Structural Transformation and the Transmission of Monetary Policy

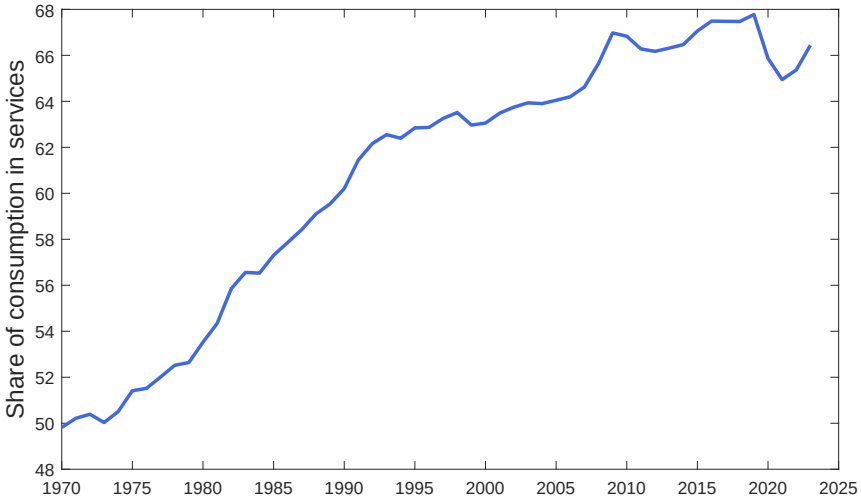
Tiago Bernardino

IIES, Stockholm University

October 22, 2025

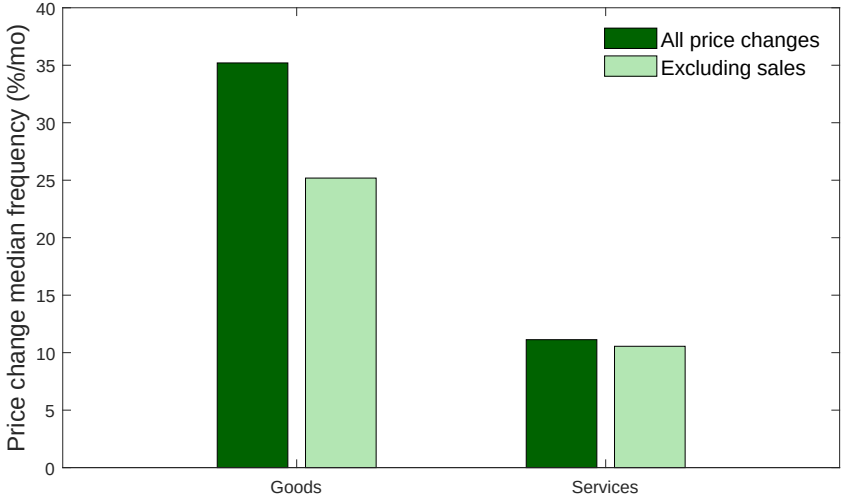
Job Market Mock Talk

Economic Growth Goes Hand in Hand with Structural Transformation



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

Prices of Services Adjust Less Frequently



Source: Nakamura & Steinsson (2008)

Data | Implied duration | Rob: Bils & Klenow (2004)

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  3. Policy experiment: increase in the nominal interest rate
     - compare monetary policy transmission across economies with different service shares

Preview of the Quantitative Model Results

1. **Structural Transformation and Monetary Policy Transmission:**
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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)

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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. Empirical Analysis
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

Empirical Analysis

#1: Monetary Policy Consumption Response Increases over Time

- Data:
  - Total personal expenditure (BEA Tables)
  - Romer and Romer (2023) narrative MP shocks Details

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- Using Jordà (2005) local projections, I estimate:

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

  - β_h gives the impulse response estimates
  - MP shocks scaled by size of the interest rate change
  - X_t are 12 months lags of ϵ^M and C

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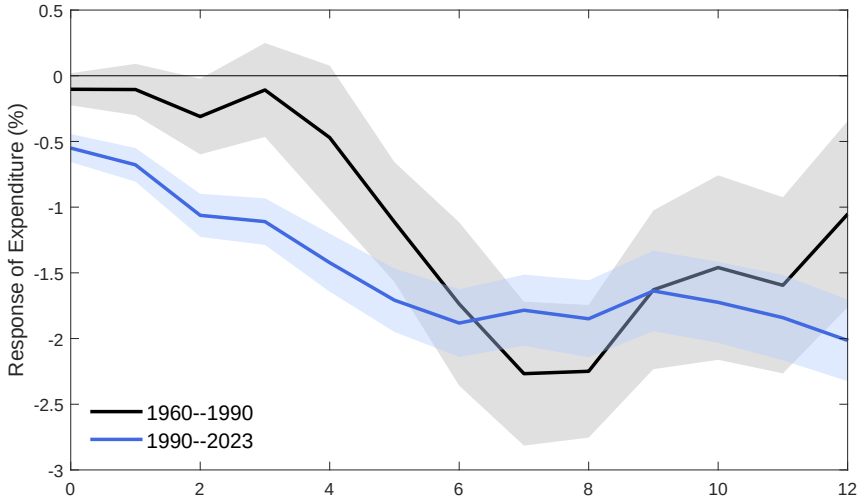

68% C.I. (Newey-West s.e.)

#2: Monetary Policy Responses Correlate with Service Share

Data:

- 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

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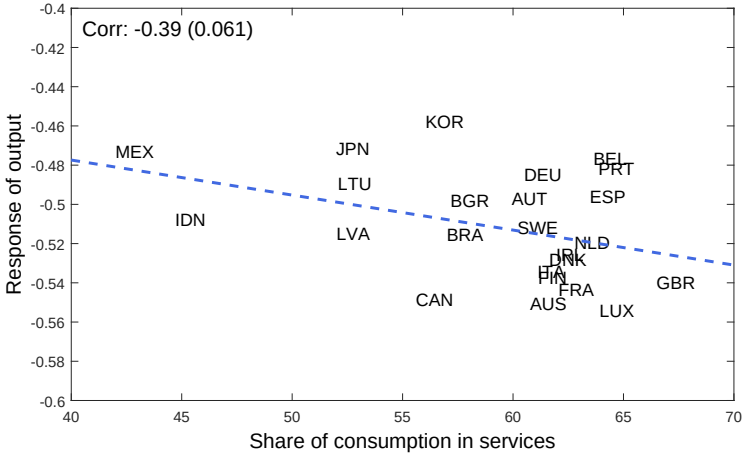

