The Regional Keynesian Cross

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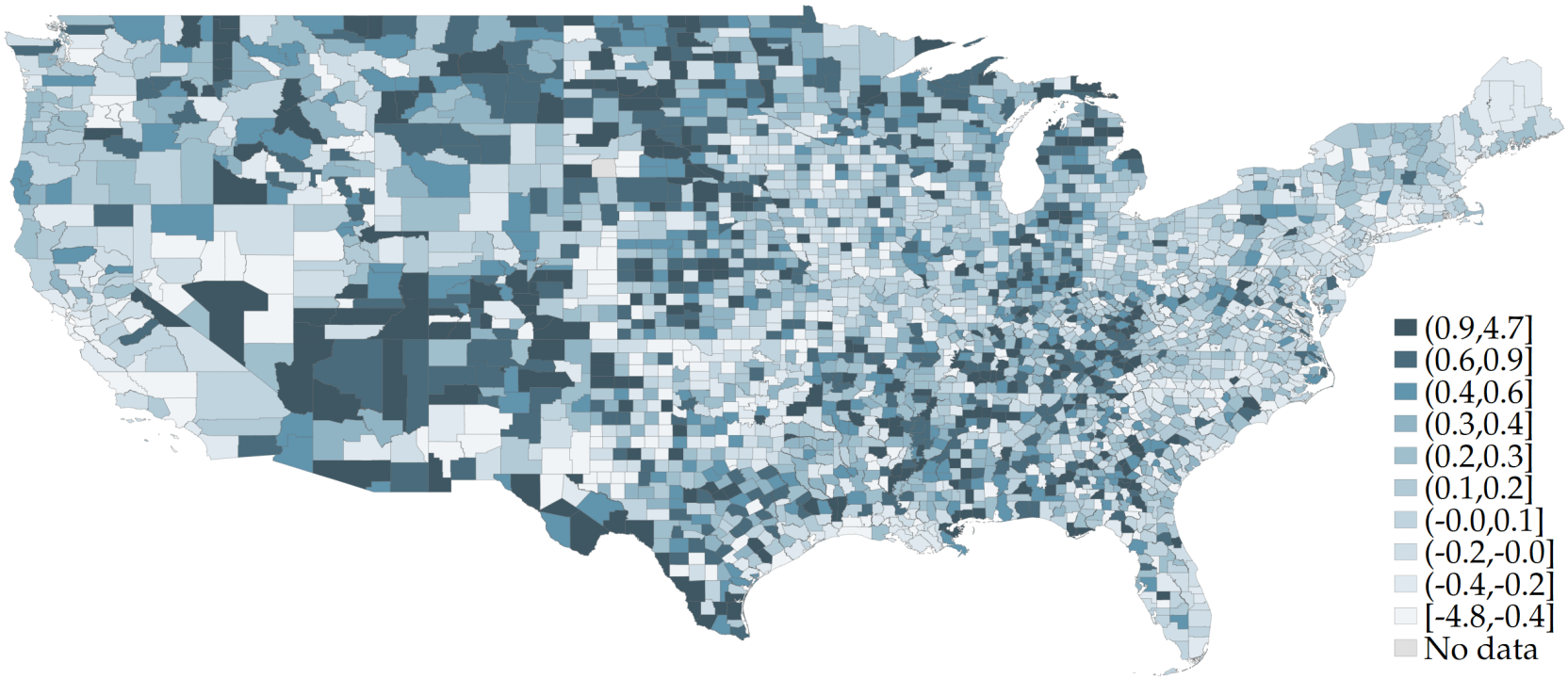
Regional Heterogeneity in the Response to MP



- Panel local projection of employment w.r.t. MP shocks $\Rightarrow$ county-specific response
- Large heterogeneity in the geographical transmission of MP shocks within the US
  - I Why?
  - II Can regional heterogeneity help shed light on the transmission of MP?
  - III Does this matter for the aggregate response?

What we do & what we find

- Empirically inspect the regional response to MP:
  - Regional MPC
  - Regional share of non-tradable employment

- Build a NK currency union model featuring two-layered heterogeneity:
  - MPC heterogeneity between counties
  - Heterogeneous industry composition between counties

  } Regional Keynesian Cross

- Household-industry interaction:
  - Ind. composition governs the extent to which household heterogeneity matters for transmission
  - Evidence of interaction in the data

- Coming soon: the National Keynesian Cross

Literature

- **Geographical transmission of MP** (Carlino and Defina, 1998; De Ridder and Pfajfar, 2017; Hauptmeier et al., 2020; Herreño and Pedemonte, 2022)
  - Our contribution: industrial composition channel & interaction with MPC

- **Heterogeneity in Keynesian frameworks** (Campbell and Mankiw, 1989; Bilbiie, 2008; Kaplan and Violante, 2014; Werning, 2015; Debortoli and Galí, 2018; Kaplan et al., 2018; Auclert, 2019; Aguiar et al., 2020; Auclert et al., 2018, 2020, 2021a,b)
  - Our contribution: two-layered regional heterogeneity

- **Regional variation to answer macro questions** (Hazell et al., 2021; Beraja et al., 2018; Chodorow-Reich et al., 2021; Hazell et al., 2022; Wolf, 2021a,b; Dupor et al., 2022; Patterson, 2022; McCrory, 2022)
  - Our contribution: focus on monetary policy & on common shocks

Empirics

Data

- Monthly county-level employment (BLS, Local Area Unemployment Statistics)
- Annual sectoral employment at the county-level (US Census, County Business Patterns)
  - Classify into tradable and non-tradable industries as in Mian and Sufi (2014)
- Annual stock market wealth per capita at the county-level (Chodorow-Reich et al., 2021)
- ε_t: HF identified monetary policy shocks (Gertler and Karadi, 2015)
- Sample: 1990m1-2015m12

Empirics

- 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):

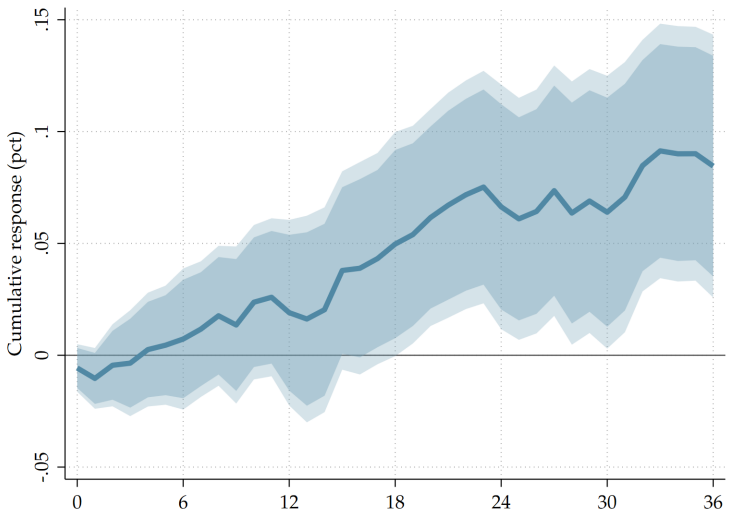
$$\Delta \log(L_{jt+h}) = \alpha_{jh} + \delta_{th} + \beta_h^T \times D_{jt}^T \times \varepsilon_t + \beta_h^W \times D_{jt}^W \times \varepsilon_t$$
$$+ \alpha_h^T D_{jt}^T + \alpha_h^W D_{jt}^W + \sum_{\ell=1}^{12} \gamma_{h\ell} \Delta \log(L_{jt-\ell}) + u_{jht}$$

