Structural Transformation and the Transmission of Monetary Policy

Tiago Bernardino

IIES, Stockholm University

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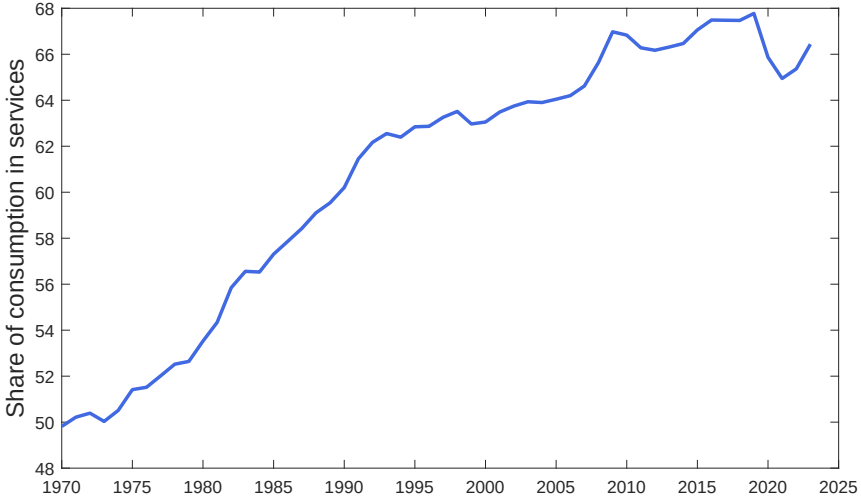
Job Market Mock Talk

Economic Growth Goes Hand in Hand with Structural Transformation



Source: U.S. B.E.A. Table 2.3.5

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- **Why does the shift toward services matter?**
  1. Price dynamics
     - prices in the services sector adjust less frequently than in the goods sector
  2. Demand composition
     - services share increases along the income distribution

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     - calibrate for sectoral productivity growth $\Rightarrow$ endogenous shift toward services
  3. Monetary policy contraction shocks
     - compare monetary policy transmission across economies with different service shares

Preview of Results

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3. **Heterogeneity and Welfare:**
   - structural transformation enlarges the inequalities generated by contractionary monetary policy

Related Literature and Contribution

1. **Long-run trends and monetary policy transmission**
   e.g: Boivin and Giannoni (2006), Galesi and Rachedi (2019), Pancrazi and Vukotić (2019), Leahy and Thapar (2022), Mangiante (2025)

   $\Rightarrow$ Study the impact of structural transformation

2. **Household heterogeneity and monetary policy transmission**
   e.g: Gornemann et al. (2016), McKay et al. (2016), Kaplan et al. (2018), Auclert (2019), Hagedorn et al. (2019), Broer et al. (2020), Cravino et al. (2020), Luetticke (2021)

   $\Rightarrow$ Study the role of heterogeneous demand composition for MP transmission

3. **Non-homotheticities for business cycle analysis**
   e.g: Jaimovich et al. (2019), Andreolli et al. (2024), Olivi et al. (2024), Orchard (2025), Boehnert et al. (2025), Orchard (2025), Becker (2024)

   $\Rightarrow$ HANK with non-homothetic preferences

Plan of the Talk

1. Motivating Evidence
2. Model
3. Taking the Model to the Data
4. Structural Transformation and the Transmission of Monetary Policy
5. Extension: Structural Transformation and Supply Shocks
6. Conclusion

Motivating Evidence:
Why Sectoral Composition Matters

Sectoral Price Rigidities

Prices in the service sector are less flexible

Data: Summary statistics on price frequency (Nakamura and Steinsson, 2008)

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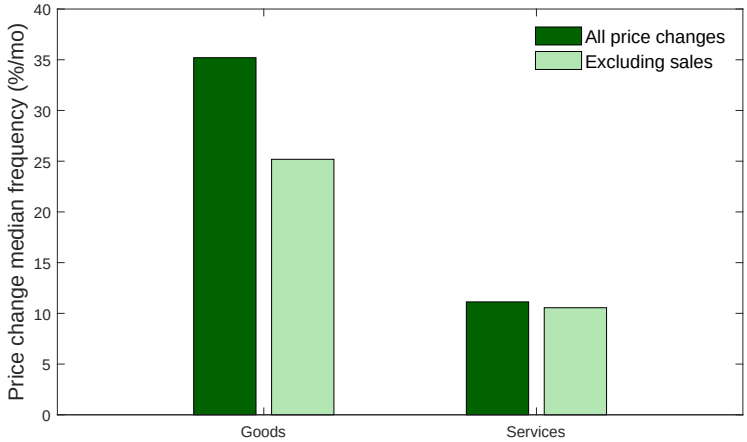

Data | Rob: Bils & Klenow (2004)

Heterogeneous Demand Composition

Services share increases along the income distribution

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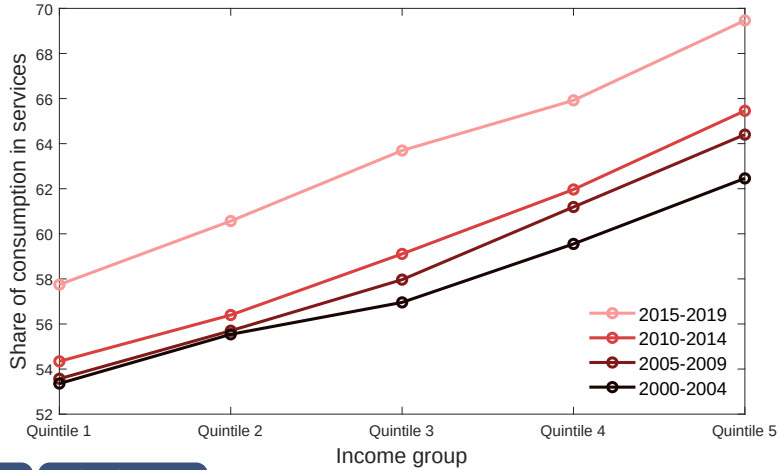

Data | Methodology | Rob: age | Rob: including B_5 and T_5

Consumption Impulse Response Function

$$\Delta \log C_{t+h|t} = \alpha_h + \beta_h \epsilon_t^M + \gamma_h X + \varepsilon_t, \text{ for } h = \{0, 1, ..., 12\}$$

