The Inflationary Effects of Sectoral Reallocation

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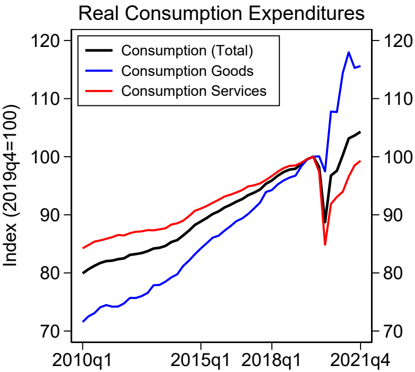
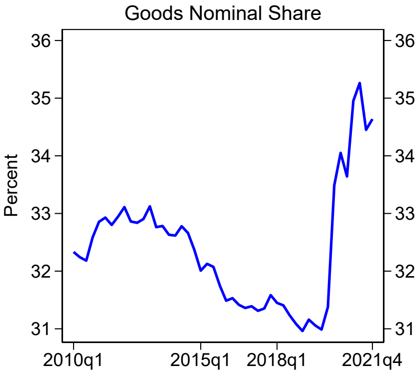
Federal Reserve Board

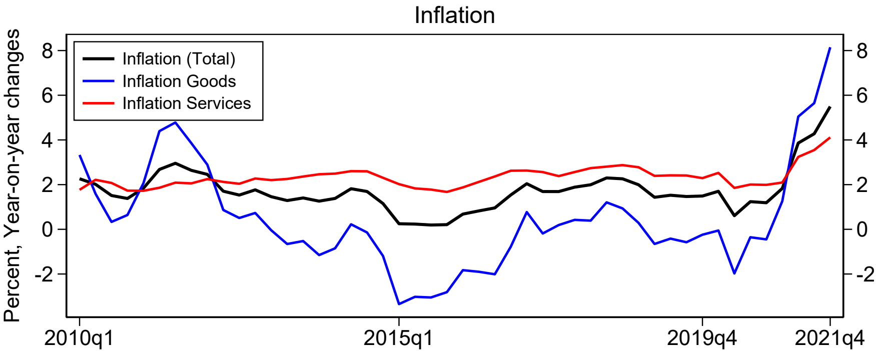
September 16, 2022
Bank of Finland/CEPR Conference
Monetary Policy in the Post-Pandemic Era

Fact 1: Sudden Shift in Consumption Expenditures

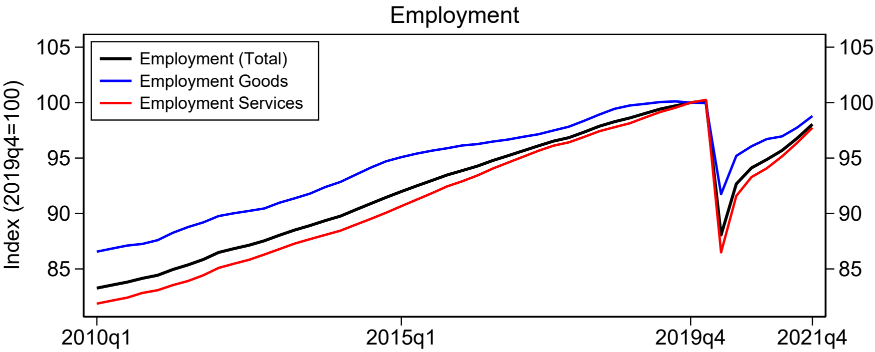




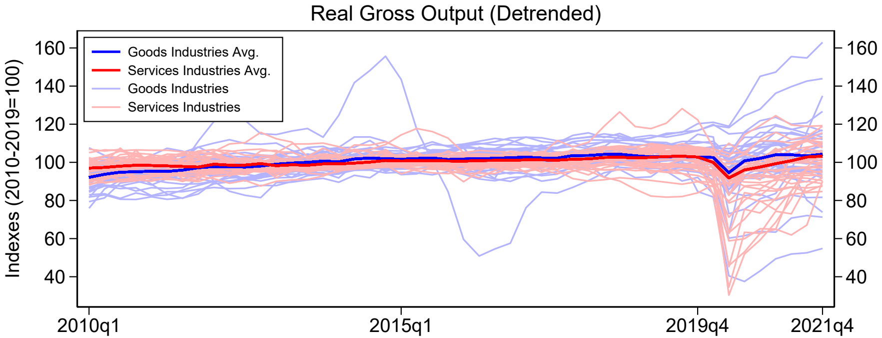
Fact 2: Rise in Inflation



Fact 3: Fall in Employment



Fact 4: Increased Industry-level Dispersion



How Does Demand Reallocation Affect Inflation?