  - 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

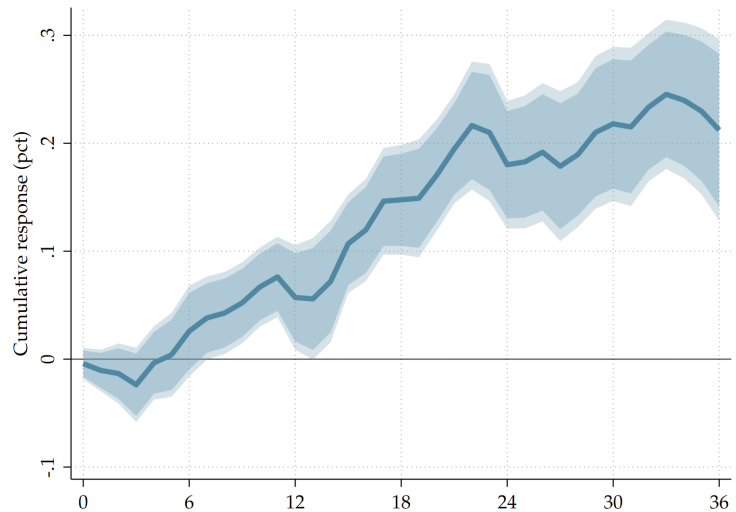
Non-Tradables & MPC Amplify the Response

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

- Response to a 1 std expansionary MP shock ε_t: ▸ Robustness



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

Model

A Stylized Model of the Regional Keynesian Cross

- Multi-region currency union with atomistic counties $j \in [0,1]$

- Within-county household heterogeneity:

$$\mathbb{E}\sum_{t\geq 0}\beta^t\{u(c_{jit})-v(\ell_{jit})\} \quad \text{s.t.} \quad c_{jit}+a_{jit+1}=\frac{W_{jt}}{P_{jt}}e_{jit}\ell_{jit}+(1+r_t)a_{jit}, \quad a_{jit+1}\geq \underline{a}$$

- Demand side, two goods:
  - I Tradables: $c^T_{jit}=\int_0^1 c^T_{jit}(j)dj \Rightarrow$ law of one price
  - II Non-tradables: consumed locally

$$\left.\begin{array}{l}\text{I Tradables: } c^T_{jit}=\int_0^1 c^T_{jit}(j)dj \Rightarrow \text{law of one price}\\ \text{II Non-tradables: consumed locally}\end{array}\right\} c_{jit}=\left[\omega^{\frac{1}{\nu}}\left(c^{NT}_{jit}\right)^{\frac{\nu-1}{\nu}}+(1-\omega)^{\frac{1}{\nu}}\left(c^{T}_{jit}\right)^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}}$$

- Supply side, two sectors: $\ell_{jit}=\left(\alpha_j^{-\frac{1}{\eta}}\left(\ell^{NT}_{jit}\right)^{\frac{\eta+1}{\eta}}+(1-\alpha_j)^{-\frac{1}{\eta}}\left(\ell^{T}_{jit}\right)^{\frac{\eta+1}{\eta}}\right)^{\frac{\eta}{\eta+1}}$ & $y^s_{jt}=\ell^s_{jt}$

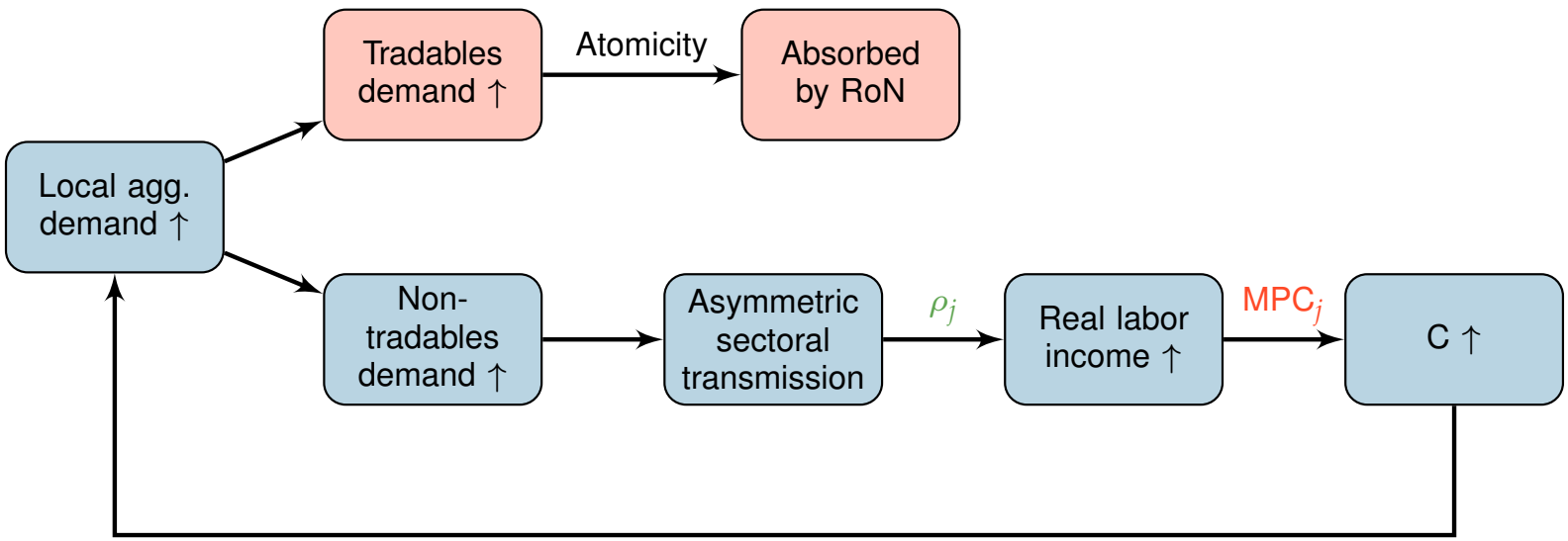
- NK block: Auclert et al. style wage rigidity ($\Longrightarrow \ell_{jit}=L_{jt}$) + real interest rate rule

Outline of Mechanism

▸ Household behavior

- One crucial elasticity:
  - Non-tradable labor income share: $\rho_j \equiv \frac{\ell_j^{NT} W_j^{NT}}{\ell W_j} \Rightarrow d \log W_{jt} = \rho_j \left(d \log W_{jt}^{NT} \right) + (1 - \rho_j) \left(d \log W_t^T \right)$