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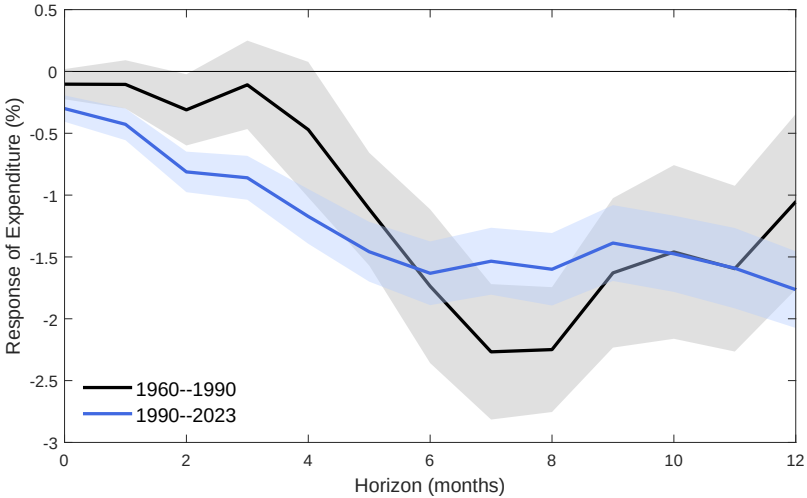
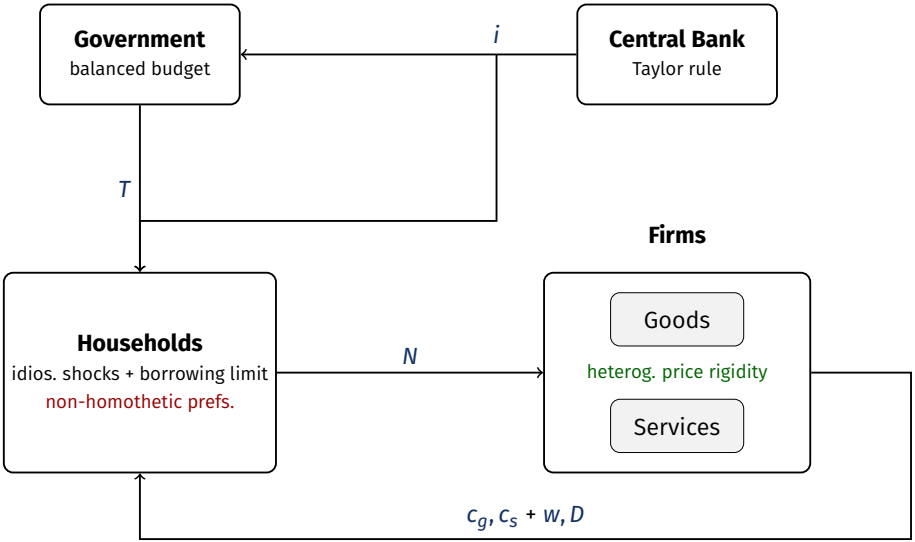


Model

Model Overview

A Two-Sector HANK Model with non-homotheticities



I. Households

Overview

- **Incomplete markets:** idiosyncratic productivity shocks and a borrowing constraint
- **Income sources:** labor earnings, asset returns, and dividends
- **Preferences:** consumption (c_t), and labor (h_t):

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

  - C is implicitly defined through a non-homothetic CES aggregator (Comin et al., 2021):

$$1 = (\Omega C^{\epsilon})^{\frac{1}{\sigma}} C_s^{\frac{\sigma-1}{\sigma}} + (c)^{\frac{1}{\sigma}} c_g^{\frac{\sigma-1}{\sigma}}$$

- **Two-stage budgeting:**
  - Intertemporal consumption-savings decision with endogenous labor supply choice
  - Intratemporal consumption allocation between goods and services

I. Households

The intratemporal sectoral expenditure allocation

- Given $\{p_i\}_{i\in\{g,s\}}$ and C, households solve the following **expenditure minimization problem**:

$$\min_{\{c_s,c_g\}} E\left(c_s, c_g; p_s, p_g\right) = p_g c_g + p_s c_s$$

$$\text{s.t. } \left(\Omega c^{\epsilon}\right)^{\frac{1}{\sigma}} c_s^{\frac{\sigma-1}{\sigma}} + (c)^{\frac{1}{\sigma}} c_g^{\frac{\sigma-1}{\sigma}} = 1$$

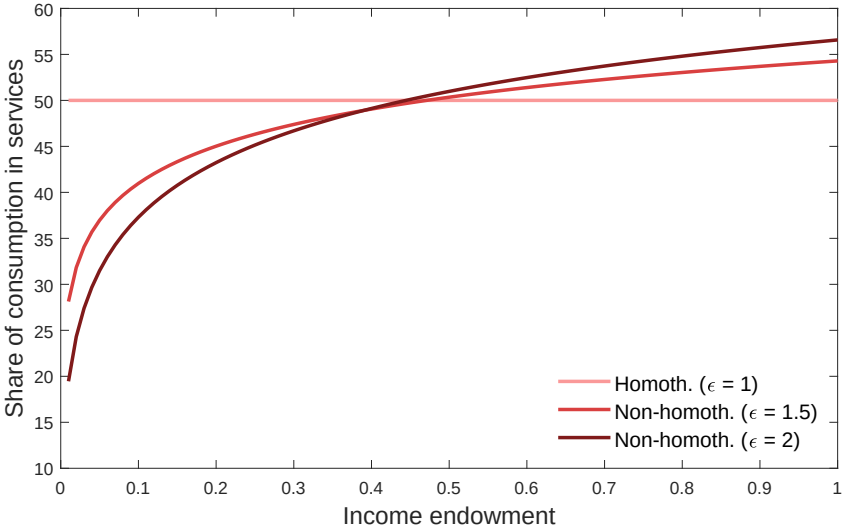
  - Note: if $\epsilon = 1$, we recover the standard (homothetic) CES aggregator

- Solution: (Hicksian) **demands**

$$c_g = \left(\frac{p_g}{E}\right)^{-\sigma} c^{1-\sigma} \text{ and } c_s = \left(\Omega\frac{p_s}{E}\right)^{-\sigma} c^{\epsilon(1-\sigma)}$$

I. Households

Static non-homothetic CES illustration



Stone-Geary

I. Households

The intertemporal consumption-savings decision problem

The intertemporal recursive representation of the household problem:

$$
\begin{aligned}
V(\omega, b; \Xi) = \max_{\{c, b', h\}} \quad & u(c, h) + \beta \mathbb{E}\left[V(\omega', b'; \Xi')\right] \\
\text{s.t.} \quad & E + p_b b' = w\omega h + (p_b + i)b + T + D \\
& E = \left[(p_g c)^{1-\sigma} + \Omega\,(p_s c^e)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \\
& \Xi' = \Psi(\Xi) \\
& c \geq 0,\ b' \geq 0,\ h \in (0, 1),
\end{aligned}
$$

with $u(C, h) = \frac{c^{1-\gamma}-1}{1-\gamma} - \chi \frac{h^{1+\eta}}{1+\eta}$ and $\omega \sim$ log-AR(1)

— Dividends are distributed according to households' productivity

II. Firms

The final producer

- Two representative final sector producers: **goods** and **services**
- Each **final producer** aggregates a continuum of intermediate inputs, j:

$$Q_m = \left(\int_0^1 q_m(j)^{\frac{\theta_m - 1}{\theta_m}} dj \right)^{\frac{\theta_m}{\theta_m - 1}}$$

- Given sectoral demand Q_m and prices $p_m(j)$, the **demand for the intermediate input** j is

$$q_m(j) = \left(\frac{p_m(j)}{P_m} \right)^{-\theta_m} Q_m,$$

with $P_m = \left(\int_0^1 p_m(j)^{1-\theta_m} \right)^{\frac{1}{1-\theta_m}}$ being the price in sector m

II. Firms

Intermediate producers

- Operate under **monopolistic competition** producing with a linear technology on labor

$$q_m(j) = Z_m n_m(j)$$

- Intermediate firms adjust prices subject to an **adjustment cost** as in Rotemberg (1982):

$$\Phi_m\left(p_{m,t}(j), p_{m,t-1}(j)\right) = \frac{\theta_m}{2\kappa_m}\left[\log\left(\frac{p_{m,t}(j)}{p_{m,t-1}(j)}\right)\right]^2 Q_{m,t}P_{m,t}$$

- The solution of the firm's problem yields the **New-Keynesian Phillips Curve**:

$$\log(1+\pi_{m,t}) = \frac{\kappa_m}{\theta_m}\left(1-\theta_m+\theta_m\frac{w_t}{Z_m P_{m,t}}\right) + \frac{1}{1+i_t}(1+\pi_{m,t+1})\log(1+\pi_{m,t+1})\frac{Q_{m,t+1}}{Q_{m,t}}$$

III. Government and Monetary Authority

- There is a **government** that collects taxes to finance interest on public debt

$$p_{b,t}B = \int (p_{b,t} + i_t) b_t d\Xi + T_t$$

- The **monetary authority** sets nominal interest rate according to a **Taylor rule**

$$i_t = i_{SS} + \phi \pi_{t-1} + \varepsilon_t^M$$

with $\varepsilon^M \sim$ AR(1).

