# The Regional Specialization Trade-off

Lukas Boehnert

January 6, 2026

University of Oxford, Department of Economics

# Introduction

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization = Concentration of economic activity across industries

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization $=$ Concentration of economic activity across industries
  - Inter-regional trade gains from comparative advantage
  - Intra-regional productivity gains from knowledge spillovers and agglomeration

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization = Concentration of economic activity across industries
  - Inter-regional trade gains from comparative advantage
  - Intra-regional productivity gains from knowledge spillovers and agglomeration
- Historically: Once-thriving highly specialized hubs often face severe declines

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization = Concentration of economic activity across industries
  - Inter-regional trade gains from comparative advantage
  - Intra-regional productivity gains from knowledge spillovers and agglomeration
- Historically: Once-thriving highly specialized hubs often face severe declines
  - Well-known examples: Rust Belt (US), Rhine-Ruhr area (Germany), Lancashire (UK)

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization = Concentration of economic activity across industries
  - Inter-regional trade gains from comparative advantage
  - Intra-regional productivity gains from knowledge spillovers and agglomeration
- Historically: Once-thriving highly specialized hubs often face severe declines
  - Well-known examples: Rust Belt (US), Rhine-Ruhr area (Germany), Lancashire (UK)
- Were these regions unlucky, or is specializing systematically detrimental?

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization = Concentration of economic activity across industries
  - Inter-regional trade gains from comparative advantage
  - Intra-regional productivity gains from knowledge spillovers and agglomeration
- Historically: Once-thriving highly specialized hubs often face severe declines
  - Well-known examples: Rust Belt (US), Rhine-Ruhr area (Germany), Lancashire (UK)
- Were these regions unlucky, or is specializing systematically detrimental?
- **This paper:** Role of regional specialization in explaining economic fortunes

# Introduction

- Conventional economic wisdom: Specialization is beneficial
  $\rightarrow$ Specialization = Concentration of economic activity across industries
    - Inter-regional trade gains from comparative advantage
    - Intra-regional productivity gains from knowledge spillovers and agglomeration
- Historically: Once-thriving highly specialized hubs often face severe declines
    - Well-known examples: Rust Belt (US), Rhine-Ruhr area (Germany), Lancashire (UK)
- Were these regions unlucky, or is specializing systematically detrimental?
- **This paper:** Role of regional specialization in explaining economic fortunes
    1. How does regional specialization affect growth?
    2. What is the optimal regional specialization?

# This Paper

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$ *(factor adjustment costs)* + *(financial friction)*

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$ *(factor adjustment costs)* + *(financial friction)*
- Optimal specialization: Regional planner balances agglomeration & frictions

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$ *(factor adjustment costs)* + *(financial friction)*
- Optimal specialization: Regional planner balances agglomeration & frictions

**Quantification:**

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$ *(factor adjustment costs)* + *(financial friction)*
- Optimal specialization: Regional planner balances agglomeration & frictions

**Quantification:**

- Model captures half of observed trade-off

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$ *(factor adjustment costs)* + *(financial friction)*
- Optimal specialization: Regional planner balances agglomeration & frictions

**Quantification:**

- Model captures half of observed trade-off $\rightarrow$ financial friction accounts for 56% of it

# This Paper

**Empirics:** Document novel specialization trade-off in U.S. regional growth since 1950

$\Rightarrow$ Highly specialized regions have higher short-run income but lower long-run growth

i) As regions grow, they become more specialized (and vice versa)

ii) At the region-industry level, specialization is highly persistent

**Theory:** Link specialization to growth

- Benefits: Productivity & income $\uparrow$ *(agglomeration)*
- Costs: Exposure to sectoral shocks $\uparrow$ *(factor adjustment costs)* + *(financial friction)*
- Optimal specialization: Regional planner balances agglomeration & frictions

**Quantification:**

- Model captures half of observed trade-off $\rightarrow$ financial friction accounts for 56% of it
- Efficient regional specialization in 1950 raises welfare by 1.2-2.2 percent

# The contribution of this paper

## The contribution of this paper

1. **Regional growth:**

   [Solow (1956), Baumol (1986), Barro and Sala-i-Martin (1991), Autor & Dorn (2013), Giannone (2022), Eckert & Peters (2023), Comin et al (2021), Gaubert et al (2020), Caselli et al (2016)]

   *Contribution:* Document specialization trade-off in U.S. regional growth since 1950

# The contribution of this paper

1. **Regional growth:**

   [Solow (1956), Baumol (1986), Barro and Sala-i-Martin (1991), Autor & Dorn (2013), Giannone (2022), Eckert & Peters (2023), Comin et al (2021), Gaubert et al (2020), Caselli et al (2016)]

   *Contribution:* Document specialization trade-off in U.S. regional growth since 1950

2. **Industrial Specialization:**

   [Jacobs (1961, 1970), Imbs & Waczarg (2003), Gaubert et al (2018), Glaeser (2019), Caselli et al (2020), Nagy (2023), Walsh (2023), Bartelme et al (2024), Heblich et al (2025)]

   *Contribution:* Endogenize costs of specialization + derive optimal specialization

# The contribution of this paper

1. **Regional growth:**

   [Solow (1956), Baumol (1986), Barro and Sala-i-Martin (1991), Autor & Dorn (2013), Giannone (2022), Eckert & Peters (2023), Comin et al (2021), Gaubert et al (2020), Caselli et al (2016)]

   *Contribution:* Document specialization trade-off in U.S. regional growth since 1950

2. **Industrial Specialization:**

   [Jacobs (1961, 1970), Imbs & Waczarg (2003), Gaubert et al (2018), Glaeser (2019), Caselli et al (2020), Nagy (2023), Walsh (2023), Bartelme et al (2024), Heblich et al (2025)]

   *Contribution:* Endogenize costs of specialization + derive optimal specialization

3. **Long-run implications of financial frictions:**

   [Kiyotaki & Moore (1997), Bernanke, Gertler & Gilchrist (1999), Mendoza (2010), Gertler & Karadi (2012), Bianchi (2011), Bianchi & Mendoza (2019), Bonciani et al (2023)]

   *Contribution:* Derive financial friction in multi-industry setting + long-run effects

# Roadmap

# Roadmap

1. Empirical results:

# Roadmap

1. Empirical results:

   $\Rightarrow$ Highly specialized regions have higher income in the short run but lower long-run growth

      i) As regions grow, they become more specialized (and vice versa)

      ii) At the region-industry level, specialization is highly persistent

# Roadmap

1. Empirical results:

   $\Rightarrow$ Highly specialized regions have higher income in the short run but lower long-run growth

   i) As regions grow, they become more specialized (and vice versa)

   ii) At the region-industry level, specialization is highly persistent

2. Theory: Formalize benefits & costs of specialization

# Roadmap

1. Empirical results:

   $\Rightarrow$ Highly specialized regions have higher income in the short run but lower long-run growth

   i) As regions grow, they become more specialized (and vice versa)

   ii) At the region-industry level, specialization is highly persistent

2. Theory: Formalize benefits & costs of specialization

3. Quantitative Analysis:

   - Quantify relevance of specialization channels for growth
   - Rationalize U.S. regional growth since 1950

# Roadmap

1. Empirical results:
   $\Rightarrow$ Highly specialized regions have higher income in the short run but lower long-run growth
   i) As regions grow, they become more specialized (and vice versa)
   ii) At the region-industry level, specialization is highly persistent
2. Theory: Formalize benefits & costs of specialization
3. Quantitative Analysis:
   - Quantify relevance of specialization channels for growth
   - Rationalize U.S. regional growth since 1950
4. Efficiency & Welfare: Constrained-efficient specialization

# Roadmap

1. Empirical results:

   $\Rightarrow$ Highly specialized regions have higher income in the short run but lower long-run growth

   i) As regions grow, they become more specialized (and vice versa)

   ii) At the region-industry level, specialization is highly persistent

2. Theory: Formalize benefits & costs of specialization

3. Quantitative Analysis:
   - Quantify relevance of specialization channels for growth
   - Rationalize U.S. regional growth since 1950

4. Efficiency & Welfare: Constrained-efficient specialization

5. Conclusion

# Empirical results

# Data

## Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]
  2. County Business Patterns (1950-2020):
     - County-industry aggregates: population, employment, income, output

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]
  2. County Business Patterns (1950-2020):
     - County-industry aggregates: population, employment, income, output
  3. US Housing Census (1970-2020):
     - County-level decennial sample of housing & land units, types & value

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]
  2. County Business Patterns (1950-2020):
     - County-industry aggregates: population, employment, income, output
  3. US Housing Census (1970-2020):
     - County-level decennial sample of housing & land units, types & value
- Measuring Specialization = concentration of economic activity across industries

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]
  2. County Business Patterns (1950-2020):
     - County-industry aggregates: population, employment, income, output
  3. US Housing Census (1970-2020):
     - County-level decennial sample of housing & land units, types & value
- Measuring Specialization = concentration of economic activity across industries
  - Baseline: Gini on county-level income shares by 3-digit industry [Imbs & Wacziarg (2003)]

