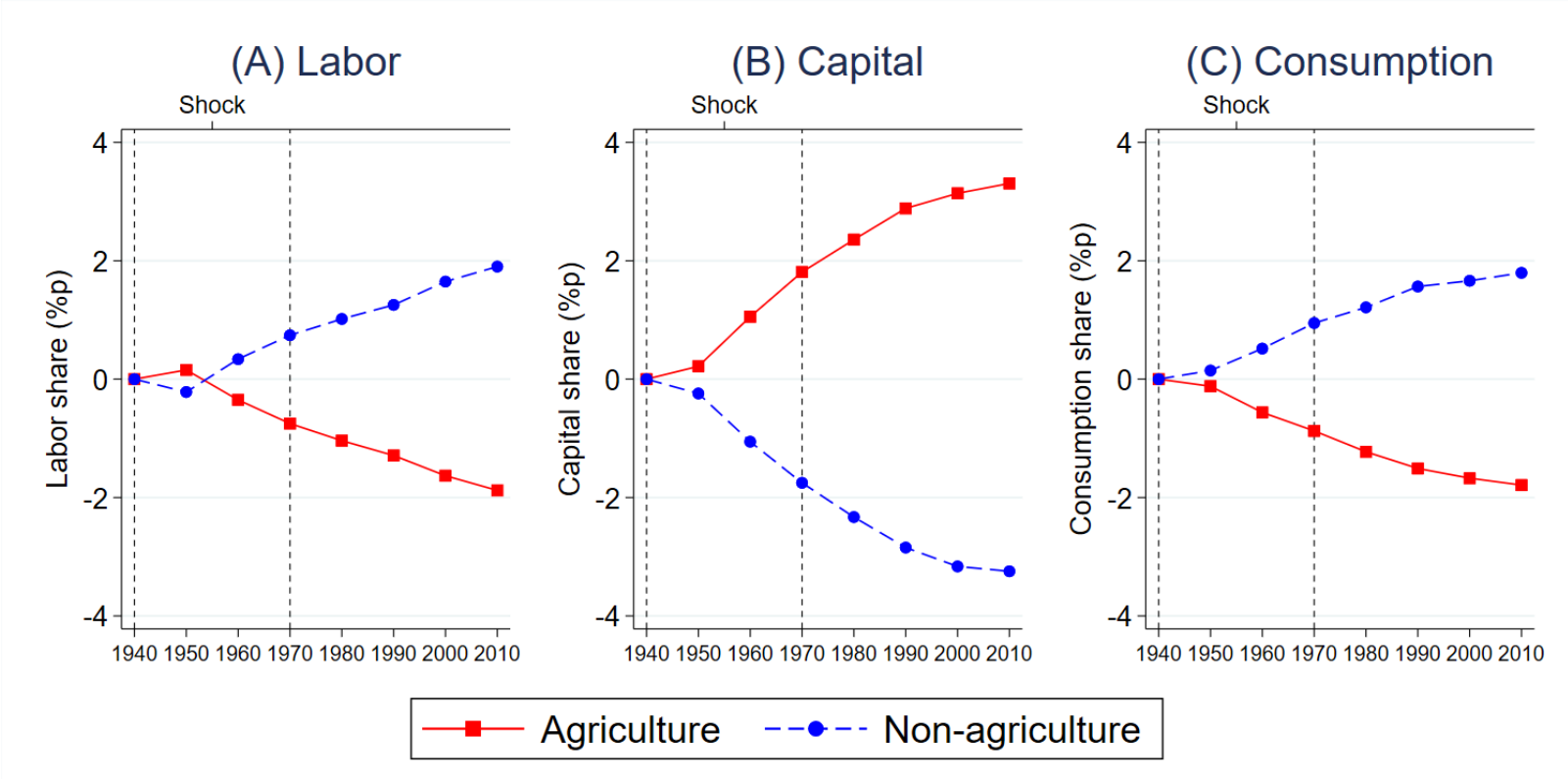
Result: Consumption Welfare

	(1) Baseline results	(2) No factor substitution	(3) No trade adjustment	(4) No directed technical change	(5) Without all adjustments
A. Consumption welfare effect	+0.66%	-1.86%	0.18%	-0.09%	-2.94%
B. Contribution of each channel	-	[69.8%]	[12.8%]	[20.4%]	[100%]

Table: Welfare effect and the contribution of each model element.

- The GM increased the United States consumption welfare by 0.66% per capita by 1970 (South: +3.2%, North: -0.4%).
- **Contribution analysis**: Columns 2-5
  - Compare the difference between the welfare effects of the full model and a constrained version by turning off each model component.
  - Labor-capital substitution played a leading role.
  - Capital-biased technical change and the trade adjustment played important supplementary roles.

Result: Economic Allocation in the South



- The economic adjustments to the GM decreased agricultural employment share by around 2 p.p. in the South.
- ... which could have contributed to around 7% of the total decrease during the study period.

Conclusion

- The Great Migration (out-migration) induced structural change and economic advancement in the American South.
  - Factor substitution most important

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Conclusion

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✓ **The American South's experience holds lessons even today.**

1. Still high share of employment in labor-intensive agriculture in rural areas in developing countries.
   - Out-migration may reduce spatial misallocation of factors.
2. Potential applications to other settings.
   - Low birth rates $\Rightarrow$ structural change within non-agriculture (more substitutable sector to complementary sector).
   - Sudden decreases in low-skilled labor $\Rightarrow$ responses depending on the substitutability across skill groups and capital (e.g., manufacturing will contract if low-skilled workers are more complementary to high-skilled and capital).

Thank You!

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Related Literature: Migration and Development

- The influences of out-migration on origin through ...
  - Labor market upgrading (Akram, Chowdhury and Mobarak, 2018),
  - Output mix adjustments (Lafortune, Tessada and González-Velosa, 2015),
  - Directed technological change (Andersson et al., 2022; San, 2023),
  - Labor/capital substitution (Hornbeck and Naidu, 2014; Clemens, Lewis and Postel, 2018; Abramitzky, Ager, Boustan, Cohen and Hansen, 2023),
  - Human capital investment (Theoharides, 2018; Caballero, Cadena and Kovak, 2023), and
  - Trade integration (Egger, Faber, Li and Lin, 2024).
- Promoting rural out-migration may help correct spatial misallocation of labor and capital.
  - Banerjee and Duflo (2005); Hsieh and Klenow (2009); Adamopoulos and Restuccia (2014); Gollin, Lagakos and Waugh (2014)

Contribution main page

Related Literature: Empirical Macroeconomics

- Theoretical results that focus on the role of physical capital:
  - Acemoglu and Guerrieri (2008); Alvarez-Cuadrado, Van Long and Poschke (2017); Alonso-Carrera and Raurich (2018); Caunedo and Keller (2024)
- Empirical evidence on the structural change mechanism:
  - Michaels, Rauch and Redding (2012); Fajgelbaum and Redding (2018); Bustos, Garber and Ponticelli (2020); Dinkelman, Kumchulesi and Mariotti (Forthcoming)
- e.g., Bustos et al. (2020) show that capital accumulation from agricultural productivity improvement led to structural change in Brazil (capital supply channel).

$\Rightarrow$ This paper emphasizes the role of capital demand from the factor substitution channel.

Contribution main page

Related Literature: Economic History

- **Great Migration**: This significant internal migration has impacted both the migrants and the regions where they have settled.
  - Kirby (1983); Boustan (2010); Black, Sanders, Taylor and Taylor (2015); Collins and Wanamaker (2014, 2015); Derenoncourt (2022); Bazzi, Ferrara, Fiszbein, Pearson and Testa (2023)
- **Southern development**: Many factors contributed to the rapid development of the South during the 20th Century.
  - Agricultural productivity growth and mechanization (Whatley, 1985; Olmstead and Rhode, 2001), health policy (Bleakley, 2007), education (Caselli and Coleman II, 2001), public investment (Depew, Fishback and Rhode, 2013; Kline and Moretti, 2014), ...
  - The South's economic transformation also contributed to the Great Migration (Day, 1967; Grove and Heinicke, 2003; Boustan, 2016).
- e.g., Hornbeck and Naidu (2014): Impacts of the Great Mississippi Flood of 1927 on subsequent Black out-migration and agricultural mechanization until 1970.

$\Rightarrow$ This paper focuses on structural change and non-agricultural development in the post-war South.

Contribution main page

Related Literature: Dynamic Spatial Frameworks

- Compared to the existing quantitative framework that features Heckscher-Ohlin forces,
  - e.g., Chor (2010); Caron, Fally and Markusen (2014); Burstein and Vogel (2017)
- I incorporate recent innovations in modeling ...
  - Migration dynamics (Artuc, Chaudhuri and McLaren, 2010; Caliendo, Dvorkin and Parro, 2019)
  - Capital investment (Kleinman, Liu and Redding, 2023), and
  - Structural change (Fan, Peters and Zilibotti, 2023).