Equilibrium definition

Taking the Model to the Data

Model Estimation

Strategy and Procedure

- Goal of the model: represent the U.S economy...
  - **long-run:** economic activity shift towards services
  - **short-run:** cross-section heterogeneity on income, wealth, and demand composition

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  - Compare dynamics around two steady-states: 1970 vs. 2019
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  - Compare dynamics around two steady-states: 1970 vs. 2019
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- Three steps:
  1. **Demand estimation:** to obtain the price and income elasticities
     - using price and consumption data, estimate the level of non-homotheticity
  2. **Pre-estimated parameters:** directed observed parameters in the data
     - including sectoral productivity growth rates and price rigidities
  3. **Simulated Method of Moments:** hours worked and service share
     - match the values in 2019

1. Demand Estimation

The relative Hicksian demand

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- The relative **Hicksian demand** between the service sector and the goods sector is:

$$\log\left(\frac{\nu_{s,t}}{\nu_{g,t}}\right) = (1-\sigma)\log\left(\frac{p_{s,t}}{p_{g,t}}\right) + (1-\sigma)(\epsilon-1)\log\left(\frac{E_t}{p_{g,t}}\right) + (\epsilon-1)\log\nu_{g,t} + \log(\Omega),$$

where νit is the expenditure share in sector i at time t

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- Using GMM, estimate σ and ϵ
  1. Use household-level consumption data (CEX)
  2. Controls: dummies for age groups, number of earners, and family size
  3. IV Rel. Prices: average price across regions excluding the own region
  4. IV Expenditure: annual household income and the income quintile of the household
- Estiamtion results: $\epsilon = 1.73$ and $\sigma = 0.234$ Details

2. External parameters

Parameter	Description	Value	Source
I. Household			
β	Discount factor	0.99	Standard (quarterly model)
γ	CRRA	1.20	Standard
η	Frisch elasticity	1.00	Chetty et al. (2011)
ρ_z	Persistence of idiosync. productivity	0.99	Krueger et al. (2016)
σ_z	Std. dev. of idiosync. productivity	0.10	Krueger et al. (2016)
II. Firm			
θ_g	Elasticity of substitution (goods)	5.8	Marto (2024)
θ_s	Elasticity of substitution (services)	4.7	Marto (2024)
κ_g	Price adjustment cost (goods)	8.5	Section 2
κ_s	Price adjustment cost (services)	89.2	Section 2
III. Government and Monetary Authority			
i_{SS}	Steady-state interest rate	0.75%	3% annual rate
ϕ_π	Taylor rule weight on inflation	1.5	Standard NK literature
ρ_M	Persistence of MP innovations	0.5	Standard NK literature

3. Simulated Method of Moments

- Parameters with SMM: χ, and Ω
- Use them to match 2 moments: average hours worked and agg. service share in 1970 and 2019
- Goal: minimize loss function

$$\min_{\chi,\Omega} \mathcal{L} = ||M_m - M_d||$$

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Moment	Model Mom.	Data Mom.	Data Source	Parameter	Param. Value
Average hours worked	0.217	0.212	OECD	χ	30.0
Average service share 2019	0.673	0.678	BEA	Ω	7.0

Model Fit

Long-run

- Heterogeneous sectoral productivity growth rates: goods = 2.2%/year, services = 1.1%/year
- My theory of structural transformation:
  1. **Cost-disease channel:** productivity growth differentials change the relative price
  2. **Non-homotheticity channel**: creates an inc. effect that shifts consumption toward "luxuries"

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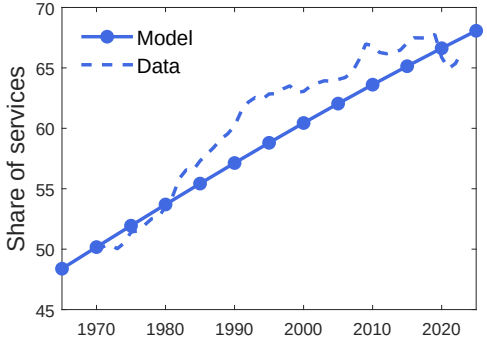
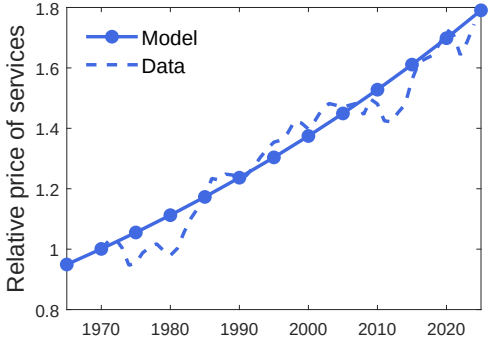
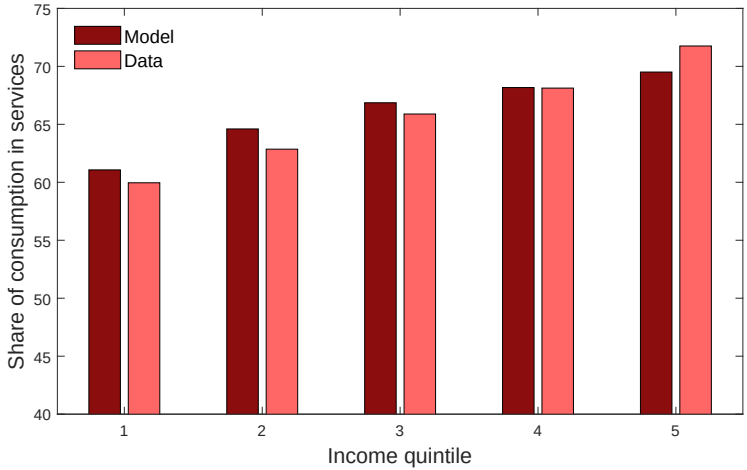




Model Fit

Short-run



Model Fit

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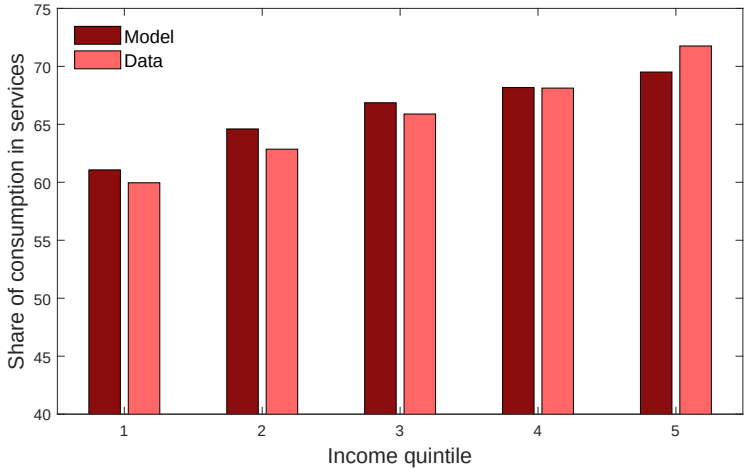