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]
  2. County Business Patterns (1950-2020):
     - County-industry aggregates: population, employment, income, output
  3. US Housing Census (1970-2020):
     - County-level decennial sample of housing & land units, types & value
- Measuring Specialization = concentration of economic activity across industries
  - Baseline: Gini on county-level income shares by 3-digit industry [Imbs & Wacziarg (2003)]
    $\rightarrow$ Gini = 1: maximal specialization (all income generated in one industry)

# Data

- US labor markets (722 Commuting Zones; Dorn, 2009): 1950-2020
- Three data sources:
  1. US Population Census (1950-2020):
     - Decennial representative sample of income, work, industry, demography and location
     - Baseline sample: Earnings of employed individuals, 15-60 years old [Heathcote et al (2023)]
  2. County Business Patterns (1950-2020):
     - County-industry aggregates: population, employment, income, output
  3. US Housing Census (1970-2020):
     - County-level decennial sample of housing & land units, types & value
- Measuring Specialization = concentration of economic activity across industries
  - Baseline: Gini on county-level income shares by 3-digit industry [Imbs & Wacziarg (2003)]
    → Gini = 1: maximal specialization (all income generated in one industry)
  - Robustness: other measures (HHI, max share), other variables (employment, value added)



▸ Topcoding ▸ Further Details

# Fact 1: The Specialization Trade-off

# Fact 1: The Specialization Trade-off

- Define
  - $r$ for commuting zone $r = \{1, ..., 722\}$
  - $Y_r$ as dependent variable
  - $Gini_{r,1950}$ as 1950 Gini on income p.c. by 3-digit industry

$$Y_r = \alpha + \beta \cdot Gini_{r,1950} \qquad\qquad + \epsilon_r$$

# Fact 1: The Specialization Trade-off

- Define
  - $r$ for commuting zone $r = \{1, ..., 722\}$
  - $Y_r$ as dependent variable
  - $Gini_{r,1950}$ as 1950 Gini on income p.c. by 3-digit industry

$$Y_r = \alpha + \beta \cdot Gini_{r,1950} + \gamma' \cdot Z_r \qquad + \epsilon_r$$

  - $Z_r$ including a set of control variables:
    - 1950 log income p.c. [Barro & Sala-i-Martin (1992)]
    - 1950 population [Eckert, Ganapati & Walsh (2024)]
    - 1950 share of high-skilled workers [Autor & Dorn (2013)]
    - 1950 old-age dependency ratio [Autor, Dorn & Hanson (2019)]
    - 1950 share of female workers [Fosso, Bergholt, Furlanetto (2025)]

# Fact 1: The Specialization Trade-off

- Define
  - $r$ for commuting zone $r = \{1, ..., 722\}$
  - $Y_r$ as dependent variable
  - $Gini_{r,1950}$ as 1950 Gini on income p.c. by 3-digit industry

$$Y_r = \alpha + \beta \cdot Gini_{r,1950} + \gamma' \cdot Z_r + \delta \cdot \hat{g}_r + \epsilon_r$$

  - $Z_r$ including a set of control variables
  - $\hat{g}_r$ as shift-share predicted growth from structural change [Borusyak et al (2025)]

$$\hat{g}_r = \sum_{i=1}^{I} s_{i,r,1950} \cdot g_i^{US}$$

  with
    - $s_{i,r,1950}$ as 1950 income share in industry $i$
    - $g_i^{US}$ as 1950-2020 US growth in industry $i$

# Fact 1: The Specialization Trade-off after controls

Highly specialized regions are richer in the short-run and have lower long-run growth.

# Fact 1: The Specialization Trade-off after controls

Highly specialized regions are richer in the short-run and have lower long-run growth.

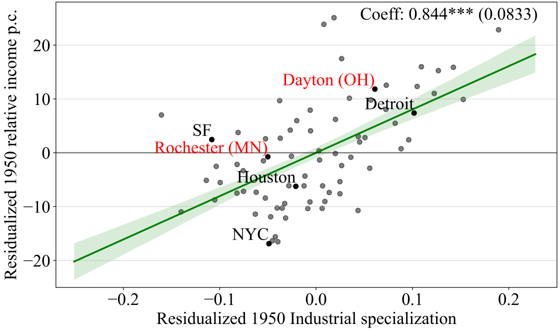



**Figure 1:** 1950 Income level

# Fact 1: The Specialization Trade-off after controls

Highly specialized regions are richer in the short-run and have lower long-run growth.

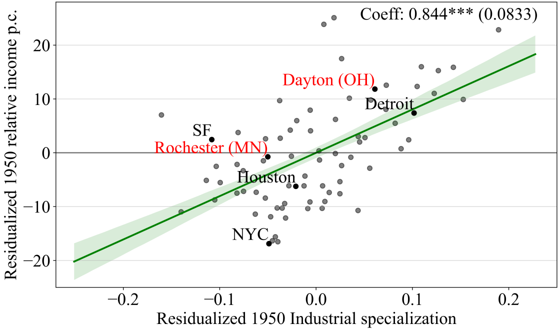



**Figure 1:** 1950 Income level

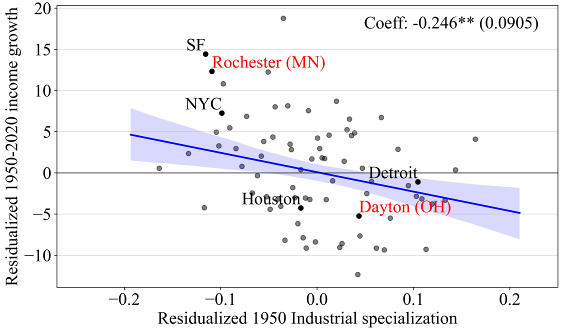



**Figure 2:** 1950-2020 Growth



Regression table

# Fact 2: As regions grow, they become more specialized

# Fact 2: As regions grow, they become more specialized

- Goals:
    1. Characterize dynamic relationship between specialization and income
    2. Observe how regions move in distribution

# Fact 2: As regions grow, they become more specialized

- Goals:
    1. Characterize dynamic relationship between specialization and income
    2. Observe how regions move in distribution
- Key point: dynamics can be highly non-linear [Imbs & Wacziarg (2003)]

# Fact 2: As regions grow, they become more specialized

- Goals:
  1. Characterize dynamic relationship between specialization and income
  2. Observe how regions move in distribution

- Key point: dynamics can be highly non-linear [Imbs & Wacziarg (2003)]

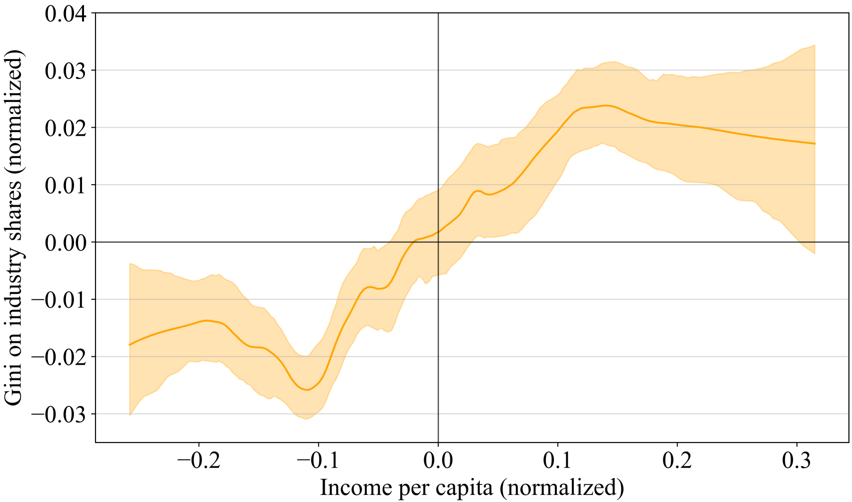
- Define non-parametric locally weighted regression:
  - $i$ as single observation: Commuting Zone $\times$ Year
  - $y_i$ as normalized specialization (Gini)
  - $x_i$ as normalized per capita income

$$y_i = \alpha(x_i) + \beta(x_i)x_i + \epsilon_i$$

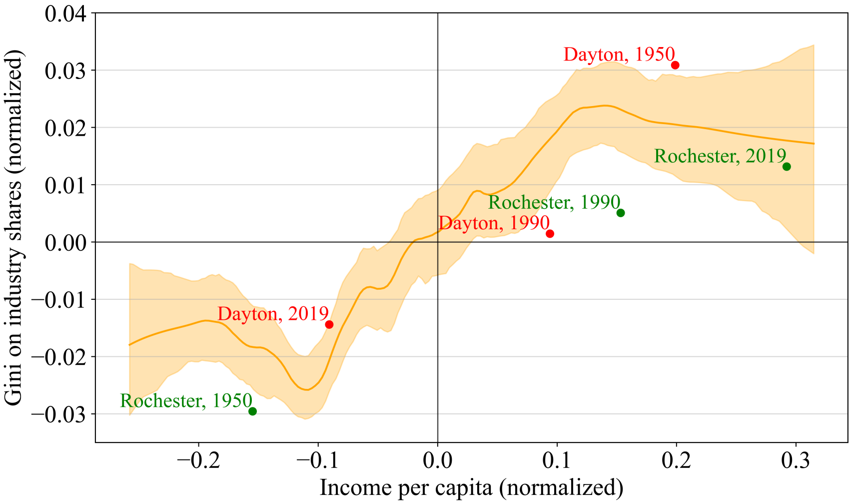
▸ Further details

# Fact 2: As regions grow, they become more specialized

# Fact 2: As regions grow, they become more specialized



# Fact 2: As regions grow, they become more specialized




▸ Further details

# Fact 3: Specialization at the region-industry level is highly persistent

# Fact 3: Specialization at the region-industry level is highly persistent

- Define
  - Revealed Comparative Advantage (RCA): $RCA_{irt} = \frac{Y_{irt}}{Y_{rt}} / \frac{Y_{it}^{US}}{Y_{t}^{US}}$
    $\rightarrow$ Measure how much a region is relatively specialized in one industry $i$