Contribution main page

History: International Immigration

- Between the 1920s border closure and the 1965 Immigration and Nationality Act (Hart-Celler), international immigration to the U.S. was largely restricted by the national quota system.
- Still, labor demand in Northern and Western states remained high (Abramitzky, Ager, Boustan, Cohen and Hansen, 2023).

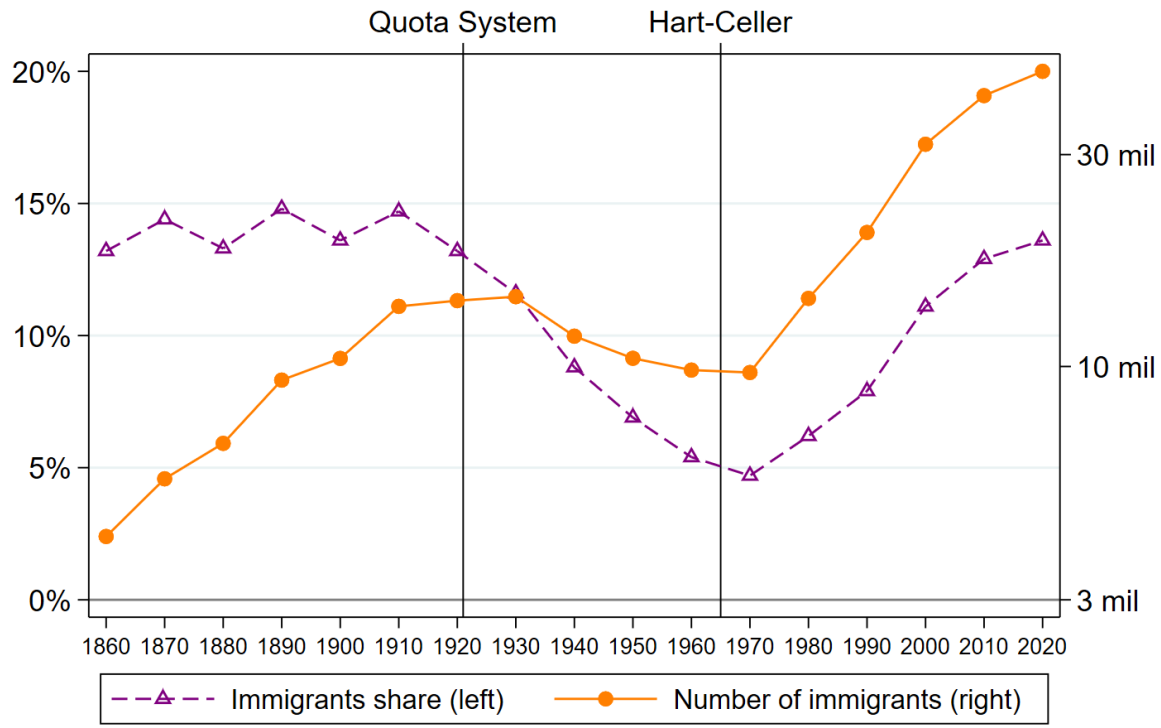
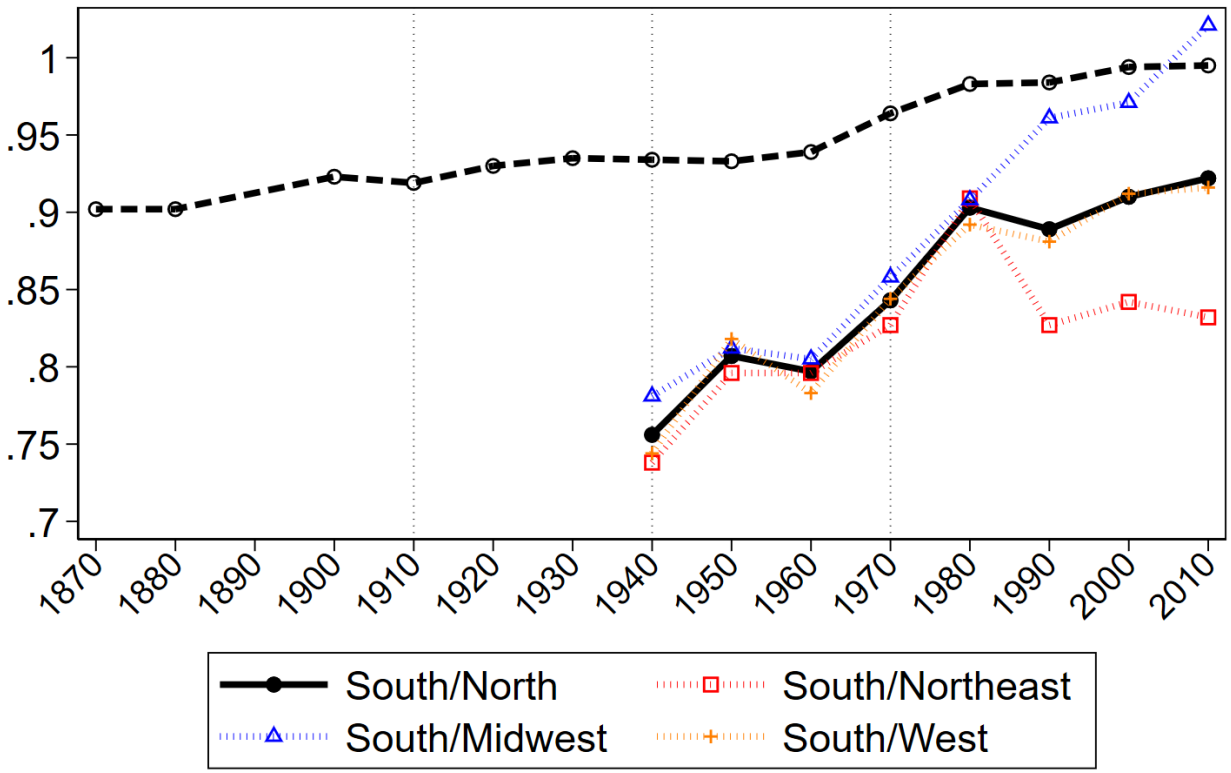


Figure A1: U.S. Immigrant Population and Share, 1860-Present.

History: Wage Convergence

- At the same time, the South caught up with the North in non-agricultural wages (labor price), especially until 1980.



* Straight line: recorded wage. Dashed line: occupational score (1950 median).

Figure A2: Non-agricultural wage ratio by region, 1940-2010.

History: structural change

Theory: Factor Substitution

- **Question**: How an economy adjust when the economy-wide capital-to-labor ratio, $k = K/L$, changes?

- **Main focus**: Factor allocation across sectors
  - Share of capital allocated to agriculture, $\kappa^A = K^A/(K^A + K^M)$
  - Labor share of agriculture, $\lambda^A = L^A/(L^A + L^M)$
  - For tractability, think of a case where $\sigma^s = 1$ for non-agriculture.
  - Both factors are fully employed and perfectly mobile across sectors.

Theory: Factor Substitution

Prediction 1 (Factor substitution)

As the economy-wide capital-labor ratio, k, increases, the fraction of capital allocated to the more flexible sector (agriculture) increases, while the fraction of labor decreases. In particular,

$$\frac{\partial \kappa^A}{\partial k} = \frac{(1-\sigma)}{\sigma G(\kappa^A) k} > 0$$

$$\frac{\partial \lambda^A}{\partial k} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{\lambda(\kappa^A)}{\kappa^A}\right)^2 \frac{\sigma - 1}{\sigma G(\kappa^A) k} < 0.$$

where $G(\kappa^A) \equiv \left[\frac{1}{\sigma(1-\lambda(\kappa^A))} + \frac{1}{\lambda(\kappa^A)}\right]\left(\frac{\lambda(\kappa^A)}{\kappa^A}\right)\left(\frac{\alpha}{1-\alpha}\right) + \left[\frac{1}{\kappa^A} + \frac{1}{\sigma(1-\kappa^A)}\right]$.

- Out-migration and resulting relative labor scarcity would lead to an increase in capital allocated to agriculture,
- ... while also inducing structural change out of agriculture.

Go back

Theory: Directed Technical Change

Remark 1

Direction of the technical change (Hicks, 1932; Acemoglu, 2002, 2007)

Assuming that the South can optimize its levels of technology, the direction of technical change would exhibit weak equilibrium bias as follows:

$$\frac{d(Z_K^{s\prime}/Z_L^{s\prime})^{\frac{\sigma^s-1}{\sigma^s}}}{d(K^s/L^s)} > 0, \tag{A1}$$

where $a \equiv Z_K/Z_L$ represents the relative level of capital- to labor-augmenting technology.

Example: *Learning-by-doing (Arrow, 1962; Atkinson and Stiglitz, 1969), Directed research and development (Kennedy, 1964; Acemoglu, 2002), Capital-embodied technical change (Mokyr, 1990; Jones and Liu, 2024)*

Go back

Endogenous Migration (Second Period)

- In the view of the standard migration settings (e.g. Rosen-Roback), the wage increases raise the value of living in the South.
  - holding migration costs and amenities constant
- Hence, the out-migration in the first period itself would ...
  - decrease gross migration flow from the South to the North, and
  - increase the flow in the opposite direction.
- Still, the net effect is ambiguous and depends on the exact value of living in each region.