#3: Services Share Increases along the Income Distribution

Data: U.S. Consumer Expenditure Survey

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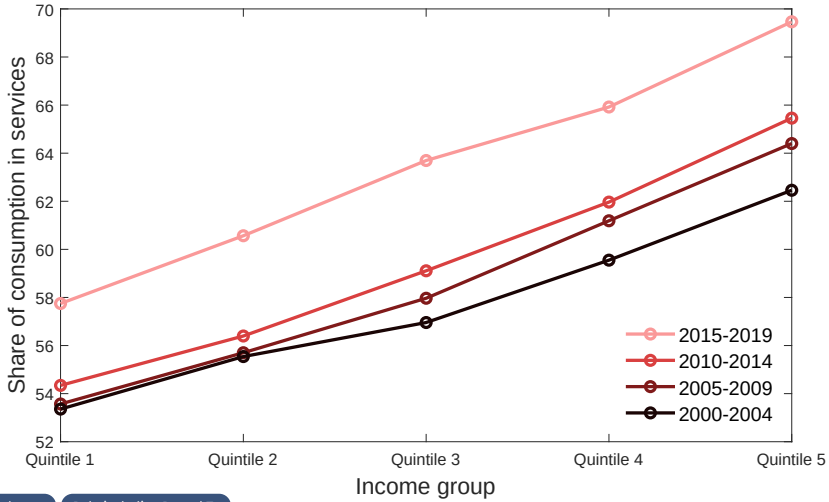
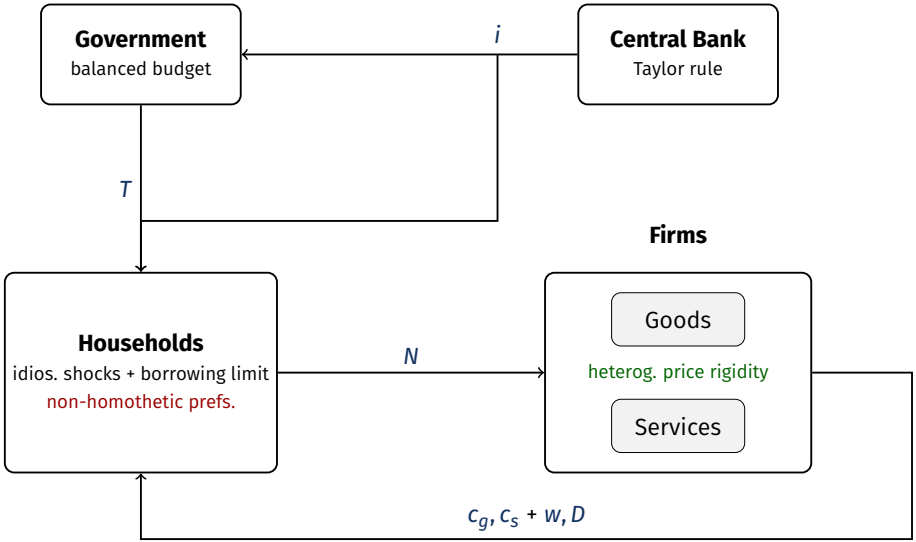


Model

Model Overview

A two-Sector HANK model with non-homothetic preferences



I. Households

Overview

- **Incomplete markets:** idiosyncratic productivity shocks and a borrowing constraint
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- **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):

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

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- **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 $\{p_m\}_{m\in\{g,s\}}$ and c, households solve the following **expenditure minimization problem**:

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

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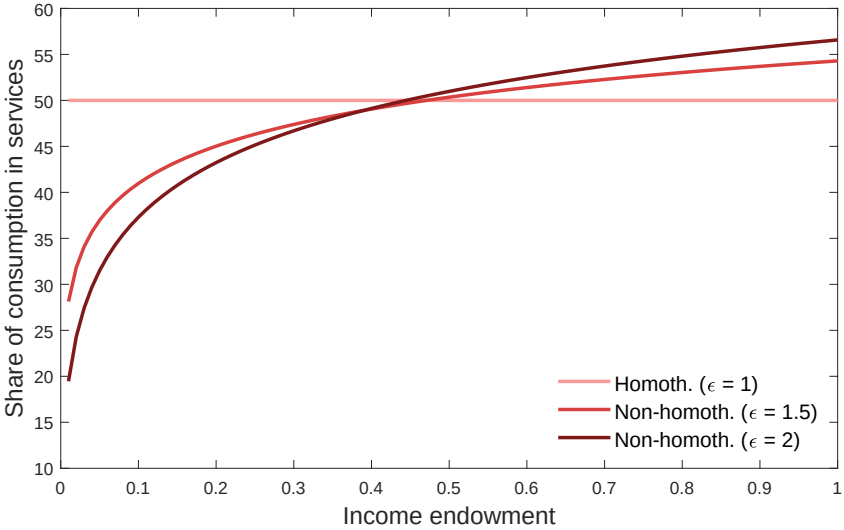
- Solution: (Hicksian) **demands**

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

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:

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

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 indexed by m: **goods** and **services**
- Each **final producer** aggregates a continuum of intermediate inputs, j:

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

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- 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

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

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

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- 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),
and π being the CPI inflation

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
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- ... to study how **structural transformation** changes **MP transmission**
  - compare dynamics around two steady-states: 1970 vs. 2019
  - steady-states only differ in terms of sectoral productivity levels
- Start with the 2019 steady-state:
  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

- Preferences depend on the income elasticity, ϵ, and price elasticity, σ

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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 ν_{mt} is the expenditure share in sector m 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
- Estimation results: $\epsilon = 1.73$ and $\sigma = 0.234$ Details

2. External Calibrated 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
Z_g^{2019}	Goods productivity	1	standardized
Z_s^{2019}	Services productivity	0.6	match 2019 relative price

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 2019
- I match the moments in the steady-state
- 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

Taking the Model to 1970

- What I do:
  1. Start from 2019: service share = 67.3%
  2. Change sectoral productivities (Z_g, Z_s):
     - goods = 2.2%/year
     - services = 1.1%/year

Taking the Model to 1970

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  1. Start from 2019: service share = 67.3%
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- My theory of structural transformation:
  1. **Cost-disease channel:** productivity growth differentials change the relative price

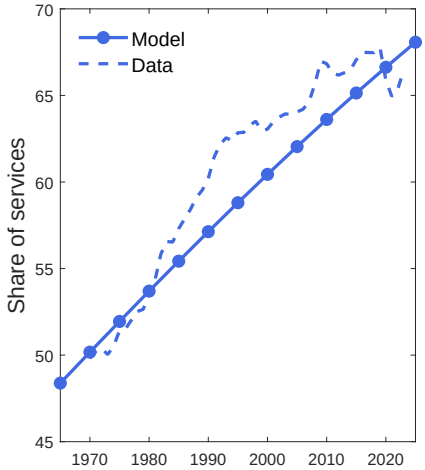
$$\frac{p_s}{p_g} = \mu \frac{Z_g}{Z_s}$$