# Fact 3: Specialization at the region-industry level is highly persistent

- Define
  - Revealed Comparative Advantage (RCA): $RCA_{irt} = \frac{Y_{irt}}{Y_{rt}} / \frac{Y_{it}^{US}}{Y_{t}^{US}}$
    $\rightarrow$ Measure how much a region is relatively specialized in one industry $i$
  - RankRCA$_{irt}$: Rank region-industries by RCA

# Fact 3: Specialization at the region-industry level is highly persistent

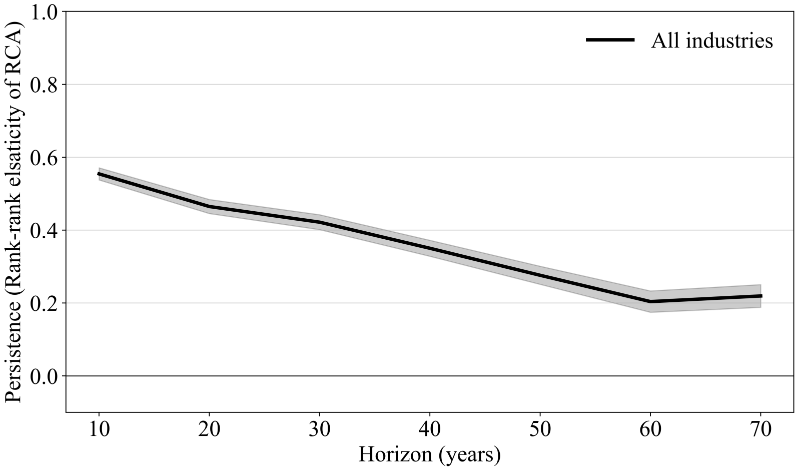
- Define
  - Revealed Comparative Advantage (RCA): $RCA_{irt} = \frac{Y_{irt}}{Y_{rt}} / \frac{Y_{it}^{US}}{Y_{t}^{US}}$
    $\rightarrow$ Measure how much a region is relatively specialized in one industry $i$
  - RankRCA$_{irt}$: Rank region-industries by RCA
  - $\delta_{r,t}$ as region-year FE
  - $\gamma_{i,t}$ as industry-year FE
  - $h$ as horizon

$$\text{logRankRCA}_{i,r,t} = \alpha + \beta_h \cdot \text{logRankRCA}_{i,r,t-h} + \delta_{r,t} + \gamma_{i,t} + \epsilon_{i,r,t}$$

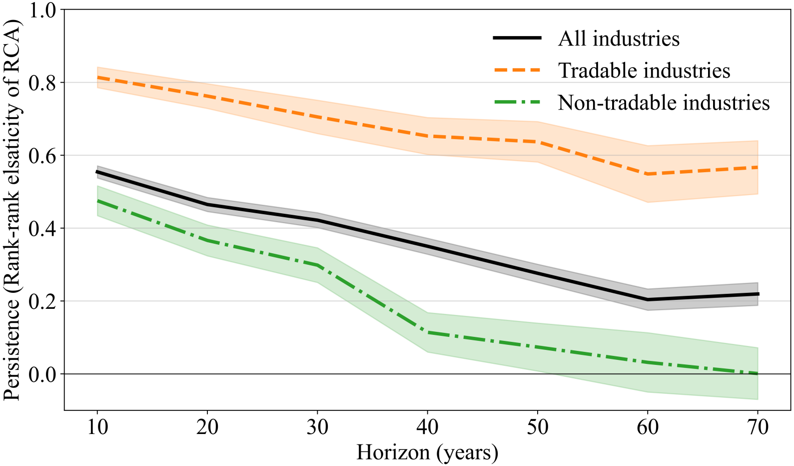
- Coefficent $\beta_h$: Rank-rank elasticity of RCA (persistence measure)

Further details

# Fact 3: Specialization at the region-industry level is highly persistent



# Fact 3: Specialization at the region-industry level is highly persistent



# Checkpoint

# Checkpoint

- **Key take-aways**:

# Checkpoint

- **Key take-aways**:
    - $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth

# Checkpoint

- **Key take-aways**:

  ⇒ Highly specialized regions are richer initially and have lower long-run growth

  i) As regions grow, they become more specialized

# Checkpoint

- **Key take-aways**:
  $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth
  i) As regions grow, they become more specialized
  ii) At the region-industry level, specialization is highly persistent

# Checkpoint

- Key take-aways:

  ⇒ Highly specialized regions are richer initially and have lower long-run growth

  i) As regions grow, they become more specialized

  ii) At the region-industry level, specialization is highly persistent

- Extensions and Robustness: ▸ Role of tradability ▸ Horizons ▸ Industries ▸ Persistence ▸ Measures

# Checkpoint

- **Key take-aways**:

  $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth

  i) As regions grow, they become more specialized

  ii) At the region-industry level, specialization is highly persistent

- Extensions and Robustness: ▸ Role of tradability ▸ Horizons ▸ Industries ▸ Persistence ▸ Measures

- Next: Formalize specialization trade-off theoretically

  1. Quantify role of specialization for long-run growth
  2. Assess welfare under optimal specialization

# Model

# Model environment

# Model environment

- Focus on single region (small open economy)

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$

## Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$
    - Stochastic productivity: $\bar{z}_{i,t}$

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$
  - Stochastic productivity: $\bar{z}_{i,t}$
  - Intra-industry Agglomeration: $z_i = \bar{z}_i \cdot k_i^{\xi_i}$ with $\xi_i \geq 0$

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$
  - Stochastic productivity: $\bar{z}_{i,t}$
  - Intra-industry Agglomeration: $z_i = \bar{z}_i \cdot k_i^{\xi_i}$ with $\xi_i \geq 0$
  - Convex capital adjustment costs: $\Phi_i(k_{i,t}, k_{i,t+1})$

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$
  - Stochastic productivity: $\bar{z}_{i,t}$
  - Intra-industry Agglomeration: $z_i = \bar{z}_i \cdot k_i^{\xi_i}$ with $\xi_i \geq 0$
  - Convex capital adjustment costs: $\Phi_i(k_{i,t}, k_{i,t+1})$
- Financial friction: Occasionally binding collateral constraint

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$
    - Stochastic productivity: $\bar{z}_{i,t}$
    - Intra-industry Agglomeration: $z_i = \bar{z}_i \cdot k_i^{\xi_i}$ with $\xi_i \geq 0$
    - Convex capital adjustment costs: $\Phi_i(k_{i,t}, k_{i,t+1})$
- Financial friction: Occasionally binding collateral constraint
    - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]

# Model environment

- Focus on single region (small open economy)
- Continuum of identical individuals produce using capital $k$
- Multiple industries $i$ producing single final good $c$
    - Stochastic productivity: $\bar{z}_{i,t}$
    - Intra-industry Agglomeration: $z_i = \bar{z}_i \cdot k_i^{\xi_i}$ with $\xi_i \geq 0$
    - Convex capital adjustment costs: $\Phi_i(k_{i,t}, k_{i,t+1})$
- Financial friction: Occasionally binding collateral constraint
    - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]
    - Borrowing against collateral: ($\theta \times$ market value of productive capital stock)

## Individual problem

# Individual problem

- Individuals solve

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to

$$c_t + \frac{b_{t+1}}{R_t} + q_t \sum\nolimits_i^I k_{i,t+1} = \sum\nolimits_i^I \Big[ \underbrace{z_{i,t} f(k_{i,t}) - \Phi_i(k_{i,t}, k_{i,t+1})}_{\text{Industry } i \text{ net output}} + q_t k_{i,t} \Big] + b_t$$

$$-\frac{b_{t+1}}{R_t} \leq \underbrace{\theta q_t \sum\nolimits_i^I k_{i,t}}_{\text{Collateral value}}$$

## Individual problem

- Individuals solve

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to

$$c_t + \frac{b_{t+1}}{R_t} + q_t \sum\nolimits_i^I k_{i,t+1} = \sum\nolimits_i^I \Big[ \underbrace{z_{i,t} f(k_{i,t}) - \Phi_i(k_{i,t}, k_{i,t+1})}_{\text{Industry } i \text{ net output}} + q_t k_{i,t} \Big] + b_t$$

$$-\frac{b_{t+1}}{R_t} \leq \underbrace{\theta q_t \sum\nolimits_i^I k_{i,t}}_{\text{Collateral value}}$$