$\Rightarrow$ **The first-period out-migration incentivizes the second-period in-migration**.

Theoretical predictions (summary)

Empirical Strategy: Mechanics

- **Shift-share instrumental variable (SSIV) strategy:**

$$(in\_mig\_rate)^{r}_{d,t} = f(pull\_factors_{d,t-10}) + \epsilon_{d,t} \tag{A2}$$

$$(\widehat{out\_migrants}^{1940-1970})_o = \sum_{t=1950}^{1970} \sum_{d} \sum_{r} \left((\widehat{in\_migrants})^{r}_{d,t} \cdot \omega^{r,1910-1940}_{do} \right) \tag{A3}$$

$$(\widehat{out\_mig\_rate}^{1940-1970})_o = \frac{(\widehat{out\_migrants}^{1940-1970})_o}{(population^{1940})_o} \tag{A4}$$

  - Combines predetermined migrant networks, $\omega^{1910-1940}_{do}$, with pull factors of receiving cities (1940-1970).
  - Function $f(\cdot)$ is separately predicted for Black and White in-migrants ($r \in \{Black, White\}$).

SSIV framework

SSIV: Validity

Consistency:

- Share (Goldsmith-Pinkham, Sorkin and Swift, 2020)
  - **Exclusion restriction**: Migration linkages (1910-1940) affected the *changes* in outcomes (after 1940) of the origin only through out-migration.
  - County FE isolates variation in changes, and state-by-year FE removes any common trends, at least at the state level.
    - Base years: 1940 and 1950

- **Alternatively,** the IV validity can rely on the idiosyncrasies of shifts (Borusyak, Hull and Jaravel, 2022).

SSIV framework

Empirical Strategy: Zero Stage

	(1)	(2)	(3)	(4)	(5)	(6)
	1940-1950		1950-1960		1960-1970	
	Black	White	Black	White	Black	White
Latitude	-5.550	-0.154	-7.302*	-0.377	-3.029*	-1.355***
	(3.605)	(0.227)	(3.937)	(0.487)	(1.828)	(0.226)
Longitude	-4.769***	0.035	-2.099	-0.412*	-1.936**	-0.248**
	(1.702)	(0.107)	(1.907)	(0.236)	(0.914)	(0.113)
Log population	67.285	3.636	-117.904	21.049	12.575	13.916**
	(73.652)	(4.636)	(106.951)	(13.216)	(49.977)	(6.172)
Log black population	-15.663***	0.101	-63.246***	1.234**	-4.314**	0.490*
	(3.423)	(0.215)	(4.044)	(0.500)	(2.076)	(0.256)
Log white population	-71.899	-3.410	162.889	-29.611**	-11.011	-13.347**
	(74.179)	(4.669)	(108.079)	(13.356)	(50.658)	(6.256)
Urbanization	-0.987***	0.057***	-0.813***	0.251***	-0.307**	-0.029*
	(0.279)	(0.018)	(0.301)	(0.037)	(0.137)	(0.017)
Median income	-3.979	0.016	26.244***	15.626***	14.718***	9.442***
	(4.364)	(0.275)	(8.928)	(1.103)	(4.577)	(0.565)
Log housing units	12.854**	-0.294	14.702**	0.819	2.392	-1.024***
	(5.283)	(0.333)	(5.736)	(0.709)	(2.646)	(0.327)
Median rent	-3.305	-0.064	-7.525	5.714***	-11.123***	5.218***
	(5.549)	(0.349)	(7.098)	(0.877)	(3.430)	(0.424)
1940 Share naturalized	3.413	-0.559***	6.187*	-0.407	5.571***	0.467**
	(3.138)	(0.198)	(3.422)	(0.423)	(1.573)	(0.194)
1940 Share foreigner	-1.768	-0.365	3.385	0.259	-1.126	-0.185
	(3.633)	(0.229)	(3.977)	(0.491)	(1.840)	(0.227)
1940 Employment rate	3.579**	0.874***	1.025	-0.163	1.328	0.469***
	(1.622)	(0.102)	(1.802)	(0.223)	(0.840)	(0.104)
1940 Occupational score	0.036	0.018**	0.227*	0.015	-0.061	-0.020***
	(0.117)	(0.007)	(0.130)	(0.016)	(0.060)	(0.007)
Republican vote share (1944)	-0.055	-0.072***	0.332	0.174***	-0.246	-0.041
	(0.438)	(0.028)	(0.484)	(0.060)	(0.224)	(0.028)
Republican vote share (1948)	-1.028**	0.032	-0.827*	0.012	-0.252	0.087***
	(0.449)	(0.028)	(0.492)	(0.061)	(0.227)	(0.028)
Republican vote share (1952)	0.478	-0.155***	0.052	0.004	0.600*	-0.007
	(0.632)	(0.040)	(0.695)	(0.086)	(0.320)	(0.039)
Republican vote share (1956)	0.101	0.234***	-0.664	-0.135*	-0.233	0.083**
	(0.577)	(0.036)	(0.633)	(0.078)	(0.291)	(0.036)
Republican vote share (1960)	-0.312	0.002	0.494	0.133**	0.090	0.044
	(0.480)	(0.030)	(0.525)	(0.065)	(0.242)	(0.030)
Republican vote share (1964)	0.169	-0.011	-0.533	-0.153***	-0.035	-0.133***
	(0.412)	(0.026)	(0.453)	(0.056)	(0.211)	(0.026)
Republican vote share (1968)	1.429**	0.028	1.636**	0.100	0.631**	0.129***
	(0.600)	(0.038)	(0.660)	(0.082)	(0.305)	(0.038)
Republican vote share (1972)	-0.090	-0.017**	0.071	0.005	-0.048	-0.016*
	(0.134)	(0.008)	(0.147)	(0.018)	(0.068)	(0.008)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observation	3,102	3,102	3,092	3,092	3,080	3,080
R^2	0.152	0.234	0.333	0.261	0.114	0.525

Figure A3: Zero-stage in-migration prediction. SSIV framework

Empirical Strategy: Controls

Time interacted control variables.

- Time-invariant county characteristics: log land area, longitude, latitude, and 1940 values of log population and total farm acres.
- 1940 agriculture conditions: the share of sharecroppers and acres harvested in cotton, tobacco, corn, and hay, as well as shares of farms in five different farm-size bins.
- Pre-period out-migration (1910-1920, 1920-1930, and 1930-1940 flows)
- Predicted rates during the treatment period (for 1940-1950, 1950-1960, and 1960-1970 flows)
  - Predicted Black out-migration from Derenoncourt (2022)
  - Predicted White out-migration from the zero stage
- Trade exposure: Japanese import penetration (Batistich and Bond, 2023).