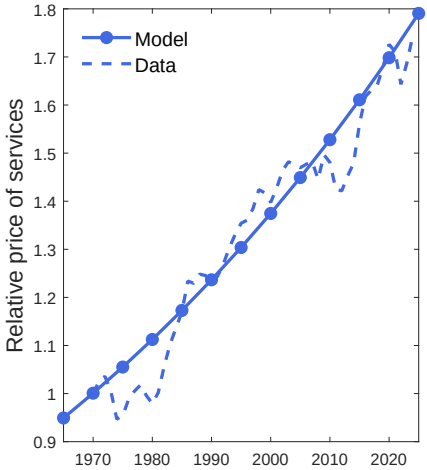
     - μ is the ratio of markups
  2. **Non-homotheticity channel**: creates an inc. effect that shifts consumption toward "luxuries"

$$C_m = Z_m N_m$$

Model Fit

Long-run





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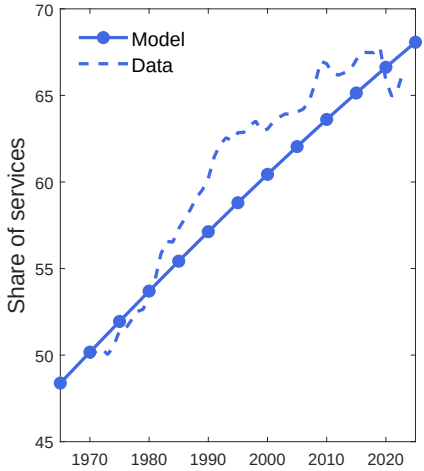
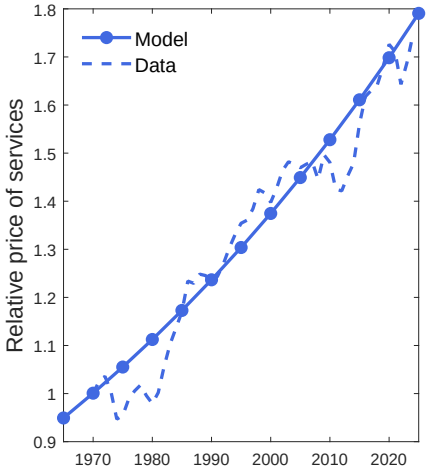


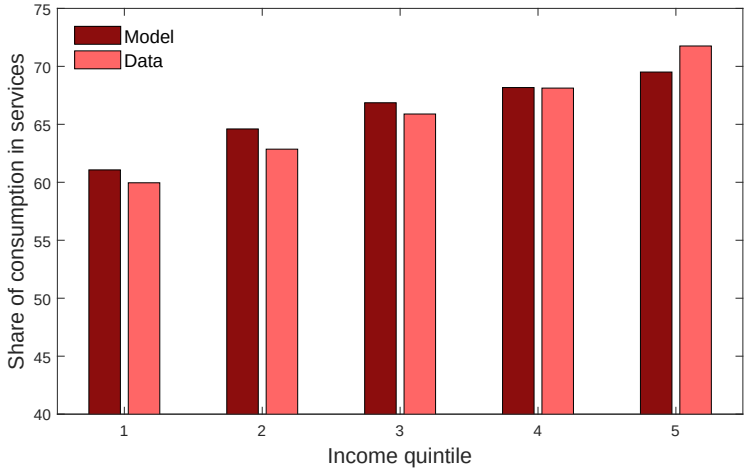


- **Hours worked:** decline 0.1%/year (data 1980–2023: -0.1%/year)

Model Fit

Engel curve 2000

Short-run



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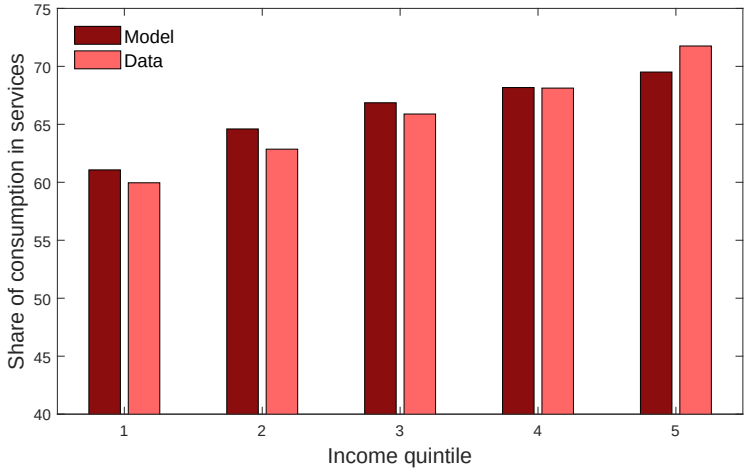

- **Average annual MPC**: 28% (data: 20 – 60%) MPC distribution
- **Share of Hand-to-Mouth**: 23.4% (data: 17.3%) Wealth Dist.

Structural Transformation & Monetary Policy Transmission

Monetary Policy Shock

- Economy is at the steady-state SS policy functions
- **Monetary shock:** the Central Bank increases the nominal interest rate by 100 bp
  - Unexpected and never-to-occur again (Boppart et al., 2018)
  - Once it is realized, agents have full information about its path
  - Shock follows an AR(1) with persistent $\rho_M = 0.5$
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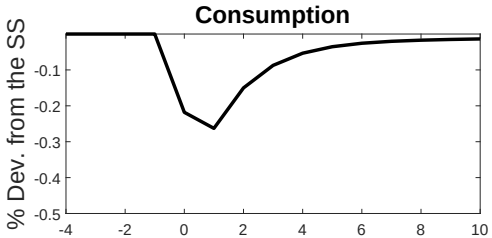
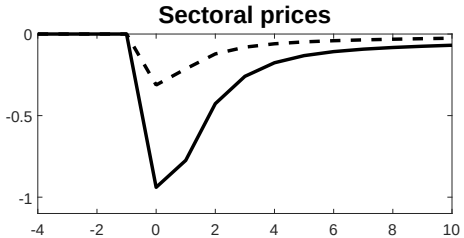
- I solve for a 1^{st} order approximation of the impulse response functions
- Monetary policy shock operates through:
  - Direct channel: income and substitution effects
  - Indirect channel: GE effects through wages and taxes