We study reallocation in New Keynesian model with

1. multi-sector input-output structure
2. costly input adjustment (hiring costs)
3. heterogeneous price rigidity across sectors

We estimate the model with three shocks:

1. Preference shift from services to goods ("COVID demand shock")
2. Sector-specific TFP shocks
3. Aggregate Labor Supply Shock ("Great Resignation")

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How Do Reallocation Shocks Affect Inflation?

Main Results:

- Demand reallocation explain a large portion of the rise in US inflation
  1. Hiring frictions $\Rightarrow$ goods sectors struggle to expand/services sectors cut employment sharply $\Rightarrow \uparrow$ inflation
  2. Goods prices more flexible than services $\Rightarrow \uparrow\uparrow$ inflation
- Demand reallocation also explains a lot of cross-sectional developments
- TFP shocks and labor supply shock explain much less of aggregate inflation
- Model Experiments:
  - Sharp shift in demand back to services may be inflationary
  - Inflationary effects of reallocation depend on expected persistence

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Model Summary: Households

- Households consume goods and services
- Each are a bundle of output of the N sectors of the economy
- Time-varying preferences for goods/services (demand reallocation shock)

$$C_t = \left(\frac{C_t^g}{\omega_t}\right)^{\omega_t} \left(\frac{C_t^s}{1-\omega_t}\right)^{1-\omega_t}$$

Model Summary: Households

- Households consume goods and services
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- Supply labor to firms (labor supply shock)

$$U(C, N) = \frac{C^{1-\gamma}}{1-\gamma} - \chi_t \frac{N^{1+\psi}}{1+\psi}$$

Model Summary: Firms

In each sector there are 3 types of firms:

1. Representative Competitive Producer
2. Monopolistically Competitive Firms
3. Labor agencies

▸ Model Details

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In each sector there are 3 types of firms:

1. Representative Competitive Producer
2. Monopolistically Competitive Firms (sectoral productivity shocks)

$$Y_t^i = A_t^i \left(\alpha^{\frac{1}{\epsilon_Y}} \left(M_t^i\right)^{\frac{\epsilon_Y - 1}{\epsilon_Y}} + (1-\alpha)^{\frac{1}{\epsilon_Y}} \left(L_t^i\right)^{\frac{\epsilon_Y - 1}{\epsilon_Y}} \right)^{\frac{\epsilon_Y}{\epsilon_Y - 1}}$$

$$M_t^i = \left(\sum_{j=1}^{N} \Gamma_{i,j}^{\frac{1}{\epsilon_M}} \left(M_{j,t}^i\right)^{\frac{\epsilon_M - 1}{\epsilon_M}} \right)^{\frac{\epsilon_M}{\epsilon_M - 1}}$$

3. Labor agencies

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1. Representative Competitive Producer
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3. Labor agencies (hiring costs)

$$\text{Profits} = P_t^{L,i} L_t^i - W_t L_t^i \left(1 + \mathbb{1}(L_t^i > L_{t-1}^i) \frac{c}{2} \left(\frac{L_t^i}{L_{t-1}^i} - 1 \right)^2 \right)$$

▸ Model Details

Taking the Model to the Data: Calibration

- Calibrated Parameters
  - Some parameters set to standard values ($\beta, \gamma, \phi, \psi$ etc)
  - Use $N = 66$ private industries
  - Factor shares/ consumption shares: BEA I-O Tables & PCE Bridge
  - Sector price stickiness from Pasten, Schoenle and Weber (2020):
    - Key feature: goods prices more flexible than services
- Calibrated Shocks
  1. Demand reallocation shock $\uparrow \omega_t$: match $\uparrow$ in goods expenditure share
  2. Sectoral Productivity shocks ΔA_t^i: calibrated to sectoral TFP data