Estimating equation

Empirical Strategy: Fixed Effects

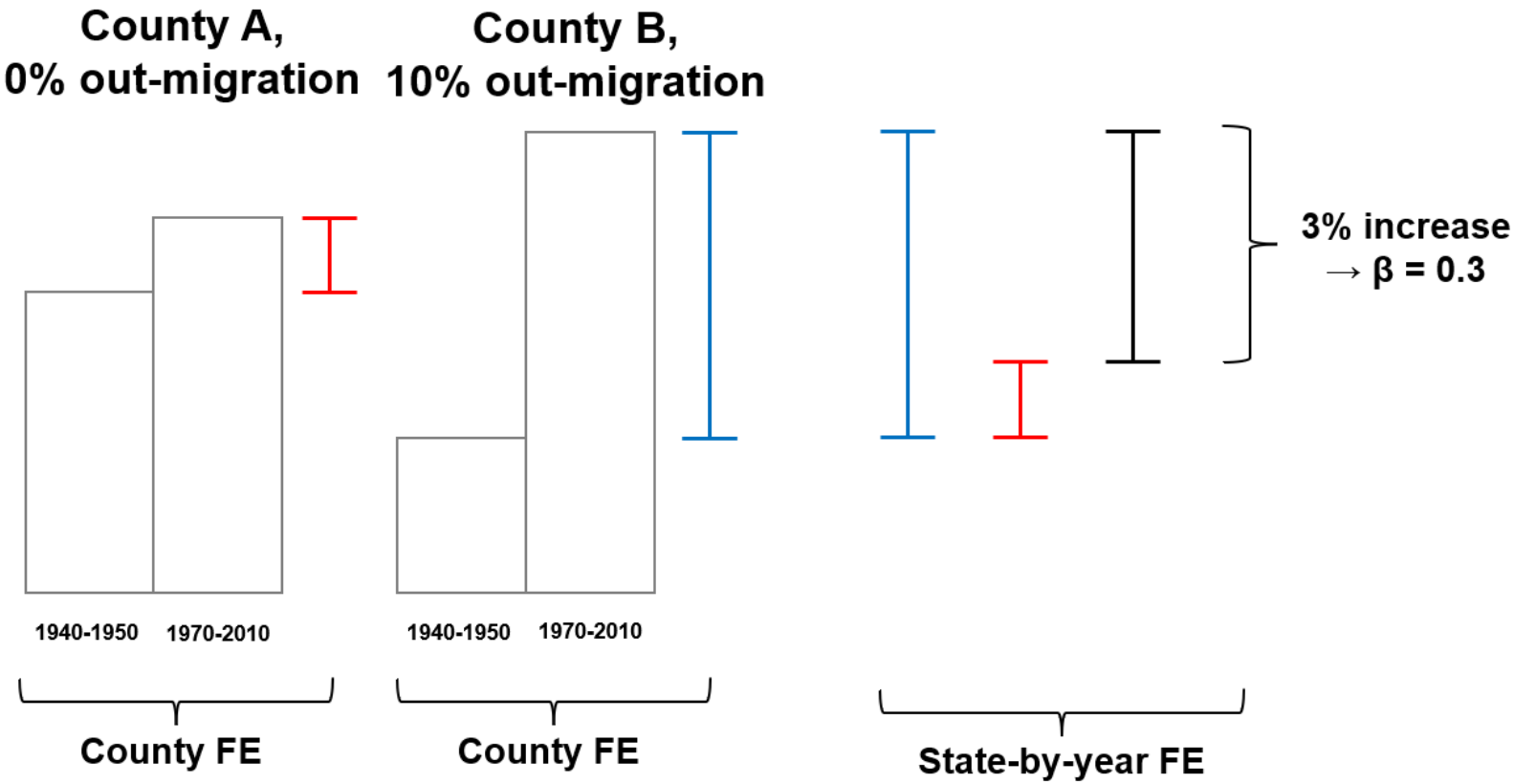


Figure A4: Conceptual role of the fixed effects. Estimating equation

More concretely, county and state-by-year fixed effects operate through removing county-level mean and state-by-year mean.

Empirical Strategy: Time-interacted Instruments

- The main empirical specification uses time-interacted instruments:

Let $\boldsymbol{x}$ be a $N \times 1$ vector of net out-migration rates between 1940 and 1970 and $\boldsymbol{z}$ be a $N \times 1$ vector of predicted net out-migration rates. The regression uses

$$\boldsymbol{X} = \begin{pmatrix} \boldsymbol{x} \cdot 1_{year=1930} & \mathbf{0} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \boldsymbol{x} \cdot 1_{year=1940} & \mathbf{0} & \cdots & \mathbf{0} \\ & & \vdots & & \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \cdots & \boldsymbol{x} \cdot 1_{year=2020} \end{pmatrix}$$

and

$$\boldsymbol{Z} = \begin{pmatrix} \boldsymbol{z} \cdot 1_{year=1930} & 0 & 0 & \cdots & 0 \\ 0 & \boldsymbol{z} \cdot 1_{year=1940} & 0 & \cdots & 0 \\ & & \vdots & & \\ 0 & 0 & 0 & \cdots & \boldsymbol{z} \cdot 1_{year=2020} \end{pmatrix},$$

where they are tridiagonal matrices ($NT \times T$) of time-interacted endogenous and instrument variables.

Empirical Strategy: Time-interacted Instruments

Given $\hat{\gamma} = (z'z)^{-1}z'x$,

$$\begin{aligned}\hat{\Gamma} &= (Z'Z)^{-1}Z'X \\ &= I_T \otimes (z'z)^{-1}z'x \\ &= I_T \otimes \hat{\gamma} \\ &= \begin{pmatrix} \hat{\gamma} & 0 & 0 & \cdots & 0 \\ 0 & \hat{\gamma} & 0 & \cdots & 0 \\ & & \vdots & & \\ 0 & 0 & 0 & \cdots & \hat{\gamma} \end{pmatrix}.\end{aligned} \tag{A5}$$

- The first stage estimates $\hat{\Gamma}$ is a diagonal matrix with its diagonal elements equal to the canonical first stage estimates $\hat{\gamma}$.

Empirical Strategy: Identification Assumption

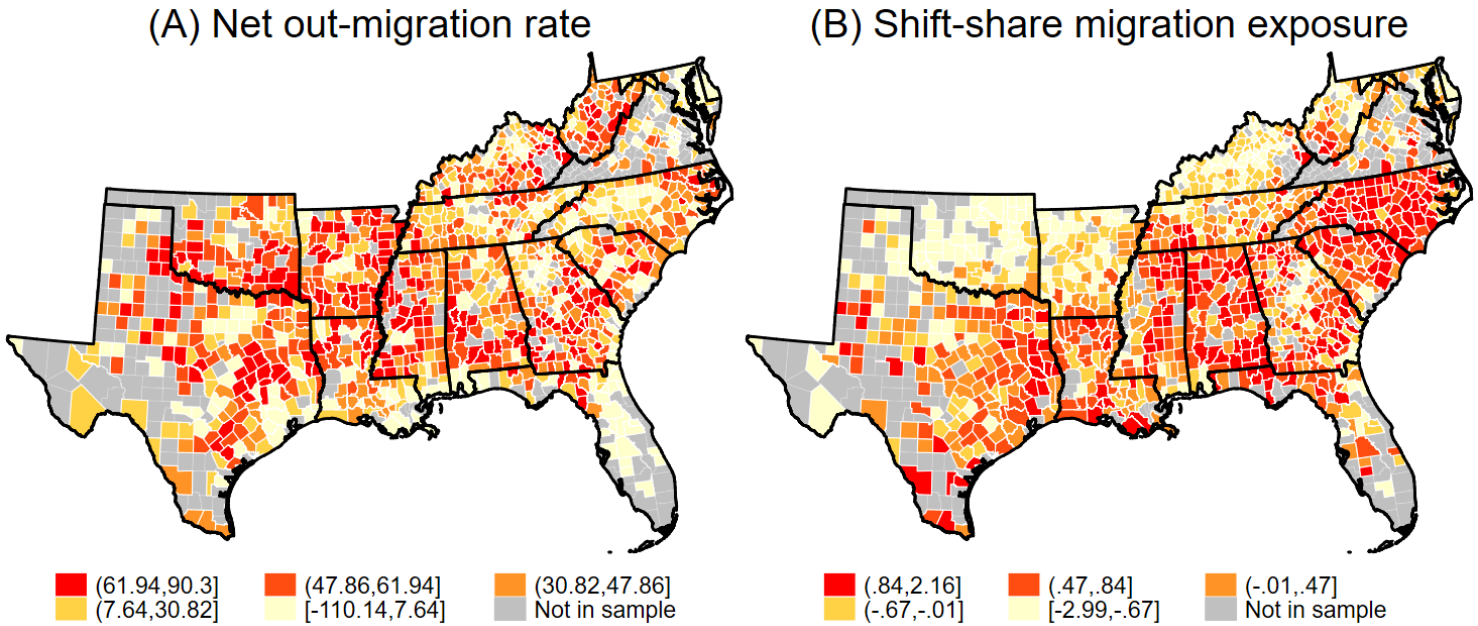


Figure A5: Map of the out-migration rate and the instrument (1940-1970)

- **Assumption:** Southern counties would have changed the same in the absence of the differential exposure to Northern pull factors (between 1940 and 1970), when compared to other counties ...
  - in the same state
  - with similar levels of Southern push factors, and
  - with similar pre-migration characteristics.

Empirical Strategy: First stage

Scatter plots:

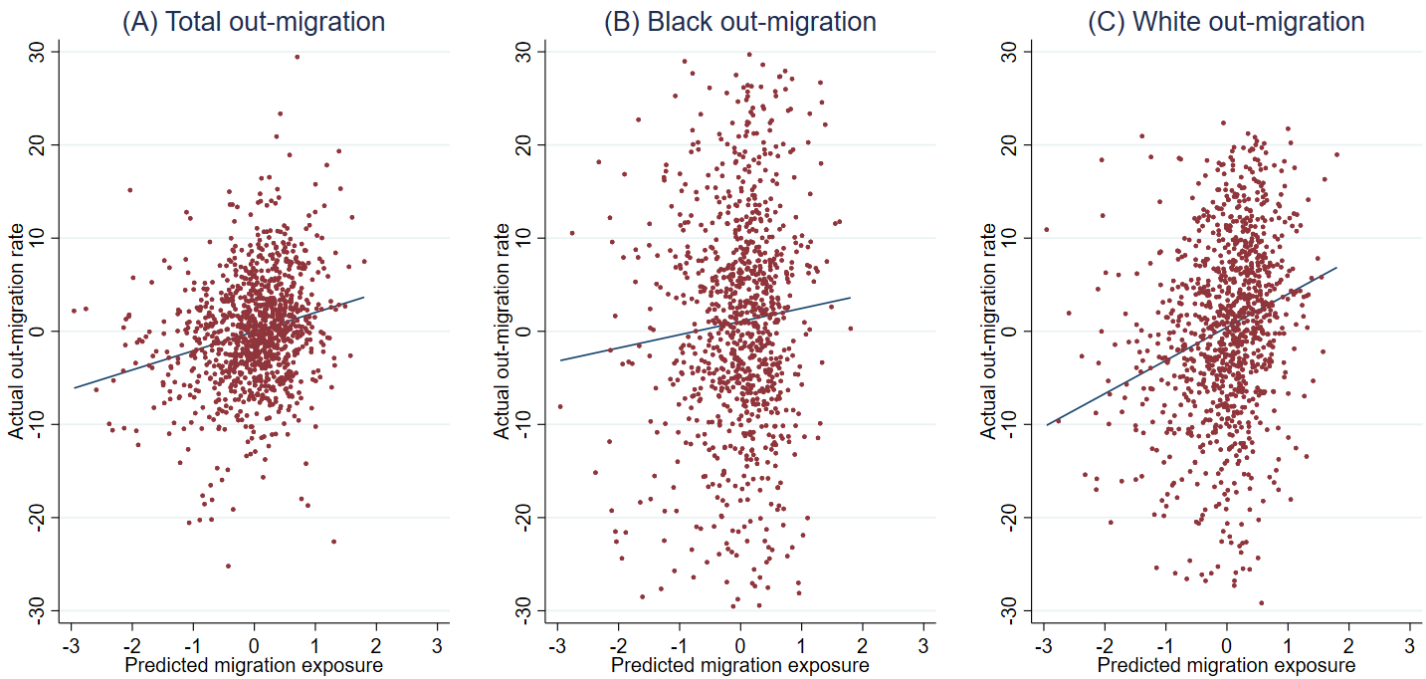


Figure A6: First-stage result.

- Results using Panel A are the baseline (combining Black and White migration).

First-stage table

Result: Agriculture, 1940-1950 vs. 1970-2010.

	(1) Agriculture employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Number of combines	(6) Farm output	(7) Farm value per acre
(A) Out-migration rate (OLS, 1%)	-0.020***	-0.009***	-0.001	0.007***	0.000	0.008***	0.012***
Clustered s.e. (county)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fixed effects	No	No	No	No	No	No	No
Controls	No	No	No	No	No	No	No
(B) Migration exposure (SSIV, 1std)	-0.003	-0.039	-0.146***	-0.013	-0.056	0.042	0.127***
Clustered s.e. (county)	(0.036)	(0.027)	(0.030)	(0.029)	(0.050)	(0.044)	(0.032)
Fixed effects	No	No	No	No	No	No	No
Controls	No	No	No	No	No	No	No
(C) Migration exposure (SSIV, 1std)	-0.180***	-0.088***	-0.074***	0.192***	0.247***	-0.046	0.010
Clustered s.e. (county)	(0.030)	(0.021)	(0.018)	(0.029)	(0.065)	(0.031)	(0.016)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	No	No	No	No	No	No
(D) Migration exposure (SSIV, 1std)	-0.042*	-0.023*	-0.082***	0.150***	0.043	-0.033	0.020
Clustered s.e. (county)	(0.024)	(0.012)	(0.015)	(0.028)	(0.062)	(0.024)	(0.013)
Conley s.e. (250km)	[0.021]	[0.012]	[0.011]	[0.023]	[0.038]	[0.021]	[0.010]
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.457	0.626	0.353	0.447	0.087	0.968	0.640
First-stage F	26.59	24.62	24.36	25.40	18.48	14.64	26.76
Counties	1,096	1,096	1,096	1,090	1,058	1,090	1,090

Unit of observation: county-year. All dependent variables are logged. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A1: Reduced-form results for agricultural outcomes.

- Agriculture became more mechanized, while farm output tended to be maintained.

Time trend (agriculture)

Result: Employment share, 1940-1950 vs. 1970-2010.

	(1) Agriculture	(2) Manufacturing	(3) Services	(4) Consumer services	(5) Producer services
Migration exposure (SSIV, 1std)	-0.081***	0.064*	0.005	0.030*	-0.033
Clustered s.e. (county)	(0.025)	(0.033)	(0.016)	(0.017)	(0.032)
Conley s.e. (250km)	[0.019]	[0.021]	[0.011]	[0.013]	[0.027]
Fixed effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
R-squared	0.345	0.127	0.085	0.258	0.133
First-stage F	25.49	21.60	23.57	21.85	24.27
counties	1,096	1,096	1,096	1,096	1,078

Unit of observation: county-year. All dependent variables are logged. Consumer services are defined to be NAICS classification in 42-45 and 61-72. Producer services include 51-56. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

- Counties more exposed to Northern pull factors experienced more structural change out of agriculture, but not much increases for producer services.
- **Potential reason**: A less capital-intensive sector is less affected by the factor reallocation (induced by the out-migration).

Go back NAICS classification

Result: Education, 1940-1950 vs. 1970-2010.

	(1) Median school year	(2) Share high school	(3) Share college	(4) Education spending	(5) Employment in education
Migration exposure (SSIV, 1std)	-0.009***	0.008	-0.023	-0.013	-0.015**
Clustered s.e. (county)	(0.003)	(0.007)	(0.029)	(0.011)	(0.007)
Conley s.e. (250km)	[0.002]	[0.006]	[0.028]	[0.007]	[0.006]
Fixed effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
R-squared	0.160	0.391	0.087	0.311	0.448
First-stage F	20.61	30.63	40.96	15.48	23.22
counties	1,096	1,096	1,096	1,094	1,096

Unit of observation: county-year. All dependent variables are logged. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2: Reduced-form results for educational outcomes.

- Overall results show that counties with higher out-migration rates did not experience meaningful improvements in education (human capital).
- The relative capital deepening might have reduced the incentive for human capital accumulation.
  - $\Rightarrow$ Out-migration could have complemented the North-South convergence in education (Caselli and Coleman II, 2001).

Go back

Results: Second-stage Results

Panel A. Agriculture

	(1) Employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Number of combines	(6) Farm output	(7) Farm value per acre
Out-migration rate (2SLS, 1%)	-0.011*	-0.006*	-0.023***	0.042***	0.014	-0.004	0.005
Clustered s.e. (County)	(0.007)	(0.004)	(0.006)	(0.010)	(0.020)	(0.004)	(0.003)
First-stage F	26.59	24.62	24.36	25.40	18.48	14.64	26.76
Counties	1,096	1,096	1,096	1,090	1,058	1,090	1,090

Panel B. Manufacturing

	(1) Employment	(2) Number of establishment	(3) Capital spending	(4) Value added	(5) Annual payroll
Out-migration rate (2SLS, 1%)	0.022**	0.026***	0.040	0.024	0.043**
Clustered s.e. (County)	(0.011)	(0.007)	(0.028)	(0.021)	(0.017)
First-stage F	23.03	24.33	15.54	21.07	22.23
Counties	1,096	1,096	1,065	1,096	1,096

Panel C. Wholesale and retail

	(1) Wholesale emp.	(2) Wholesale est.	(3) Wholesale sales	(4) Wholesale payroll	(5) Retail emp.	(6) Retail est.	(7) Retail sales	(8) Retail payroll
Out-migration rate (2SLS, 1%)	0.047***	0.040***	0.026*	0.035**	0.021***	0.010***	0.015***	0.022***
Clustered s.e. (County)	(0.011)	(0.010)	(0.014)	(0.015)	(0.006)	(0.003)	(0.005)	(0.007)
First-stage F	27.46	24.93	27.57	22.70	25.07	25.06	25.07	25.04
Counties	1,083	1,096	1,086	1,086	1,096	1,096	1,096	1,096

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Second-stage estimates (two-stage least squares).

Result: 2SLS and Robustness

Results: Pretrend tests

Panel A. Agriculture

	(1) Employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Farm output	(6) Farm value per acre
Migration exposure (SSIV, 1std)	0.051***	0.009	0.014	0.029	0.038***	-0.004
Clustered s.e. (county)	(0.013)	(0.011)	(0.018)	(0.021)	(0.012)	(0.013)
First-stage F	12.97	12.97	15.99	16.71	12.97	12.97
Counties	1,096	1,096	1,095	1,090	1,096	1,096

Panel B. Manufacturing

	(1) Employment	(2) Number of establishments	(3) Value added	(4) Annual payroll	(5) Intermediate goods	(6) Revenue
Migration exposure (SSIV, 1std)	-0.058	0.022	-0.041	-0.066	-0.007	-0.021
Clustered s.e. (county)	(0.041)	(0.019)	(0.033)	(0.042)	(0.042)	(0.036)
First-stage F	14.36	13.05	12.69	12.69	12.69	12.69
Counties	1,035	1,058	994	994	994	994

Panel C. Wholesale

	(1) Wholesale employment	(2) Wholesale establishment	(3) Wholesale sales	(4) Wholesale annual payroll
Migration exposure (SSIV, 1std)	-0.035	-0.001	-0.036	0.003
Clustered s.e. (county)	(0.038)	(0.030)	(0.033)	(0.036)
First-stage F	14.52	14.83	14.77	13.13
Counties	947	1,060	953	943

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Preperiod outcomes (1920-1930 vs. 1940).