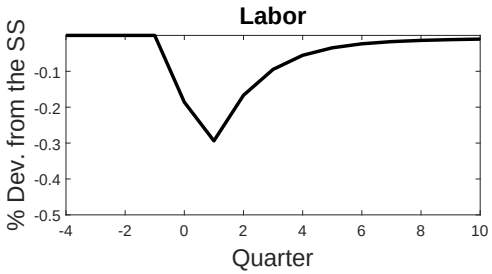
Response to Monetary Policy

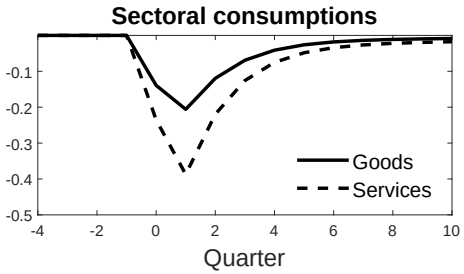
Demand Composition

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





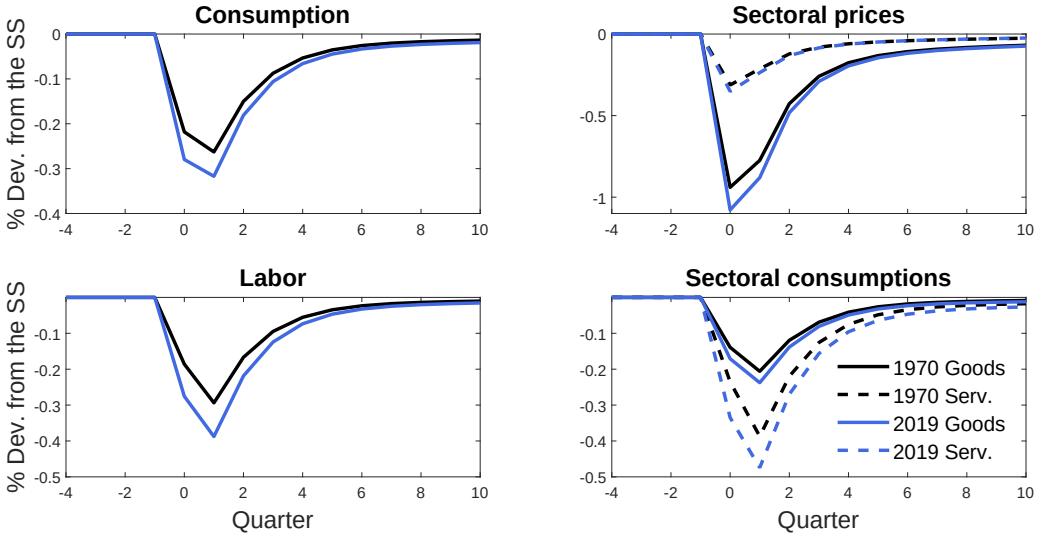




Structural Transformation and Monetary Policy

More years

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



Decomposing the Effects

Goal: separate heterogeneous price rigidities from non-homothetic preferences

1. Understand the role of heterogeneous price rigidities:
   - price rigidities only have a role in the transition
   - set $\kappa_g = \kappa_s$ (Hagedorn et al., 2019)

2. Understand the role of non-homothetic preferences
   - set $\epsilon = 1$
   - recalibrate model to match service share in 1970 and 2019 using Ω

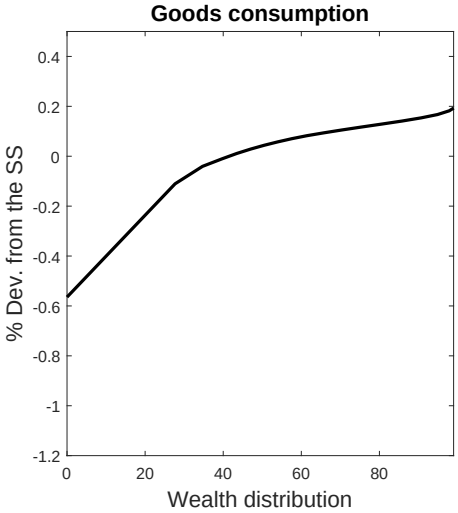
The Role of Heterogeneous Price Rigidities and Non-Homotheticity

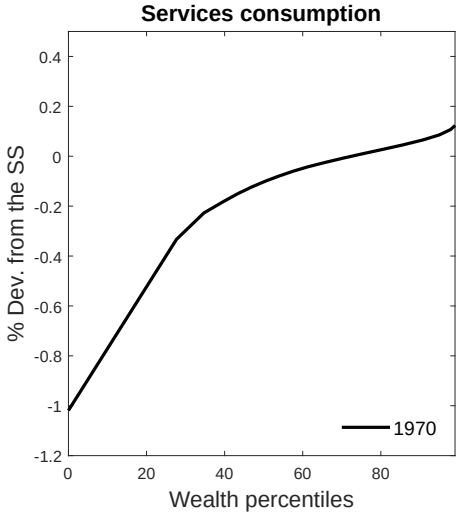
	(1) Baseline		(2) Homog. κ_m		(3) Homothetic	
	1970	2019	1970	2019	1970	2019
Service share	51.3	67.3	51.3	67.3	51.0	67.2
MPC	8.1	7.6	8.1	7.6	8.6	8.4
Consump. response (% change vs. 1970)	20.6		3.5		24.1	
Price of goods response (% change vs. 1970)	13.7		5.9		6.3	
Price of serv. response (% change vs.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