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Taking the Model to the Data: Estimation

- Estimated Parameters
  - Production function elasticities (ϵ_M and ϵ_Y)
  - Hiring costs (c)
- Estimated Shocks
  1. Labor supply shock ($\uparrow \chi_t$)
- Estimated parameters/shocks chosen to minimize distance between model and data:
  1. Cross-section of prices/output/labor
  2. Aggregate employment
  3. Goods inflation - services inflation

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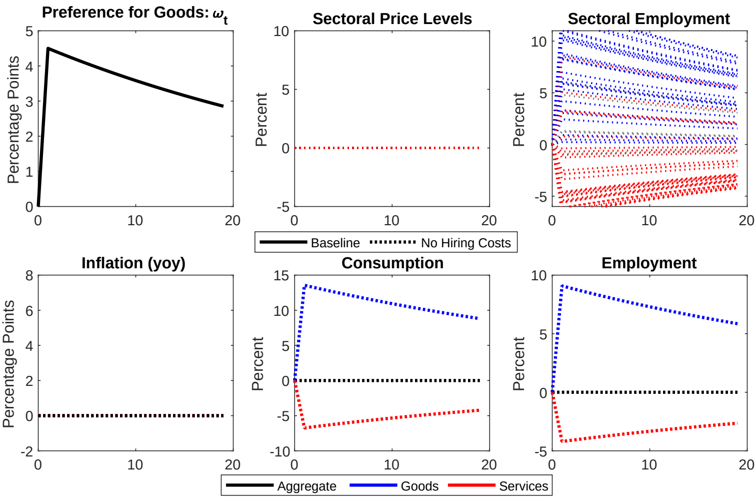
▸ Parameters

COVID Demand Reallocation Shock ($\uparrow \omega_t$)



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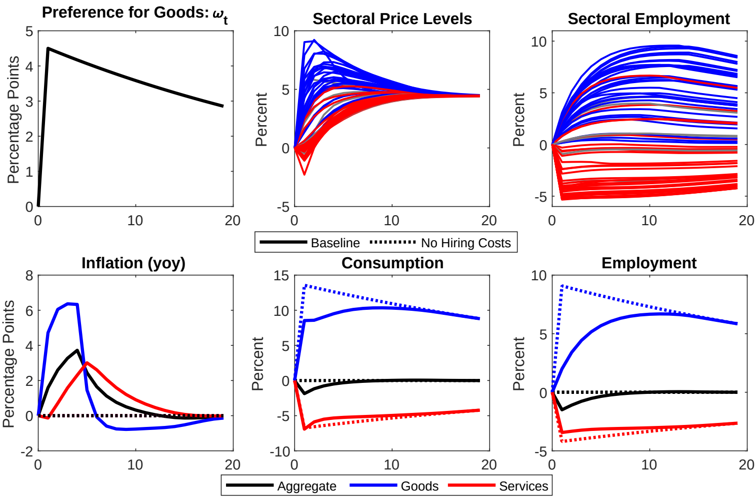

