The Regional Keynesian Cross

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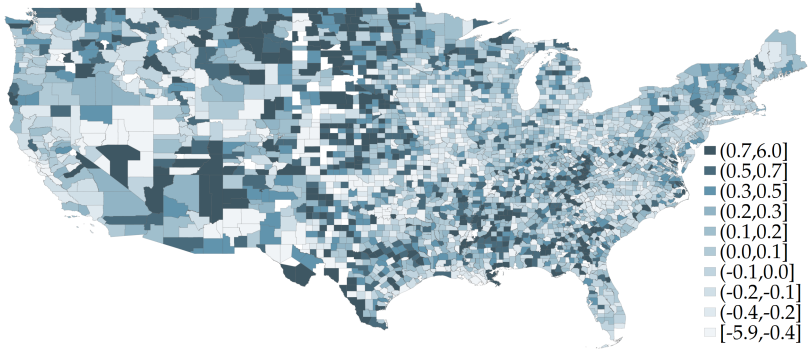
Regional Heterogeneity in the Response to MP



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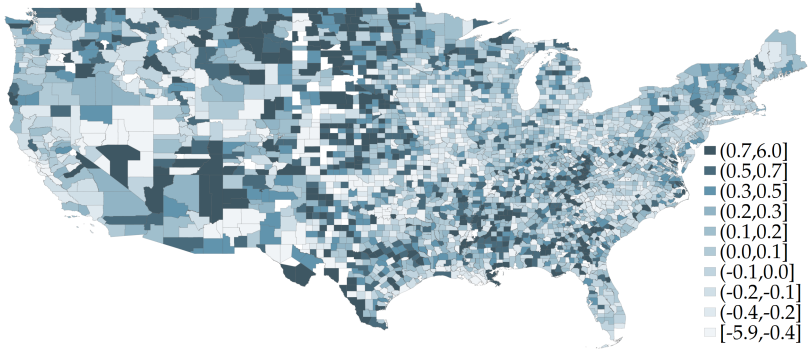

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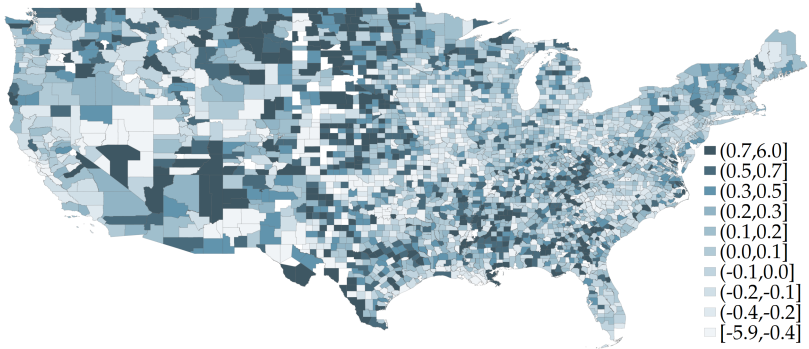

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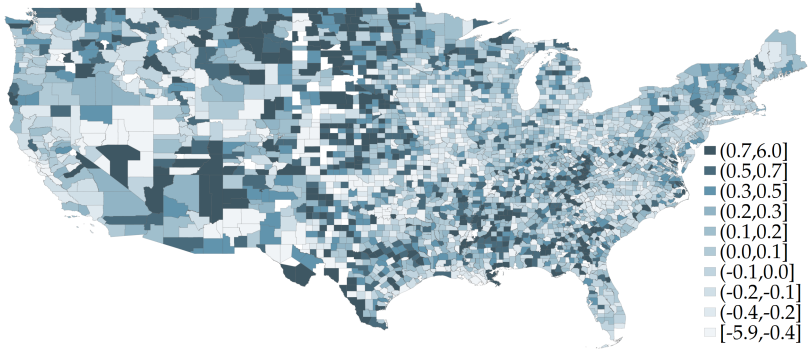

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- Large heterogeneity in the geographical transmission of MP shocks within the US
  - I Why?
  - II Does it matter?

What We Do & What We Find

- Document large heterogeneity in the regional response to MP across US counties:
  - Regional MPC & regional share of non-tradable employment amplify the response

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- National Keynesian Cross:
  - Joint distribution of MPCs & non tradability across space matters for national response
  - Representative region when all goods are tradable

Literature

I **Heterogeneity in Keynesian Frameworks** (?Bilbiie, 2008; Werning, 2015; Debortoli and Galí, 2018; Kaplan et al., 2018; Auclert, 2019; Hagedorn et al., 2019; de Ferra et al., 2020; Auclert et al., 2023, 2020, 2021a,b; **?**; **?**)

- ◇ Heterogeneity & MPCs shape the Keynesian multiplier

II **Optimal Currency Areas** (Mundell, 1961; McKinnon, 1963; Kenen, 1969; Alesina et al., 2002; Kenen and Meade, 2008; Farhi and Werning, 2016a, 2017)

- ◇ Openness to trade determines potency of monetary and fiscal stabilization tools

Our contribution: theoretically & empirically integrate I with II $\Rightarrow$ novel & testable insights

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- ▶ Sequence space methods (Mankiw and Reis, 2006; Boppart et al., 2018; Auclert et al., 2023)
- ▶ Open-economy macroeconomics (Obstfeld and Rogoff, 1995; Galí and Monacelli, 2005, 2008; Rey, 2013; Miranda-Agrippino and Rey, 2020)
- ▶ MP across space (Carlino and Defina, 1998; De Ridder and Pfajfar, 2017; Hauptmeier et al., 2023; Corsetti et al., 2021; Herreño and Pedemonte, 2022; Almgren et al., 2022)
- ▶ Cross-sectional identification (Nakamura and Steinsson, 2014, 2018; Beraja et al., 2018; Chodorow-Reich et al., 2021; Hazell et al., 2022; Wolf, 2021a,b)