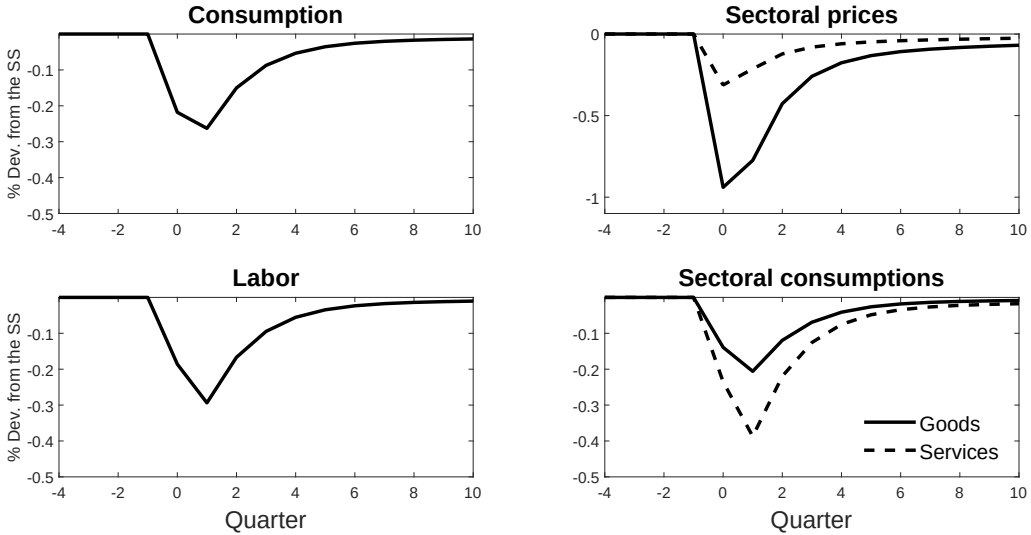
- **Average annual MPC**: 28% (data: 20 – 60%) MPC distribution
- **Share of Hand-to-Mouth**: 23.4% (data: 17.3%) Wealth Dist.

Structural Transformation & Monetary Policy Transmission

Response to Monetary Policy

SS policy functions | Demand Composition

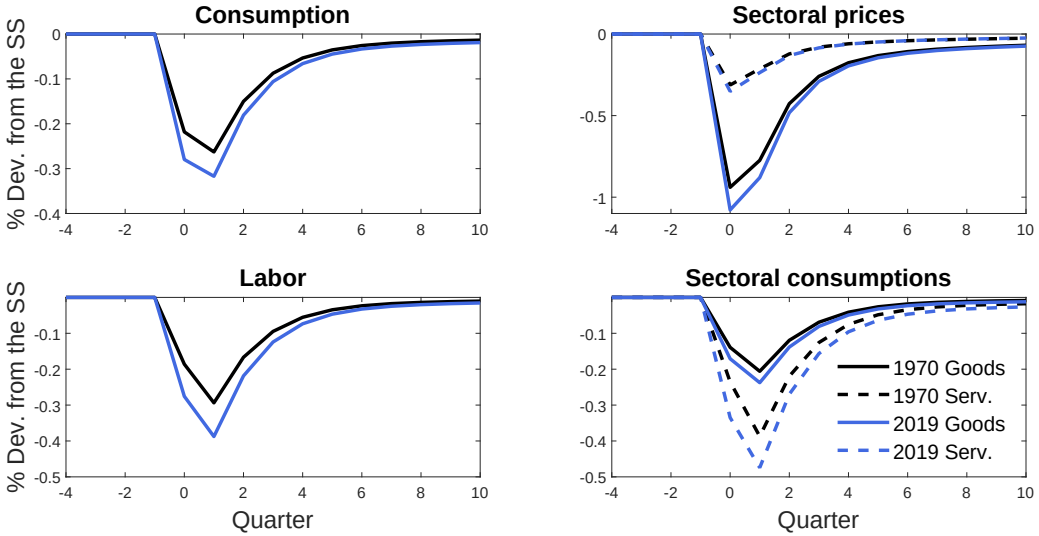
Aggregate Responses to a 100 bp Contractionary Shock: 1970 vs 2019



Structural Transformation and Monetary Policy

More years

Aggregate Responses to a 100 bp Contractionary Shock: 1970 vs 2019



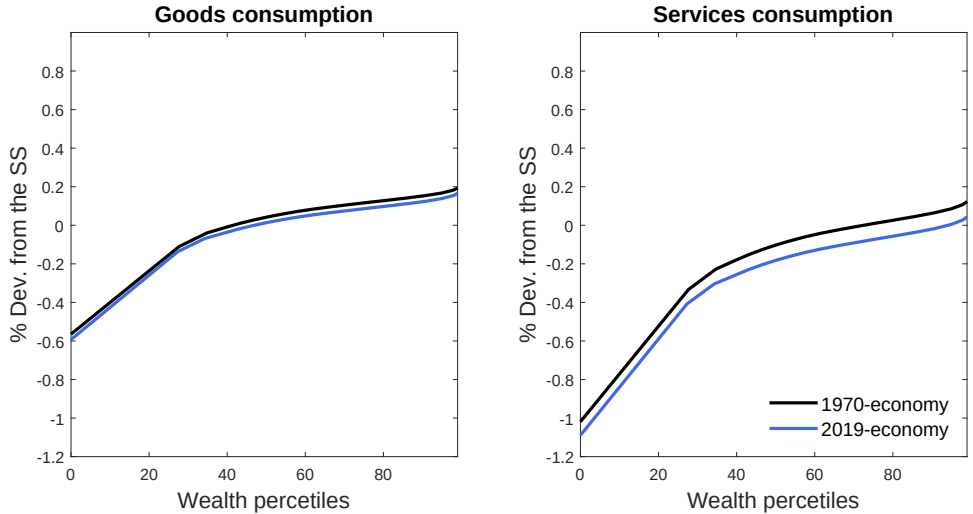
The Role of Non-Homotheticity and Heterogeneous Price Rigidities

	(1) Baseline		(2) Homog. κ_m		(3) Homothetic	
	1970	2019	1970	2019	1970	2019
Service share	51.3	67.3	51.3	67.3	51.0	67.2
MPC	8.1	7.6	8.1	7.6	8.6	8.4
Consump. response (% change vs. 1970)	20.6		3.5		24.1	
Price of goods response (% change vs. 1970)	13.7		5.9		6.3	
Price of serv. response (% change vs. 1970)	10.7		5.9		3.5	