- Regional Keynesian Cross:



Deriving the Regional Keynesian Cross

- Regional aggregate consumption function captures all the heterogeneity:

$$\int_0^1 c_{jit} di = \mathcal{C}_t \left(\left\{ \frac{W_{js}}{P_{js}} L_{js} \right\}_{s \geq 0}, \{r_s\}_{s \geq 0} \right)$$

- Plug in non-tradables market clearing + MIT shock to real interest rate r_s & linearize
  - Hand-to-mouth RoN $\Rightarrow$ no response to r_s shock

$$\underbrace{d \ln L_{jt}^{NT}}_{\text{NT labor change}} = -\nu \underbrace{d \ln \left(\frac{P_{jt}^{NT}}{P_{jt}} \right)}_{\text{Relative price change}} + \frac{1}{C_j} \sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t(\cdot)}{\partial Z_s} \underbrace{d \left(\frac{W_{js}}{P_{js}} L_{js} \right)}_{\text{Real inc. change}} + \frac{1}{C_j} \sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t(\cdot)}{\partial r_s} \underbrace{dr_s}_{\text{Int. rate shock}}$$

- Stack in matrix notation:

$$\frac{d\boldsymbol{L}_j^{NT}}{L_j^{NT}} = -\nu \left(\frac{d\boldsymbol{P}_j^{NT}}{P_j^{NT}} - \frac{d\boldsymbol{P}_j}{P_j} \right) + \boldsymbol{M}_j \left(\frac{d\boldsymbol{W}_j}{W_j} - \frac{d\boldsymbol{P}_j}{P_j} + \frac{d\boldsymbol{L}_j}{L_j} \right) + \boldsymbol{M}_j^r d\boldsymbol{r}$$

The Regional Keynesian Cross

Proposition

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

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

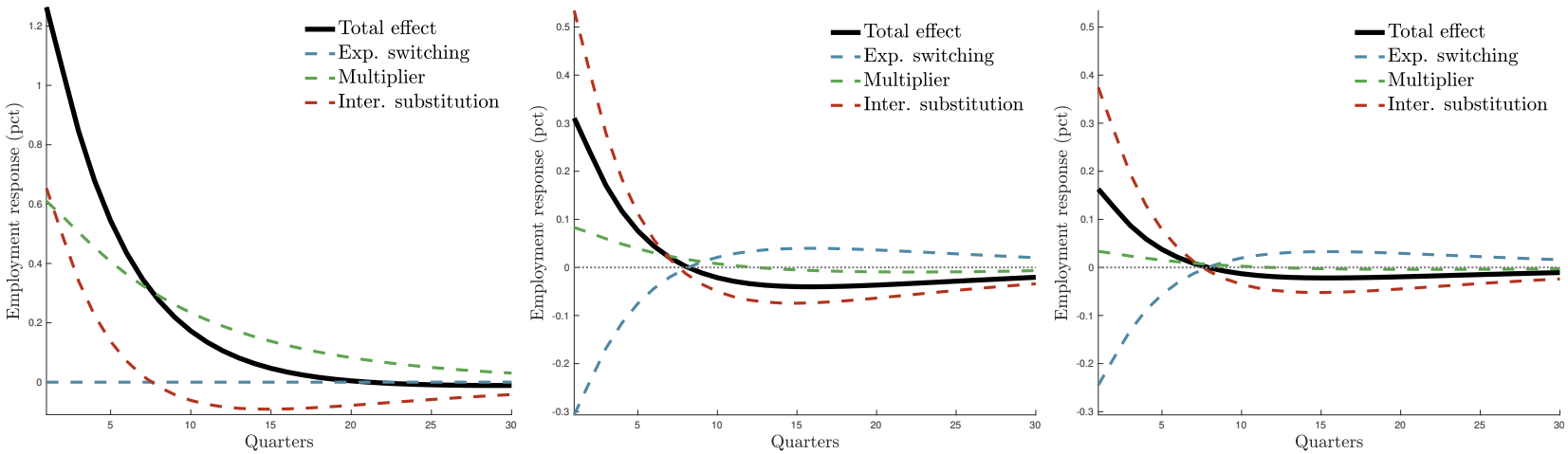
- Nests the Intertemporal Keynesian cross (Auclert et al., 2018) when $\rho_j = 1$:

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

- Coming soon: National Keynesian Cross $\Rightarrow \mathrm{Cov}(\rho_j, M_j)$

The Role of Supply Composition

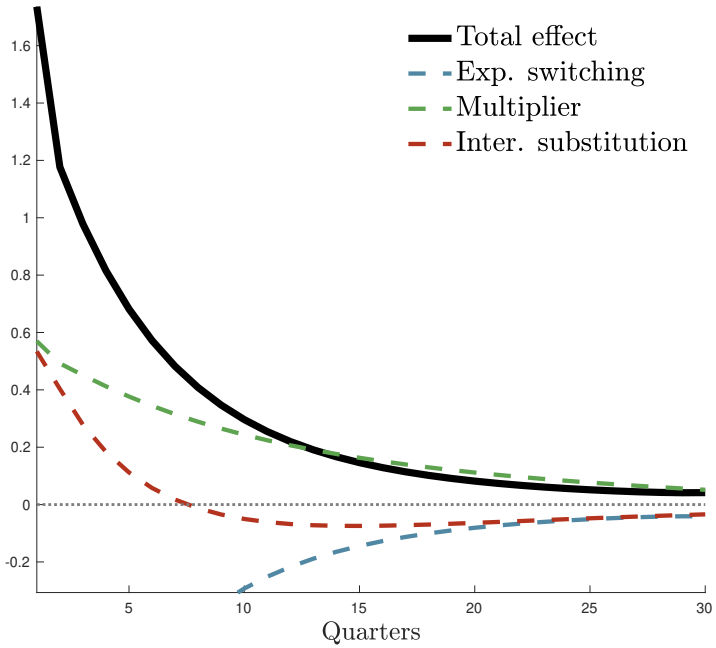
▸ Calibration



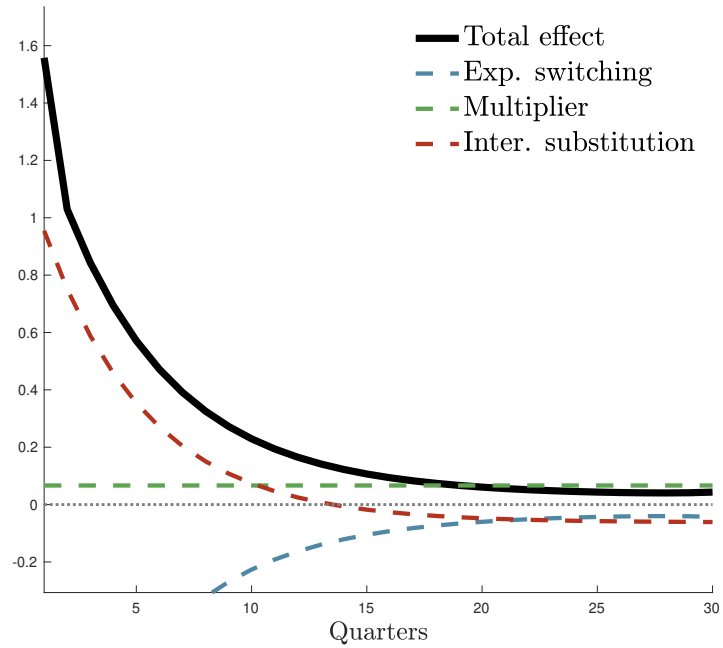
Non-tradables only benchmark ($\alpha_j = 1$) | Two-industry economy, high α_j | Two-industry economy, low α_j