- **Two decisions:**

# Individual problem

- Individuals solve

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to

$$c_t + \frac{b_{t+1}}{R_t} + q_t \sum\nolimits_i^I k_{i,t+1} = \sum\nolimits_i^I \Big[ \underbrace{z_{i,t} f(k_{i,t}) - \Phi_i(k_{i,t}, k_{i,t+1})}_{\text{Industry } i \text{ net output}} + q_t k_{i,t} \Big] + b_t$$

$$-\frac{b_{t+1}}{R_t} \leq \underbrace{\theta q_t \sum\nolimits_i^I k_{i,t}}_{\text{Collateral value}}$$

- **Two decisions:**
  1. Portfolio allocation: Allocate capital $k$ across industries $i \in \{1, ..., I\}$

# Individual problem

- Individuals solve

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to

$$c_t + \frac{b_{t+1}}{R_t} + q_t \sum_i^I k_{i,t+1} = \sum_i^I \Big[ \underbrace{z_{i,t} f(k_{i,t}) - \Phi_i(k_{i,t}, k_{i,t+1})}_{\text{Industry } i \text{ net output}} + q_t k_{i,t} \Big] + b_t$$

$$-\frac{b_{t+1}}{R_t} \leq \underbrace{\theta q_t \sum_i^I k_{i,t}}_{\text{Collateral value}}$$

- **Two decisions:**
  1. Portfolio allocation: Allocate capital $k$ across industries $i \in \{1, ..., I\}$
  2. Consumption vs saving: Borrow to invest in $k$

# Key optimality conditions (Competitive Equilibrium)

# Key optimality conditions (Competitive Equilibrium)

- Define:
  - $\tilde{q}_{i,t} = q_t - \phi_2(k_{i,t}, k_{i,t+1})$ as marginal capital price (net of adjustment costs)
  - $\eta_t \geq 0$ as Lagrange multiplier on the collateral constraint

# Key optimality conditions (Competitive Equilibrium)

- Define:
  - $\tilde{q}_{i,t} = q_t - \phi_2(k_{i,t}, k_{i,t+1})$ as marginal capital price (net of adjustment costs)
  - $\eta_t \geq 0$ as Lagrange multiplier on the collateral constraint

Portfolio allocation: $\underbrace{\tilde{q}_{i,t} u'(c_t)}_{\text{MC}} = \beta \, \mathbb{E}_t \Big[ \underbrace{u'(c_{t+1}) \big( \tilde{q}_{i,t+1} + z_{i,t+1} f'(k_{i,t+1}) \big)}_{\text{Expected MB of capital}} + \underbrace{\theta q_{t+1} \eta_{t+1}}_{\text{Collateral value}} \Big] \; \forall \, i$

# Key optimality conditions (Competitive Equilibrium)

- Define:
  - $\tilde{q}_{i,t} = q_t - \phi_2(k_{i,t}, k_{i,t+1})$ as marginal capital price (net of adjustment costs)
  - $\eta_t \geq 0$ as Lagrange multiplier on the collateral constraint

Portfolio allocation: $\underbrace{\tilde{q}_{i,t} u'(c_t)}_{\text{MC}} = \beta\, \mathbb{E}_t \Big[ \underbrace{u'(c_{t+1})\big(\tilde{q}_{i,t+1} + z_{i,t+1} f'(k_{i,t+1})\big)}_{\text{Expected MB of capital}} + \underbrace{\theta q_{t+1} \eta_{t+1}}_{\text{Collateral value}} \Big] \,\forall\, i$

Consumption-savings: $u'(c_t) = \beta R_t\, \mathbb{E}_t \big[u'(c_{t+1})\big] + \eta_t$

# Recursive Unregulated Competitive Equilibrium

A **Recursive Unregulated Competitive Equilibrium** is a set $\{V, c, b', k_i', q, \Gamma\}$ such that:

# Recursive Unregulated Competitive Equilibrium

A **Recursive Unregulated Competitive Equilibrium** is a set $\{V, c, b', k_i', q, \Gamma\}$ such that:

1. **Individual optimization:** Given $(B, b, \mathcal{K}, \mathcal{Z})$, agents solve

$$V(B, b, \mathcal{K}, \mathcal{Z}) = \max_{c, b', k_i'} u(c) + \beta \mathbb{E} V(B', b', \mathcal{K}', \mathcal{Z}')$$

subject to budget and collateral constraints.

# Recursive Unregulated Competitive Equilibrium

A **Recursive Unregulated Competitive Equilibrium** is a set $\{V, c, b', k'_i, q, \Gamma\}$ such that:

1. **Individual optimization:** Given $(B, b, \mathcal{K}, \mathcal{Z})$, agents solve

$$V(B, b, \mathcal{K}, \mathcal{Z}) = \max_{c, b', k'_i} u(c) + \beta \mathbb{E} V(B', b', \mathcal{K}', \mathcal{Z}')$$

   subject to budget and collateral constraints.

2. **Market clearing:**
   - Capital market: $\sum_i^I k_i = K$
   - Goods market: $\sum_i^I [z_i f(k_i) - \Phi_i(k_i, k'_i)] = c$

# Recursive Unregulated Competitive Equilibrium

A **Recursive Unregulated Competitive Equilibrium** is a set $\{V, c, b', k_i', q, \Gamma\}$ such that:

1. **Individual optimization:** Given $(B, b, \mathcal{K}, \mathcal{Z})$, agents solve

$$V(B, b, \mathcal{K}, \mathcal{Z}) = \max_{c, b', k_i'} u(c) + \beta \mathbb{E} V(B', b', \mathcal{K}', \mathcal{Z}')$$

   subject to budget and collateral constraints.

2. **Market clearing:**
   - Capital market: $\sum_i^I k_i = K$
   - Goods market: $\sum_i^I [z_i f(k_i) - \Phi_i(k_i, k_i')] = c$

3. **Consistency:**
   - Law of motion of aggregate bond holdings: $B' = \Gamma(B, \mathcal{K}, \mathcal{Z})$
   - Capital pricing function: $q(B, \mathcal{K}, \mathcal{Z}) = \hat{q}(B, \mathcal{K}, \mathcal{Z})$

# Specialization and financial frictions: Intuition

- The role of specialization:
  - Benefits: Productivity & income $\uparrow$ *(agglomeration)*
  - Costs: Costly & long-lasting reallocation *(factor adjustment costs)* + *(financial frictions)*

# Specialization and financial frictions: Intuition

- The role of specialization:
  - Benefits: Productivity & income $\uparrow$ *(agglomeration)*
  - Costs: Costly & long-lasting reallocation *(factor adjustment costs)* + *(financial frictions)*

- Financial friction: Occasionally binding collateral constraint
  - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]
  - Use value of productive capital as collateral [Gan (2007), Lustig et al. (2010)]

# Specialization and financial frictions: Intuition

- The role of specialization:
  - Benefits: Productivity & income ↑ *(agglomeration)*
  - Costs: Costly & long-lasting reallocation *(factor adjustment costs)* + *(financial frictions)*

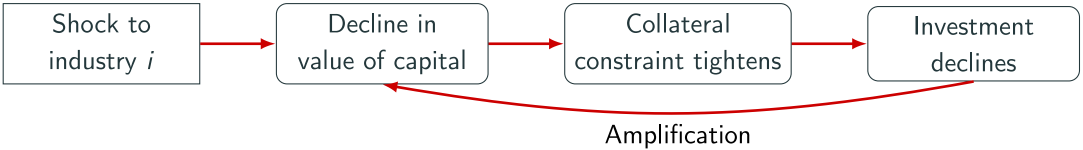
- Financial friction: Occasionally binding collateral constraint
  - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]
  - Use value of productive capital as collateral [Gan (2007), Lustig et al. (2010)]

Shock to industry $i$ → Decline in value of capital → Collateral constraint tightens → Investment declines

# Specialization and financial frictions: Intuition

- The role of specialization:
  - Benefits: Productivity & income ↑ *(agglomeration)*
  - Costs: Costly & long-lasting reallocation *(factor adjustment costs)* + *(financial frictions)*

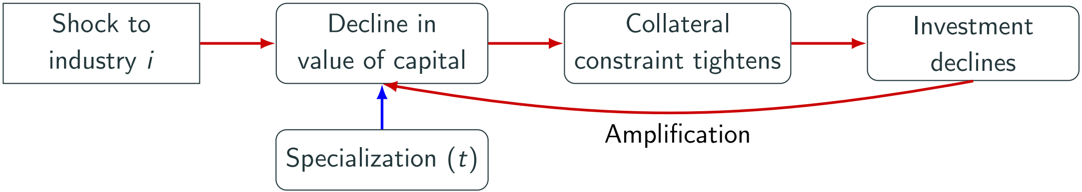
- Financial friction: Occasionally binding collateral constraint
  - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]
  - Use value of productive capital as collateral [Gan (2007), Lustig et al. (2010)]



# Specialization and financial frictions: Intuition

- The role of specialization:
  - Benefits: Productivity & income ↑ *(agglomeration)*
  - Costs: Costly & long-lasting reallocation *(factor adjustment costs)* + *(financial frictions)*