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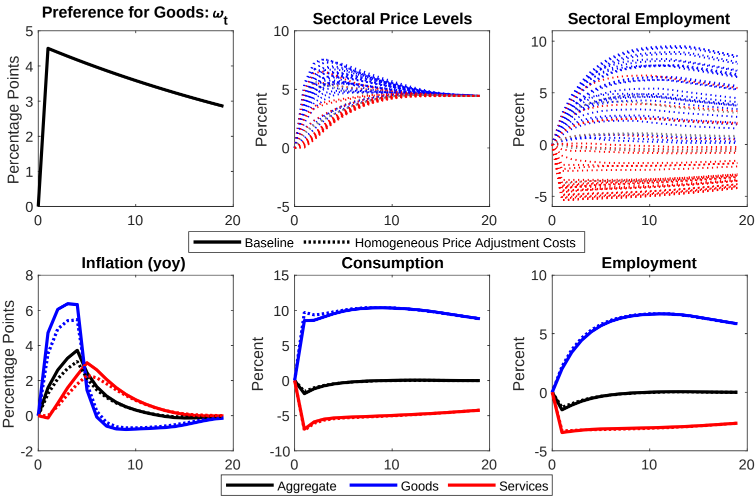
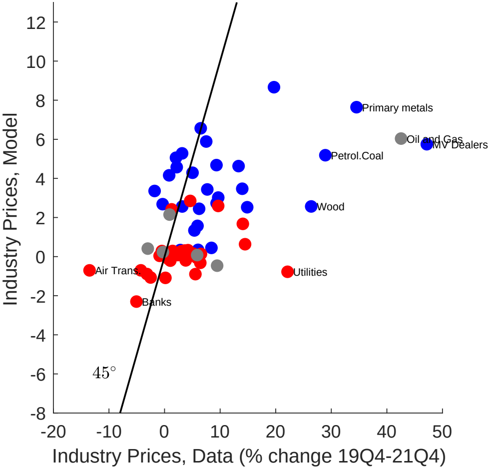


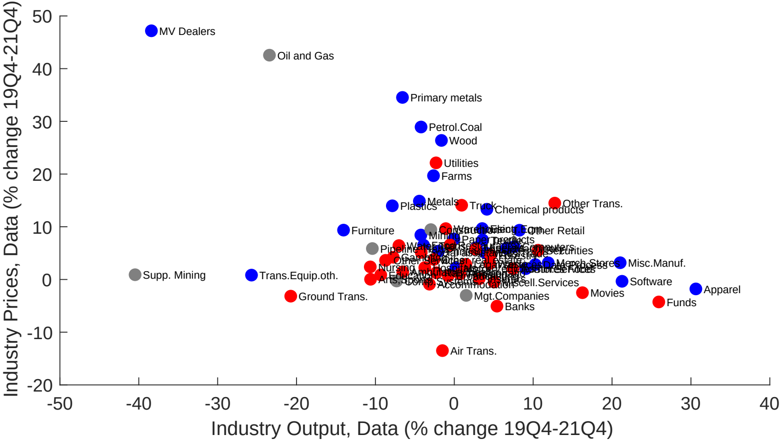
COVID Demand Reallocation Shock: Cross-Section



Details

Industry Dispersion in Price and Output Growth

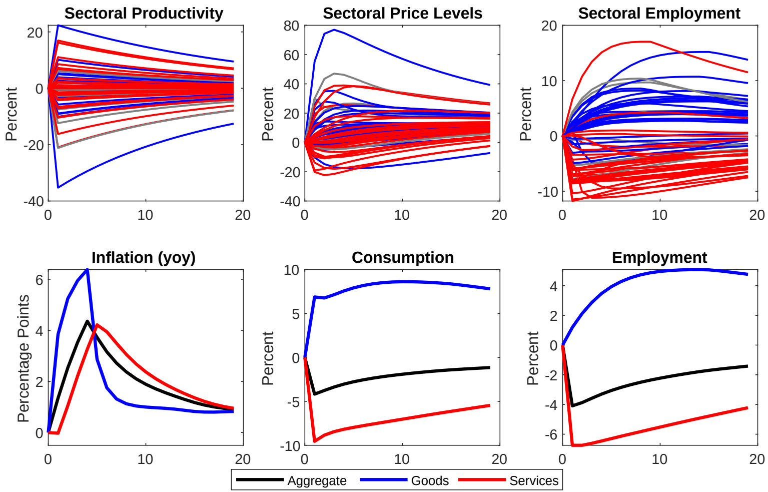
For some industries, price and quantity dynamics are hard to explain with the dynamics following demand reallocation shock:



Adding TFP Shocks and Labor Supply Shocks

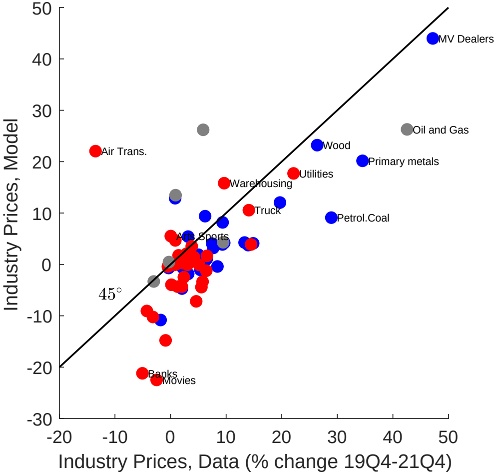
- We measure evolution of TFP at the industry level between 2019 and 2021 and feed estimated idiosyncratic TFP into model
- We estimate the size of the aggregate labor supply shock required to match decline in aggregate employment

All Three Shocks: Aggregates



▸ TFP Shocks ▸ Labor Supply Shock

All Three Shocks: Cross-Section



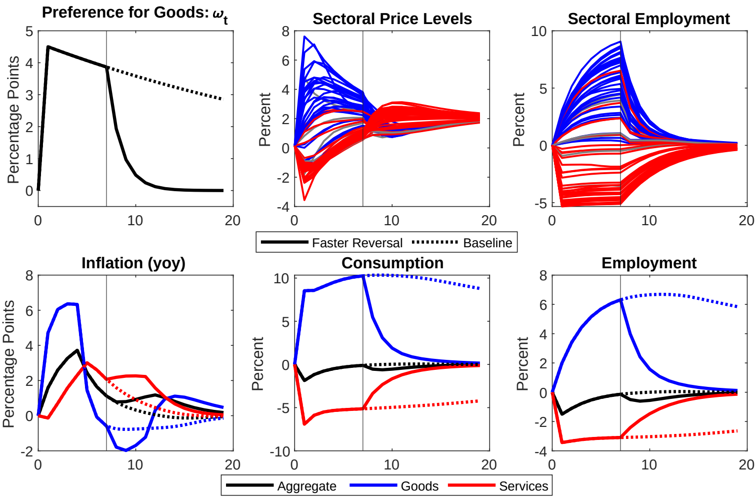
What if demand shifts back unexpectedly?

- We have assumed demand reallocation shock is persistent ($\rho = 0.975$)
- Now assume that this falls to $\rho = 0.5$ after 8 quarters

$$\rightarrow$$

- **Inflation rises again**: services sectors had cut employment too much and now face hiring costs

Reversal Experiment



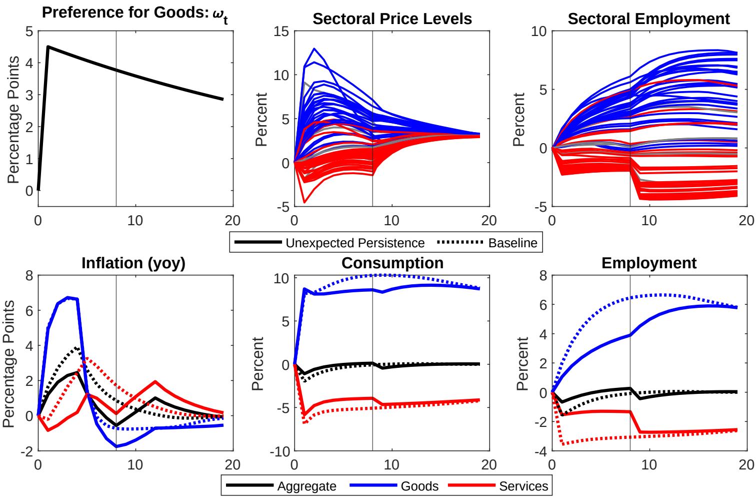
What if demand reallocation was surprisingly persistent?