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

The Role of Household Heterogeneity



Two-industry economy, HA case



Two-industry economy, RA case

- Under some conditions household heterogeneity amplifies the response
  - Fiscal reaction
  - National response

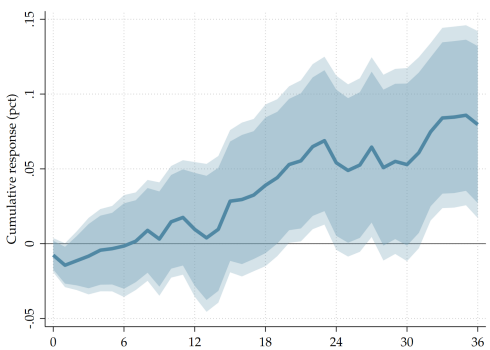
Household-Industry Interaction

- Interaction between industry composition & household heterogeneity:
  - Assume η large $\Longrightarrow$ expenditure switching channel ≈ 0

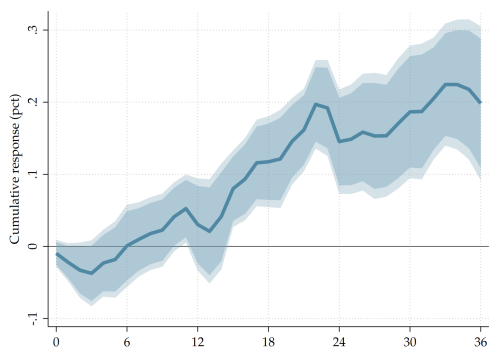
$$d\boldsymbol{L}_j \approx \underbrace{\sum_{k\geq 0} \left(\rho_j \boldsymbol{M}_j\right)^k}_{\text{MPC-supply interaction}} \rho_j \boldsymbol{M}_j^r d\boldsymbol{r}_j$$

  - "Cross-derivative" > 0 $\Rightarrow$ role of MPC for aggregate response increasing in ρ_j
  - Ind. composition governs the extent to which household heterogeneity matters for the transmission

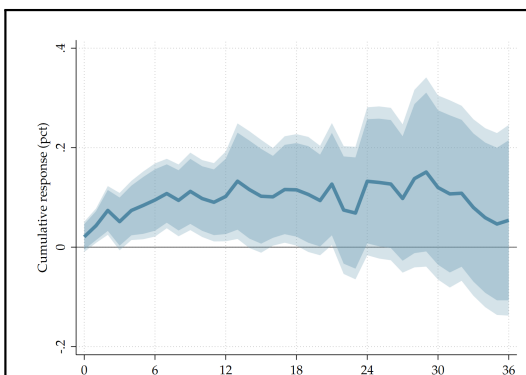
- Evidence of interaction in the data $\Rightarrow$ triple interaction: wealth $\times$ ind. comp. $\times$ shock



β_h^T



β_h^W



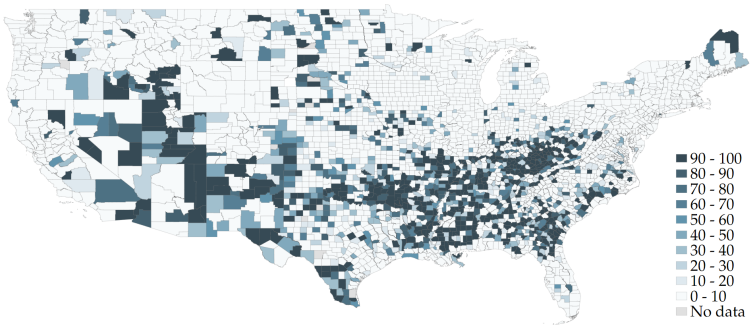
Triple inter.

Conclusion

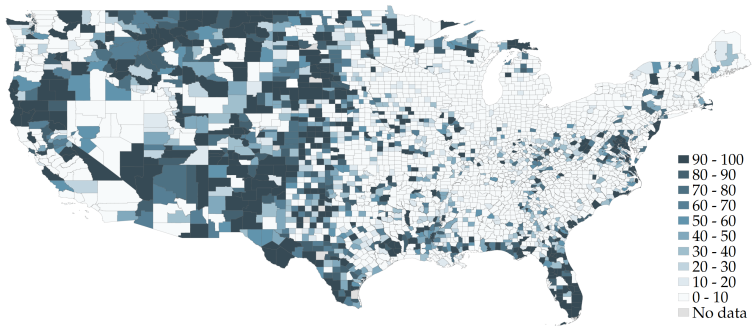
- Empirics:
  - Large regional heterogeneity in the transmission of MP within the US
  - Regional industry composition & MPC matter
- NK model of a monetary union with two-layered heterogeneity & atomistic counties:
  - Household heterogeneity
  - Industry composition
- Regional Keynesian Cross:
  - Sufficient statistic
  - Household-industry interaction
- Next step: aggregation $\Rightarrow$ regional vs national Keynesian cross

Appendix

Distribution of D_t^W and D_t^T



Stock wealth per capita



Non-tradable to tradable empl.

Regression Specification

Back

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

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

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

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 × shock; include state × time FEs × shock

V. Seasonally adjust county employment data

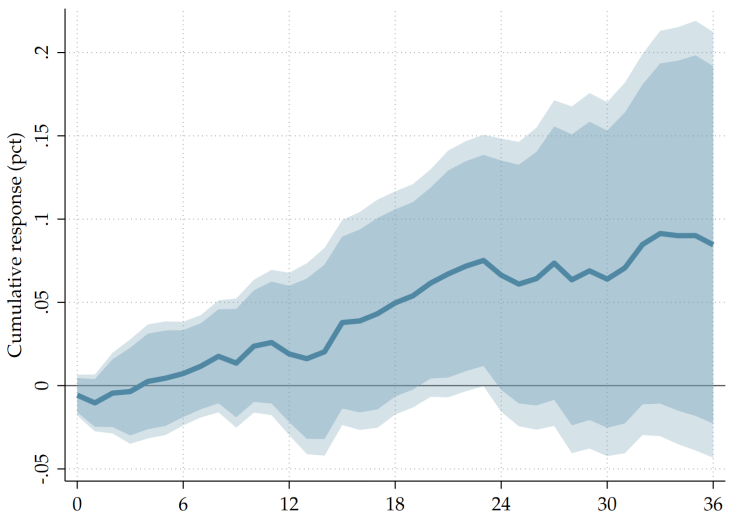
VI. Different measures of MP shock: Romer & Romer, Miranda-Agrippino & Ricco (2021)