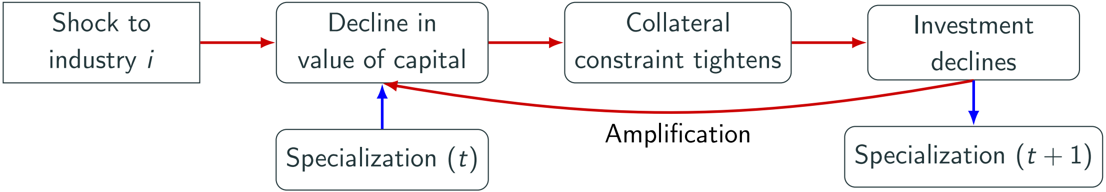
- Financial friction: Occasionally binding collateral constraint
  - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]
  - Use value of productive capital as collateral [Gan (2007), Lustig et al. (2010)]



# Specialization and financial frictions: Intuition

- The role of specialization:
  - Benefits: Productivity & income ↑ *(agglomeration)*
  - Costs: Costly & long-lasting reallocation *(factor adjustment costs)* + *(financial frictions)*

- Financial friction: Occasionally binding collateral constraint
  - Investment is debt-financed [Kiyotaki & Moore (1997), Bianchi & Mendoza (2018)]
  - Use value of productive capital as collateral [Gan (2007), Lustig et al. (2010)]



# Specialization and the value of capital

# Specialization and the value of capital

- Re-write pricing condition:

$$q_t = \mathbb{E}_t \sum_{j=0}^{\infty} \underbrace{\left[ \prod_{s=0}^{j} \mathbb{E}_{t+j} (\bar{R}^q_{t+1+s})^{-1} \right]}_{\text{Weighted capital return}} \underbrace{\bar{d}_{t+j+1}}_{\substack{\text{Weighted} \\ \text{expected dividends}}} - \underbrace{\bar{\phi}^2_t}_{\substack{\text{Weighted} \\ \text{Adj. costs}}}$$

# Specialization and the value of capital

- Re-write pricing condition:

$$q_t = \mathbb{E}_t \sum_{j=0}^{\infty} \underbrace{\left[ \prod_{s=0}^{j} \mathbb{E}_{t+j} (\bar{R}^q_{t+1+s})^{-1} \right]}_{\text{Weighted capital return}} \underbrace{\bar{d}_{t+j+1}}_{\substack{\text{Weighted} \\ \text{expected dividends}}} - \underbrace{\bar{\phi}^2_t}_{\substack{\text{Weighted} \\ \text{Adj. costs}}}$$

- Specialization **determines response of $q_t$ to** sectoral productivity $z_{i,t}$: $Cov(q, z_i)$

# Specialization and the value of capital

- Re-write pricing condition:

$$q_t = \mathbb{E}_t \sum_{j=0}^{\infty} \underbrace{\left[ \prod_{s=0}^{j} \mathbb{E}_{t+j} (\bar{R}^q_{t+1+s})^{-1} \right]}_{\text{Weighted capital return}} \underbrace{\bar{d}_{t+j+1}}_{\substack{\text{Weighted}\\ \text{expected dividends}}} - \underbrace{\bar{\phi}^2_t}_{\substack{\text{Weighted}\\ \text{Adj. costs}}}$$

- Specialization **determines response of $q_t$ to** sectoral productivity $z_{i,t}$: $Cov(q, z_i)$

  1. $[I = 1]$: $q = \mathbb{E}_t \sum_{j=0}^{\infty} \frac{z_{t+j+\mathbf{1}} f'(k_{t+j+\mathbf{1}})}{\prod_{s=\mathbf{0}}^{j} R^q_{t+\mathbf{1}+s}}$ $\rightarrow$ **Benchmark model** [Kiyotaki & Moore (1997)]

# Specialization and the value of capital

- Re-write pricing condition:

$$q_t = \mathbb{E}_t \sum_{j=0}^{\infty} \underbrace{\left[\prod_{s=0}^{j} \mathbb{E}_{t+j}(\bar{R}^q_{t+1+s})^{-1}\right]}_{\text{Weighted capital return}} \underbrace{\bar{d}_{t+j+1}}_{\substack{\text{Weighted} \\ \text{expected dividends}}} - \underbrace{\bar{\phi}^2_t}_{\substack{\text{Weighted} \\ \text{Adj. costs}}}$$

- Specialization **determines response of $q_t$ to** sectoral productivity $z_{i,t}$: $Cov(q, z_i)$

1. $[I = 1]$: $q = \mathbb{E}_t \sum_{j=0}^{\infty} \frac{z_{t+j+\mathbf{1}} f'(k_{t+j+\mathbf{1}})}{\prod_{s=\mathbf{0}}^{j} R^q_{t+\mathbf{1}+s}} \rightarrow$ **Benchmark model** [Kiyotaki & Moore (1997)]
2. $[I > 1$ and $\Phi = 0]$: $\lim_{I\rightarrow\infty} Cov\,(q, z_i) = 0 \rightarrow$ **Full diversification**

# Specialization and the value of capital

- Re-write pricing condition:

$$q_t = \mathbb{E}_t \sum_{j=0}^{\infty} \underbrace{\left[ \prod_{s=0}^{j} \mathbb{E}_{t+j} (\bar{R}^q_{t+1+s})^{-1} \right]}_{\text{Weighted capital return}} \underbrace{\bar{d}_{t+j+1}}_{\substack{\text{Weighted} \\ \text{expected dividends}}} - \underbrace{\bar{\phi}^2_t}_{\substack{\text{Weighted} \\ \text{Adj. costs}}}$$

- Specialization **determines response of $q_t$ to** sectoral productivity $z_{i,t}$: $Cov(q, z_i)$

1. $[I = 1]$: $q = \mathbb{E}_t \sum_{j=0}^{\infty} \frac{z_{t+j+1} f'(k_{t+j+1})}{\prod_{s=0}^{j} R^q_{t+1+s}}$ $\rightarrow$ **Benchmark model** [Kiyotaki & Moore (1997)]
2. $[I > 1$ and $\Phi = 0]$: $\lim_{I \to \infty} Cov(q, z_i) = 0$ $\rightarrow$ **Full diversification**
3. $[I > 1$ and $\Phi > 0]$: $Cov(q, z_i) = F(\sum_i w_i)$ $\rightarrow$ **Specialization matters for exposure**

# Specialization and the collateral constraint

# Specialization and the collateral constraint

- Re-write bond Euler condition:

$$\beta R_t \mathbb{E}_t \left[ \frac{u'(c_{t+1})}{u'(c_t)} \right] = (1 - \eta_t)$$

with

  - $\eta_t = 0$: Unconstrained consumption smoothing
  - $\eta_t > 0$: Constrained borrowing ability

## Specialization and the collateral constraint

- Re-write bond Euler condition:

$$\beta R_t \mathbb{E}_t \left[ \frac{u'(c_{t+1})}{u'(c_t)} \right] = (1 - \eta_t)$$

with

  - $\eta_t = 0$: Unconstrained consumption smoothing
  - $\eta_t > 0$: Constrained borrowing ability

- Collateral constraint **determines ability to invest**:

Portfolio allocation: $$\tilde{q}_{i,t} = \frac{1}{R_t} \mathbb{E}_t \Bigg[ \underbrace{(1 - \eta_t)}_{\text{Tightness of constraint}} \underbrace{\left(\tilde{q}_{i,t+1} + z_{i,t+1} f'(k_{i,t+1})\right)}_{\text{Expected MB of capital}} + \frac{\theta q_{t+1} \eta_{t+1}}{u'(c_t)} \Bigg] \forall\, i$$

# Quantitative Analysis

# Calibration

- Functional forms:
  - Utility: u(c) $= \frac{c^{(\mathbf{1}-\gamma)}-1}{(1-\gamma)}$
  - Production function: $f(k_i) = k_i^{\alpha}$
  - Adjustment costs: $\phi(k, k') = \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k$

# Calibration

- Functional forms:
  - Utility: $u(c) = \frac{c^{(1-\gamma)}-1}{(1-\gamma)}$
  - Production function: $f(k_i) = k_i^{\alpha}$
  - Adjustment costs: $\phi(k, k') = \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k$
- Key parameters set independently:

# Calibration

- Functional forms:
  - Utility: u(c) $= \frac{c^{(1-\gamma)}-1}{(1-\gamma)}$
  - Production function: $f(k_i) = k_i^{\alpha}$
  - Adjustment costs: $\phi(k, k') = \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k$

- Key parameters set independently:
  1. Industry-specific agglomeration: [Bartelme et al (2024)]
  2. Industry-specific adj. costs: [Hall (2004) and Groth & Khan (2010)]
  3. Tightness of collateral constraint (loan-to-value ratio): [Graham et al (2015)]

# Calibration

- Functional forms:
  - Utility: u(c) $= \frac{c^{(1-\gamma)}-1}{(1-\gamma)}$
  - Production function: $f(k_i) = k_i^{\alpha}$
  - Adjustment costs: $\phi(k, k') = \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k$

- Key parameters set independently:
  1. Industry-specific agglomeration: [Bartelme et al (2024)]
  2. Industry-specific adj. costs: [Hall (2004) and Groth & Khan (2010)]
  3. Tightness of collateral constraint (loan-to-value ratio): [Graham et al (2015)]

- Key parameters set internally:

# Calibration

- Functional forms:
  - Utility: $u(c) = \frac{c^{(1-\gamma)}-1}{(1-\gamma)}$
  - Production function: $f(k_i) = k_i^\alpha$
  - Adjustment costs: $\phi(k, k') = \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k$
- Key parameters set independently:
  1. Industry-specific agglomeration: [Bartelme et al (2024)]
  2. Industry-specific adj. costs: [Hall (2004) and Groth & Khan (2010)]
  3. Tightness of collateral constraint (loan-to-value ratio): [Graham et al (2015)]
- Key parameters set internally:
  1. 1950 fixed capital stock: Matching 1950 income shares
  2. Discount factor: Matching U.S. NFA position

# Calibration

| Parameter | Value | Source/ Target |
|---|---|---|
| *Parameters set independently* | | |
| Risk Aversion | $\gamma = 5$ | Average value in literature |
| Capital Share | $\alpha = 0.3$ | Avg. US capital income share |
| Adjustment Costs | $\Phi_i \in [0, 3.26]$ | Hall (2004); Groth & Khan (2010) |
| Agglomeration | $\xi_i \in [0.1, 0.29]$ | Bartelme et al. (2024) |
| Collateral regime | $\theta = 0.35$ | Historical LTV ratio (Graham et al, 2015) |
| Interest Rate | $\bar{R} = 1.3\%, \rho_R = 0.01$ | U.S. 90-day T-Bills |
| | $\sigma_R = 0.0186$ | |
| TFP Process | $\rho_i \in [0.71, 0.9]$ | Std. and autoc. of U.S. industry TFP |
| | $\sigma_i \in [0.013, 0.027]$ | |
| *Parameters set internally* | | |
| 1950 capital stock | $k_{i,1950} \in [0.1, 0.29]$ | Matching income shares |
| Discount Factor | $\beta = 0.95$ | Avg. NFA position = -20% of GDP |

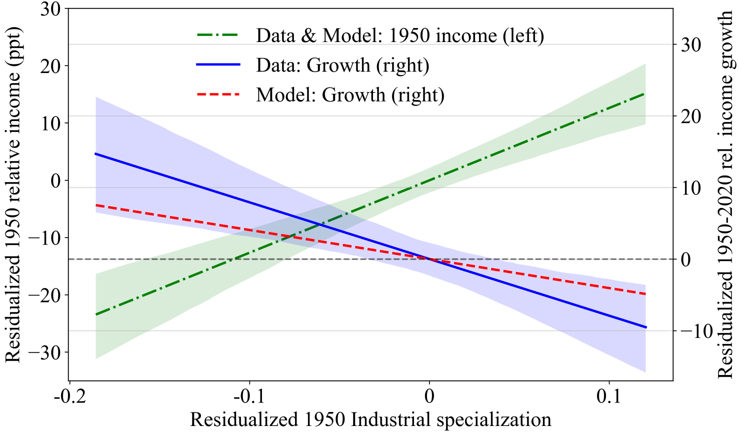
## The Regional Specialization Trade-off: Data vs. Model

# The Regional Specialization Trade-off: Data vs. Model

- Experiment: Match 1950 specialization (722 CZs) + simulate using realized TFP process

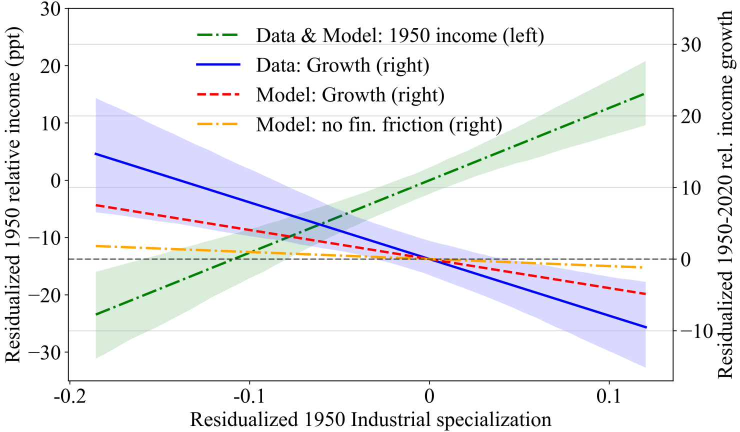
# The Regional Specialization Trade-off: Data vs. Model

- Experiment: Match 1950 specialization (722 CZs) + simulate using realized TFP process



# The Regional Specialization Trade-off: Data vs. Model

- Experiment: Match 1950 specialization (722 CZs) + simulate using realized TFP process




⇒ Financial friction captures 56% of adverse specialization effect on growth!

# Efficiency & Welfare

# Constrained Efficiency

# Constrained Efficiency

- Best feasible allocation taking market incompleteness as given

# Constrained Efficiency

- Best feasible allocation taking market incompleteness as given
- Constrained-efficient planner s.t. identical collateral constraint

# Constrained Efficiency

- Best feasible allocation taking market incompleteness as given
- Constrained-efficient planner s.t. identical collateral constraint
  - $\Rightarrow$ Internalize externalities
  - $\Rightarrow$ Instructs agents to deviate from private optimality conditions

# Constrained Efficiency

- Best feasible allocation taking market incompleteness as given
- Constrained-efficient planner s.t. identical collateral constraint
  - $\Rightarrow$ Internalize externalities
  - $\Rightarrow$ Instructs agents to deviate from private optimality conditions
- Two sources of inefficiency:

## Constrained Efficiency

- Best feasible allocation taking market incompleteness as given
- Constrained-efficient planner s.t. identical collateral constraint
  - $\Rightarrow$ Internalize externalities
  - $\Rightarrow$ Instructs agents to deviate from private optimality conditions
- Two sources of inefficiency:
  1. Agglomeration externality: Productivity = function of aggregate capital in industry $i$

# Constrained Efficiency

- Best feasible allocation taking market incompleteness as given

- Constrained-efficient planner s.t. identical collateral constraint
  - $\Rightarrow$ Internalize externalities
  - $\Rightarrow$ Instructs agents to deviate from private optimality conditions

- Two sources of inefficiency:

  1. Agglomeration externality: Productivity = function of aggregate capital in industry $i$

  2. Pecuniary externality: Price of capital = function of capital portfolio + bond position

# Constrained Efficiency

- Best feasible allocation taking market incompleteness as given
- Constrained-efficient planner s.t. identical collateral constraint
  - $\Rightarrow$ Internalize externalities
  - $\Rightarrow$ Instructs agents to deviate from private optimality conditions
- Two sources of inefficiency:
  1. Agglomeration externality: Productivity = function of aggregate capital in industry $i$

     $\Rightarrow$ Increase specialization
  2. Pecuniary externality: Price of capital = function of capital portfolio + bond position

     $\Rightarrow$ Increase diversification

# Constrained-efficient Planner

- Planner maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to

$$c_t + \frac{b_{t+1}}{R_t} = \sum_i^I \left[z_{i,t} f(k_{i,t}) - \Phi_i(k_{i,t}, k_{i,t+1})\right] + b_t$$

$$-\frac{b_{t+1}}{R_t} \leq \theta q_t$$

$$\sum_i^I k_{i,t} = \bar{K} \quad \forall\, t$$

$$\boxed{z_{i,t} = \bar{z}_{i,t} \cdot k_{i,t}^{\xi_i} \quad \forall\, i}$$

$$\boxed{\tilde{q}_{i,t} u'(c_t) = \beta\, \mathbb{E}_t \left[u'(c_{t+1})\left(\tilde{q}_{i,t+1} + z_{i,t+1} f'(k_{i,t+1})\right) + \theta q_{t+1} \eta_{t+1}\right] \forall\, i}$$

# Key optimality conditions (Planner Equilibrium)

# Key optimality conditions (Planner Equilibrium)

- Define:
  - $\eta_t^* \geq 0$ as Lagrange multiplier on the collateral constraint
  - $\delta_i$ as Lagrange multiplier on implementability constraint
  - $\lambda_t = u'(c_t) - \frac{u''(c_t)}{u'(c_t)}\theta\eta_t q_t - u''(c_t)\sum_i^I \delta_{i,t}\phi_{i,t}$ as shadow value of wealth

# Key optimality conditions (Planner Equilibrium)

- Define:
  - $\eta_t^* \geq 0$ as Lagrange multiplier on the collateral constraint
  - $\delta_i$ as Lagrange multiplier on implementability constraint
  - $\lambda_t = u'(c_t) - \frac{u''(c_t)}{u'(c_t)}\theta\eta_t q_t - u''(c_t)\sum_i^I \delta_{i,t}\phi_{i,t}$ as shadow value of wealth

$$\text{Portfolio all.:}\ \underbrace{\lambda_t\phi_{i,t}}_{\text{MC}} = \beta\mathbb{E}_t\Big[\underbrace{\lambda_{t+1}\big(\bar{z}_{i,t+1}(\xi_i+\alpha)k_{i,t+1}^{\xi_i+\alpha-1} - \phi_{i,t+1}\big)}_{\text{Social net MPK}} + \underbrace{\sum\nolimits_i^I \delta_{i,t}\Omega_{i,t+1}^K}_{\text{GE effect on price}}\Big] + \underbrace{\Xi}_{\substack{\text{Market}\\ \text{Clearing}}}$$