Results: Overidentification Tests

Panel A. Agriculture

	(1) Employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Number of combines	(6) Farm output	(7) Farm value per acre
Out-migration rate (2SLS, 1%)	-0.012*	-0.010**	-0.024***	0.039***	0.019	-0.016**	0.005
	(0.006)	(0.004)	(0.006)	(0.011)	(0.020)	(0.008)	(0.003)
First-stage F	13.69	13.16	13.16	13.22	10.93	13.16	13.16
Sargan-Hansen J	0.43	0.15	1.74	0.17	1.78	0.03	0.00
Sargan-Hansen p-value	0.51	0.70	0.19	0.68	0.18	0.87	1.00

Panel B. Manufacturing

	(1) Employment	(2) Number of establishment	(3) Capital spending	(4) Value added	(5) Annual payroll
Out-migration rate (2SLS, 1%)	0.020*	0.026***	0.044	0.019	0.039**
	(0.011)	(0.007)	(0.027)	(0.019)	(0.016)
First-stage F	12.38	12.82	8.00	11.04	11.67
Sargan-Hansen J	1.79	0.03	1.90	4.59	4.20
Sargan-Hansen p-value	0.18	0.87	0.17	0.03**	0.04**

Panel C. Wholesale and retail

	(1) Wholesale emp.	(2) Wholesale est.	(3) Wholesale sales	(4) Wholesale payroll	(5) Retail emp.	(6) Retail est.	(7) Retail sales	(8) Retail payroll
Out-migration rate (2SLS, 1%)	0.052***	0.042***	0.029**	0.037***	0.019***	0.009***	0.013***	0.020***
	(0.012)	(0.010)	(0.014)	(0.014)	(0.005)	(0.003)	(0.004)	(0.006)
First-stage F	14.40	13.25	14.39	12.46	13.16	13.16	13.16	13.15
Sargan-Hansen J	5.89	0.74	1.32	0.60	12.05	2.35	13.59	15.43
Sargan-Hansen p-value	0.02**	0.39	0.25	0.44	0.00***	0.13	0.00***	0.00***

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Overidentification tests using shares (second-stage estimates).

Robustness: Falsification Tests

	(1) Local government employment	(2) Local government annual payroll	(3) Federal government employment
Migration exposure (SSIV, 1std)	-0.015	-0.018*	0.019
Clustered s.e. (county)	(0.009)	(0.010)	(0.021)
Conley s.e. (250km)	[0.009]	[0.008]	[0.021]
R-squared	0.404	0.187	0.219
First-stage F	17.11	23.81	16.85
County	1,096	1,096	1,096

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: SSIV estimation results from the public sector.

Result: 2SLS and Robustness

Robustness: Placebo Tests

Panel A. Agriculture

	(1) Employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Number of combines	(6) Farm output	(7) Farm value per acre
Migration exposure	0.001	0.000	-0.001	0.004	0.003	0.004	-0.001
	(0.009)	(0.003)	(0.003)	(0.006)	(0.018)	(0.006)	(0.003)
R-squared	0.457	0.625	0.338	0.438	0.088	0.968	0.639
First-stage F	0.72	0.39	0.39	0.40	0.25	0.39	0.39

Panel B. Manufacturing

	(1) Employment	(2) Number of establishment	(3) Capital spending	(4) Value added	(5) Annual payroll
Migration exposure	-0.004	-0.001	0.079*	0.013	0.003
	(0.012)	(0.005)	(0.042)	(0.028)	(0.021)
R-squared	0.156	0.411	0.161	0.144	0.173
First-stage F	0.52	0.77	0.96	1.28	1.30

Panel C. Wholesale and retail

	(1) Wholesale emp.	(2) Wholesale est.	(3) Wholesale sales	(4) Wholesale payroll	(5) Retail emp.	(6) Retail est.	(7) Retail sales	(8) Retail payroll
Migration exposure	-0.005	0.001	0.001	0.008	-0.001	-0.001	-0.002	0.001
	(0.010)	(0.006)	(0.027)	(0.027)	(0.004)	(0.003)	(0.004)	(0.005)
R-squared	0.269	0.435	0.141	0.129	0.659	0.727	0.679	0.623
First-stage F	0.35	0.37	0.36	0.16	0.38	0.39	0.39	0.38

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7: Placebo test - Shuffled migration exposure.

Result: 2SLS and Robustness

Robustness: Placebo Tests

Panel A. Agriculture

	(1) Employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Number of combines	(6) Farm output	(7) Farm value per acre
Migration exposure	-0.000	-0.007	-0.011*	0.000	0.039	-0.015	0.005
	(0.015)	(0.006)	(0.006)	(0.020)	(0.035)	(0.013)	(0.007)
R-squared	0.457	0.625	0.339	0.438	0.087	0.968	0.640
First-stage F	0.02	0.02	0.05	0.00	0.04	2.49	0.02

Panel B. Manufacturing

	(1) Employment	(2) Number of establishment	(3) Capital spending	(4) Value added	(5) Annual payroll
Migration exposure	-0.015	-0.006	-0.108	-0.070	-0.023
	(0.024)	(0.010)	(0.111)	(0.049)	(0.041)
R-squared	0.156	0.411	0.160	0.144	0.173
First-stage F	0.00	0.06	0.28	0.14	0.15

Panel C. Wholesale and retail

	(1) Wholesale emp.	(2) Wholesale est.	(3) Wholesale sales	(4) Wholesale payroll	(5) Retail emp.	(6) Retail est.	(7) Retail sales	(8) Retail payroll
Migration exposure	0.013	0.013	0.048	0.031	0.009	-0.002	0.013*	0.013
	(0.016)	(0.011)	(0.044)	(0.037)	(0.008)	(0.006)	(0.007)	(0.010)
R-squared	0.269	0.435	0.141	0.130	0.659	0.727	0.679	0.623
First-stage F	0.17	0.12	0.16	0.04	0.04	0.04	0.04	0.05

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A8: Placebo test - Random share.

Result: 2SLS and Robustness

Robustness: Placebo Tests

Panel A. Agriculture

	(1) Employment	(2) Number of farms	(3) Acres in farmland	(4) Number of tractors	(5) Number of combines	(6) Farm output	(7) Farm value per acre
Migration exposure	-0.021	-0.003	0.003	0.004	0.003	-0.030*	-0.029
	(0.017)	(0.015)	(0.014)	(0.014)	(0.053)	(0.016)	(0.020)
R-squared	0.457	0.625	0.338	0.438	0.087	0.968	0.641
First-stage F	5.07	7.76	5.75	5.15	4.76	0.03	3.38

Panel B. Manufacturing

	(1) Employment	(2) Number of establishment	(3) Capital spending	(4) Value added	(5) Annual payroll
Migration exposure	0.060**	0.039***	-0.005	0.035	0.045
	(0.029)	(0.013)	(0.030)	(0.035)	(0.030)
R-squared	0.157	0.413	0.160	0.144	0.173
First-stage F	2.95	3.66	2.58	2.63	2.62

Panel C. Wholesale and retail

	(1) Wholesale emp.	(2) Wholesale est.	(3) Wholesale sales	(4) Wholesale payroll	(5) Retail emp.	(6) Retail est.	(7) Retail sales	(8) Retail payroll
Migration exposure	0.035	0.037**	-0.002	0.015	0.030*	0.009	0.017	0.030*
	(0.030)	(0.018)	(0.030)	(0.030)	(0.016)	(0.008)	(0.012)	(0.018)
R-squared	0.270	0.436	0.141	0.130	0.660	0.727	0.679	0.624
First-stage F	2.23	2.61	2.29	1.58	4.31	4.31	4.31	4.30

All results include the set of fixed effects and control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A9: Placebo test - Random shift.

Result: 2SLS and Robustness

Robustness: Alternative Specifications

1. Using the 1935-1940 migration matrix
2. Separate estimates by race
3. Alternative approaches for in-migration prediction
   - actual number of in-migrants random forest algorithm
4. Former Confederate sample
5. Balanced counties sample (for all the main variables)
6. 1940 population-weighted regression
7. Dropping the time-varying controls
   - Contemporaneous population and net migration rate
8. Dropping the predicted migration rates between 1940-1970
9. Alternative base years
   - Only 1940 vs. All years (1940, 1950, and 1960)
10. Adding a weighted average of other Southern counties' exposures
    - Adjacent counties vs. Within-South migration linkages

Result: 2SLS and Robustness

Appendix: NAICS Classification

Sector	Definition
42-45	Wholesale and Retail Trade
48-49	Transportation and Warehousing
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative Support, Waste Management and Remediation
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Accommodation and Food Services
81	Other Services (except Public Administration)
92	Public Administration

Table A11: NAICS industry classification.