Inc. & Sub. effects

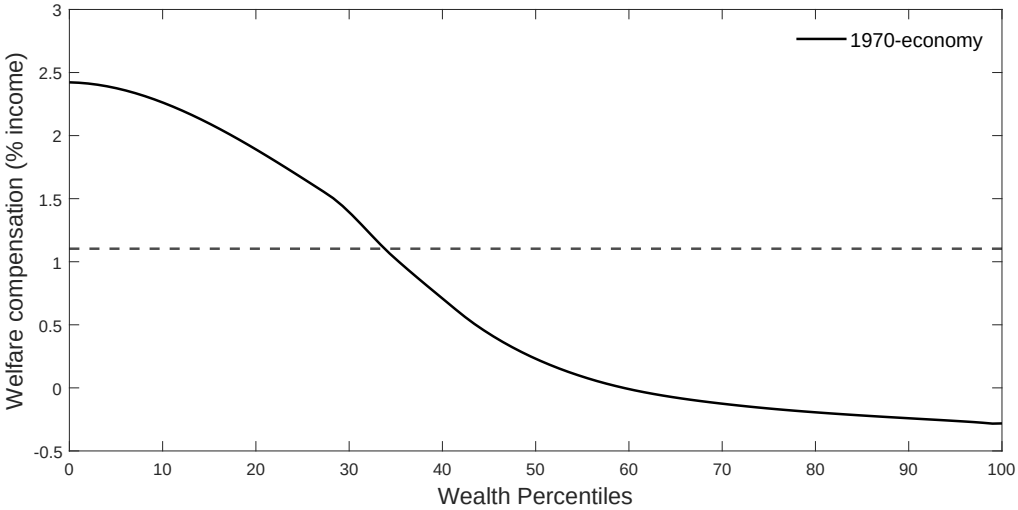
Sectoral Consumption Responses by Wealth Position

Low-wealth households decrease their consumption more than high-wealth households



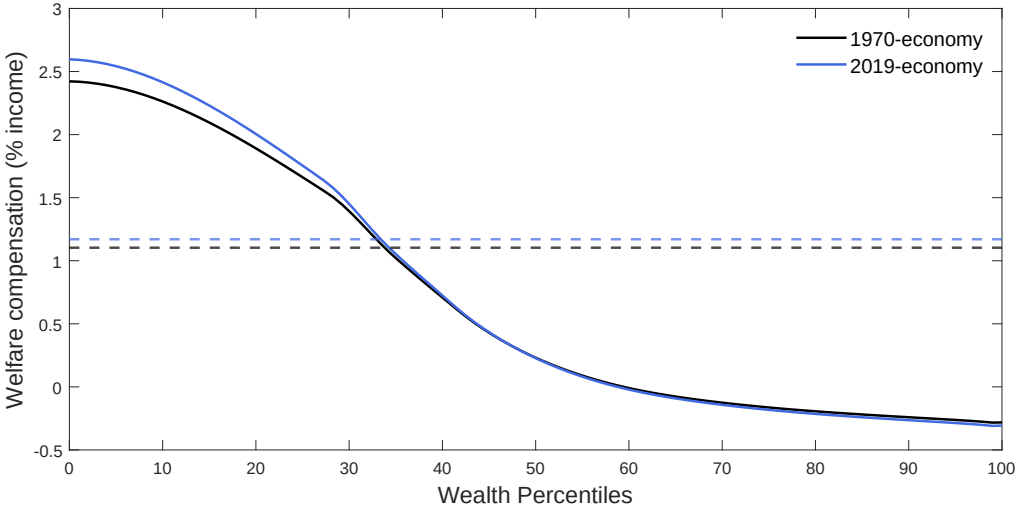
Response to Monetary Policy

Welfare cost



Structural Transformation and Monetary Policy

Monetary policy became more costly in terms of welfare



Structural Transformation & Negative Supply Shocks

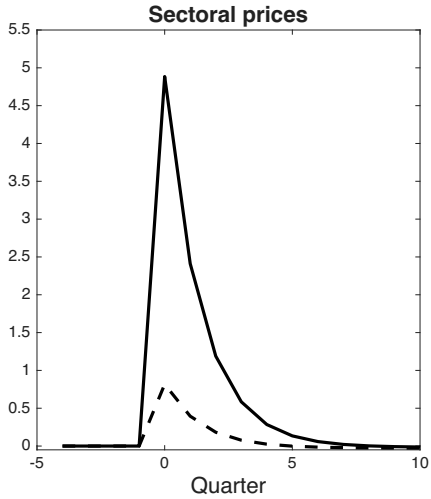
Extension: What is the Role of Services for Economic Resilience?

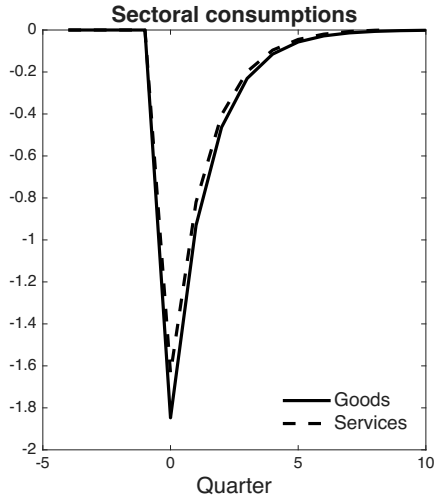
- **Goal:** Compare the effects of supply shocks with different demand compositions
  - compare the 1970-economy (50% services) and the 2019-economy (68% services).

- **Setup:**
  1. Economy is at the Steady-State
  2. Unexpected shock in the sectoral productivity (same for both sectors: $\Delta Z_m / Z_m = -5\%$)
     - Unexpected and never to occur again
     - Once it is realized, agents have full information about its path
     - Shock is persistent, but after one year is halfway to the SS value

Structural Transformation and Supply Shocks

Aggregate responses to a negative 5% aggregate TFP shock

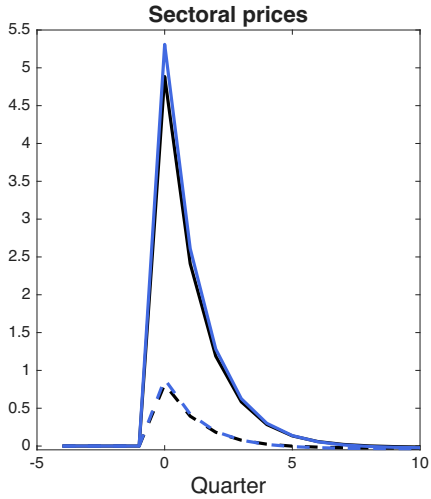


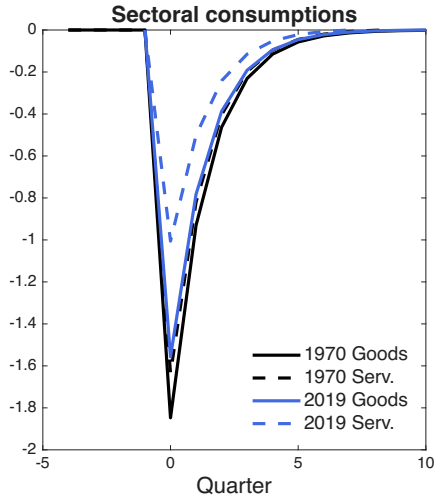


Structural Transformation and Supply Shocks

Back

Higher services share makes the economy less responsive to supply shocks





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MPC	8.1	7.6	8.1	7.6	8.6	8.4
Consump. response (% change vs. 1970)	-37.3		-9.2		-19.9	
Price of goods response (% change vs. 1970)	8.3		0.9		4.9	
Price of serv. response (% change vs. 1970)	6.9		0.9		4.1	

Conclusion

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- **Structural transformation** shifts economic activity towards services
- **This paper:** What are the implications for the transmission of MP
  - prices in the service sector are stickier
  - services share increase along the income distribution

- Using a quantitative dynamic model:
  - The rise in the services share from 1970 to 2019 increased monetary non-neutrality by 21%

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Thank You!