- We assumed persistence of demand reallocation shock known on impact
- Now assume that everyone thought it was $\rho = 0.5$ for first 8 quarters
- Households and firms are repeatedly surprised about the persistence for two years (true persistence still $\rho = 0.975$)

$$\rightarrow$$

- **Demand reallocation less inflationary**: services sectors cut employment less and prices more

Unexpected Persistence



Conclusion

- Demand reallocation explain a large portion of the rise in US inflation
- Demand reallocation also explains a lot of cross-sectional developments
- TFP shocks and labor supply shock explain less of aggregate inflation

Model: Households

- Consume goods and services
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- Time-varying preferences for goods services (reallocation shock)
- Supply labor to firms

Households

Households problem:

$$\max E_t \sum_{i=0}^{\infty} \frac{C_{t+i}^{1-\gamma}}{1-\gamma} - \chi_t \frac{(N_{t+i})^{1+\psi}}{1+\psi} \tag{1}$$

where

$$C_t = \left(\frac{C_t^g}{\omega_t}\right)^{\omega_t} \left(\frac{C_t^s}{1-\omega_t}\right)^{1-\omega_t} \tag{2}$$

$$C_t^g = \prod_{i=1}^{N} \left(\frac{C_{i,t}^g}{\gamma_i^g}\right)^{\gamma_i^g} \text{ and } C_t^s = \prod_{i=1}^{N} \left(\frac{C_{i,t}^s}{\gamma_i^s}\right)^{\gamma_i^s} \tag{3}$$

subject to

$$P_t C_t + B_{t+1} = W_t N_t + (1+i_t) B_t + Profits_t \tag{4}$$

Model: Firms

In each sector there are 3 types of firms:

1. Representative Competitive Producer
2. Monopolistically Competitive Firms
3. Labor Agencies

Model: Monopolistically Competitive Firms

$$Y_t^i = A_t^i \left(\alpha^{\frac{1}{\epsilon_Y}} \left(M_t^i\right)^{\frac{\epsilon_Y - 1}{\epsilon_Y}} + (1-\alpha)^{\frac{1}{\epsilon_Y}} \left(L_t^i\right)^{\frac{\epsilon_Y - 1}{\epsilon_Y}} \right)^{\frac{\epsilon_Y}{\epsilon_Y - 1}} \tag{5}$$

$$M_t^i = \left(\sum_{j=1}^{N} \Gamma_{i,j}^{\frac{1}{\epsilon_M}} \left(M_{j,t}^i\right)^{\frac{\epsilon_M - 1}{\epsilon_M}} \right)^{\frac{\epsilon_M}{\epsilon_M - 1}} \tag{6}$$

Sector-specific Rotemberg price adjustment costs (κ_i) $\rightarrow$

$$1 - \epsilon + \epsilon \frac{MC_t^i}{P_t^i} - \kappa_i (\Pi_t^i - 1)\Pi_t^i + E_t \left(M_{t+1} \Pi_{t+1}^i (\Pi_{t+1}^i - 1) \frac{Y_{t+1}^i}{Y_t^i} \right) = 0 \tag{7}$$

Model: Monopolistically Competitive Firms

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Model: Labor Agencies

- Labor agency in each sector hires labor from HHs at W_t and supplies it to monopolistically competitive firms at $P_t^{L,i}$
- Subject to convex hiring costs

$$V_t(L_{t-1}^i) = \max_{L_t^i} P_t^{L,i} L_t^i - W_t L_t^i \left(1 + \mathbb{1}(L_t^i > L_{t-1}^i)\frac{c}{2}\left(\frac{L_t^i}{L_{t-1}^i} - 1\right)^2\right) + E_t[M_{t+1} V_{t+1}(L_t^i)] \quad (8)$$

Monteary Policy and Equilibrium

Monetary policy follows a standard Taylor rule.

$$log(i_{t+1}) = log(R_{ss}) + \phi \log \Pi_t \tag{9}$$

where $\Pi_t = \frac{P_t}{P_{t-1}}$. Goods market clearing:

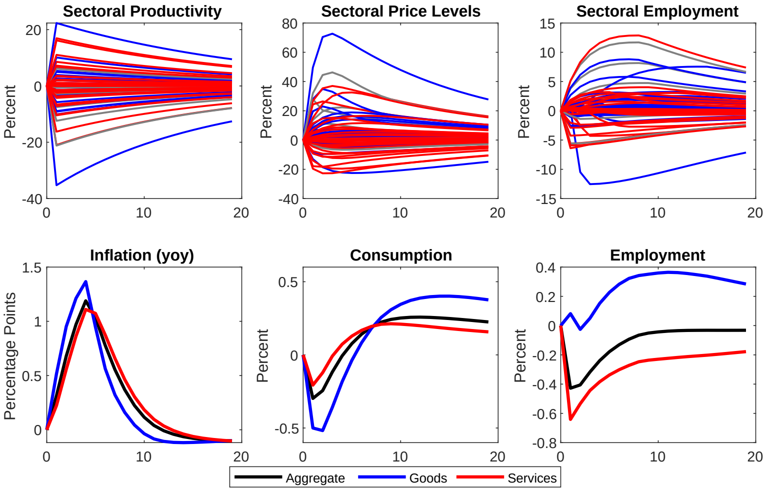
$$Y_t^i = C_{i,t}^g + C_{i,t}^s + \sum_{j=1}^{N} M_{i,t}^j \quad \forall i \tag{10}$$

Labor market clearing:

$$\sum_{j=1}^{N} L_t^i \left(1 + \mathbb{1}(L_t^i > L_{t-1}^i) \frac{c}{2} \left(\frac{L_t^i}{L_{t-1}^i} - 1 \right)^2 \right) = N_t \tag{11}$$