Inc. & Sub. effects

The Role of Heterogeneous Price Rigidities and Non-Homotheticity

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

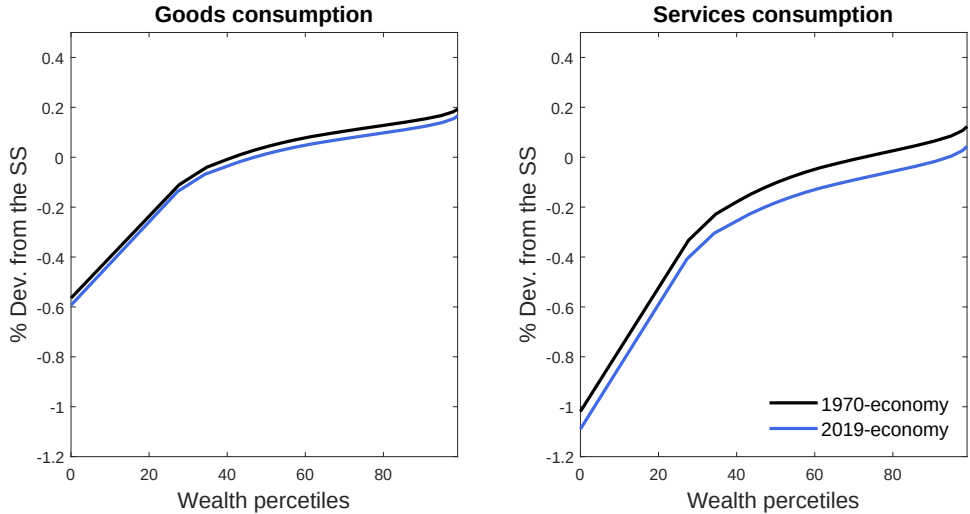




Sectoral Consumption Responses by Wealth Position

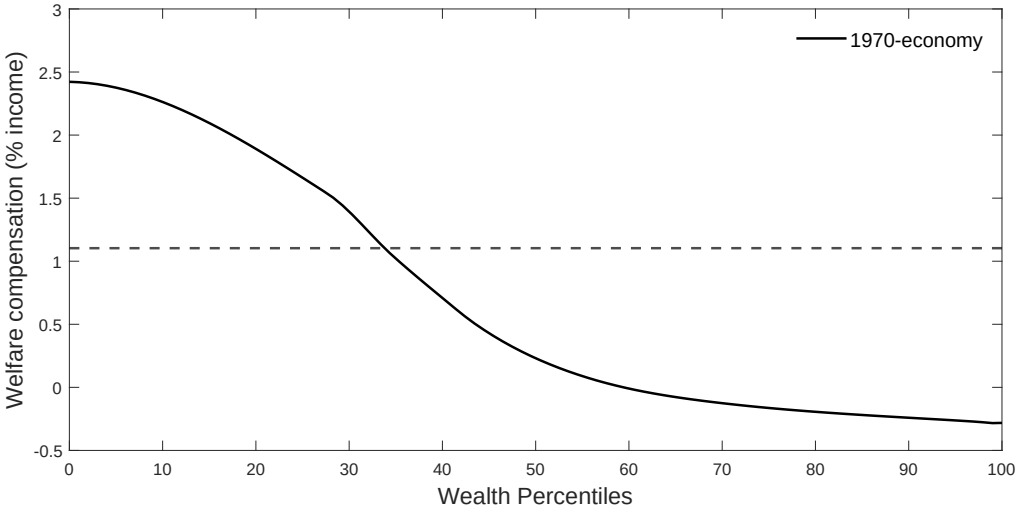
Consumption & Labor

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



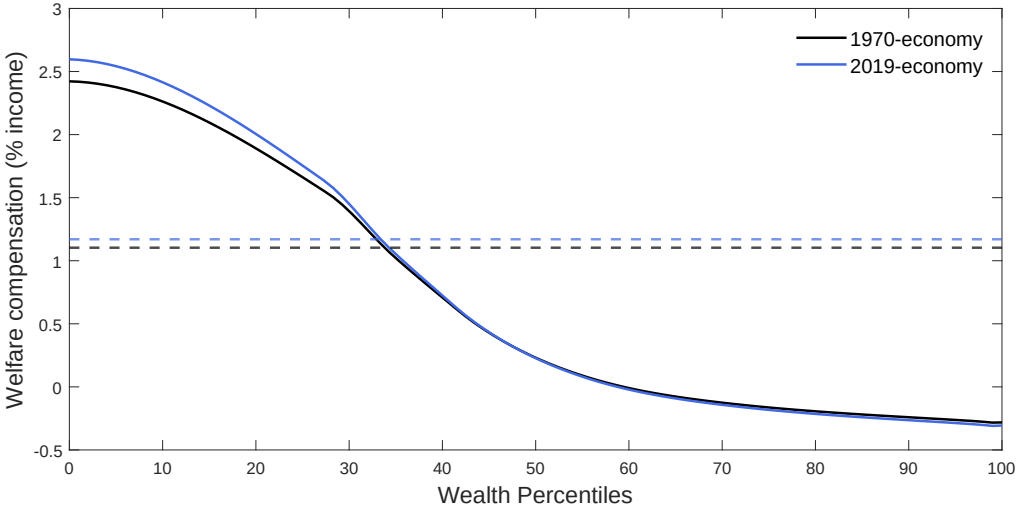
Welfare Cost of Monetary Policy

Welfare Cost of Monetary Policy



Structural Transformation and the Welfare Costs of Monetary Policy

Structural Transformation increases the welfare inequality costs of MP



Structural Transformation & Negative Supply Shocks

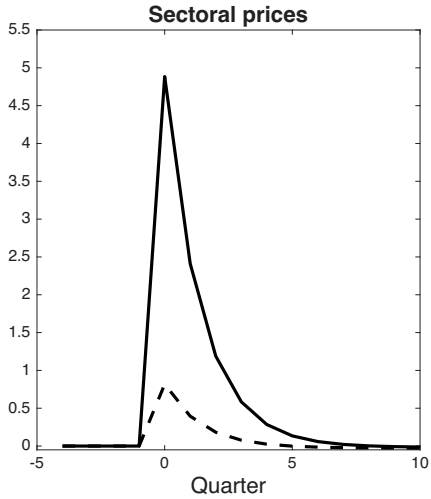
Extension: What is the Role of Services for Economic Resilience?

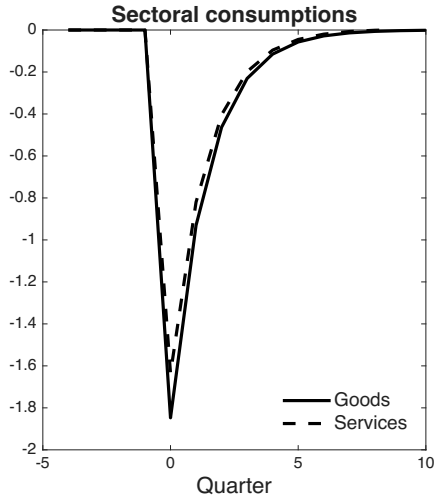
- **Goal:** Compare the effects of supply shocks with different demand compositions
  - compare the 1970-economy (50% services) and the 2019-economy (68% services).

- **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

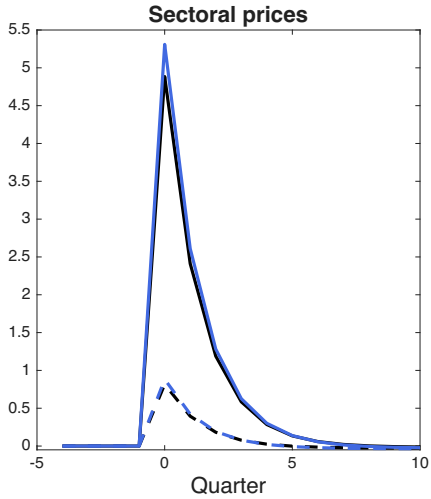
Aggregate responses to a negative 5% aggregate TFP shock

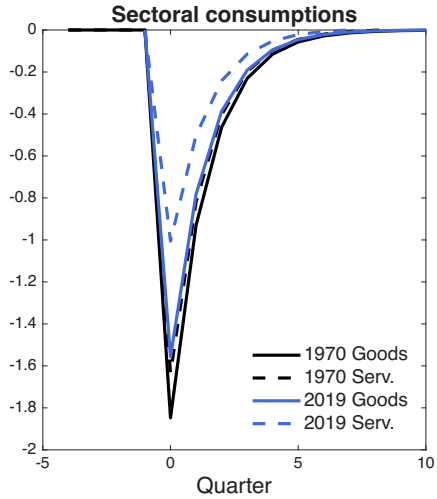




Structural Transformation and Supply Shocks

Higher services share makes the economy less responsive to supply shocks





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)	-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

Conclusion

- **This paper:** Sectoral composition matters for the transmission of monetary policy
- Using a quantitative dynamic model:
  - The **rise in the services share** from 1970 to 2019 **increased monetary non-neutrality by 21%**

Conclusion

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- **Policy implications**: common monetary policy with countries at different development levels

Conclusion

- **This paper:** Sectoral composition matters for the transmission of monetary policy
- Using a quantitative dynamic model:
  - The **rise in the services share** from 1970 to 2019 **increased monetary non-neutrality by 21%**
- **Policy implications**: common monetary policy with countries at different development levels

Thank You!

Appendix

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, covering 70% of expenditures

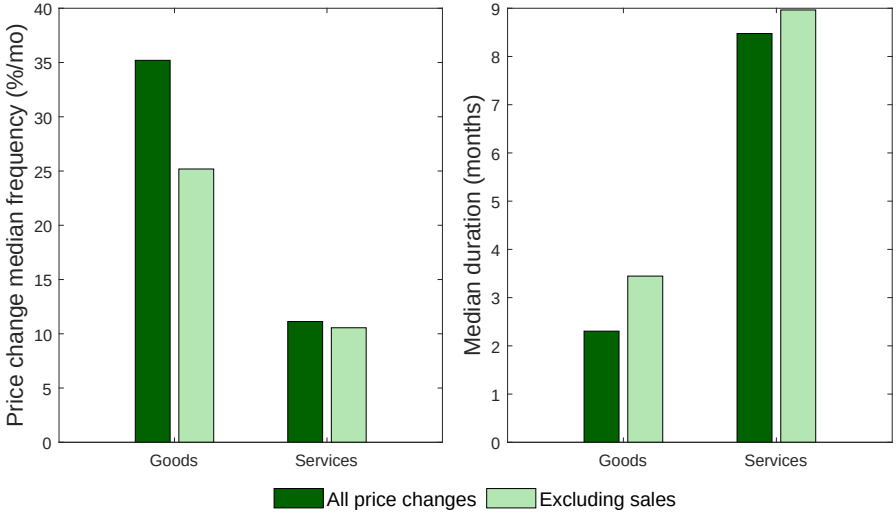
Category	Weight	Median Freq. (Regular)	Median Freq. (All)
Processed food	8.2	10.5	25.9
Unprocessed food	5.9	25.0	37.3
Household furnishing	5.0	6.0	19.4
Apparel	6.5	3.6	31.0
Transportation goods	8.3	31.3	31.3
Recreation goods	3.6	6.0	11.9
Other goods	5.4	15.0	15.5
Utilities	5.3	38.1	38.1
Vehicle fuel	5.1	87.6	87.6
Travel	5.5	41.7	42.8
Services (excl. travel)	38.5	6.1	6.6
All sectors	100.0	8.7	19.4