Plan for Today

I Empirics: dissecting the regional heterogeneity in the response to MP

II Model set-up & outline of mechanism

III Regional Keynesian Cross

IV Aggregation: National Keynesian Cross

Empirics

MPCs & Non-Tradables Drive the Heterogeneous Response to MP

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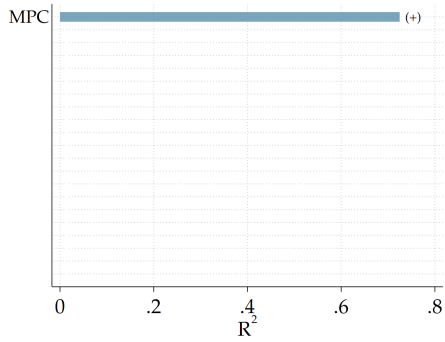
  1. Regress avg response on avg stock market wealth p.c. $\Rightarrow$ R^2 of 0.504



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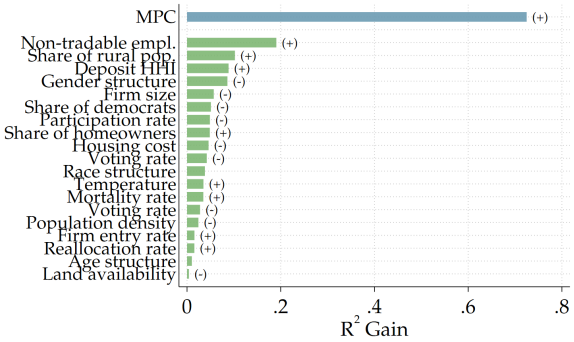

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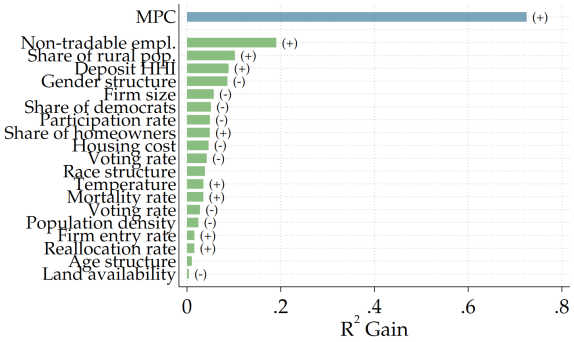

Model

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- NK block: wage rigidity + labor union ($\Rightarrow \ell_{jit} = L_{jt}$)

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Local agg. demand $\uparrow$

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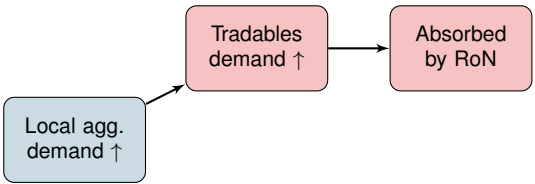

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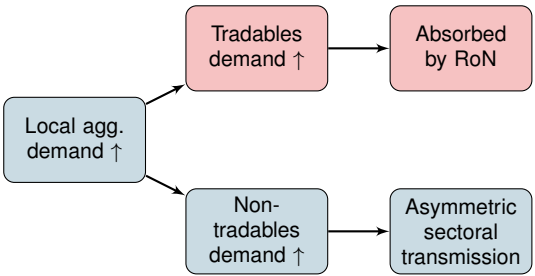

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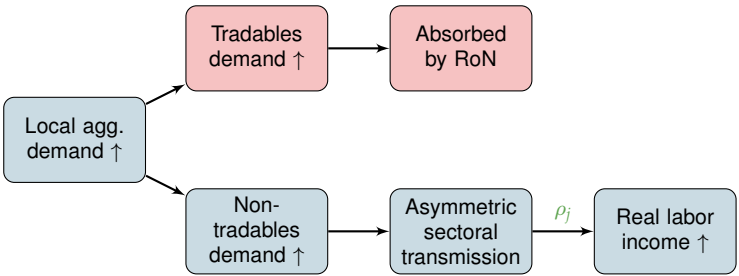

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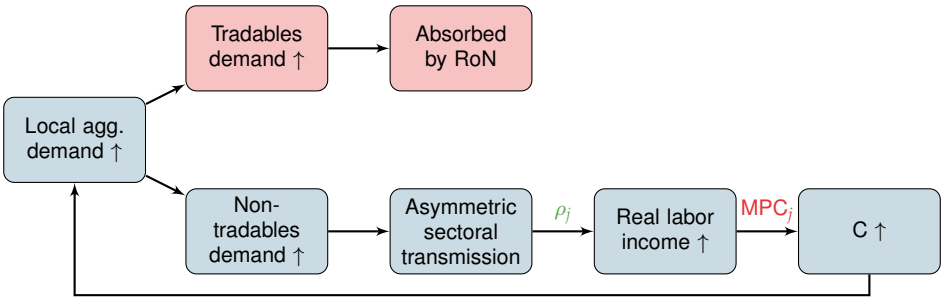

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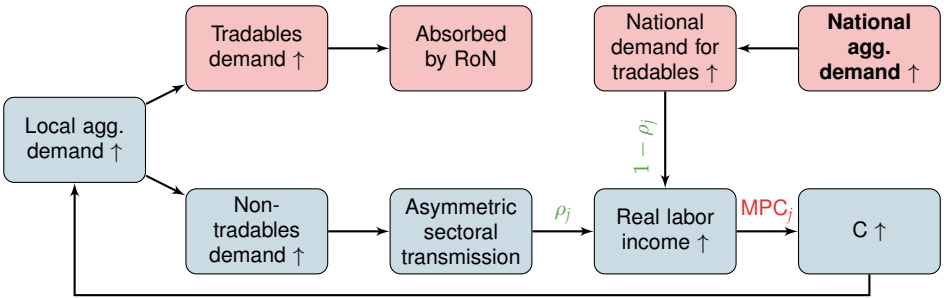

Sequence Space Definitions

- Regional aggregate consumption function captures all the heterogeneity:

$$\mathcal{C}_{jt}\left(\left\{Z_{js}\right\}_{s\geq 0},\left\{r_{js}\right\}_{s\geq 0}\right), \qquad Z_{js}\equiv\frac{W_{js}}{P_{js}}L_{js}$$

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- Stack in vector notation:

$$d\boldsymbol{L}_j \equiv \begin{bmatrix} d\log L_{j1} \\ d\log L_{j2} \\ \vdots \end{bmatrix}$$