VII. End in December 2006; start in January 1997

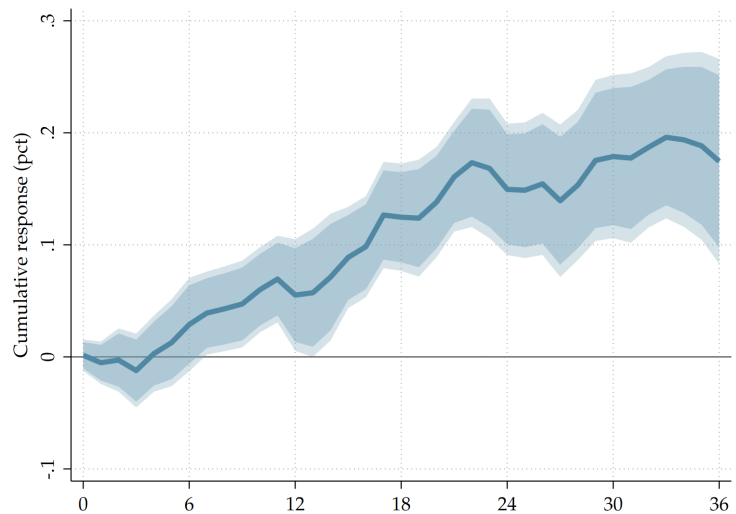
VIII. Remove Alaska, Hawaii & DC; remove Florida

Two-Way Clustering at Time-County

Back



β_h^T



β_h^W

Top 5%, Top 15% & Top 50%

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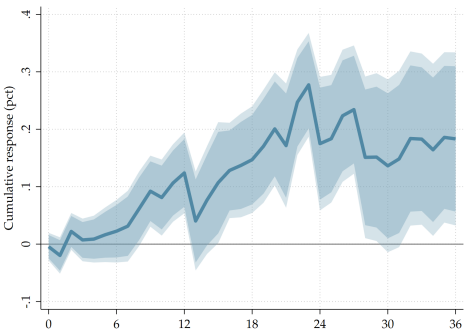
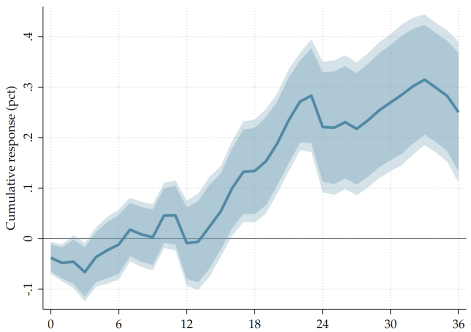
Top 5%