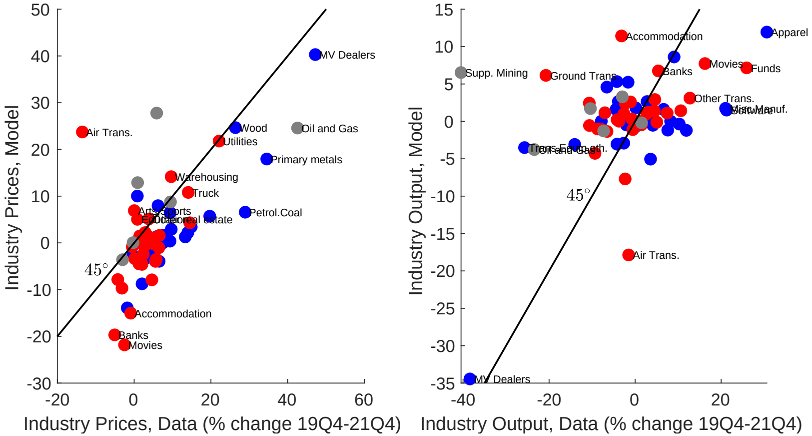
Back

TFP Shocks: Aggregates



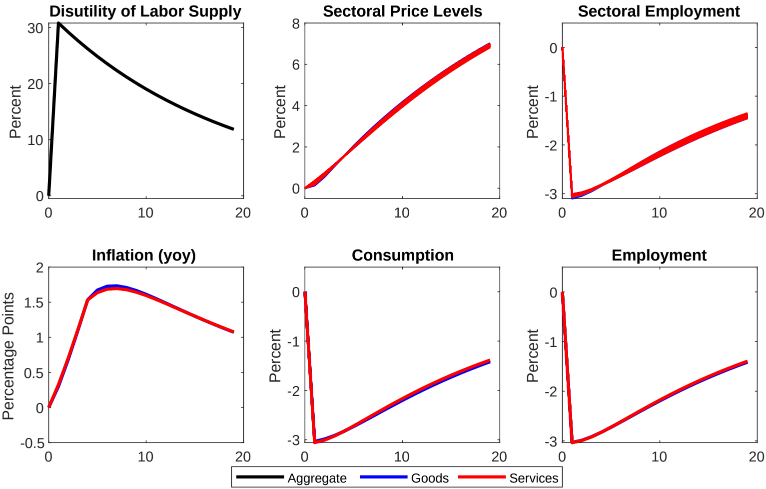
All Shocks

TFP Shocks: Cross-section



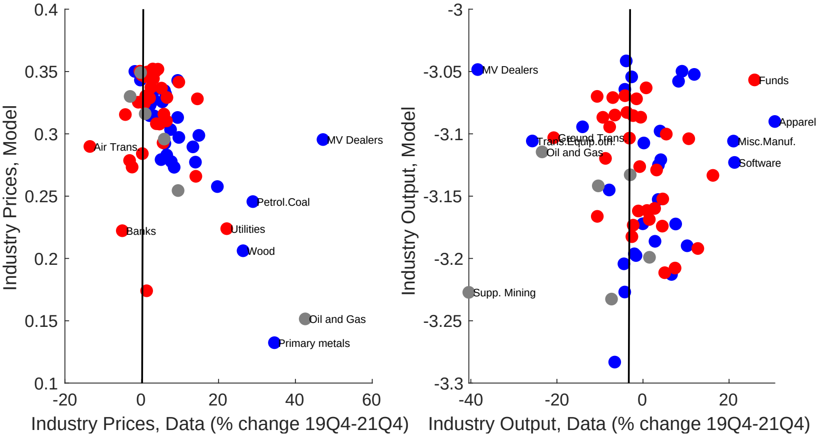
All Shocks

Labor Supply Shock: Aggregates



All Shocks

Labor Supply Shock: Cross-section



All Shocks

Parameters

Calibrated Parameters	Value	Target/Source
γ	2	Standard
$\bar{\chi}$	1	Standard
ψ	1	Standard
ϕ	1.5	Standard
β	0.99	Standard
ϵ	10	Standard
$\bar{\omega}$	0.31	Expenditure share: Goods
κ_i	0.05 to 98	Pasten, Schoenle & Weber (2020)
α	0.12 to 0.84	BEA

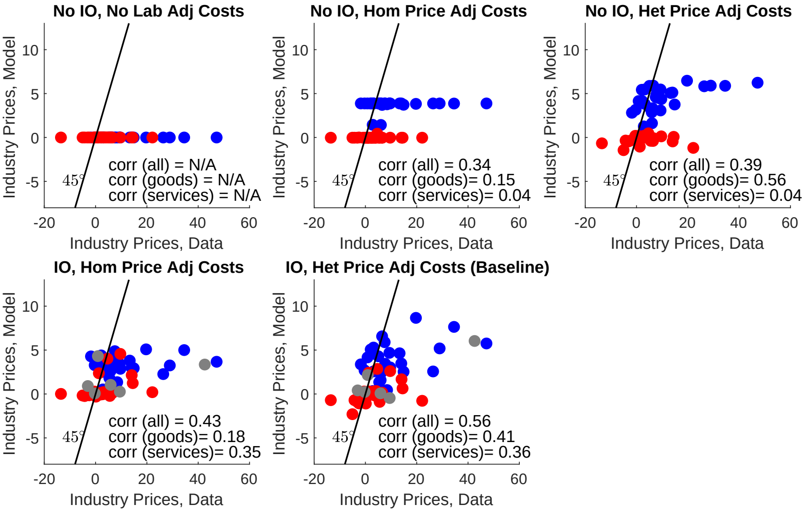
Estimated Parameters	Value	Target/Source
c	48.8	Estimated
ϵ_M	0.05	Estimated
ϵ_Y	0.6	Estimated
$\Delta\chi$	0.056	Estimated

Parameters

Calibrated Parameters/Shocks	Value	Target/Source
γ	2	Standard
χ	1	Normalization
ψ	1	Standard
ϕ	1.5	Standard
β	0.995	Standard
ϵ	10	Standard
$\bar{\omega}$	0.31	Goods Expenditure Share
α	0.5	Pasten, Schoenle & Weber (2020)
κ_i	0.05 to 98	Pasten, Schoenle & Weber (2020)
ρ_ω	0.975	Path of Goods Expenditure Share
ρ_χ	0.95	Standard
ρ_A	0.95	Standard
Δ_ω	0.045	Δ Goods Expenditure Share
ΔA_t^i	-0.29 to 0.25	Measured Sectoral TFP
Estimated Parameters/Shocks	**Value**	**Target/Source**
c	31.3	Estimated
ϵ_M	0.01	Estimated
ϵ_Y	0.58	Estimated
$\Delta\chi$	0.11	Estimated

Back

Both I-O and Het Price Stickiness Important



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