The Regional Keynesian Cross

Proposition

The first-order response of employment $d\boldsymbol{L}_j$ to a monetary shock $d\boldsymbol{r}_j$ and tradable goods demand shock $d\boldsymbol{C}^T$ solves

$$d\boldsymbol{L}_j = \underbrace{\rho_j \left(\boldsymbol{M}_j^r d\boldsymbol{r}_j + \boldsymbol{M}_j d\boldsymbol{L}_j \right)}_{\text{Regional exposure}} + \underbrace{(1-\rho_j) d\boldsymbol{C}^T}_{\text{National exposure}} - \underbrace{\frac{\nu}{\eta}(1-\rho_j)\left(d\boldsymbol{L}_j - d\boldsymbol{C}^T \right)}_{\text{Expenditure switching}}$$

ν: elasticity of subs. between c^{NT} & c^T

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- Full dependence on national demand & homogeneous response when $\rho_j \to 0$:

$$d\boldsymbol{L}_j = d\boldsymbol{C}^T$$

MPC-Non tradability Complementarity

- Interaction between non tradability & MPC:

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  - "Cross-derivative" > 0: effect of MPCs on multiplier increasing in ρ_j
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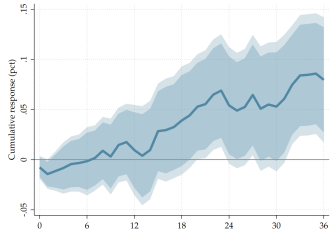
- Evidence of complementarity in the data $\rightarrow$ triple interaction



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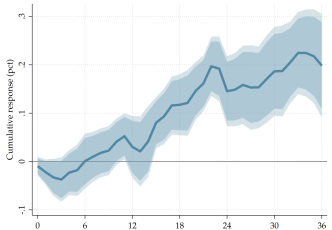

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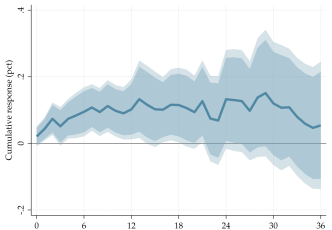

Triple inter.

The National Keynesian Cross

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$$d\boldsymbol{L} \quad = \quad \underbrace{\boldsymbol{M}^r \, d\boldsymbol{r} \quad + \quad \boldsymbol{M} \, d\boldsymbol{L}}_{\text{Representative county}}$$

The National Keynesian Cross

- Integrate RKCs over counties $j \Rightarrow$ nation-wide response $d\boldsymbol{L} \equiv \int d\boldsymbol{L}_j dj$:

$$d\boldsymbol{L} \quad = \quad \underbrace{\boldsymbol{M}^r \, d\boldsymbol{r} \quad + \quad \boldsymbol{M} \, d\boldsymbol{L}}_{\text{Representative county}} + \underbrace{\mathbb{C}\text{ov}(\boldsymbol{M}_j, d\boldsymbol{L}_j) + \mathbb{C}\text{ov}(\boldsymbol{M}_j^r, d\boldsymbol{r}_j)}_{\text{MPC heterogeneity}}$$

- Integrate RKCs over counties $j \Rightarrow$ nation-wide response $d\boldsymbol{L} \equiv \int d\boldsymbol{L}_j dj$:

$$d\boldsymbol{L} = \underbrace{\boldsymbol{M}^r \, d\boldsymbol{r} + \boldsymbol{M} \, d\boldsymbol{L}}_{\text{Representative county}} + \underbrace{\boldsymbol{M} \, \mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j) + \boldsymbol{M}^r \, \mathbb{C}\text{ov}(\rho_j, d\boldsymbol{r}_j) + \frac{\nu}{\eta} \, \mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j)}_{\text{Non tradability heterogeneity}}$$

The National Keynesian Cross

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$$d\boldsymbol{L} = \underbrace{\boldsymbol{M}^r\, d\boldsymbol{r} + \boldsymbol{M}\, d\boldsymbol{L}}_{\text{Representative county}} + \underbrace{\mathbb{C}\text{ov}(\boldsymbol{M}_j, d\boldsymbol{L}_j) + \mathbb{C}\text{ov}(\boldsymbol{M}_j^r, d\boldsymbol{r}_j)}_{\text{MPC heterogeneity}}$$
$$+ \underbrace{\boldsymbol{M}\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j) + \boldsymbol{M}^r\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{r}_j) + \frac{\nu}{\eta}\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j)}_{\text{Non tradability heterogeneity}}$$
$$+ \underbrace{\mathbb{C}\text{ov}(\boldsymbol{M}_j, (\rho_j - \rho) d\boldsymbol{L}_j) + \mathbb{C}\text{ov}(\boldsymbol{M}_j^r, (\rho_j - \rho) d\boldsymbol{r}_j)}_{\text{MPC-non tradability complementarity}}$$

- Integrate RKCs over counties $j \Rightarrow$ nation-wide response $d\boldsymbol{L} \equiv \int d\boldsymbol{L}_j dj$:

$$d\boldsymbol{L} = \underbrace{\boldsymbol{M}^r\, d\boldsymbol{r} + \boldsymbol{M}\, d\boldsymbol{L}}_{\text{Representative county}} + \underbrace{\mathbb{C}\text{ov}(\boldsymbol{M}_j, d\boldsymbol{L}_j) + \mathbb{C}\text{ov}(\boldsymbol{M}_j^r, d\boldsymbol{r}_j)}_{\text{MPC heterogeneity}}$$
$$+ \underbrace{\boldsymbol{M}\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j) + \boldsymbol{M}^r\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{r}_j) + \frac{\nu}{\eta}\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j)}_{\text{Non tradability heterogeneity}}$$
$$+ \underbrace{\mathbb{C}\text{ov}(\boldsymbol{M}_j, (\rho_j - \rho) d\boldsymbol{L}_j) + \mathbb{C}\text{ov}(\boldsymbol{M}_j^r, (\rho_j - \rho) d\boldsymbol{r}_j)}_{\text{MPC-non tradability complementarity}}$$