Appendix

Fact #1: Prices in the service sector are stickier

Back

Data and Methodology

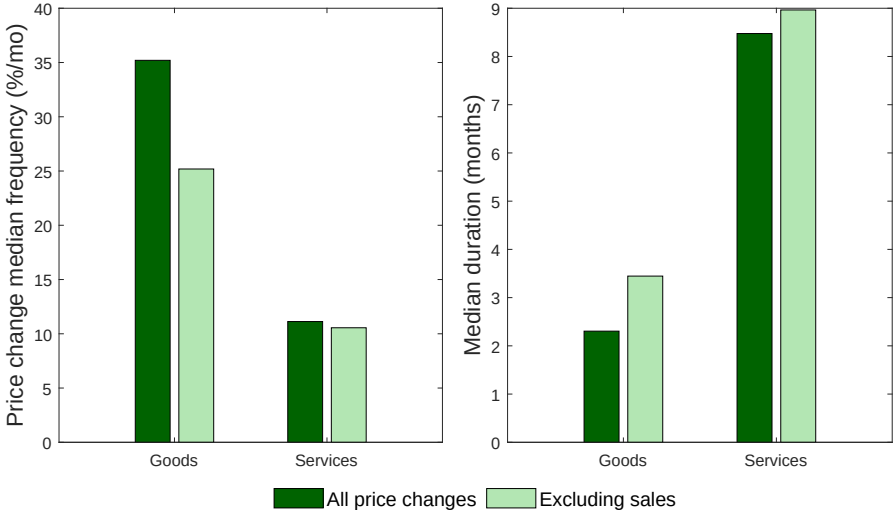
- **Data:** Summary statistics about price frequency assembled by Nakamura and Steinsson, 2008
  - Source: BLS monthly microdata that underlies the U.S. CPI
  - covers 70% of consumer expenditures

- **Methodology**
  1. Aggregate by goods and services categories (BEA classification)
  2. Compute implied duration using a Poisson distribution

Fact #1: Robustness

Back

Implied Duration



Fact #1: Robustness

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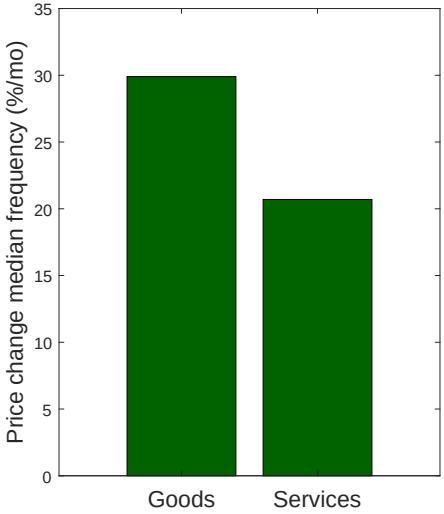
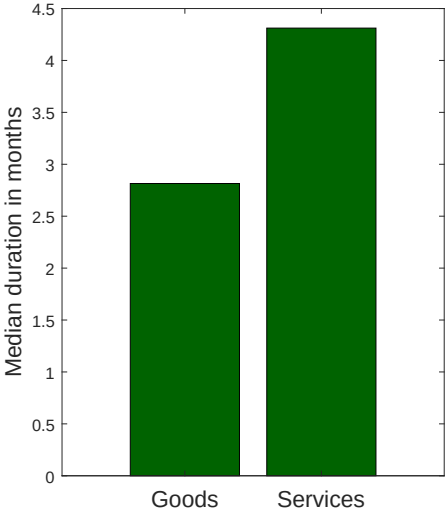
Using Bils and Klenow (2004) dataset





Fact #2: Data details

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- **Consumer Expenditure Survey (CEX)**
  - curated by the US BLS
  - used to compute the relative importance of goods and services in the CPI basket
- **Coverage**
  - time frame: between 2000 and 2022
  - each wave has between 5 000 – 8 000 households
- **Consumption and Expenditure data**
  - household expenditure by broad categories (e.g., food at home, education)
  - demographic variables (income, age, household composition, etc)

Fact #2: Methodology details Back

1. Household **sample selection**:
   - keep those who participate in the 4 waves
   - household head age between 25 and 64
2. Divide households into **5 income groups** (similar to Aguiar and Bils, 2015):
   - income = pre-tax income + alimony + gifts + gambling winnings + inheritance
   - regress income on household size, average age of household earners head, and no income earners
   - from the regression residuals build 5 income groups
3. Classify expenditure by **economic activity**:
   - Services: Food Away, Shelter, Education, Public Transportation, Health Care, Utilities, Personal Care, Entertainment, Other Vehicle Expenses
   - Goods: Food and Alcohol at Home, Motor Vehicles, Apparel, Tobacco and Gasoline
4. Compute the **average share of consumption** in services along time

Fact #2: Robustness

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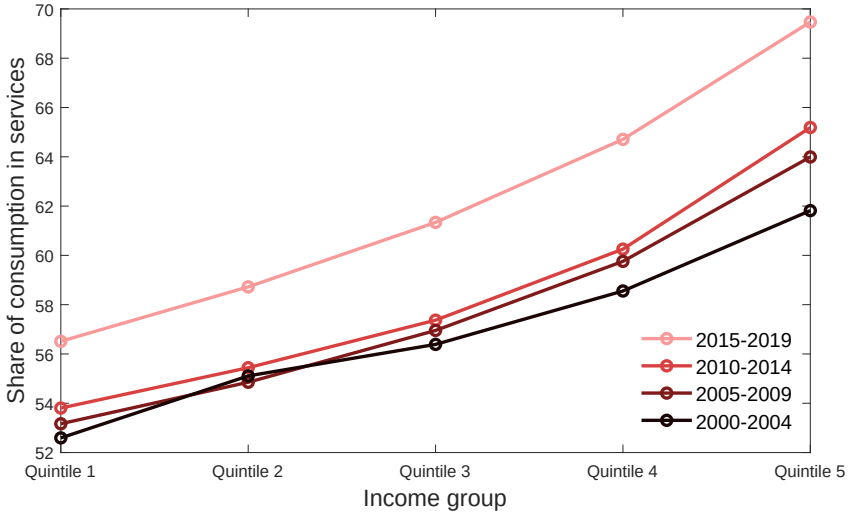
Excluding old households