# Key optimality conditions (Planner Equilibrium)

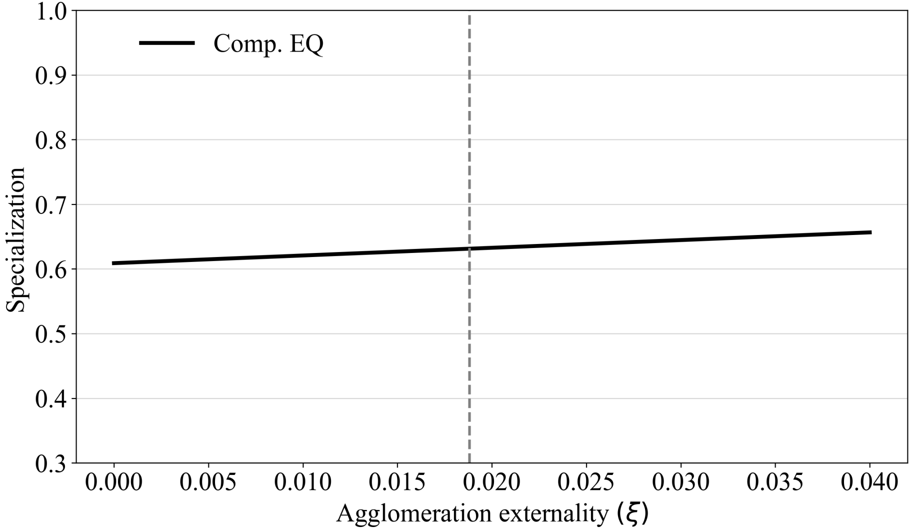
- Define:
  - $\eta_t^* \geq 0$ as Lagrange multiplier on the collateral constraint
  - $\delta_i$ as Lagrange multiplier on implementability constraint
  - $\lambda_t = u'(c_t) - \frac{u''(c_t)}{u'(c_t)}\theta\eta_t q_t - u''(c_t)\sum_i^I \delta_{i,t}\phi_{i,t}$ as shadow value of wealth

Portfolio all.: $$\underbrace{\lambda_t\phi_{i,t}}_{\text{MC}} = \beta\mathbb{E}_t\left[\underbrace{\lambda_{t+1}\left(\bar{z}_{i,t+1}(\xi_i+\alpha)k_{i,t+1}^{\xi_i+\alpha-1} - \phi_{i,t+1}\right)}_{\text{Social net MPK}} + \underbrace{\sum_i^I \delta_{i,t}\Omega_{i,t+1}^K}_{\text{GE effect on price}}\right] + \underbrace{\Xi}_{\text{Market Clearing}}$$

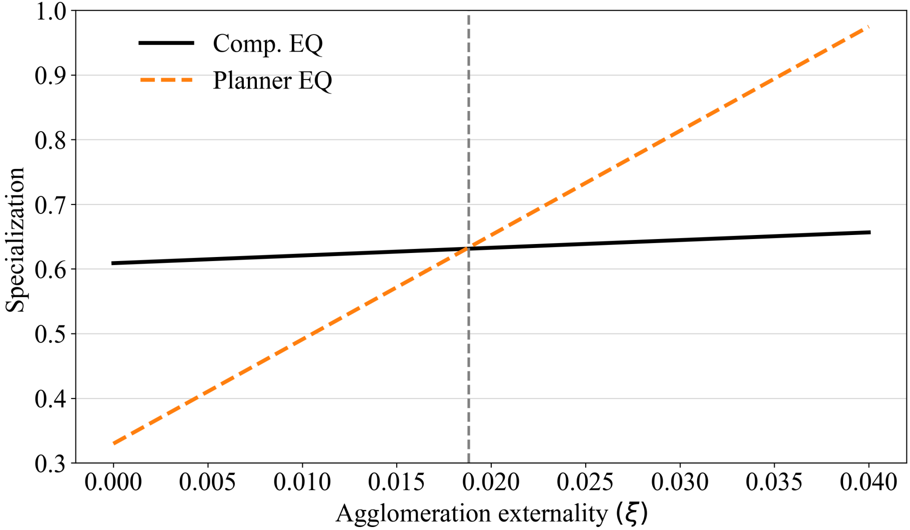
Cons.-savings: $$\lambda_t = \beta R_t\,\mathbb{E}_t\left[\lambda_{t+1} + \underbrace{\sum_i^I \delta_{i,t}\Omega_{i,t+1}^B}_{\text{GE effect on price}}\right] + \eta_t^*$$

# The Specialization Trade-off: Individual vs. Planner

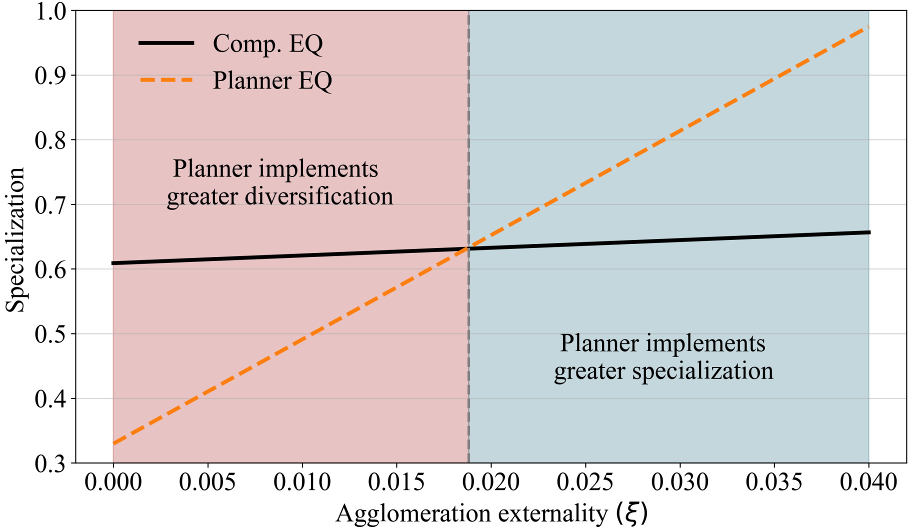
# The Specialization Trade-off: Individual vs. Planner



# The Specialization Trade-off: Individual vs. Planner

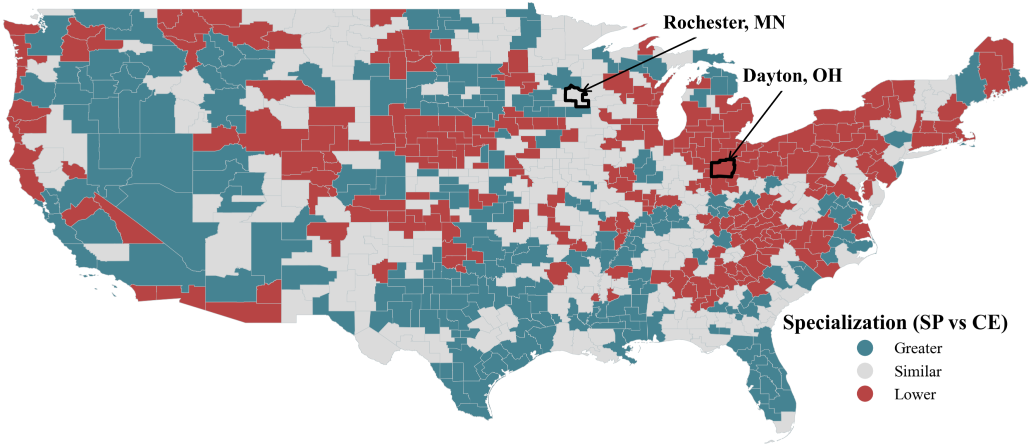


# The Specialization Trade-off: Individual vs. Planner



# Constrained-efficient regional specialization in 1950

# Constrained-efficient regional specialization in 1950



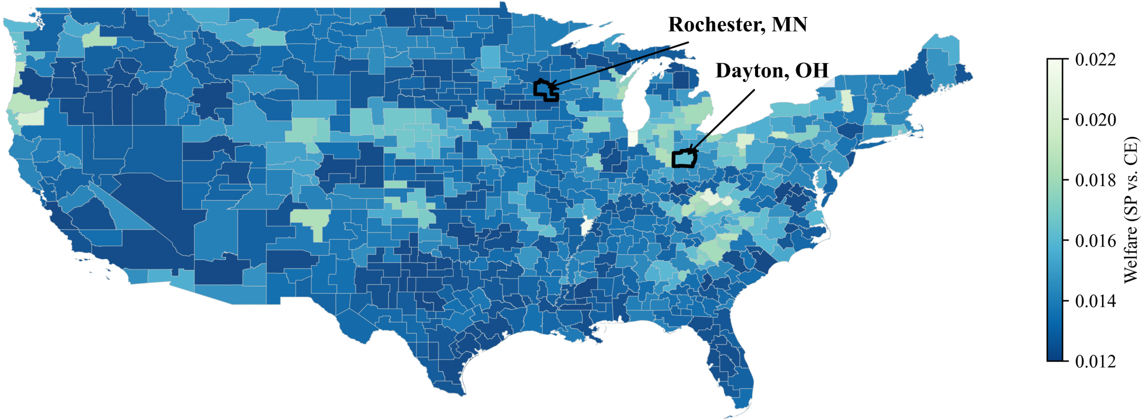
# Constrained-efficient welfare gains in 1950