- Joint distribution of MPCs and non-tradability across space matters

The National Keynesian Cross

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$$+ \underbrace{\boldsymbol{M}\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j) + \boldsymbol{M}^r\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{r}_j) + \frac{\nu}{\eta}\,\mathbb{C}\text{ov}(\rho_j, d\boldsymbol{L}_j)}_{\text{Non tradability heterogeneity}}$$
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- Joint distribution of MPCs and non-tradability across space matters

Corollary

When $\rho_j \to 0$, as-if representative county, MPCs heterogeneity doesn't matter:

$$d\boldsymbol{L} = \boldsymbol{M}^r\, d\boldsymbol{r} + \boldsymbol{M}\, d\boldsymbol{L}$$

Conclusion

- Empirics:
  - Large regional heterogeneity in the transmission of MP within the US
  - Regional MPC & size of non-tradable sector matter
- NK model of a monetary union with two-layered heterogeneity & atomistic counties:
  - MPC
  - Size of non-tradable sector
- Regional Keynesian Cross $\longrightarrow$ MPC $\times$ size of non-tradable sector
- National Keynesian cross:
  - Joint distribution of MPCs & non tradability across space matters for the national response
  - Work in progress: quantify the national keynesian cross using sufficient statistics

Appendix

Regression Specification

Back

- Panel local-projection (weighted by 2000 population):

$$\Delta \log(L_{jt+h}) = \alpha_{jh} + \delta_{th} + \beta_{jh} \times D_{jh} \times \varepsilon_t + \sum_{\ell=1}^{12} \gamma_{h\ell} \Delta \log(L_{jt-\ell}) + u_{jht}$$

  - D_{jh}: Dummy for county j
  - α_{jh}: county fixed effect
  - δ_{th}: time fixed effect $\Rightarrow$ absorbs the shock
  - β_{jh}: county-specific slope $\Rightarrow$ unexplained heterogeneity

Data

Back

- Deposits: FDIC Summary of Dep, 1994-2015 avg
- Temperature:
  - North America Land Data Assimilation System, 2011 avg
- Firm size: County Business Patterns
  - Mean number of empl. per estab. 1990-2015 avg
- Age, race & gender: Population Estimates Program , 1990-2015 avg
  - Share $\leq$ 35 y.o. & share 40-65 y.o. (Leahy and Thapar, 2022)
  - Share of blacks & share of hispanics
  - Share of women
- Pop. density: 2010 US Census
- Land avail.: (Lutz and Sand, 2022) 2002-2015 avg
- Particip. rate: BLS Local Area Unem. Stats
  - 1990-2015 avg
- Realloc. & firm entry rates: Business Dyn. Stats
  - 1990-2015 avg
- Housing costs & homeown.: ACS, 2011-2015 avg
  - Share of househ. spending > 35% of income in housing
  - Share of owner occupied houses
- Voting rate: MIT Election Lab
  - 6 presidential elections 2000-2020

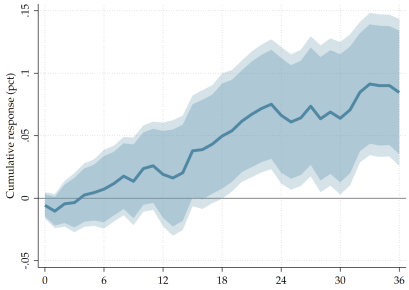
- For county j, year t compute non-tradable to tradable employment ratio: $\rho_{jt} = L_{jt}^{NT}/L_{jt}^{T}$
- Rank counties in quartiles based on ρ_{jt} & wealth p.c. $\Rightarrow$ indicator variables:
  - I $D_{jt}^{T} = 1$ if county j is in the top 25% of the ρ_{jt} distribution in year before t
  - II $D_{jt}^{W} = 1$ if county j is in the bottom 25% of the wealth p.c. distribution in year before t
- Panel local-projection (weighted by 2000 population):

$$\Delta \log(L_{jt+h}) = \alpha_{jh} + \delta_{th} + \beta_h^T \times D_{jt}^T \times \varepsilon_t + \beta_h^W \times D_{jt}^W \times \varepsilon_t + \alpha_h^T D_{jt}^T + \alpha_h^W D_{jt}^W + \sum_{\ell=1}^{12} \gamma_{h\ell} \Delta \log(L_{jt-\ell}) + u_{jht}$$

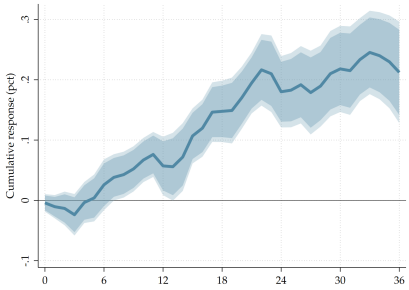
  - I Baseline group: high wealth (low MPC), low non-tradables counties
  - II β_h^T: differential response of high wealth, high non-tradables counties
  - III β_h^W: differential response of low wealth, low non-tradables counties

$$\Delta \log(L_{jt+h}) = \alpha_{jh} + \delta_{th} + \beta_h^T \times D_{jt}^T \times \varepsilon_t + \beta_h^W \times D_{jt}^W \times \varepsilon_t + \cdots + u_{jht}$$

- Response to a 1 std expansionary MP shock ε_t:



β_h^T



β_h^W

- Baseline group: high wealth (low MPC), low non-tradables counties
  - I High non-tradables, high wealth counties more responsive than the baseline
  - II Low wealth ($\approx$ high MPC) , low non-tradables counties more responsive than the baseline

Data for LPs

Back

- Monthly county-level employment (BLS, Local Area Unemployment Statistics)
- Annual sectoral employment at the county level (U.S. Census, County Business Patterns)
  - Classify into tradables and non-tradables as in Mian and Sufi (2014)
- Annual stock market wealth per capita at the county level $w_{j,t}$ (Chodorow-Reich et al., 2021)
- ε_t: high-frequency identified monetary policy surprise (Gurkaynak et al., 2005)
- Sample: 1990m1-2015m12