Fact #2: Robustness

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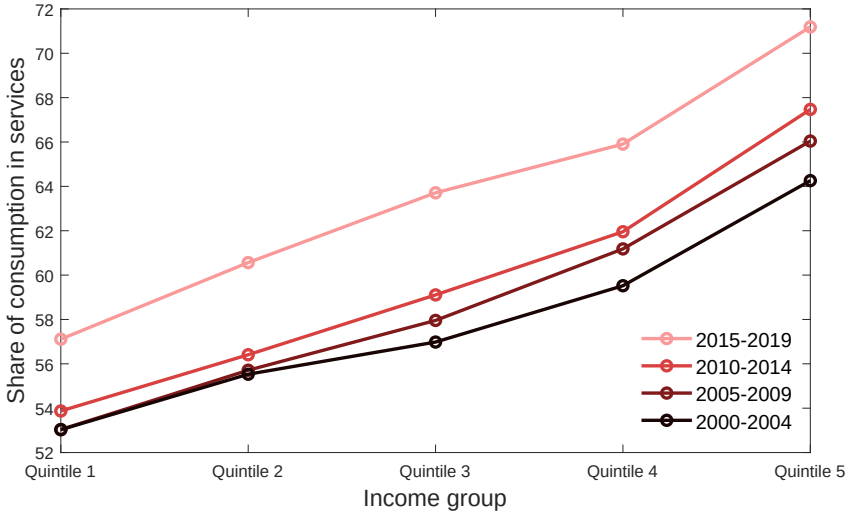
Including bottom and top 5%



Suggestive Motivation Details Back

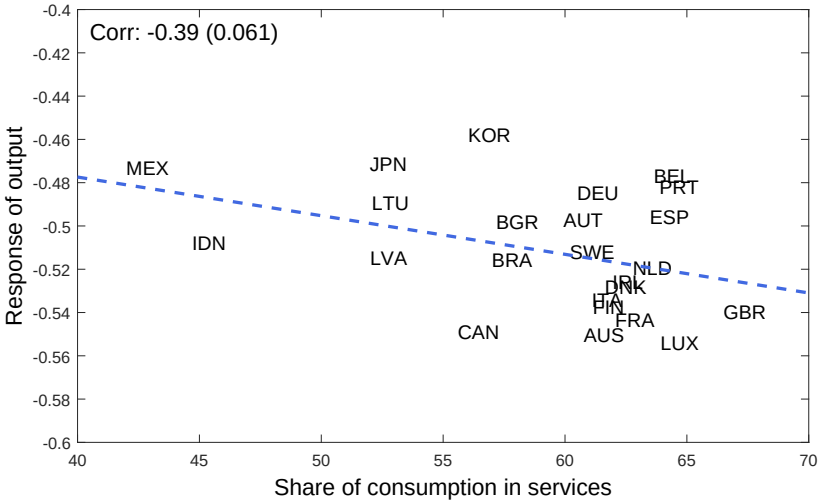
- **Local Projections exercise**
  - Data:
    - Total personal expenditure from the BEA Tables
    - Romer and Romer (2023) narrative MP shocks
  - Using Jordà (2005) local projections, I estimate:

$$\Delta \log E_{t+h|t} = \alpha^h + \beta_h \epsilon_t^M + \sum_{j=1}^{12} \gamma_j^h y_{t-j} + \sum_{j=1}^{12} \delta_j^h \epsilon_{t-j}^M + \mu_m + \varepsilon_t, \text{ for } h = \{0, 1, ..., 24\}$$

- **Cross-country correlation exercise**
  - Galesi and Rachedi (2019) SVAR model (Y_t, π_t, i_t) estimates with sign restriction identification
  - 20-year average service share from national accounts

Cross-Country Evidence

Details Back



Static non-homothetic CES illustration

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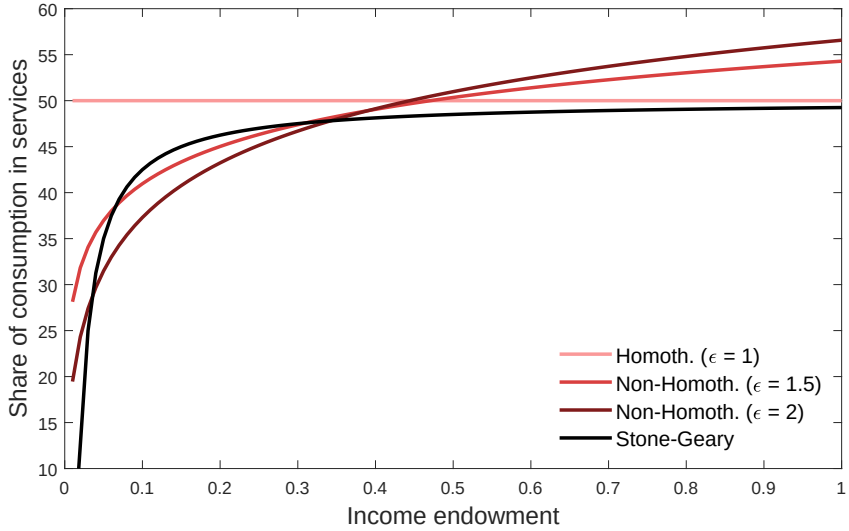
Comparison with Stone-Geary class



Competitive Equilibrium

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Definition: A competitive equilibrium is a sequence of lump-sum transfers T_t; interest rates i_t; value functions V_t with policy functions $\hat{c}_{g,t}, \hat{c}_{s,t}, \hat{h}_t$ and $\hat{b}_t$; prices p_t^b, p_t^g, p_t^s, and w_t; profits $\pi_{g,t}$ and $\pi_{s,t}$; and a law of motion Ψ, such that:

1. V_t satisfies the Bellman Equation, with the solution given by the policy functions $\hat{c}_{g,t}, \hat{c}_{s,t}, \hat{h}_t$ and $\hat{b}_t$ given sequences of lump-sum taxes, prices, interest rate and dividends.
2. Firms maximize profits, which are distributed in the form of dividends to households.
3. The government runs a balanced budget.
4. For all Ξ_t, the asset, labor, and goods markets clear.
5. The aggregate law of motion of the distribution, Ψ, is generated by the savings policy function.

1. Demand Estimation

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Results

$$\log\left(\frac{\nu_{s,t}^n}{\nu_{g,t}^n}\right) = (1-\sigma)\log\left(\frac{p_{s,t}^n}{p_{g,t}^n}\right) + (1-\sigma)(\epsilon-1)\log\left(\frac{E_t^n}{p_{g,t}^n}\right) + (\epsilon-1)\log\nu_{g,t}^n + \zeta^n + \tilde{\zeta}_t^n,$$

	(1)	(2)	(3)
σ	0.209	0.176	0.234
	(0.044)	(0.039)	(0.051)
ϵ	1.619	1.667	1.731
	(0.061)	(0.058)	(0.080)
Region FE	N	Y	Y
Year $\times$ Quarter FE	N	N	Y

Steady-State Policy Functions

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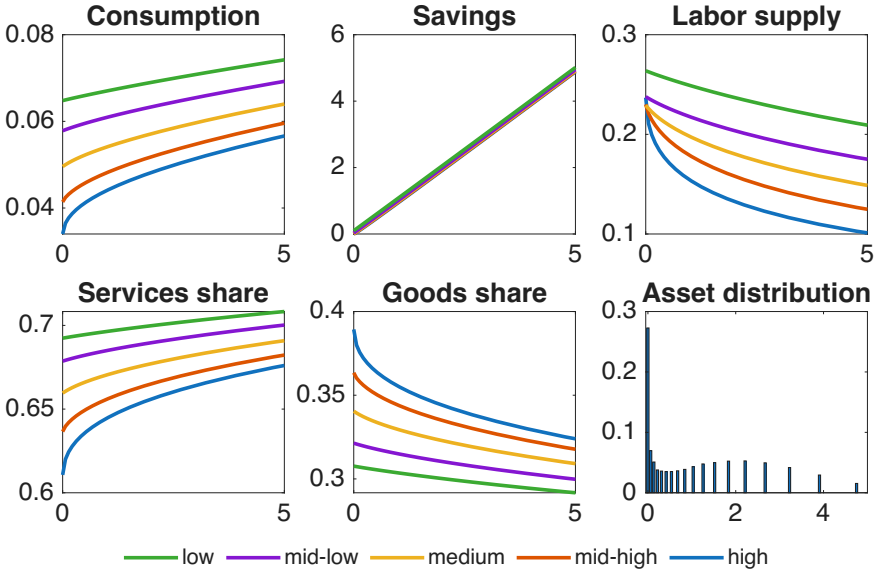