- **Methodology:** Aggregate by goods and services categories (BEA classification)

Fact #1: Robustness

Back

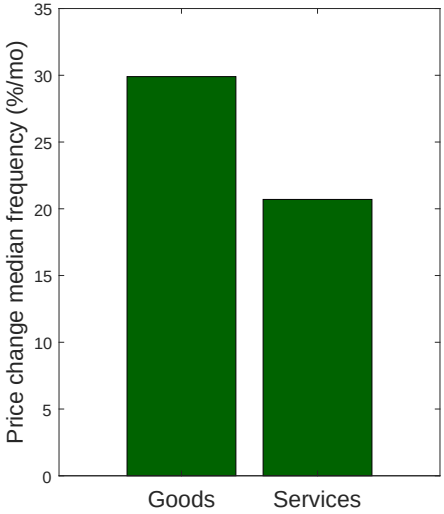
Implied Duration

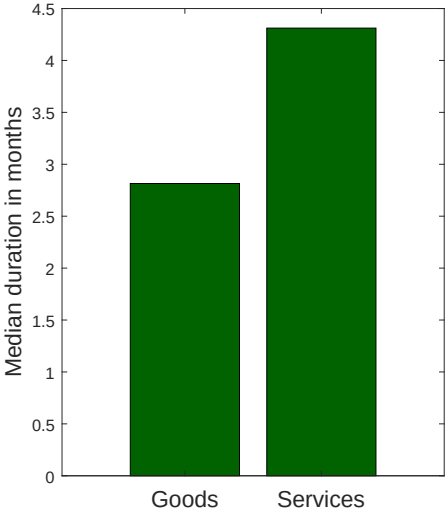


Fact #1: Robustness

Back

Using Bils and Klenow (2004) dataset





Romer and Romer (2023) Monetary Policy Shocks

Back

Date	Shock
October 1947	(–)
August 1955	(–)
September 1958	(–)
December 1968	(–)
January 1972	(+)
April 1974	(–)
August 1978	(–)
October 1979	(–)
May 1981	(–)
December 1988	(–)
September 2022	(–)

Fact #2: Data details Back

- **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)