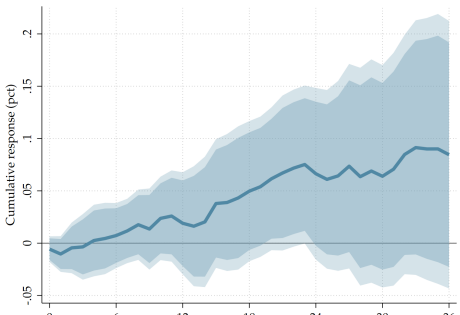
Local Projections: Robustness

Back

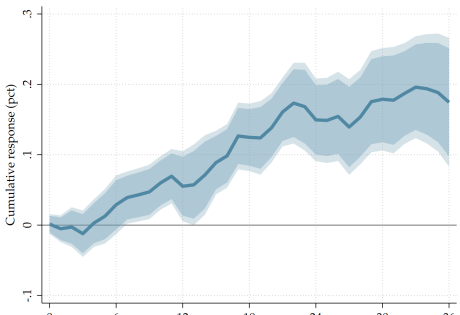
- Results robust to:
  - I Two-way clustering at date & county
  - II Look at top 5%, top 15%, top 50%
  - III Continuous interaction: percentiles
  - IV Include state FEs$\times$shock; include state$\times$time FEs$\times$shock
  - V Seasonally adjust county employment data
  - VI Different measures of MP shock: Romer & Romer, Miranda-Agrippino & Ricco (2021)
  - VII End in December 2006; start in January 1997
  - VIII Remove Alaska, Hawaii & DC; remove Florida