Frontier: MP response and services share

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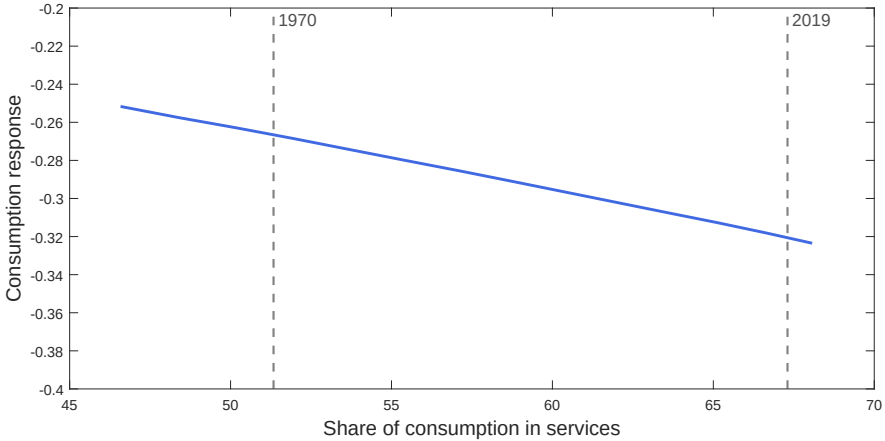

Monetary Policy and Demand Composition

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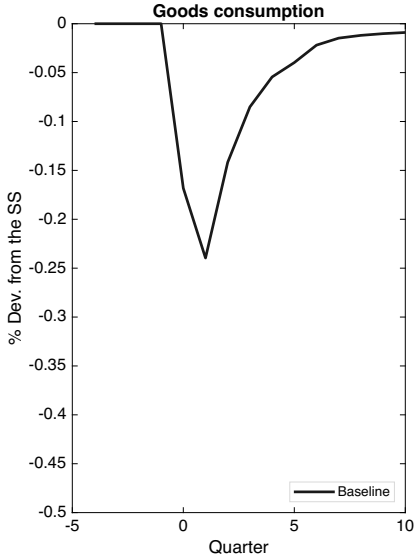
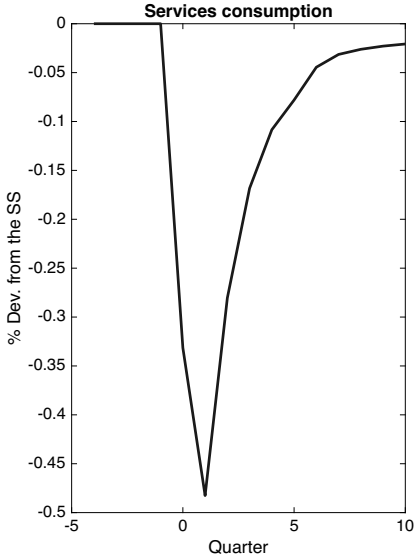
MP contractions shift expenditure towards goods





Demand Composition: Decomposition

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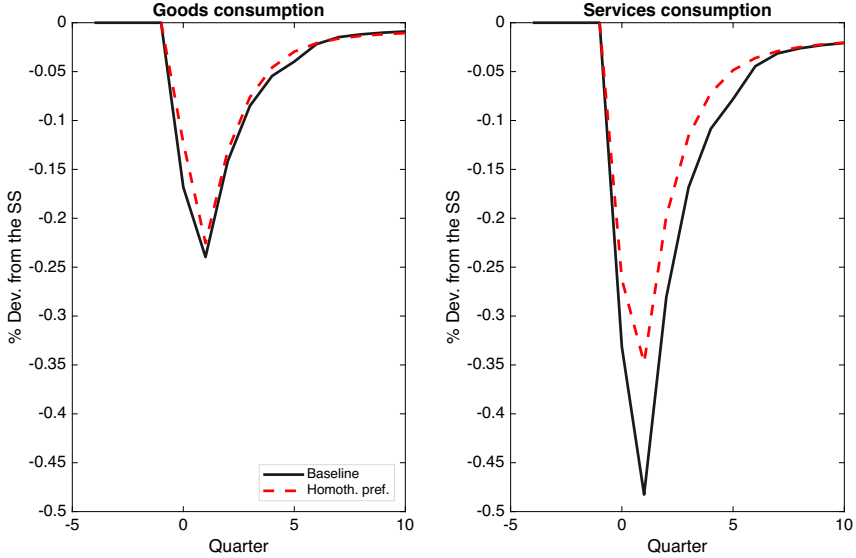
Non-homotheticity accounts for around half of the differences in the response



Demand Composition: Decomposition

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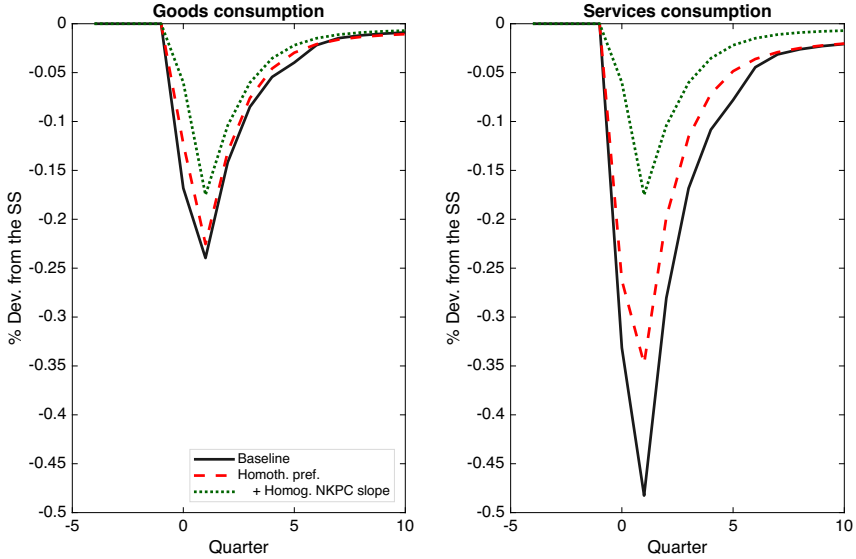
Differences in the price rigidities account for the other half



Counterfactuals: income vs substitution effects

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Two forces that drive the increase in services:

1. Higher **income** makes consumption shift toward "luxuries"
2. changes in the **relative prices** change consumption composition

	(1) 1970 (bsl)	(1) 2019 (bsl)	(2) Income effect	(3) Substitution effect
Consump. response (vs. 1970)	–	20.64	11.52	14.02
Relative price	1.00	1.68	1.00	1.68
SS consumption	0.03	0.05	0.05	0.03
Service share	51.34	67.30	58.09	61.22

$\Rightarrow$ Income and price effect have the same relevance for the amplification of MP transmission

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