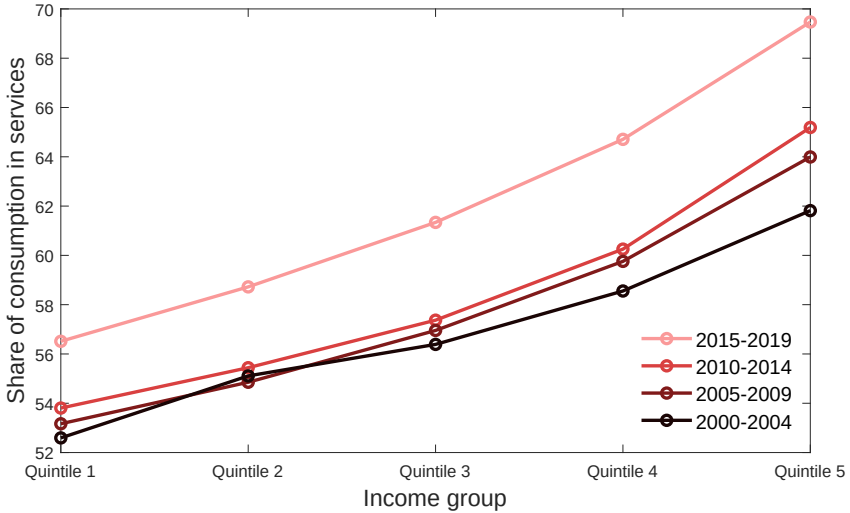
Fact #2: Methodology details Back

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

Back

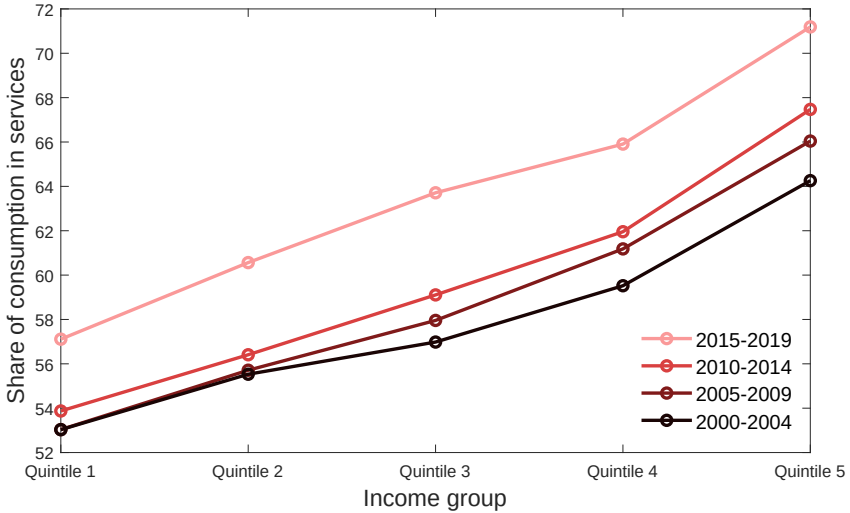
Excluding old households



Fact #2: Robustness

Back

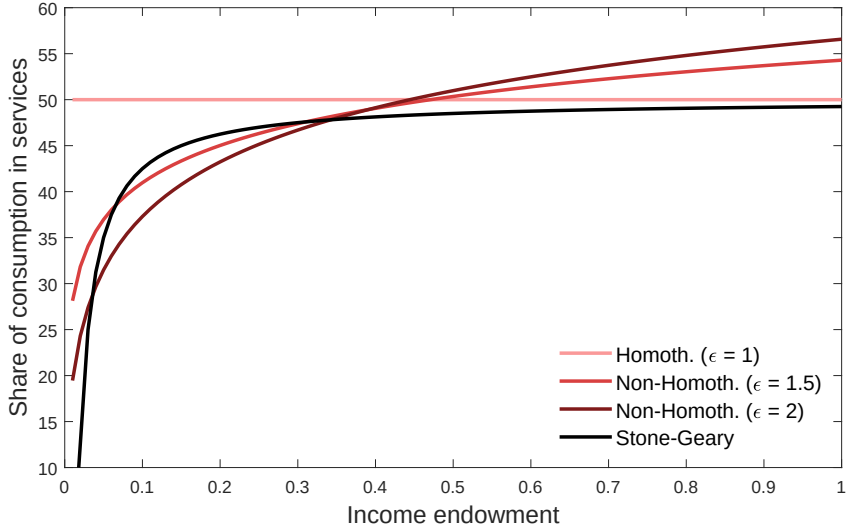
Including bottom and top 5%



Static non-homothetic CES illustration

Back

Comparison with Stone-Geary class



Competitive Equilibrium

Back

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

Back

Results

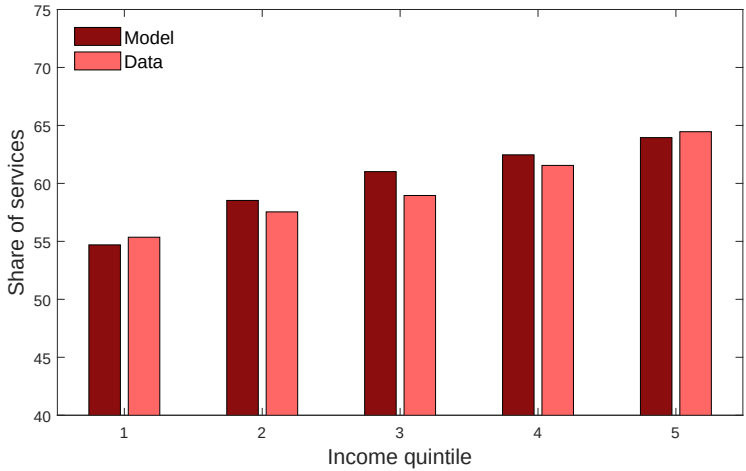
$$\log\left(\frac{\nu_{s,t}^n}{\nu_{g,t}^n}\right) = (1-\sigma)\log\left(\frac{p_{s,t}^n}{p_{g,t}^n}\right) + (1-\sigma)(\epsilon-1)\log\left(\frac{E_t^n}{p_{g,t}^n}\right) + (\epsilon-1)\log\nu_{g,t}^n + \zeta^n + \tilde{\zeta}_t^n,$$

	(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

Model Fit

Back

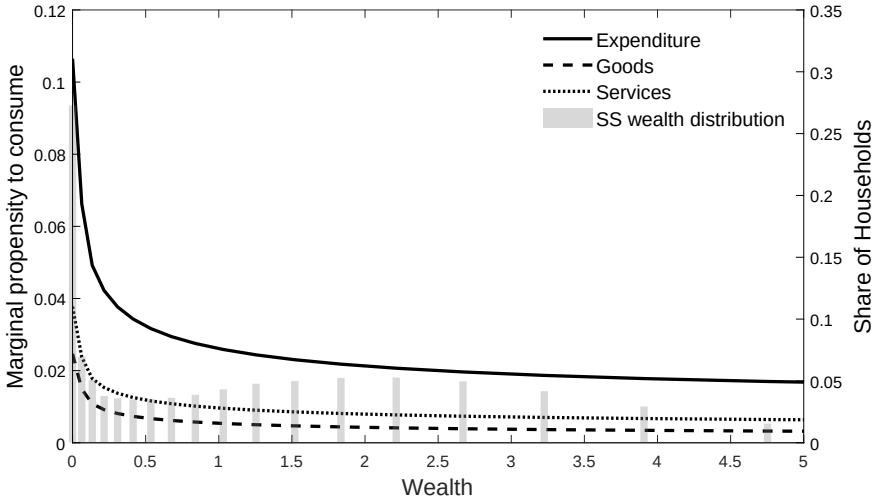
Engel curve 2000



Model Fit

Back

Short-run household behavior: quarterly marginal propensity to consume



Model Fit

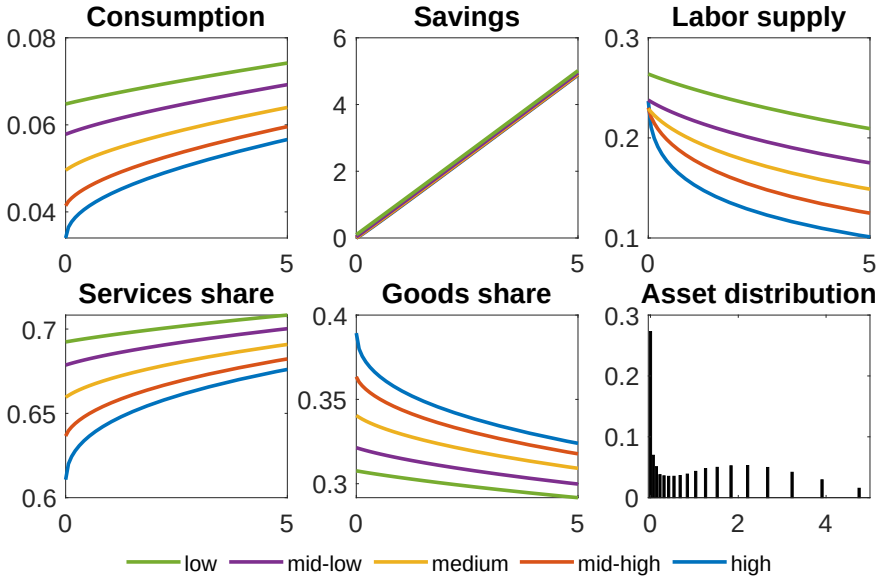
Back

Short-run household behavior: wealth distribution

Wealth Statistic	Data	Model
Mean wealth	4.1	4.4
Median wealth	1.5	1.8
Wealth, bottom 50%	2.5%	3.1%
Wealth, top 10%	49.9%	48.6%
HtM share	17.3%	23.4%