Structural change (table)

Migrants Selection: 1910-1930 (1910 characteristics)

	White Males			Black Males		
	Average	Simple Difference	Adjusted Difference	Average	Simple Difference	Adjusted Difference
A. Literacy rate ($N = 14,761$ white and $3,702$ black)						
Non-migrants	0.924	–	–	0.650	–	–
S-to-N Migrants	0.936	0.013**	-0.004	0.684	0.035*	0.008
B. School attendance rate (age 6 to 15) ($N = 6,587/1,705$)						
Non-migrants	0.828	–	–	0.613	–	–
S-to-N Migrants	0.838	0.010	-0.003	0.655	0.043	0.035
C. Occupation education score ($N = 11,834/3,239$)						
Non-migrants	10.77	–	–	7.90	–	–
S-to-N Migrants	10.92	0.148***	0.062	8.02	0.120***	0.025
D. Farm origin ($N = 21,367/5,462$)						
Non-migrants	0.610	–	–	0.592	–	–
S-to-N Migrants	0.500	-0.071***	-0.090***	0.502	-0.090***	-0.033*
E. Homeownership rate ($N = 21,367/5,462$)						
Non-migrants	0.543	–	–	0.222	–	–
S-to-N Migrants	0.505	-0.038**	-0.037**	0.251	0.030**	0.007

Controls: age and county-of-origin FE. SE clustered by county. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Reproduced from Collins and Wanamaker (2015).

- While there is some evidence of positive selection during the First Great Migration, the degree of selection was small, and participation in migration was widespread (Collins and Wanamaker, 2015). Go back

Migrants Selection: 1940-1950 (1940 characteristics)

Go back

Model Algebra

- Model elements
  - Workers' problem Workers' problem
  - Labor supply Labor supply
  - Capitalist's problem Capitalist's problem
  - Capital supply Capital supply
  - Production Production
- General equilibrium
  - Migration Migration
  - Trade Trade
- Model calculation
  - Notations Notation
  - Temporary equilibrium Temporary equil.
  - Sequential equilibrium Sequential equil.

Go back to main slides Model parameters

Quantitative Model - Workers

Consumption.

Workers' consumption preferences fall in the non-homothetic Price-Independent Generalized Linear (PIGL) class as in Boppart (2014) and Fan et al. (2023). The indirect utility of an agent with expenditure e is given by:

$$C(e, P_i) = \frac{1}{\varepsilon}\left(\frac{e}{(P_i^a)^{\phi^a}(P_i^m)^{\phi^m}(P_i^l)^{\phi^l}}\right)^{\varepsilon} - \sum_{s\in\{a,m,l\}} \nu^s \ln P_i^s, \tag{A6}$$

where $P_i \equiv (P_i^a)^{\phi^a}(P_i^m)^{\phi^m}(P_i^l)^{\phi^l}$ is the local price index.

By applying Roy's identity, the consumption shares are:

$$\varphi^s(P_i, e) = \phi^s + \nu^s\left(\frac{e}{P_i}\right)^{-\varepsilon}. \tag{A7}$$

with

- Income elasticity ε, price elasticity ν^s, and
- Asymptotic consumption share ϕ^s with $\sum_{s\in\{a,m,l\}} \phi^s = 1$

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Quantitative Model - Workers

Labor supply.

A worker supplies a_i^s efficiency units to sector s that are drawn from a sector-specific Frechet distribution, $P(a_{i,t}^{w,s} \leq a) = \exp(-(a/A_i^{w,s})^{-\zeta^w})$ with ...

- The dispersion parameter ζ^w, and
- The fundamental level of labor efficiency in the region $A_i^{w,s}$

Each worker chooses a sector to maximize their income, $y_i^s = \max_s\{a_i^s w_i^s\}$.
The sectoral employment shares are given by:

$$s_i^{w,s} = (A_i^{w,s} w_i^s / \bar{w}_i)^{\zeta^w} \quad \text{where} \quad \bar{w}_i = \left((A_i^{w,a} w_i^a)^{\zeta^w} + (A_i^{w,m} w_i^m)^{\zeta^w} + (A_i^{w,l} w_i^l)^{\zeta^w}\right)^{1/\zeta^w}.$$

The measure of workers in sector s is then given as $s_i^s L_i$, and the effective unit of labor supplied can be written as:

$$L_i^s = \Gamma_{\zeta^w} A_i^{w,s} (A_i^{w,s} w_i^s / \bar{w}_i)^{\zeta^w - 1} L_i \equiv A_i^{w,s} \tilde{L}_i^s, \tag{A8}$$

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General Equilibrium - Migration

Migration.

Individuals make forward-looking decisions over which region n to live in the next period:

$$\mathbb{V}_{i,t} = U(C_{i,t}) + \max_{\{n\}} \left\{ \beta \mathbb{E}[\mathbb{V}_{n,t+1}] - \kappa_{ni,t} + \eta u_{n,t} \right\}, \tag{A9}$$

with migration costs κ and idiosyncratic shock u from a mean zero EVT1.

The solution to the above problem yields the migration share proportional to the migration cost- and elasticity-adjusted utility, compared to that of all other possible destinations:

$$\mathbb{M}_{in,t} = \frac{\exp\left(\beta \mathbb{E}_t(v_{n,t+1} - \kappa_{ni})/\eta\right)}{\sum_{j=1}^{N} \exp\left(\beta \mathbb{E}_t(v_{j,t+1} - \kappa_{nj,t})/\eta\right)}, \tag{A10}$$

where i indexes origin and n is destination.

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Quantitative Model - Capitalists

Consumption and investment.

In each region, geographically immobile capitalists choose their consumption and investment to maximize:

$$v_{i,t}^k = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \frac{(C_{i,t}^k)^{1-1/\psi}}{1-1/\psi}, \tag{A11}$$

- ... in intertemporal elasticity of substitution form with parameter ψ.
- ... subject to their budget constraints:

$$\bar{r}_{i,t} K_{i,t} = P_{i,t}\big(C_{i,t}^k + K_{i,t+1} - (1-\delta)K_{i,t}\big). \tag{A12}$$

- ... where $\bar{r}_{i,t}$ is the average net return on capital. The gross real return on capital is $\bar{R}_{i,t} \equiv 1 - \delta + \bar{r}_{i,t}/P_{i,t}$ with the depreciation rate δ.

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Quantitative Model - Capitalists

Capital allocation (intertemporal).

In each period t, capitalists consume a fixed share $\varsigma_{i,t}$ of their real gross investment income $\bar{R}_{i,t}K_{i,t}$, as in Kleinman et al. (2023):

$$\varsigma_{i,t}^{-1} = 1 + \mathbb{E}_t \beta^{\psi} ([R_{i,t+1}^{\frac{\psi-1}{\psi}} \varsigma_{i,t+1}^{-\frac{1}{\psi}}])^{\psi}, \tag{A13}$$

- Solved recursively with the expected sequences of future returns.
- A special case of log utility ($\psi = 1$) yields a constant consumption rate $\varsigma_{i,t} = 1 - \beta$.

Go back to model overview

Quantitative Model - Capitalists

Capital allocation (intratemporal).

The capital efficiency follows a sector-specific Frechet distribution, $P(a_{i,t}^{k,s} \leq a) = \exp(-(a/A_i^{k,s})^{-\zeta^k})$. The capital allocation across sectors is:

$$s_i^{k,s} = (A_i^{k,s} r_i^s / \bar{r}_i)^{\zeta^k}, \tag{A14}$$

and the effective capital for each sector is:

$$K_i^s = \Gamma_{\zeta^k} A_i^{k,s} (r_i^s / \bar{r}_i)^{\zeta^k - 1} K_i \equiv A_i^{k,s} \tilde{K}_i^s. \tag{A15}$$

The capital efficiency consists of exogenous fundamental $\bar{A}$ and endogenous components $F^s(\cdot)$ that depends on regional economic allocations:

$$A_i^{k,s} = \bar{A}_i^{k,s} \times F^s(\cdot), \tag{A16}$$

where $F^s(\cdot)$ incorporates the dynamic weak equilibrium bias in reduced form.

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Quantitative Model - Production

Production.

In each region i, a representative local firm in each sector s uses the following CES technology:

$$Y_{i,t}^s = z_{i,t}^s \left(\rho_i^s (A_{i,t}^{w,s} \tilde{L}_{i,t}^s)^{\frac{\sigma^s - 1}{\sigma^s}} + (1 - \rho_i^s)(A_{i,t}^{k,s} \tilde{K}_{i,t}^s)^{\frac{\sigma^s - 1}{\sigma^s}} \right)^{\frac{\sigma^s}{\sigma^s - 1}}, \qquad \text{(A17)}$$

with Hicks-neutral technology z_i^s drawn from a Frechet distribution with local fundamental Z_i^s and the shape parameter θ^s.

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General Equilibrium - Trade

Trade.

The price of a good in importer region n for industry s is determined as the minimum unit cost across all regions:

$$p_{n,t}^{s} = \min_{1 \leq i \leq N} \left\{ \frac{x_{i,t}^{s} \tau_{ni,t}^{s}}{z_{i,t}^{s}} \right\}. \tag{A18}$$

The unit cost function follows from the CES production structure:

$$x_{i,t}^{s} = \min \left(w_{i,t}^{s} A_{i,t}^{w,s} \tilde{L}_{i,t}^{s} + r_{i,t}^{s} A_{i,t}^{k,s} \tilde{K}_{i,t}^{s} \right) = \left((\rho_{i}^{s})^{\sigma^{s}} (w_{i,t}^{s})^{1-\sigma^{s}} + (1-\rho_{i}^{s})^{\sigma} (r_{i,t}^{s})^{1-\sigma^{s}} \right)^{\frac{1}{1-\sigma^{s}}}.$$

With the distributional assumption on the Hicks-neutral productivity term, the bilateral expenditure share is given by:

$$\mathbb{S}_{ni,t}^{s} = \frac{Z_{i,t}^{s} \left(x_{i,t}^{s} \tau_{ni,t}^{s} \right)^{-\theta^{s}}}{\sum_{j=1}^{N} Z_{j,t}^{s} \left(x_{j,t}^{s} \tau_{nj,t}^{s} \right)^{-\theta^{s}}}, \tag{A19}$$

where i indexes exporter and n is importer.