Two-Way Clustering at Time-County

Back



β_h^T

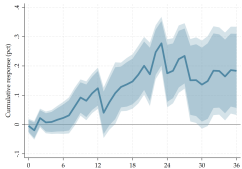


β_h^W

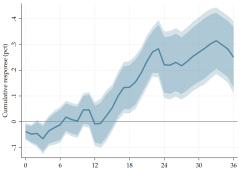
Top 5%, Top 15% & Top 50%

Back

Top 5%

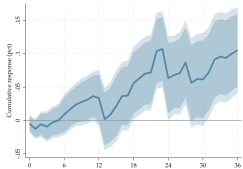


β_h^T

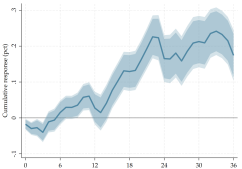


β_h^W

Top 15%

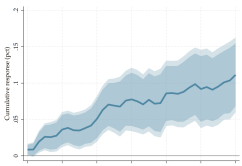


β_h^T

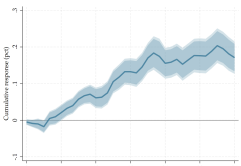


β_h^W

Top 50%



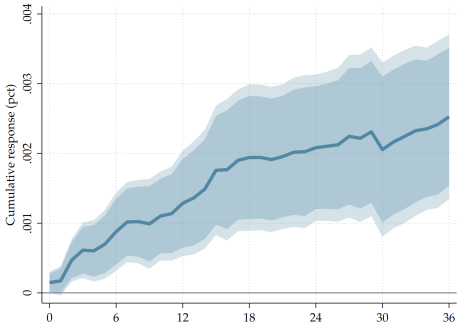
β_h^T



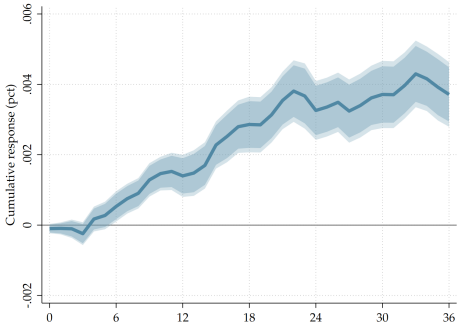
β_h^W

Continuous Interaction: Percentiles

Back



β_h^T

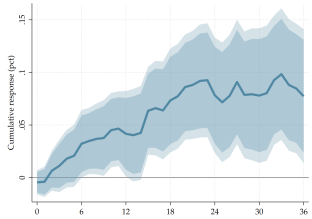


β_h^W

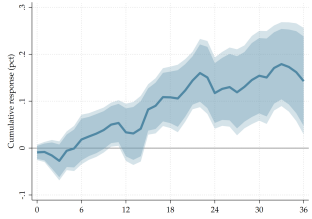
Slope FEs

Back

State FE×shock

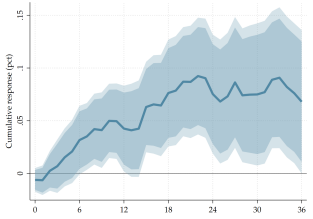


β_h^T

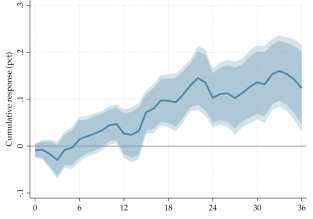


β_h^W

State FE×date FE×shock



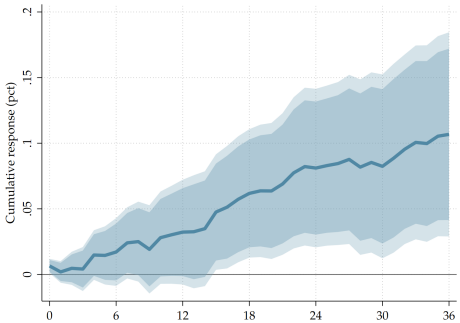
β_h^T



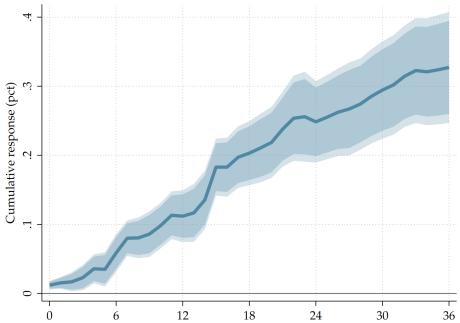
β_h^W

Seasonally Adjusted Employment

Back



β_h^T

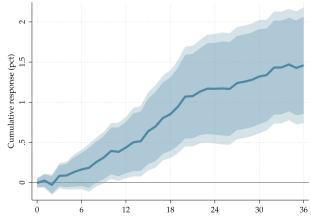


β_h^W

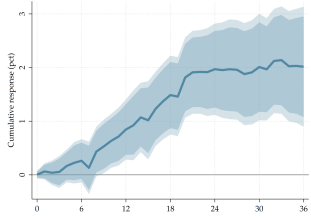
Different Shock Measures

Back

Romer & Romer

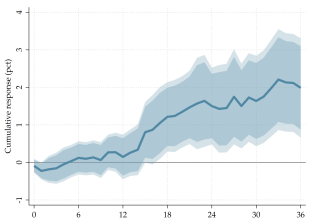


β_h^T

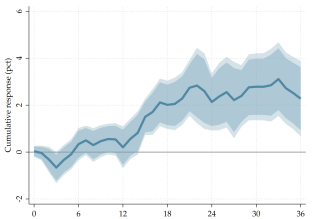


β_h^W

Miranda-Agrippino & Ricco



β_h^T

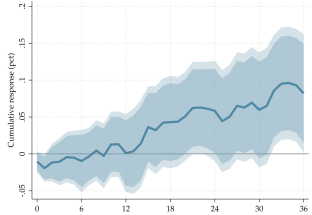


β_h^W

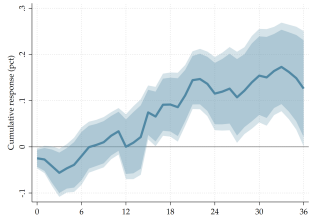
Different Time Sample

Back

End in December 2006

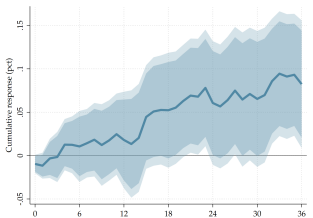


β_h^T

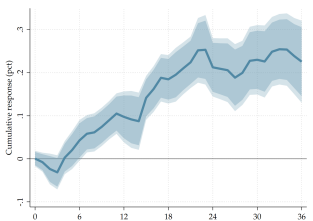


β_h^W

Start in January 1997



β_h^T

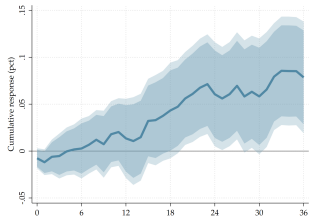


β_h^W

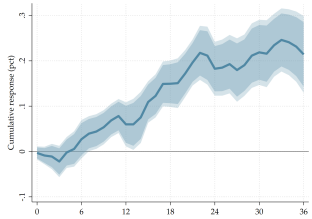
Different Space Sample

Back

Exclude Alaska, Hawaii & DC

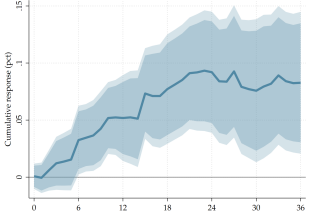


β_h^T

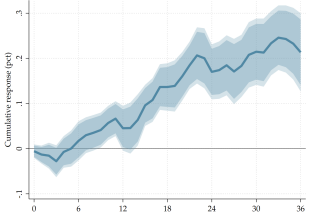


β_h^W

Exclude Florida



β_h^T



β_h^W

- Plug aggr. cons. function in NT & T mkt clearing + MIT shock to real interest rate r_s & linearize:

$$\underbrace{d \ln \boldsymbol{L}_j^{NT}}_{\text{NT labor change}} = -\nu(1-\rho_j) \underbrace{(d \ln \boldsymbol{W}_j^{NT} - d \ln \boldsymbol{W}^T)}_{\text{Relative price change}} + \boldsymbol{M}_j \underbrace{d \ln \boldsymbol{L}_j}_{\text{Real inc. change}} + \boldsymbol{M}_j^r \underbrace{d\boldsymbol{r}_j}_{\text{Int. rate shock}}$$

$$d \ln \boldsymbol{L}_j^T = \int \left\{ -\nu \rho_i \left(d \ln \boldsymbol{W}^T - d \ln \boldsymbol{W}_i^{NT} \right) + \boldsymbol{M}_i d \ln \boldsymbol{L}_i + \boldsymbol{M}_i^r d\boldsymbol{r}_i \right\} d\lambda(i)$$

- Plug aggr. cons. function in NT & T mkt clearing + MIT shock to real interest rate r_s & linearize:

$$\underbrace{d\ln \boldsymbol{L}_j^{NT}}_{\text{NT labor change}} = -\nu(1-\rho_j)\underbrace{(d\ln \boldsymbol{W}_j^{NT} - d\ln \boldsymbol{W}^T)}_{\text{Relative price change}} + \boldsymbol{M}_j \underbrace{d\ln \boldsymbol{L}_j}_{\text{Real inc. change}} + \boldsymbol{M}_j^r \underbrace{d\boldsymbol{r}_j}_{\text{Int. rate shock}}$$

$$d\ln \boldsymbol{L}_j^T = \int \left\{-\nu\rho_i \left(d\ln \boldsymbol{W}^T - d\ln \boldsymbol{W}_i^{NT}\right) + \boldsymbol{M}_i d\ln \boldsymbol{L}_i + \boldsymbol{M}_i^r d\boldsymbol{r}_i\right\} d\lambda(i)$$

- Law of one price $\rightarrow d\ln \boldsymbol{L}_j^T = d\ln \boldsymbol{L}_i^T \equiv d\ln \boldsymbol{L}^T$
- Use T labor supply $d\ln \boldsymbol{L}_j^T = \eta\rho_j \left(d\ln \boldsymbol{W}^T - d\ln \boldsymbol{W}_j^{NT}\right) + d\ln \boldsymbol{L}_j$

Plug into T market clearing

- Use labor aggregator $d\ln \boldsymbol{L}_j = \rho_j d\ln \boldsymbol{L}_j^{NT} + (1-\rho_j) d\ln \boldsymbol{L}^T$