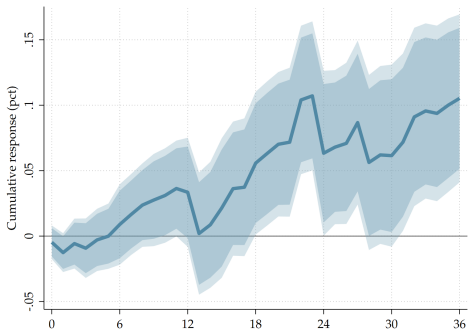


β_h^T

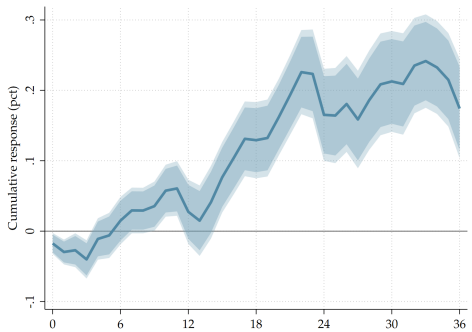


β_h^W

Top 15%

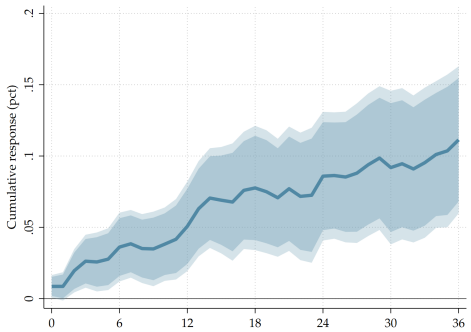


β_h^T

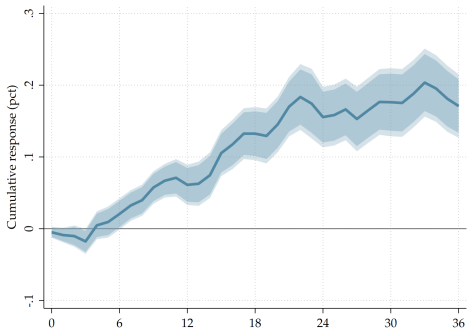


β_h^W

Top 50%



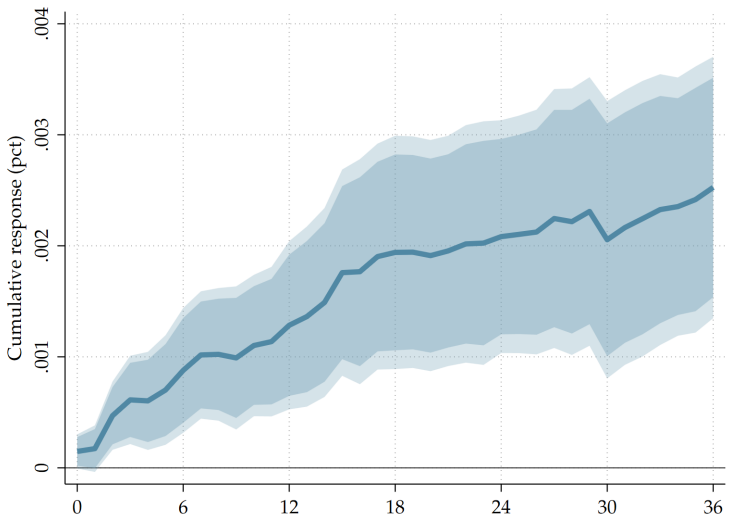
β_h^T



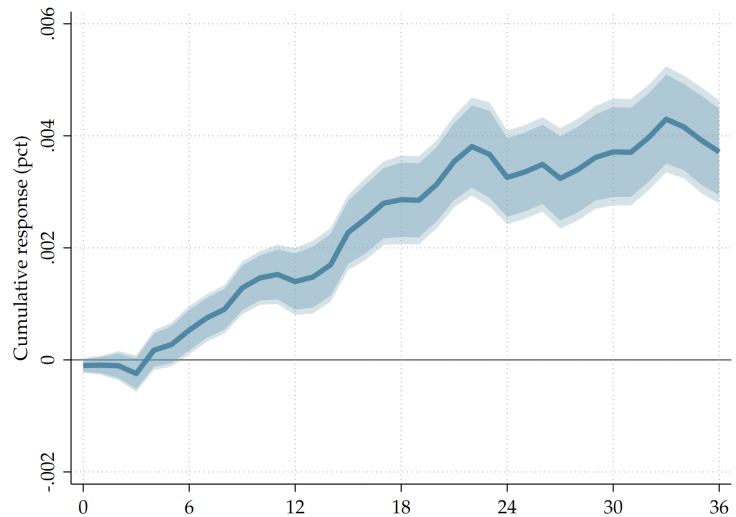
β_h^W

Continuous Interaction: Percentiles

Back



β_h^T



β_h^W

Slope FEs

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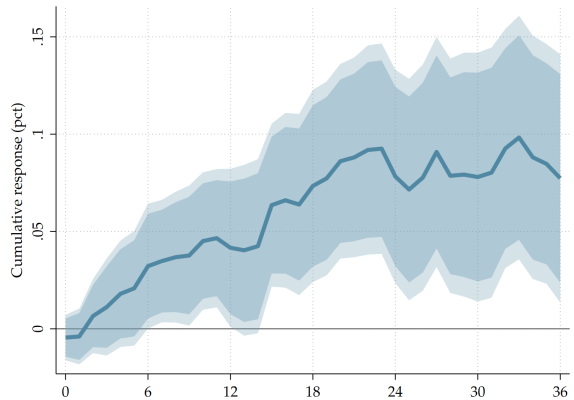
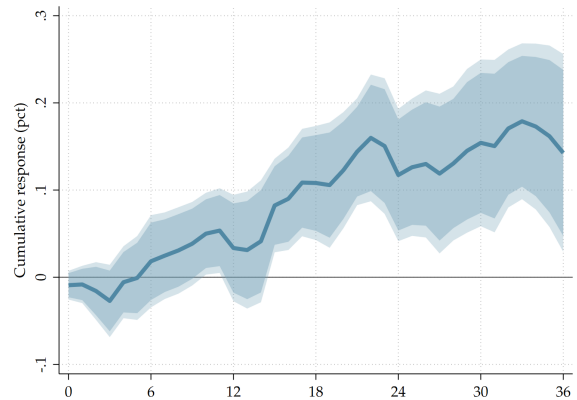
State FEs × shock