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Dynamic Exact Hat Algebra: Notation

- Time-varying/time-constant fundamentals and economic outcomes.
  - Geographic fundamentals: $\{\bar{Z}^s_{i,t}, \bar{A}^{w,s}_{i,t}, \bar{A}^{k,s}_{i,t}, B_{i,t}, \tau^s_{ni,t}, \kappa_{ni,t}\}$.
  - Prices and allocation: $\{w^s_{i,t}, r^s_{i,t}, L_{i,t}, K_{i,t}, \mathbb{V}_{i,t}\}$.

- Hat Algebra notations.
  - A "dot" represents changes over time: $\dot{Y}_{t+1} \equiv Y_{t+1}/Y_t$.
  - A "hat" represents counterfactual time changes relative to the baseline time changes, $\hat{Y}_t \equiv \dot{Y'}_t/\dot{Y}_t$.

- **Stationary Equilibrium.** A sequential competitive equilibrium in which no aggregate variables change over time. It requires fundamentals to be constant.

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Dynamic Exact Hat Algebra: Temporary Equilibrium

Given the economic allocation at t, the solution to the **Temporary Equilibrium** at $t+1$ for a given change in $\{\dot{L}_{t+1},\ \dot{K}_{t+1},\ \dot{\Theta}_{t+1}\}$ are calculated as the solution to the following system of non-linear equations:

$$\dot{x}^s_{i,t+1} = \left((\xi^s_{i,t})(\dot{w}^s_{i,t+1})^{1-\sigma^s} + (1-\xi^s_{i,t})(\dot{r}^s_{i,t+1})^{1-\sigma^s} \right)^{\frac{1}{1-\sigma^s}}, \tag{T1}$$

$$\dot{P}^s_{n,t+1} = \left[\sum_{i=1}^{N} \mathbb{S}^s_{ni,t} \left(\dot{\tau}^s_{ni,t+1} \dot{x}^s_{i,t+1} \right)^{-\theta^s} \right]^{-1/\theta^s}, \tag{T2}$$

$$\mathbb{S}^s_{ni,t+1} = \mathbb{S}^s_{ni,t} \left(\frac{\dot{\tau}^s_{ni,t+1} \dot{x}^s_{i,t+1}}{\dot{P}^s_{n,t+1}} \right)^{-\theta^s}, \tag{T3}$$

$$s^{w,s}_{i,t+1} = s^{w,s}_{i,t} \left(\frac{\dot{A}^{w,s}_{i,t+1} \dot{w}^s_{i,t+1}}{\bar{\dot{w}}_{i,t+1}} \right) \quad \text{and} \quad s^{k,s}_{i,t+1} = s^{k,s}_{i,t} \left(\frac{\dot{A}^{k,s}_{i,t+1} \dot{R}^s_{i,t+1}}{\bar{\dot{R}}_{i,t+1}} \right), \tag{T4}$$

$$\dot{L}^s_{i,t+1} = \dot{A}^{w,s}_{i,t+1} \dot{s}^{w,s}_{i,t+1} \dot{L}_{i,t+1} \quad \text{and} \quad \dot{K}^s_{i,t+1} = \dot{A}^{k,s}_{i,t+1} \dot{s}^{k,s}_{i,t+1} \dot{K}_{i,t+1}, \tag{T5}$$

Dynamic Exact Hat Algebra: Temporary Equilibrium

$$E^s_{n,t+1} = \dot{w}^s_{n,t+1}\dot{L}^s_{n,t+1}w^s_{n,t}L^s_{n,t} \quad \text{and}$$
$$E^k_{n,t+1} = (1-\beta)\sum_{s\in\{a,m,l\}}\dot{R}^s_{n,t+1}\dot{K}^s_{n,t+1}R^s_{n,t}K^s_{n,t} \tag{T6}$$

$$\varphi^k_{is,t+1} = \phi^k + \left(\varphi^k_{is,t} - \phi^k\right)\left(\frac{\dot{w}^s_{i,t+1}}{\dot{P}_{i,t+1}}\right)^{-\varepsilon}, \tag{T7}$$

$$\dot{Y}^s_{i,t+1}Y^s_{i,t} = \sum_{n=1}^{N}\mathbb{S}^s_{ni,t+1}\left(\sum_{s=1}^{S}\varphi^s_{ns,t+1}E^s_{n,t+1} + \varphi^k_{ns,t+1}E^k_{n,t+1}\right), \tag{T8}$$

$$\dot{w}^s_{n,t+1}\dot{L}^s_{n,t+1}w^s_{n,t}L^s_{n,t} = \xi^s_{i,t+1}\dot{Y}^s_{i,t+1}Y^s_{i,t} \quad \text{and}$$
$$\dot{r}^s_{n,t+1}\dot{K}^s_{n,t+1}r^s_{n,t}K^s_{n,t} = (1-\xi^s_{i,t+1})\dot{Y}^s_{i,t+1}Y^s_{i,t}, \tag{T9}$$

$$K_{i,t+1} = \beta\bar{R}_{i,t}K_{i,t}. \tag{T10}$$

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Dynamic Exact Hat Algebra: Sequential Equilibrium

Given an initial allocation of the economy and an anticipated convergent sequence of time changes in fundamentals, the solutions to the **Sequential Equilibrium** are obtained as the solution to the following system of equations:

$$\mathbb{M}_{in,t+1} = \frac{\mathbb{M}_{in,t}\left(\dot{\mathbb{V}}_{i,t+2}\right)^{\beta/\eta}}{\sum_{l=1}^{N}\mathbb{M}_{il,t}\left(\dot{\mathbb{V}}_{l,t+2}\right)^{\beta/\eta}}, \tag{S1}$$

$$\dot{\mathbb{V}}^{k}_{n,t+1} = \dot{B}_{n,t+1}\dot{C}_{n}\left(\dot{L}_{t+1},\dot{\Theta}_{t+1}\right)\left(\sum_{i=1}^{N}\sum_{s=1}^{k}\mathbb{M}_{ni,t}(\dot{\mathbb{V}}_{i,t+2})^{\beta/\eta}\right)^{\eta}, \tag{S2}$$

$$L_{n,t+1} = \sum_{i=1}^{N}\mathbb{M}_{in,t}L_{i,t}. \tag{S3}$$

The changes consumption indirect utility, $C_n(\dot{L}_{t+1},\dot{\Theta}_{t+1})$, is constructed from the solution of the temporary equilibrium given $\{\dot{L}_t,\dot{\Theta}_t\}_{t=1}^{\infty}$:

$$C_{n,t+1} = \frac{1}{\varepsilon}\left(\frac{\dot{\bar{w}}_{n,t+1}}{\dot{P}_{n,t+1}}\frac{\bar{w}_{n,t}}{P_{n,t}}\right)^{\varepsilon} - \sum_{s=1}^{k}\nu^{s}\ln\dot{P}^{s}_{n,t+1}P^{s}_{n,t}.$$

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Structural Parameters

Definition	Parameter	Comment
Panel (A) Utility parameters		
Asymptotic consumption share	$\phi = (0.01, 0.33, 0.66)$	Moment condition (Yang, 2024)
Preference elasticity	$\nu = (1.27, -0.27, -1.0)$	Moment condition (Yang, 2024)
Engel elasticity	$\eta = 0.39$	Estimation (Yang, 2024)
Migration elasticity	$\chi = 0.84$	Estimation (Yang, 2024)
Discount rate	$\beta = 0.67$	Set to $(0.96)^{10}$
Panel (B) Productivity parameters		
EIS between labor and capital	$\sigma = (1.58, 0.80, 0.75)$	Herrendorf et al. (2015)
Average labor weights in production	$\bar{\rho} = (0.49, 0.71, 0.66)$	Herrendorf et al. (2015)
Factor efficiency distribution	$(\zeta^L, \zeta^K) = (6.9, 6.9)$	Eckert and Peters (2023)
Hicks-neutral productivity distribution	$\theta = (12, 6.5, \infty)$	Nigai (2016)
Capital depreciation rate	$\delta = 0.34$	Hulten and Wykoff (1981)
Changes in Southern capital efficiency	$\dot{\mathbf{F}}^s(\cdot) = (1.168, 1.040, 1.027)$	Internally calibrated

Table A12: Parameters for Quantitative Analysis.

- The model parameters are either externally calibrated (CES production function), estimated (demand parameters), or internally calibrated (growth rate of capital-augmenting technologies).

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