PROPOSITION

The first-order response of employment $d\boldsymbol{L}_j$ to a monetary shock $d\boldsymbol{r}_j$ solves

$$d\boldsymbol{L}_j = \underbrace{\rho_j \boldsymbol{M}_j^r d\boldsymbol{r}_j}_{\text{Int. substitution}} + \underbrace{\rho_j \boldsymbol{M}_j d\boldsymbol{L}_j}_{\text{Multiplier}} + \underbrace{(1-\rho_j) d\boldsymbol{N}}_{\text{National response}} - \underbrace{\frac{\nu}{\eta}(1-\rho_j) d\boldsymbol{L}_j}_{\text{Exp. switching}}$$

- Where:

$$d\boldsymbol{N} = \underbrace{\int \boldsymbol{M}_i d\boldsymbol{L}_i di}_{\text{Multiplier}} + \underbrace{\int \boldsymbol{M}_i^r d\boldsymbol{r}_i di}_{\text{Int. substitution}} + \underbrace{\frac{\nu}{\eta} \int d\boldsymbol{L}_i di}_{\text{Exp. switching}}$$

Regional Keynesian Cross: No Balanced Trade

Back

- Linearize around SS without balanced trade
  - New object → non-tradable consumption share: $\xi_j \equiv \frac{c_j^{NT} W_j^{NT}}{C_j P_j}$ $\underbrace{=\rho_j}_{\text{Under balanced trade}}$
- Regional Keynesian Cross:

$$d\boldsymbol{L}_j = -\overbrace{\frac{\nu}{\eta}(1-\xi_j)d\boldsymbol{L}_j}^{\text{Exp. switching}} + \overbrace{\boldsymbol{M}_j\frac{\rho_j-\xi_j}{\eta}d\boldsymbol{L}_j}^{\text{Real income}} + \overbrace{\rho_j\boldsymbol{M}_j d\boldsymbol{L}_j}^{\text{Multiplier}} + \overbrace{\rho_j\boldsymbol{M}_j^r d\boldsymbol{r}_j}^{\text{Int. subst.}}$$
$$+ \underbrace{\frac{\nu(1-\xi_j)}{\eta}\Gamma d\boldsymbol{N}}_{\text{Exp. switching}} + \underbrace{\boldsymbol{M}_j\frac{(1-\rho_j)-(1-\xi_j)}{\eta}\Gamma d\boldsymbol{N}}_{\text{Real income}} + \underbrace{(1-\rho_j)\Gamma d\boldsymbol{N}}_{\text{National impulse}}$$

  - Where:

$$d\boldsymbol{N} \equiv \underbrace{\frac{\nu}{\eta}\int\frac{\xi_i}{\rho_i}d\boldsymbol{L}_i d\mu(i)}_{\text{Exp. switching}} + \underbrace{\int\boldsymbol{M}_i\frac{\rho_i-\xi_i}{\eta\rho_i}d\boldsymbol{L}_i d\mu(i)}_{\text{Real income}} + \underbrace{\int\boldsymbol{M}_i d\boldsymbol{L}_i d\mu(i)}_{\text{Multiplier}} + \underbrace{\int\boldsymbol{M}_i^r d\boldsymbol{r}_i d\mu(i)}_{\text{Int. subst.}}$$

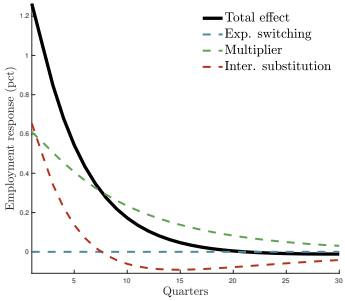
  - And:

$$\Gamma \equiv \left(\boldsymbol{I} + \frac{\nu}{\eta}\int\frac{\xi_i}{\rho_i}d\mu(i) + \int\boldsymbol{M}_i\frac{\rho_i-\xi_i}{\eta\rho_i}d\mu(i)\right)^{-1}$$

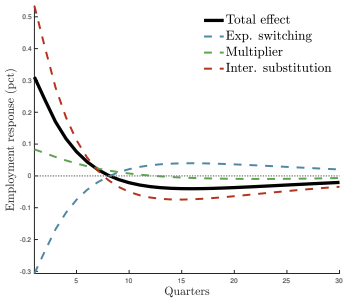
$$
\begin{aligned}
d\ln \boldsymbol{L} &= \boldsymbol{M} d\ln \boldsymbol{L} + \boldsymbol{M}^r d\ln \boldsymbol{r} \\
&+ \mathbb{C}\mathrm{ov}\left(\boldsymbol{M}_j, d\ln \boldsymbol{L}_j\right) + \mathbb{C}\mathrm{ov}\left(\boldsymbol{M}^r_j, d\ln \boldsymbol{r}_j\right) \\
&+ \boldsymbol{M}\,\mathbb{C}\mathrm{ov}\left(\rho_j, d\ln \boldsymbol{L}_j\right) + \boldsymbol{M}^r\,\mathbb{C}\mathrm{ov}\left(\rho_j, d\ln \boldsymbol{r}_j\right) + \frac{\nu}{\eta}\left[\mathbb{C}\mathrm{ov}\left(\rho_j, \frac{\xi_j}{\rho_j} d\ln \boldsymbol{L}_j\right) + \mathbb{C}\mathrm{ov}\left(\frac{\xi_j}{\rho_j}, d\ln \boldsymbol{L}_j\right)\right] \\
&+ \mathbb{C}\mathrm{ov}\left(\boldsymbol{M}_j, (\rho_j - \rho) d\ln \boldsymbol{L}_j\right) + \mathbb{C}\mathrm{ov}\left(\boldsymbol{M}^r_j, (\rho_j - \rho) d\ln \boldsymbol{r}_j\right) \\
&+ \mathbb{C}\mathrm{ov}\left(\boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j}, d\ln \boldsymbol{L}_j\right) + \mathbb{C}\mathrm{ov}\left(\rho_j, \boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j} d\ln \boldsymbol{L}_j\right) \\
&+ \left(\mathbb{I} + \frac{\nu}{\eta}\right)^{-1} \left\{ \frac{\nu}{\eta}\,\mathbb{C}\mathrm{ov}\left(\xi_j - \rho_j, \boldsymbol{M}_j d\ln \boldsymbol{L}_j + \boldsymbol{M}^r_j d\ln \boldsymbol{r}_j + \boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j} d\ln \boldsymbol{L}_j + \frac{\nu}{\eta}\frac{\xi_j}{\rho_j} d\ln \boldsymbol{L}_j\right) \right. \\
&+ \mathbb{C}\mathrm{ov}\left(\rho_j \boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j}, \boldsymbol{M}_j d\ln \boldsymbol{L}_j + \boldsymbol{M}^r_j d\ln \boldsymbol{r}_j + \boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j} d\ln \boldsymbol{L}_j + \frac{\nu}{\eta}\frac{\xi_j}{\rho_j} d\ln \boldsymbol{L}_j\right) \\
&\left. + \mathbb{C}\mathrm{ov}\left(\boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j} - \frac{\nu}{\eta}\frac{\xi_j}{\rho_j}, \rho_j \left(\boldsymbol{M}_j d\ln \boldsymbol{L}_j + \boldsymbol{M}^r_j d\ln \boldsymbol{r}_j + \boldsymbol{M}_j \frac{\rho_j - \xi_j}{\eta\rho_j} d\ln \boldsymbol{L}_j + \frac{\nu}{\eta}\frac{\xi_j}{\rho_j} d\ln \boldsymbol{L}_j\right)\right) \right\}
\end{aligned}
$$