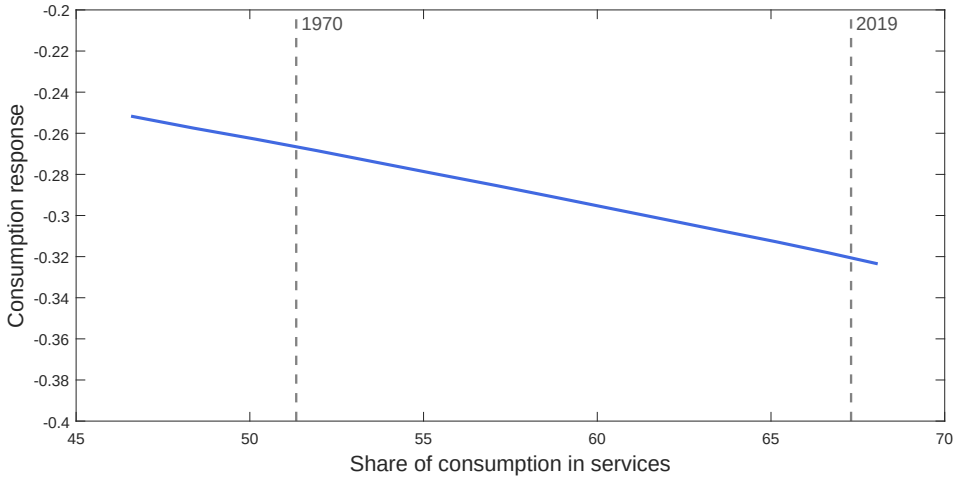
Steady-State Policy Functions

Back



Frontier: MP Response and Services Share

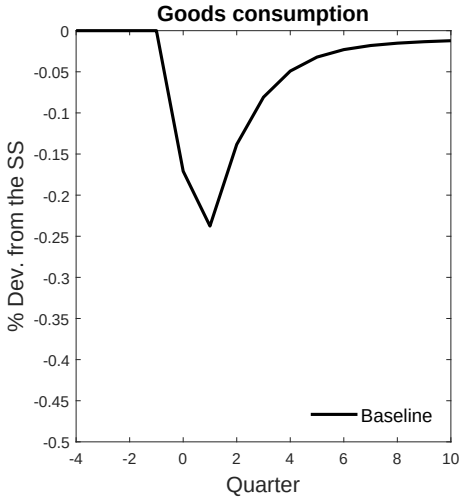
Back

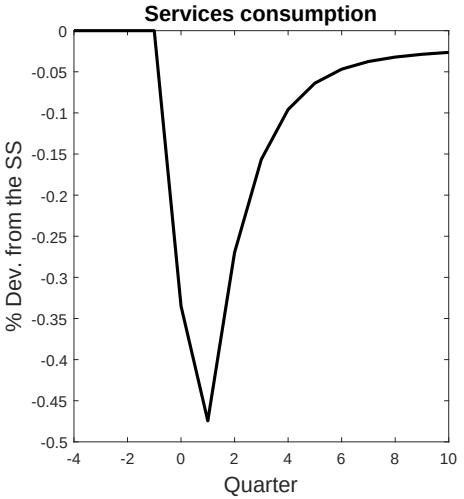


Monetary Policy and Demand Composition

Back

MP contractions shift expenditure towards goods

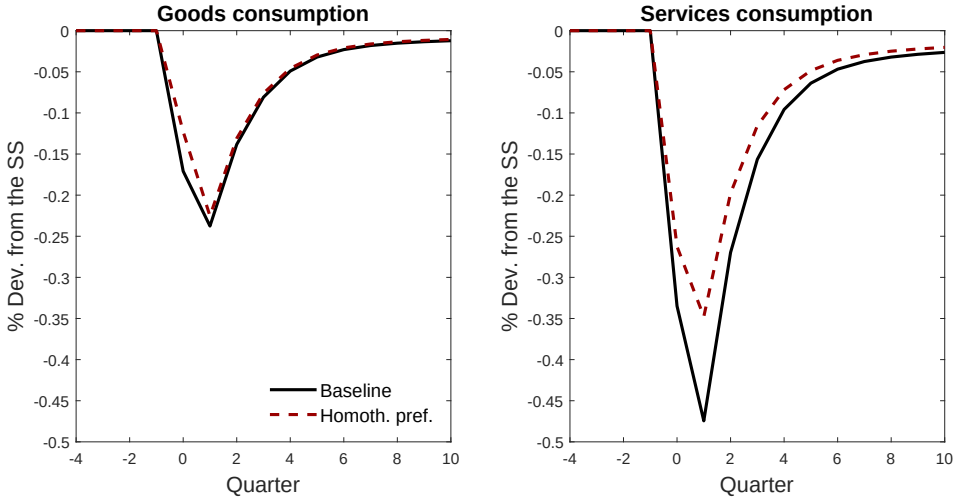




Demand Composition: Decomposition

Back

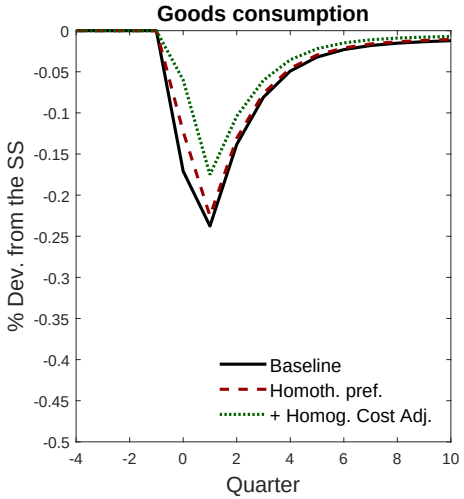
Non-homotheticity accounts for around half of the differences in the response

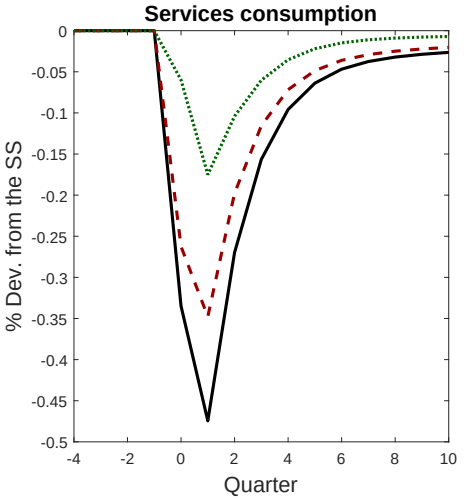


Demand Composition: Decomposition

Back

Differences in the price rigidities account for the other half





Counterfactuals: income vs substitution effects

Back

Two forces that drive the increase in services:

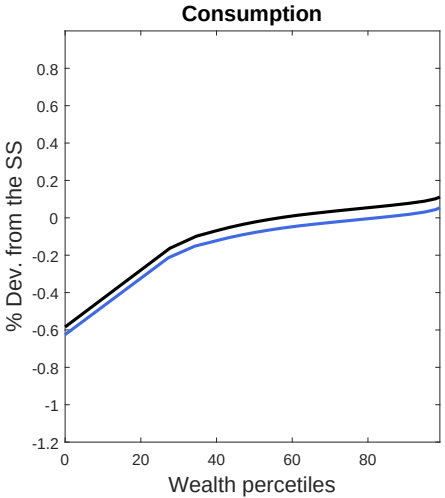
1. Higher **income** makes consumption shift toward "luxuries"
2. changes in the **relative prices** change consumption composition

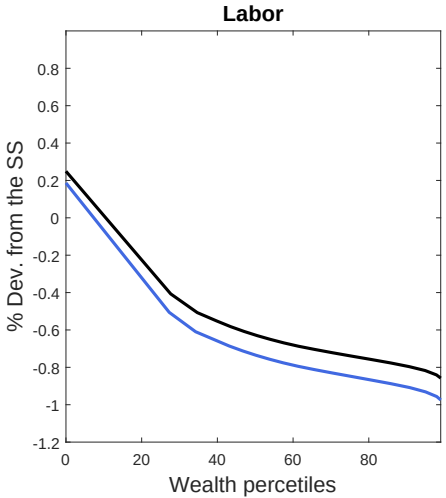
	(1) 1970 (bsl)	(1) 2019 (bsl)	(2) Income effect	(3) Substitution effect
Consump. response (vs. 1970)	–	20.64	11.52	14.02
Relative price	1.00	1.68	1.00	1.68
SS consumption	0.03	0.05	0.05	0.03
Service share	51.34	67.30	58.09	61.22

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

Heterogenous Responses

Back





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