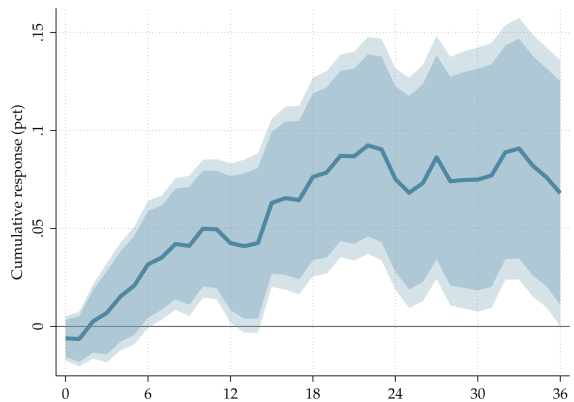


β_h^T

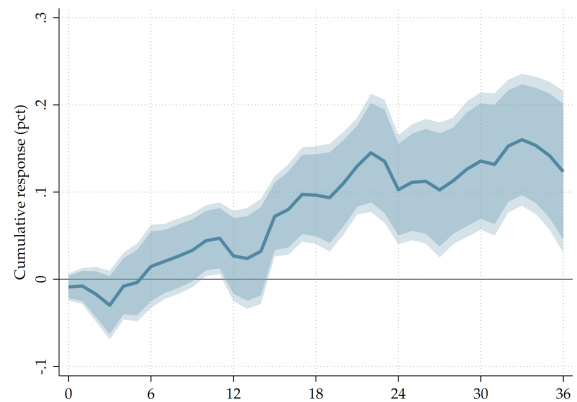


β_h^W

State × date FEs × shock



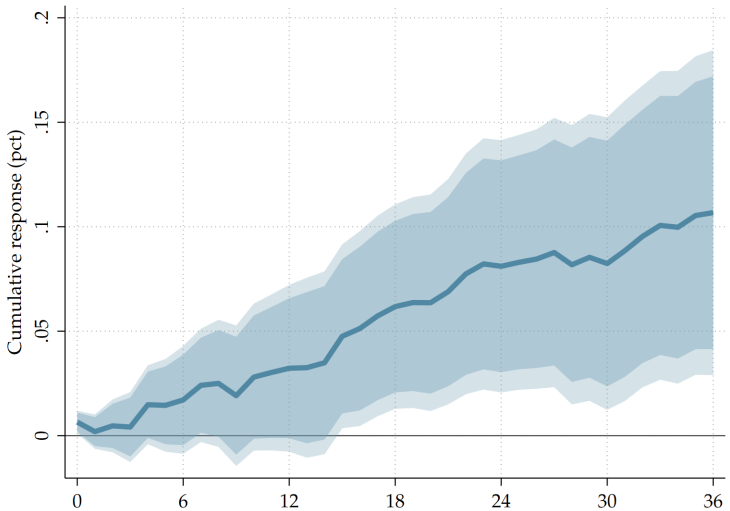
β_h^T



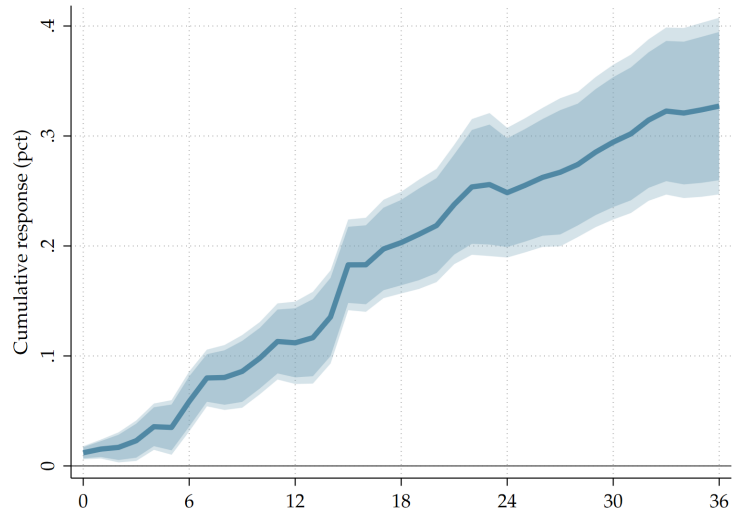
β_h^W

Seasonally Adjusted Employment

Back



β_h^T



β_h^W

Different Shock Measures

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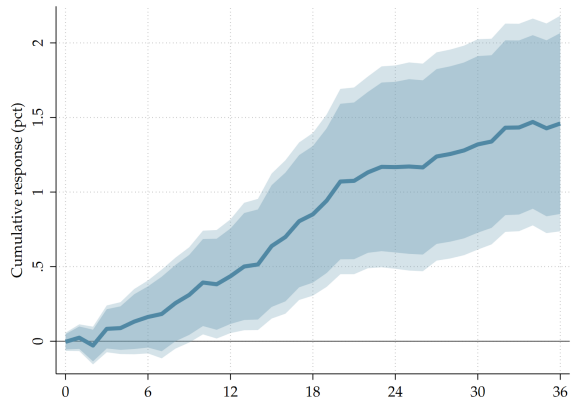
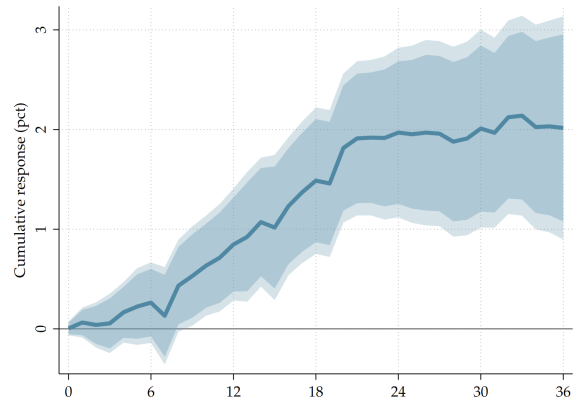
Romer & Romer