The Role of non tradability

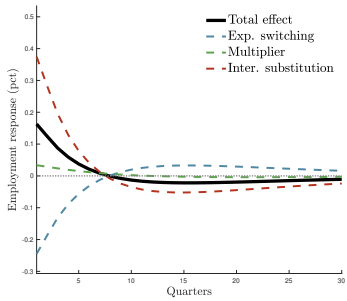
▸ Parameters



Non-tradables only benchmark ($\alpha_j = 1$)



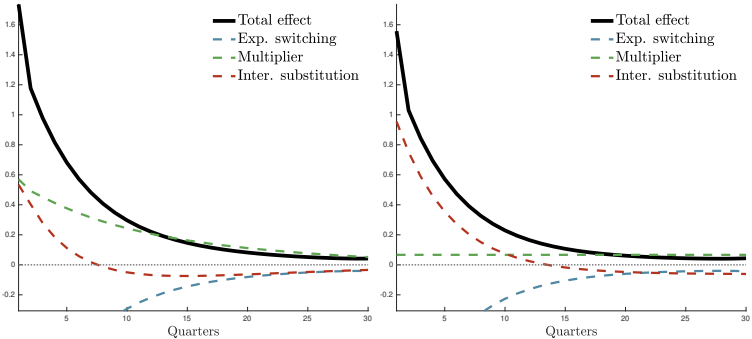
Two-industry economy, high α_j



Two-industry economy, low α_j

- Compared to single region, single industry ($\alpha_j = 1$) benchmark:
  - Intertemporal substitution channel barely affected
  - Multiplier shrinks massively $\Rightarrow$ higher-order effects
- Low non-tradable (low α_j) counties less responsive $\Rightarrow$ as in the data

The Role of Household Heterogeneity



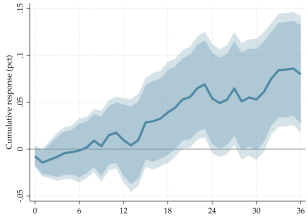
Two-industry economy, HA case

Two-industry economy, RA case

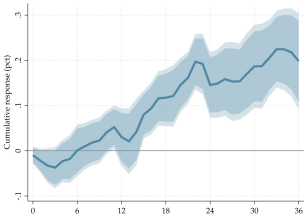
- Compared to representative agent benchmark:
  - Direct effect (int. subst.) dampened ⇒ borrowing constraint
  - Indirect effect (multiplier) amplified ⇒ MPCs
- Household heterogeneity amplifies response ⇒ as in the data

Triple Interaction

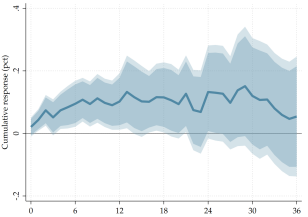
Back



(A) $\hat{\beta}_h^{NT}$



(B) $\hat{\beta}_h^{W}$



(C) $\hat{\beta}_h^{NT,W}$

$$\Delta \log(L_{jt+h}) = \underbrace{\alpha_{jh} + \delta_{th}}_{\text{Fixed effects}} + \underbrace{\beta_h^{NT} \times D_{jt}^{NT} \times \varepsilon_t}_{\text{Openness interaction}} + \underbrace{\beta_h^{W} \times D_{jt}^{W} \times \varepsilon_t}_{\text{Wealth interaction}} + \underbrace{\beta_h^{NT,W} \times D_{jt}^{NT} \times D_{jt}^{W} \times \varepsilon_t}_{\text{Triple interaction}}$$

$$+ \underbrace{\alpha_h^{T} D_{jt}^{NT} + \alpha_h^{W} D_{jt}^{W} + \alpha_h^{T,W} D_{jt}^{NT} \times D_{jt}^{W}}_{\text{Interaction controls}} + \underbrace{\sum_{\ell=1}^{12} \gamma_{h\ell} \Delta \log(L_{jt-\ell})}_{\text{Lagged controls}} + u_{jht}$$

Model Parametrization

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Parameter	Description	Value	Comment
β	Discount rate	0.9957	Standard
σ	Inverse EIS	1	Standard
φ	Frisch Elasticity	1	**?**
ψ	Labor disutility	1	Normalization
ω	Preference for non-tradables	0.66	Hazell et al. (2022)
ν	Elasticity of substitution between the two goods	1.5	Hazell et al. (2022)
η	Elasticity of substitution between the two sectors	0.45	Berger et al. (2022)
ρ_e	Persistence of the log-productivity process	0.9	Target MPC = 0.25
σ_e	Cross-sectional std of log-productivity process	0.1	Target MPC = 0.25
$\underline{b}$	Borrowing limit (as pct. of natural borrowing limit)	1.7%	Target MPC = 0.25
P^T	Tradable price index	1	Numeraire
C^T	Rest of nation demand for tradable goods	1	Exogenous

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