# Constrained-efficient welfare gains in 1950

- Define welfare: $\Lambda = \left(\frac{V_{SP}}{V_{CE}}\right)^{\frac{1}{1-\gamma}} - 1$

# Constrained-efficient welfare gains in 1950

- Define welfare: $\Lambda = \left(\frac{V_{SP}}{V_{CE}}\right)^{\frac{1}{1-\gamma}} - 1$



# Conclusion

# Conclusion

- **Empirical take-away**: The Regional Specialization Trade-off

  $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth

- **Theoretical take-away**:

  $\Rightarrow$ Specialization: productivity $\uparrow$ + exposure to sectoral shock $\uparrow$

  $\Rightarrow$ Frictions make reallocation costly & long-lasting

- **Quantitative take-away**:

  $\Rightarrow$ Financial frictions play key role in generating adverse specialization effect on growth

  $\Rightarrow$ Efficient degree of specialization implies sizable welfare gains

# Conclusion

- **Empirical take-away**: The Regional Specialization Trade-off
  - $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth
- **Theoretical take-away**:
  - $\Rightarrow$ Specialization: productivity $\uparrow$ + exposure to sectoral shock $\uparrow$
  - $\Rightarrow$ Frictions make reallocation costly & long-lasting
- **Quantitative take-away**:
  - $\Rightarrow$ Financial frictions play key role in generating adverse specialization effect on growth
  - $\Rightarrow$ Efficient degree of specialization implies sizable welfare gains
- **Future Research**:

# Conclusion

- **Empirical take-away**: The Regional Specialization Trade-off
  - $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth
- **Theoretical take-away**:
  - $\Rightarrow$ Specialization: productivity $\uparrow$ + exposure to sectoral shock $\uparrow$
  - $\Rightarrow$ Frictions make reallocation costly & long-lasting
- **Quantitative take-away**:
  - $\Rightarrow$ Financial frictions play key role in generating adverse specialization effect on growth
  - $\Rightarrow$ Efficient degree of specialization implies sizable welfare gains
- **Future Research**:
  - Regional vs. National Planner (introduce migration frictions + place-based insurance)

# Conclusion

- **Empirical take-away**: The Regional Specialization Trade-off
  - $\Rightarrow$ Highly specialized regions are richer initially and have lower long-run growth
- **Theoretical take-away**:
  - $\Rightarrow$ Specialization: productivity $\uparrow$ + exposure to sectoral shock $\uparrow$
  - $\Rightarrow$ Frictions make reallocation costly & long-lasting
- **Quantitative take-away**:
  - $\Rightarrow$ Financial frictions play key role in generating adverse specialization effect on growth
  - $\Rightarrow$ Efficient degree of specialization implies sizable welfare gains
- **Future Research**:
  - Regional vs. National Planner (introduce migration frictions + place-based insurance)
  - Heterogeneously specialized countries in a currency union [w. de Ferra, Mitman & Romei]

Thank you very much!

# Appendix

# Topcoding income

- Topcoding: Recode/ cut income above certain threshold
  - In individual-level income survey
  - Prevent identification of individuals in sample

- Problem: manipulates income distribution for high earners

- Regression approach (following Heathcote et al, 2023):
  - Assume underlying distribution of income is Pareto
  - Forecast the mean top-coded income by extrapolating Pareto density fitted to upper end of non-top-coded income
  - Following algorithm by David Domeij

Return

# Industry details

# Industry details

| | Industry | 1950 | 1990 | 2020 | Tradable |
|---|---|---|---|---|---|
| 1 | Agriculture | 20.71 | 3.61 | 3.46 | Yes |
| 2 | Business Services | 2.96 | 4.43 | 7.61 | Yes |
| 3 | Communication | 0.61 | 1.52 | 1.36 | No |
| 4 | Construction | 8.75 | 9.98 | 11.91 | No |
| 5 | Durable | 13.53 | 15.88 | 10.77 | Yes |
| 6 | Entertainment | 0.66 | 1.06 | 1.28 | No |
| 7 | Finance | 2.20 | 4.47 | 4.79 | No |
| 8 | Mining | 3.99 | 1.90 | 1.82 | Yes |
| 9 | Nondurable | 9.48 | 8.64 | 5.77 | Yes |
| 10 | Personal Services | 2.37 | 1.39 | 1.60 | No |
| 11 | Routine Prof. Serv. | 4.39 | 11.26 | 13.19 | No |
| 12 | Non-routine Prof. Serv. | 0.37 | 2.02 | 3.33 | Yes |
| 13 | Public | 4.67 | 7.96 | 6.98 | No |
| 14 | Retail | 11.84 | 11.15 | 13.26 | No |
| 15 | Transportation | 8.09 | 6.61 | 6.91 | Yes |
| 16 | Utilities | 1.80 | 2.53 | 2.34 | No |
| 17 | Wholesale | 3.59 | 5.60 | 3.63 | Yes |

Return

# Fact 1: Controls

# Fact 1: Controls

| | 1950-2020 Growth | | 1950 Income p.c. | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Specialization | -0.233* | | 0.844*** | |
| | (0.0901) | | (0.084) | |
| Tradable | | -0.151*** | | 0.110** |
| | | (0.0388) | | (0.0423) |
| Non-tradable | | 0.632 | | -0.43 |
| | | (0.294) | | (0.456) |
| 1950 measures: | | | | |
| $\hat{g}$ | -0.180*** | -0.133* | -0.187** | -0.319*** |
| | (0.0471) | (0.0521) | (0.058) | (0.0631) |
| log income p.c. | -0.868*** | -0.885*** | | |
| | (0.0339) | (0.0323) | | |
| High-skill labor share | 1.435*** | 1.618*** | 6.042*** | 5.692*** |
| | (0.41) | (0.418) | (0.402) | (0.431) |
| Old-age dependency ratio | 0.0145** | 0.0120* | -0.0187*** | -0.0230*** |
| | (0.00532) | (0.00553) | (0.00484) | (0.00526) |
| Female labor share | 0.984*** | 0.965*** | 0.0754 | 0.283 |
| | (0.167) | (0.184) | (0.164) | (0.187) |
| Population | 170.6*** | 163.0*** | 136.8*** | 152.0*** |
| | (35.55) | (33.46) | (25.75) | (31.66) |
| N | 722 | 722 | 722 | 722 |
| adj. R-sq | 0.538 | 0.544 | 0.41 | 0.344 |

Return

# Regional specialization in the U.S.

# Regional specialization in the U.S.

The US **labor markets become more specialized** over time.

| Year | Gini on income shares | | | Gini on employment shares | | |
|---|---|---|---|---|---|---|
| | Mean | CV | p90/p10 | Mean | CV | p90/p10 |
| 1950 | 0.46 | 0.162 | 1.55 | 0.45 | 0.152 | 1.50 |
| 1970 | 0.48 | 0.123 | 1.35 | 0.47 | 0.116 | 1.35 |
| 1990 | 0.47 | 0.089 | 1.23 | 0.46 | 0.082 | 1.26 |
| 2010 | 0.53 | 0.089 | 1.29 | 0.50 | 0.073 | 1.20 |
| 2020 | 0.53 | 0.089 | 1.24 | 0.51 | 0.068 | 1.20 |

**Table 1:** U.S. Regional specialization over time

Return

# Production and agglomeration

# Production and agglomeration

- Multiple industries $i \in \{i, \ldots, I\}$ produce single tradable good $c$
- Productivity processes (AR1):

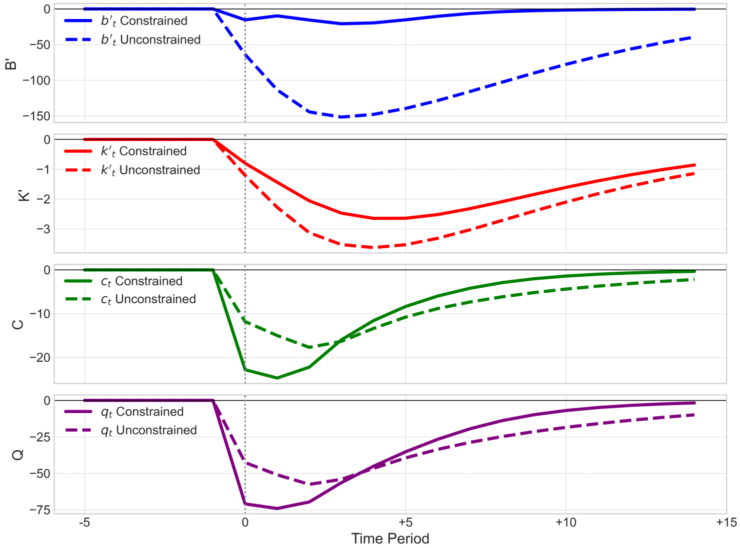
$$\bar{z}_{i,t} = \tilde{z}_i + g_{i,t}t + \rho u_{i,t-1} + \epsilon_{i,t} \quad \text{with } \epsilon_{i,t} \sim \mathcal{N}(0, \sigma_i^2)$$

- Agglomeration:

$$z_{i,t} = \bar{z}_{i,t} \cdot k_{i,t}^{\xi_i}$$

with intra-industry agglomeration $\xi_i \geq 0$ [Bartelme et al (2024)]

# IRF to a 2SD adverse productivity shock to one industry




Return