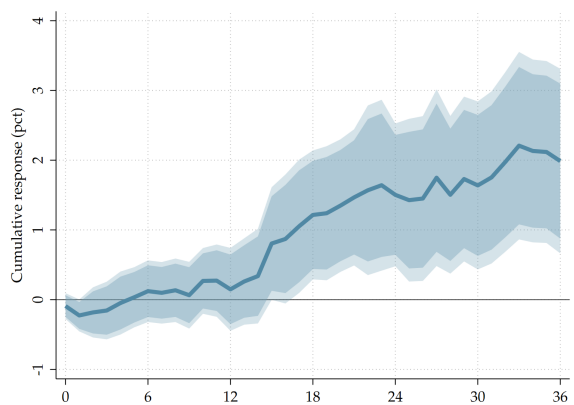


β_h^T

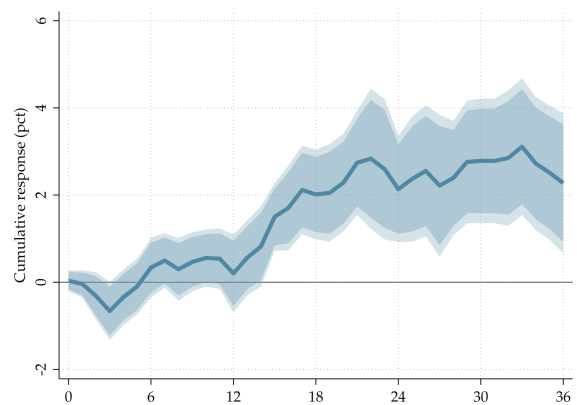


β_h^W

Miranda-Agrippino & Ricco



β_h^T

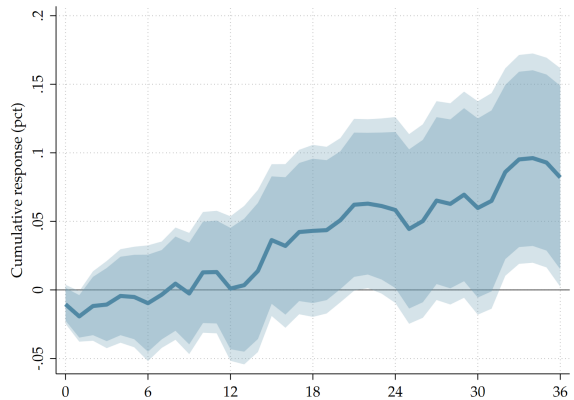


β_h^W

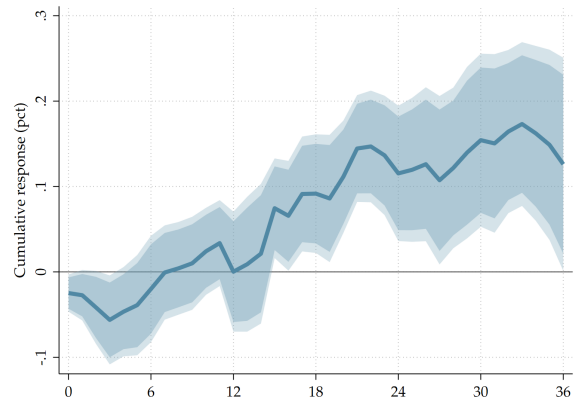
Different Time Sample

Back

End in December 2006

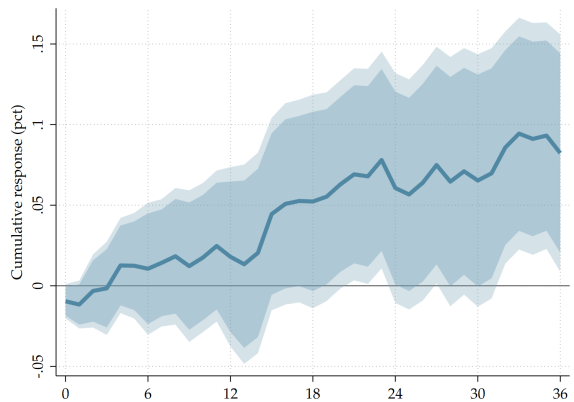


β_h^T

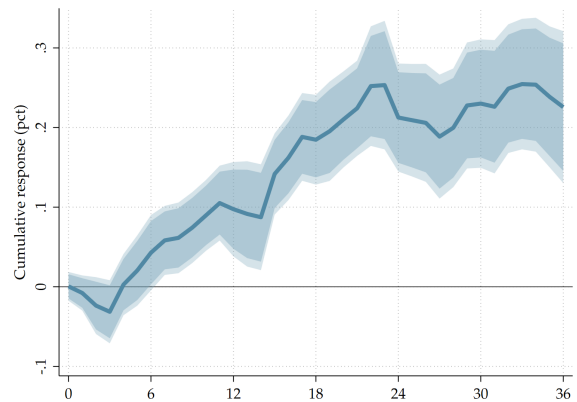


β_h^W

Start in January 1997



β_h^T

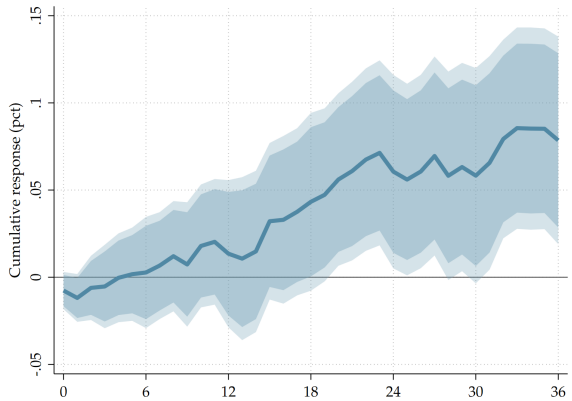


β_h^W

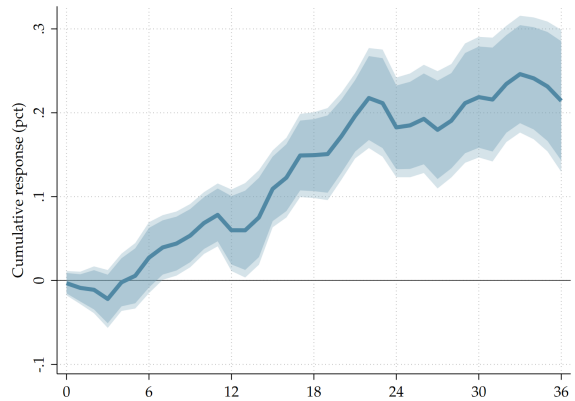
Different Space Sample

Back

Exclude Alaska, Hawaii & DC

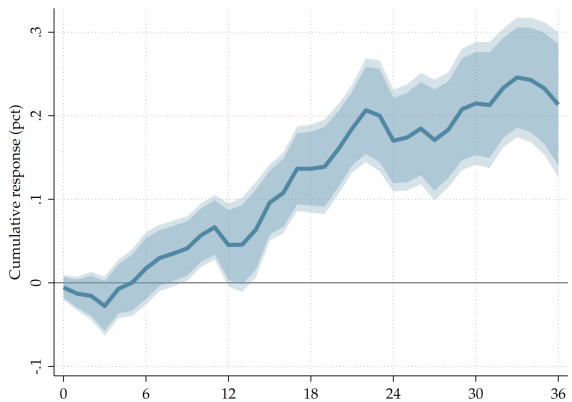


β_h^T

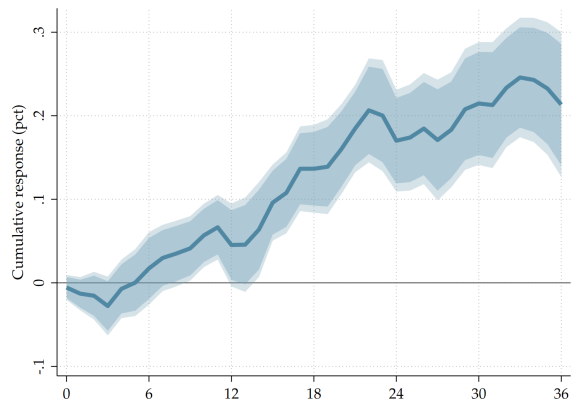


β_h^W

Exclude Florida



β_h^T



β_h^W

Household behavior

Back

- Consumption demand & labor supply curves:

$$c_{it}^{NT} = \omega \left(\frac{P_t^{NT}}{P_t} \right)^{-\nu} c_{it} \quad \text{and} \quad c_{it}^{T} = (1-\omega) \left(\frac{P_t^{T}}{P_t} \right)^{-\nu} c_{it}$$

$$\ell_{it}^{NT} = \alpha \left(\frac{W_t^{NT}}{W_t} \right)^{\eta} \ell_{it} \quad \text{and} \quad \ell_{it}^{T} = (1-\alpha) \left(\frac{W_t^{T}}{W_t} \right)^{\eta} \ell_{it}$$

Calibration

Back

Parameter	Description	Value	Comment
β	Discount rate	0.9975	0.97 annual
σ	Inverse IES	1	standard
φ	Frisch Elasticity	1	standard
μ	Share of hand-to-mouth	0.75	$\Longrightarrow$ multiplier $\approx$ inter. substitution
ω	Preference for non-tradables	0.9	For clarity of exposition
ν	Elasticity of substitution between the two goods	1.5	Hazell et al.
η	Elasticity of substitution between the two sectors	0.45	Berger et al.
P^T	Tradable price index	1	Normalization
C^T	Rest of Nation demand for tradable goods	1	Normalization

Demand-Supply Complementarities in the Data

Back

- Include a triple interaction: wealth × industry composition × shock
  - Cross-derivative $\frac{\partial y_{t+h}/\partial \varepsilon_t}{\partial \text{MPC} \partial \rho} \Rightarrow$ captures complementarities

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

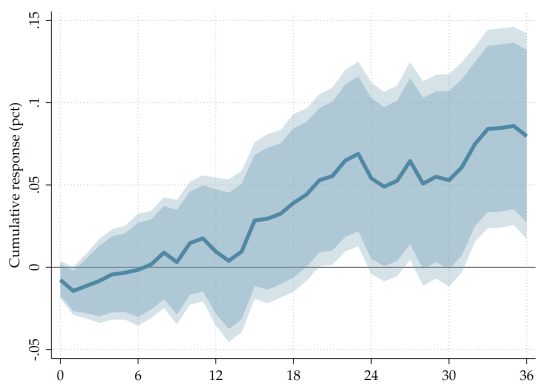
I Baseline group: low wealth, low non-tradables counties

II β_h^T: differential response of low wealth, high non-tradables counties

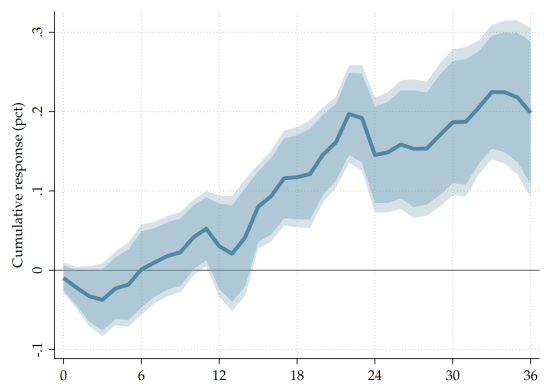
III β_h^W: differential response of high wealth, low non-tradables counties

IV $\beta_h^T + \beta_h^W + \beta_h^{T,W}$: differential response of high wealth, high non-tradables counties

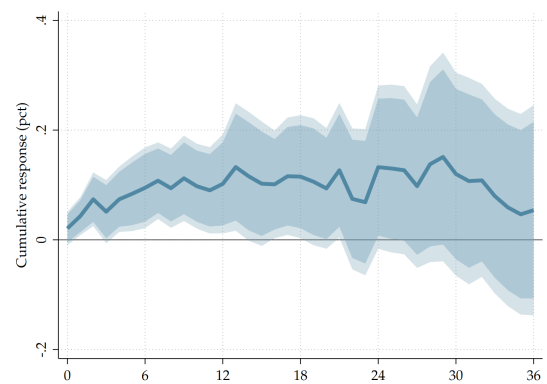
$\Rightarrow \beta_h^{T,W} > 0$: effect of ρ increasing in MPC (& vice-versa)



β_h^T



β_h^W



$\beta_h^{T,W}$

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